

ORAL PRESENTATIONS

O1

Classification of vestibular migraine: consensus with the international headache society

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Introduction: The Committee for Classification of Vestibular Disorders of the Barany Society has approached the Migraine Group of the International Headache Society (IHS) to jointly formulate diagnostic criteria for vestibular migraine (VM), which should also enter the International Classification of Headache Disorders (ICHD).

Materials and Methods: A draft of the Barany group that proposed the three diagnostic categories of definite, probable and possible VM, was discussed with the Headache group at the IHS congress in Berlin in 2011 and by repeated e-mail exchanges.

Results: The new ICHD will only include vestibular migraine (=definite VM), while the Barany classification will contain also probable VM. The category of possible VM was dropped. Vestibular migraine will appear in an appendix of the ICHD, a first step for new entities according to IHS procedures. The diagnosis of VM is based on recurrent vestibular symptoms, a history of migraine, temporal association of vestibular symptoms with migraine symptoms and exclusion of other causes. Vestibular symptoms must be of moderate or severe intensity. Duration of acute episodes is limited to a window between 5 minutes and 72 hours. Symptoms that qualify for a diagnosis of VM include various types of vertigo or head motion-induced dizziness with nausea, whereas dizziness alone was excluded to enhance specificity.

Conclusion: The classification of VM is based on expert consensus and will be revised as new evidence emerges from clinical studies.

O2

Progress report of the behavioral subcommittee of the international committee for classification of vestibular disorders

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Introduction: In 2010, the International Committee for Classification of Vestibular Disorders formed a Behavioral Subcommittee to ensure that psychiatric disorders and behavioral morbidity are represented suitably in the International Classification of Vestibular Disorders (ICVD), being developed under the auspices of the Barany Society. The Behavioral Subcommittee's goals were to: (1) identify psychiatric disorders that may cause vestibular symptoms or co-exist with vestibular diseases, (2) adapt definitions of those disorders for the ICVD, (3) identify behavioral syndromes that may be unique to neurotology, and (4) draft diagnostic criteria for them.

Materials and Methods: The Behavioral Subcommittee reviewed past, present, and proposed criteria for psychiatric disorders in the International Classification of Diseases (ICD) and Diagnostic and Statistical Manual of Mental Disorders (DSM), and research on the relationships of psychiatric disorders to vestibular diseases. The subcommittee also identified behavioral elements in the syndromes of phobic postural vertigo (PPV), chronic subjective dizziness (CSD), space motion discomfort (SMD), and visual vertigo (VV).

Results: Convincing data show that anxiety disorders cause vestibular symptoms. Depression may manifest with non-vertiginous dizziness. Anxiety and depressive disorders often co-exist with or occur secondary to vestibular diseases. Dizziness is a common somatoform symptom, but different criteria for somatoform disorders in ICD and DSM make it difficult to define one or more vestibular somatic symptom disorders compatible with both ICD and DSM. Common features of PPV, CSD, SMD, and VV

suggest that they are part of a single syndrome.

Conclusions: The Behavioral Subcommittee found evidence to include episodic and generalized anxiety disorders and depression in the ICVD. A vestibular somatic symptom disorder is warranted, but awaits future research. Core elements of PPV, CSD, SMD, and VV form one disorder.

O3

No abstract available

O4

Classification of benign paroxysmal positional vertigo

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Objectives: A formal disease classification system and standardized nomenclature facilitates vestibular research and patient care. As a first step, the Committee for the Classification of Vestibular Disorders of the Bárány Society published a Classification of Vestibular Symptoms. Subsequently individual subcommittees have been tasked with defining consensus diagnostic criteria for specific vestibular disorders.

Methods: An international group of neurologists and otolaryngologists was commissioned to classify and define diagnostic criteria for benign paroxysmal positional vertigo (BPPV). We reviewed the literature and drafted a classification that was discussed and revised by email exchange among the authors to reach consensus.

Results: Diagnostic criteria for several variants of BPPV have been developed: canalolithiasis of the posterior canal, canalolithiasis of the horizontal canal, cupulolithiasis of the horizontal canal, and probable benign paroxysmal positional vertigo (spontaneously resolved). Furthermore emerging and controversial syndromes have been defined: canalolithiasis of the anterior canal, cupulolithiasis of the posterior canal, lithiasis of multiple canals, and possible benign paroxysmal positional vertigo.

Conclusion: During the last two decades several new variants of BPPV have been described. The establishment of diagnostic criteria for BPPV as part of the International Classification of Vestibular Disorders should facilitate the diagnosis of these variants and can be helpful for clinical and scientific purposes.

O5

Classification of vestibular examination signs and techniques, part 1: nystagmus

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Objectives: Vestibular research and patient care have been hindered by the lack of standardized terminology and a formal disease classification system. In 2009, the Committee for the Classification of Vestibular Disorders of the Bárány Society published a Classification of Vestibular Symptoms. Subsequently the Committee has commissioned a group to develop a classification system and definitions for vestibular examination signs and techniques, with the goal of establishing a consistent universal nomenclature.

Methods: The Committee was created to develop classification criteria to support standardization for vestibular research and patient care. A multi-layer structure guides its development, consisting of: symptoms/signs, syndromes, diseases/disorders, and mechanisms. An international group of neurologists and otolaryngologists was commissioned to classify and define vestibular examination signs and techniques. This group reviewed the literature and drafted an initial classification organized around vestibulo-ocular, ocular motor, otologic, and balance examination signs and techniques. The draft was discussed and revised by email exchange among the authors to reach consensus.

Results: Characterizing nystagmus is vital to the vestibular examination. Given its complexity and lack of universal nomenclature, we initially addressed only nystagmus in this Part 1 document. We created

definitions that were as purely phenomenological as possible, while also categorizing terms that imply etiology or pathophysiology. Necessary attributes for a complete description of nystagmus were elaborated. Where nomenclature was confusing, we suggested preferred, alternative, and rejected terminology.

Conclusions: Establishing a consensus classification of vestibular examination signs and techniques, beginning with nystagmus, should facilitate the Bárány Society's effort to define diseases and disorders in its development of an International Classification of Vestibular Disorders.

O6

No abstract available

O7

No abstract available

O8

Vestibular migraine: long-term follow-up of clinical symptoms and vestibulo-cochlear findings

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Objective: To assess the evolution of clinical symptoms and vestibulo-cochlear function in patients with definite vestibular migraine (dVM).

Methods: We reassessed 61 patients (54 women, 7 men, aged 24-76 years) with dVM according to validated diagnostic criteria after a median follow-up time of 9 years (range 5.5-11). Initial and follow-up assessment comprised a clinical interview and comprehensive neurotological examination including pure tone audiometry and caloric testing.

Results: The majority of patients (87%) still suffered from recurrent vertigo at follow-up. Frequency of vertigo was reduced in 56%, increased in 29% and unchanged in 16%. Impact of vertigo was rated severe by 21%, moderate by 43% and mild by 36% of those with ongoing vertigo attacks. Eighteen percent reported mild persistent gait unsteadiness.

The proportion of patients with interictal ocular motor abnormalities had increased from 16% initially to 41% at follow-up. The most frequent finding was positional nystagmus (PN) in 28% of patients, including central-type PN in 18%. However, only one of nine patients with ocular motor abnormalities at initial presentation showed similar findings at follow-up. Concomitant cochlear symptoms during vertigo attacks had increased from 15% initially to 49% at follow-up. Eleven patients (18%) had developed mild bilateral sensorineural hearing loss involving the low-frequency range, but peaking in the high frequencies.

Conclusions: The majority of patients continue to suffer from recurrent vertigo in the long-term evolution of the disease and impact of vertigo may remain severe. While interictal ocular motor and vestibular abnormalities in VM may show some variation over time, vestibulo-cochlear function mildly progresses in some VM patients. Interictal central-type positional nystagmus may help distinguish VM from peripheral vestibular disorders such as Menière's disease.

O9

The prevalence of vestibular symptoms in patients with migraine and tension-type headache

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Background: We assessed the frequency of vestibular symptoms in Headache Clinic patients over 10 years.

Methods: A case-control study of 5111 consecutive patients with tension-type headache (TTH) or migraine, analyzed for dizziness/vertigo accompanying headache and for a lifetime history of motion-sickness, cyclic vomiting, recurrent abdominal pain or atopy. Migraine patients were re-grouped as those with vestibular symptoms (dizziness/vertigo or motion sickness) and those without and their data then re-analyzed.

Results: There were 1880 migraine patients and 3231 TTH patients. Significantly more migraine patients than TTH patients experienced vestibular symptoms ($p < 0.000$). The migraine with vestibular symptoms (MwV) group was significantly younger ($p < 0.05$) and had more frequent headaches ($p < 0.05$) than the

migraine without vestibular symptoms (MwoV) group and their headaches were more often associated with phonophobia ($p < 0.000$). Menstruation and reported sleep problems impacted on headaches. While past history of cyclic vomiting, recurrent abdominal pain or atopy was about twice as common in migraine with aura as in migraine without aura, they were much more prevalent in MwV symptoms than in MwoV symptoms.

Conclusions: Vestibular symptoms are common in migraine patients. Migraine with vestibular symptoms might constitute a special group, one more likely to have had cyclic vomiting, recurrent abdominal pain or atopy. Also, MwV patients might overlap with patients who have migrainous vertigo attacks.

O10

An observational study to assess the correlation between an acute vestibular event and the onset of vestibular migraine in patients that present to the dizziness clinic

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Introduction: Studies have demonstrated that patients with pre-existing migraine can be triggered within 24 hours of a caloric test to develop migraine. These findings suggest a strong vestibular stimulus can be a migraine trigger. The aim of our study was to establish if the onset of vestibular symptoms e.g. acute vestibular event (AVE): vestibular neuritis, could be a trigger for late onset migraine or vestibular migraine, when compared to a control group of patients with non-specific dizziness.

Materials and Methods: We recruited sequential new dizzy patients attending a balance clinic. Symptoms consistent with an AVE were identified and these patients recruited to the active group (Grp A). Patients who were not found to have a vestibular cause for their dizziness, were recruited as controls (Grp B). All patients had routine audiometric assessment, including pure tone audiometry and Tympanometry. Those in Grp A went on to have VNG/Calorics. Both groups completed 3 questionnaires: The migraine questionnaire structured according to the International Headache Society (IHS) criteria, the vestibular migraine questionnaire structured to Neuhausers criteria and the 'Vertigo Symptom Scale shortened form.

Results: 48 patients were recruited for Grp A and 11 in Grp B. Of the 48 patients, 37 were found to have developed vestibular/probable vestibular migraine. In these patients 13 had new onset migraine, 12 old migraine and 12 had pre-existing headaches not meeting the migraine IHS criteria. In Grp B, 6 had vestibular/probable vestibular migraine, of which 3 had new onset migraine, 2 old migraines and 1 with old headaches. Using the Fishers Exact Test to compare Grp A and B versus onset of vestibular migraine or not, the 2-tail P-value was 0.042 ($P < 0.05$).

Conclusion: This study demonstrates that there is a link between an acute vestibular event and triggering late onset migraine and more significantly vestibular migraine.

O11

Tone burst electrocochleography to separate vestibular migraine from Meniere's disease

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Introduction: Meniere's disease is diagnosed according to the 1995 AAO-HNS Equilibrium Committee Guidelines, which make no allowance for any objective evidence of endolymphatic hydrops.

Transtympanic electrocochleography (EcochG) is an underutilised and sensitive electrophysiological test for hydrops with published parameters. Although vertigo is not part of the International Classification of Headache Disorders (2004) it is recognised that vertigo attacks can be part of the spectrum of migraine symptomatology, called vestibular migraine.

Materials and Methods: 371 patients with recurrent vertigo were tested by transtympanic tone burst EcochG and the data stored on an Excel database. Their age at the first attack was recorded. Patients were questioned about headache and classified into migraine (N=29), no migraine but vertigo with headache (N=23) and no migraine but vertigo without headache (N=249). The likelihood of having Meniere's disease was a Gibson score of $> 7/10$. The data from patients with a "positive" EcochG diagnosis was compared for the three categories.

Results: In the migraine group 15% had a "positive" EcochG (hydrops); in the no migraine but vertigo with or without a headache 60% were positive. For Gibson scores the migraine group had a statistically lower score than the no migraine but vertigo without a headache group ($p < 0.033$). For hearing loss the thresholds of the three groups were different for all the frequencies tested. The age of onset was similar for all three groups.

Conclusions: Some patients diagnosed as Meniere's disease may have vestibular migraine. There

appear to be patients with Meniere's disease with *coincidental* headache. In two disorders which are both diagnosed on symptomatic criteria confusion and diagnostic errors are inevitable.

O12

Evaluation of balance in vestibular migraine and migraine patients without history of vertigo

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Objective: The purpose of this study is to assess and compare the balance, gait and dizziness handicap level between migraineurs with and those without vestibular migraine and in healthy controls without either migraine or vertigo.

Material and method: Thirty definite vestibular migraine (VM) patients, 26 migraine patients without history of vertigo and 17 healthy controls were included in the study. The definite VM diagnosis was made according to Neuhauser criteria after neuro-otological examination. Twenty-six migraine patients without history of vertigo and 17 healthy control subjects were taken as control groups and they were age matched and gender controlled. The patients were assessed by using of the Berg Balance Scale (BBS), the Dizziness Handicap Inventory (DHI), the Falls Efficacy Scale (FES) and the Dynamic Gait Index (DGI).

Results: The significant differences in all assessment parameters were established among three groups ($p < 0.05$). VM patients demonstrated worse scores in all tests compared with two control groups ($p = 0.000$).

Conclusion: Our results showed that VM patients had problems in static and dynamic balance. Their DGI and FES scores demonstrated that they have risk of falling and fear of falling. Their DHI scores showed that they have moderate handicap level.

O13

Migraine and sudden deafness

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Introduction: In previous papers (Bárány Society Meeting, Kyoto, Japan, 2008. Ther Clin Risk Manag. 2009; 5: 661–669) we suggested that vestibular migraine, mainly with auditory symptoms, is a risk factor for sudden deafness. We have decided to carry out a retrospective study on the 28 patients who consulted a general ORL due to sudden deafness over a 12 month period.

Material and methods: We studied 28 subsequent patients who suffered from sudden deafness, 10 women and 18 men. We performed a clinical exam, Audiogram with speech discrimination upon diagnosis 10 days later and after treatment with a combination of meprednisone 1 mg/kg per day and decreasing doses every 10 days, during 30 days and pentoxifiline 600 mg, twice a day during 30 days. Both drugs were orally administered, with Ranitidine 300 mg per day for gastric protection. Additionally, all patients were studied with Echo-G and ABR and MRI to rule out brain tumors. All patients were retrospectively questioned by an expert and the history of migraine was collected according to the current IHS (International Headache Society) criteria.

Results: In this group of patients 5 of 10 women suffered from migraine (50%) and only 2 of the 18 men (11%). The age mean was 45 year. As regards the kind of audiometric affectionation upon diagnosis, 2 of them presented ascending curves, 2 flat ones, 2 descendents and 1 total. As regards evolution, it was good in only one case, moderate in most (4) and none in 1.

Conclusions: Migraine seems to be a risk factor, at least in women, where its prevalence was twice that in the general population. In fact, our previous paper all the cases with associated migraine; auditory symptoms and sudden deafness were women. The prognosis is slightly worse than that observed in other series with similar treatment protocols.

O14

Gravity sensitive cupula of Posterior Semicircular Canal (PSC)

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In recent years, a few Authors referred about steady intensity and persistent direction changing positional nystagmus (PDCPN) observed either rotating patient's head from side to side while supine, or changing its bending angle in the pitch plane in upright position. Neutral positions in which any

nystagmus disappears were described.

This was ascribed to a modified density ratio between Lateral Semicircular Canal cupula and the surrounding endolymph.

The author reports about 16 cases of PDCPN ascribable to a modified density ratio of the Cupula Vs Endolymph in the Posterior Semicircular Canal (PSC). They are 13 female and 3 male, all of them suffering from migraine. All the patients had acute onset of symptoms, with intense rotatory positional vertigo, associated with severe neurovegetative symptoms. The otoneurological examination within 24 hours of the symptoms onset was always performed. One case of this series is here described. The search for spontaneous-positional nystagmus highlighted the following features:

- Upright position:

- Erect head: no nystagmus.
- Flexed head: down beating, clockwise nystagmus.
- Extended head: up beating, counterclockwise nystagmus.

- Right Dix-Hallpike: up beating, counterclockwise nystagmus, which was recorded longer than 10 minutes. It stops and reverses with head rotated from 45° to 55° towards the left side keeping the head extended 20° over the bed: neutral position. All the observed nystagmus were persistent with steady intensity, short or no latency. Any liberatory manoeuvre with or without mastoid vibrator was ineffective. No other neurological/audiological associated symptoms were found, CNS MRI was negative. Vertigo and PDCPN decreased respectively in one and two weeks. Hypothesis: acute perturbation in labyrinthine function related to a heavy cupula mechanism of right PSC. Acute heavy cupula effect was caused by a localized diffusion from the labyrinth microcirculation due to migraine.

O15

Visual vertigo and vestibulopathy: physiological and clinical findings

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Introduction: Dynamic visual inputs can provoke visual vertigo (VV) in people with vestibulopathy. We studied the effect of VV on oculomotor and balance responses and the relation between anxiety and VV.

Materials and Methods: Oculomotor activity, balance responses, and anxiety levels were compared between subjects with vestibulopathy and VV (8), without VV (10), and healthy controls (10).

Oculomotor response was studied with 2D video-oculography. Subjects were exposed to dynamic visual input of vertical bars moving across a screen. Measurements were done in sitting and Romberg stance in 3 gaze tasks: 1) baseline condition-fixed target without dynamic visual input; 2) dynamic visual input and no target; 3) dynamic visual input with a fixed target. Oculomotor activity was quantified by nystagmus frequency and gain. Postural sway was studied using the Sensory Organization Test (SOT). Anxiety was assessed with the Short Anxiety Screening Test.

Results: In Romberg, VV subjects had higher optokinetic nystagmus frequency than controls in both dynamic visual input tasks (no target: 41±9 vs. 28±10, P<0.05; target: 7±7 vs. 1±2, P<0.05). When sitting and no target, nystagmus frequency was higher in VV than control subjects (37±9 vs. 24±9; P<0.05). In Romberg stance, dynamic visual input with no target induced higher nystagmus gain in the VV group (0.8±0.2) than in controls (0.6±0.2; P=0.024). There were no differences between VV and Vest in any oculomotor test. The VV group had the most difficulty balancing in SOT conditions 1-3 (P<0.05). With eyes closed during sway-referencing, the VV group had higher scores than controls (P=0.018). Anxiety scores were highest in the VV group (24±6) vs 16±2 in vestibulopathic subjects vs 14±3 in controls P<0.005).

Conclusion: VV subjects had higher optokinetic nystagmus frequency, and gain closer to 1 than controls. When trying to maintain balance, they tended to depend on visual inputs although dizziness increased. Anxiety should be considered a facet of VV.

O16

Ocular vestibular evoked myogenic potentials (OVEMPs) produced by naso-occipital (NO) axis whole-body vibration (WBV)

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Introduction: Since the discovery of the OVEMP [1], and its first interpretation [2,3], there has amassed a considerable literature [4]. It has been assumed that the OVEMP is related to the linear

vestibular-ocular reflex (LVOR), but this has not been demonstrated directly.

Materials and Methods: OVEMP and electro-oculogram recordings were made simultaneously from six subjects during NO-axis WBV over a range of frequencies from 0.5 to 64 Hz with constant peak acceleration of 1.0 ms⁻² (i.e. 0.1 g). Measurements were made in two context conditions: a gaze fixation context, 0 vs. 20 deg, and a visual context, head-fixed vs. earth-fixed.

Results: In the low frequency range (0.5 – 2 Hz), response magnitude is related to head displacement, and so reduced with increasing frequency in the earth-fixed condition, but in the high frequency range both response magnitude and response gain, defined as the ratio of response magnitude at 20 and 0 deg, increased with increasing frequency. Both low- and high-frequency responses showed a visual context effect.

Conclusions: The high-pass characteristic, a property shared with the LVOR, and the high-frequency visual context effect are consistent with the hypothesis that the OVEMP is a high-frequency manifestation of the LVOR. The high-pass effect in gain suggests that its origin is not peripheral, i.e. neither due to reflex scaling by analogy to the VEMP nor to a change in muscle proximity with gaze (hypotheses which both predict a constant gain as a function of frequency), but rather central, e.g. due to cerebellar modulation.

References: 1. Todd NPM, Curthoys IS, Aw ST, Todd MJ, McGarvie LA, Rosengren SM, Colebatch JG, and Halmagyi GM. *J Vestib Res* 14: 123-124, 2004. 2. Todd NPM, Rosengren SM, and Colebatch JG. *J Vestib Res* 14: 215-216, 2004a. 3. Todd NPM, Rosengren SM, and Colebatch JG. *J Vestib Res* 14: 216-217, 2004b. 4. Rosengren SM, Welgampola MS, and Colebatch JG. *Clin Neurophysiol* 121: 636-651, 2010.

O17

The caloric test and the video head-impulse test in patients with peripheral vestibulopathy

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Introduction: The caloric test is the most commonly used tool to study vestibular function because left and right horizontal semicircular canal (HSC) function can be examined separately. However, not only is the stimulus non-physiological but also the responses in this test are extremely variable. The video head-impulse test (vHIT) is a recent acquisition in vestibular examination that also helps in the examination of peripheral vestibular function. In this presentation we want to test the performance of the vHIT and caloric tests in patients with peripheral vestibulopathy.

Study, design, setting and patients: This is an open and prospective study conducted at a tertiary care center in which 123 patients were subjected to the video head-impulse test and caloric test on the same day. The results of the vHIT were considered as normal or pathological according to gain of the vestibulo-ocular reflex (VOR) and the existence of refixation saccades: a measure of interaural difference in gain was also obtained. The caloric test was evaluated according to the amount of canal paresis according to Jongkees' formula.

Results: 1) the gain of the VOR is significantly different for rightward and leftward head impulses only when canal paresis is >40%, 2) there are more refixation saccades for impulses to the ipsilesional side (according to CP), 3) there is a modest correlation between canal paresis and interaural gain difference, 4) the use of gain and saccades in combination for the assessment of the vHIT provides a better correlation with respect to the canal paresis.

Conclusion: The head impulse and the caloric test are able to discriminate similar subject based on the combined use of gain and refixation saccades assessment in the former.

O18

Impairment of the visual-vestibular interaction in Friedreich's ataxia

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Introduction: To investigate the vestibulo-cerebellar interaction in Friedreich's ataxia (FRDA) to further elucidate the neuro-otological manifestations of this disease and elucidate a possible bio-marker for FRDA clinical treatment trials.

Background: Friedreich's ataxia (FRDA) is the most commonly occurring inherited ataxia, and involves

widespread neurodegenerative sequelae. Whilst oculomotor, vestibular and cerebellar affects have been documented¹, little is understood about the clinical consequences of pathology affecting these interacting systems. Impairment of the visually enhanced vestibulo-ocular reflex (VVOR; also called the "doll's head", "doll's eye" or oculo-cephalic reflex) reflects a compound deficit in the three compensatory reflexes involved in eye movement, namely the vestibulo-ocular reflex, smooth pursuit, and the optokinetic reflex².

Materials and methods: A prospective observational study.

Results: We report 20 patients with genetically confirmed FRDA and uniformly reduced VVOR gain on rapid video-oculography, that is, eye velocity which failed to match head velocity resulting in gaze position errors, which were corrected with bursts of saccades and perceptible as the clinical sign of an impaired VVOR.

Conclusions: This study further elucidates the pathophysiology of the neuro-otological manifestations of FRDA. Given the robust and uniform nature of these results, the VVOR is to be utilized as a biomarker in soon to be commenced FRDA treatment trials.

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O19

Semicircular canal plane head impulse test characteristics in acute vestibular syndrome

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Introduction: Bedside head impulse test (HIT) is valuable in the differentiation of central from peripheral acute vestibular syndrome (AVS), but its interpretation is subjective. We aim to characterize the angular vestibulo-ocular reflex (VOR) as measured by the quantitative HIT in patients with AVS.

Materials and Methods: We studied 43 patients, 24 due to central and 19 due to peripheral AVS. Central AVS was diagnosed by abnormal MRI, and peripheral AVS according to negative brain imaging and compatible neuro-otological findings. Bedside HIT was performed by two examiners and independently rated by a third person. Quantitative HIT in the semicircular canal (SCC) planes was recorded within 7 days from vertigo onset using the search coils technique in 22 central and 16 peripheral AVS, and five patients had only horizontal HIT. Results were compared to 15 healthy subjects.

Results: In peripheral AVS the VOR gain was reduced (all SCCs, lateral and/or anterior SCCs and posterior SCC only). In central AVS involving the lateral medulla (n=6), the VOR gain was: reduced ipsilesionally in all SCCs; normal; or increased in the plane of paired vertical SCCs. With inferior cerebellar lesions (n=7) the VOR gain was normal (mean). Lesions of pontocerebellar distribution produced reduced (all SCCs: n=2; lateral and anterior SCCs: n=2) or normal (n=2) VOR gain. HIT was normal in superior cerebellar lesions (n=3) but abnormal in dorsal pontomesencephalic lesions (n=2) with selective posterior SCC involvement. Quantitative HIT correctly suggested the localization in 92% of central and all of peripheral AVS, whereas bedside horizontal HIT was predictive in 62.5% of central and 74% of peripheral AVS.

Conclusion: Normal HIT is typical in pure cerebellar lesions, whilst abnormal HIT occurs with brainstem lesions. The high rates of both false-positive and -negative bedside HIT underscores the importance in measuring HIT when assessing AVS patients.

O20

Head impulse test in internuclear ophthalmoplegia

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Introduction: Internuclear ophthalmoplegia (INO) is characterized by adduction paresis of the ipsilesional eye and abduction nystagmus of the contralesional eye during horizontal saccade. Although visual blurring is believed to be a result of binocular fusion breakdown during saccades, we investigated if the binocular vestibular function to head impulse test (HIT) is deficient in INO.

Materials and Methods: We studied 24 MS patients with INO (15 bilateral, 9 unilateral) with 3D HIT to examine their individual semicircular canal function. Binocular eye rotations were recorded with dual-search coils in response to high-acceleration (2000-3000°/s²) head impulses delivered in individual semicircular canal planes. All patients underwent horizontal and vertical volitional saccade testing to 20° eccentric targets. Their results were compared to normal subjects.

Results: In bilateral INOs, HIT showed severe reduction in posterior canal function (gain=0.07-0.11)

with relative sparing of anterior canal function (gain=0.23-0.36) and also reduction in horizontal canal function (gain: ipsilesional eye=0.41-0.43, contralesional eye=0.54-0.57). Horizontal HIT showed a difference in peak slow phase velocity between the abducting to adducting eye (ratio: left HIT=2.0, right HIT=1.4) with a paucity of horizontal refixation saccades in the adducting eye. In unilateral INO, while the vestibulo-ocular reflex (VOR) deficits were comparable to bilateral INOs for the vertical canals, there was no deficit in peak slow phase velocity or VOR gain of the abducting eye.

Conclusion: INO is associated with significant vestibular dysfunction accounting for the oscillopsia. Gaze instability during head motion is due both to VOR gain deficits and horizontal dysconjugacy in peak slow phase velocity and saccades.

O21

The rapid video-oculographic measurement of the normal vestibulo-ocular reflex

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Introduction: To accurately quantify the normal daily variation in the vestibulo-ocular reflex (VOR), hitherto absent in the published literature.□□□

Background: The development of rapid video-oculography (rVOG) technology offers an immediate, objective, and relatively inexpensive clinical assessment of the VOR (1-3). In order that this technology is able to find a place in the day-to-day assessment of the dizzy patient, we have documented a comprehensive definition of what comprises a normal video head impulse test.□□□

Materials and methods: A prospective observational study.□□□

Results: We define and discuss the insignificant daily variation in VOR in 24 normal subjects.□□□

Conclusions: We are now able to define the normal physiological day-to-day variation in VOR which may be seen in a given individual. It is envisaged that this information will aid the incorporation of rVOG into the daily in-office practice of neuro-otology as well as establish a valuable baseline for future vestibular research.□

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O22

The video head impulse test (vHIT) detects vertical semicircular canal dysfunction

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Introduction: The video head impulse test (vHIT) is a useful clinical tool to detect semicircular canal dysfunction. However, so far vHIT has been limited to measurement of the function of the horizontal semicircular canals. The goal of this study was to extend the application of vHIT to detect vertical semicircular canal dysfunction and validate the measurements with simultaneous scleral search coil recordings.

Materials and Methods: Head impulses were delivered diagonally in the plane of the vertical semicircular canals while gaze was directed along the same plane. Head and eye movements were recorded simultaneously with vHIT (250Hz) and scleral search coils (1000Hz). Patients with unilateral, bilateral and individual semicircular canal dysfunction were tested and compared to normal subjects.

Results: Simultaneous vHIT and search coil recordings of head and eye movements were closely comparable. vHIT detected dysfunction of individual vertical semicircular canals as accurately as search coils. vHIT and search coils displayed comparable patterns of covert and overt catch-up saccades.

Conclusions: vHIT detects dysfunction of individual vertical semicircular canals as accurately as search coils. In contrast to search coils, the method is practical in clinics as a promising new tool for diagnosing dysfunction of individual vertical semicircular canals in vestibular patients.

Flash induced afterimage versus single spot visual object influence on visual-vestibular interaction mechanism in detection threshold for self-motion perception

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Introduction: In a previous study we established lowering the threshold for self-motion perception when subjects are moving in a sinusoidal way in visual-vestibular interaction (VVI) - when subject fixates his gaze on LED rotating with the subject aligned with his head compared to that measured in darkness. The threshold was measured by method of upper and lower limit for five frequencies: 0.025, 0.05, 0.1, 0.2, and 0.4 Hz.

Purpose: The purpose of the present study was: I. To (a) investigate the effect of wider range of frequencies that includes higher frequencies than the previous experiment and (b) modified method of rotation and subjects assessment of self-motion - one-interval, multiple-stimuli, two-response classification design, that was combined with a 3-down, 1-up staircase paradigm; II. To investigate whether, if we use flash induced afterimage, instead LED, which has different physiological mechanism of generation on the retina, as a visual signal, the threshold of self-motion perception will be changed.

Materials and Methods: Seven subjects were tested - rotated sinusoidally in yaw about earth-vertical axis, while they fixated their gaze at a LED aligned with their head. Stimuli were single cycles of sinusoidal acceleration at six frequencies: 0.1, 0.2, 0.5, 1, 2 and 5 Hz. The second experiment was similar to first except the visual stimulus - flash induced after image from flash camera fixated at the same position as LED, and four frequencies were used: 0.1, 0.2, 0.5, and 1 Hz. MOOG motion platform was used to generate motion. Results: With LED the results obtained indicate lowering of the threshold for self-motion perception, frequency dependent and more pronounced at lower frequencies. With flash induced afterimage the perception threshold also was lower than in complete darkness and frequency dependent. However, interestingly, compared to that with LED the threshold was higher.

Results: With LED the results obtained indicate lowering of the threshold for self-motion perception, frequency dependent and more pronounced at lower frequencies. With flash induced afterimage the perception threshold also was lower than in complete darkness and frequency dependent. However, interestingly, compared to that with LED the threshold was higher.

Conclusion: The mechanism of flash induced afterimage lowering of the threshold for self-motion perception differs from that generated from VVI single spot real visual object — LED due to different factors involved in the process of visual perception in the two visual stimuli conditions.

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Update on tests of standing balance for screening patients for vestibular disorders

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Introduction: Although computerized dynamic posturography has been the standard for balance testing of patients with vestibular impairments the equipment is expensive and difficult to transport so it is not ideal for screening people in epidemiologic studies, screening patients in facilities with limited equipment such as nursing homes, and testing people in remote locations such as astronauts at landing sites upon return from long-duration space flight. Therefore we have been studying the use of Romberg testing on a compliant surface to determine if such testing can be used for screening. We will discuss the data we have collected since the previous Barany Society meeting in 2010.

Materials and Methods: Normals and patients with known vestibular disorders wore a vest around the torso and a headband, each instrumented with lightweight inertial motion sensors (Xsens Technologies BV, The Netherlands), while they stood on medium density, compliant foam (Sunmate, Dynamic Systems, Leicester, NC, USA). Subjects were tested with eyes open or closed and with the head still or moving; we will report only the eyes closed data. Some subjects were also tested on posturography (Equitest, Neurocom International, Clackamas, OR, USA), while standing quietly and while moving the head at 0.33 Hz, in pitch and in yaw. Kinematic measures were obtained from the head and torso

sensors.

Results: Normals and patients used different kinematic patterns. Tests that were sharpened with pitch rotations of the head were more challenging for normals and for patients, and were more sensitive than tests involving quiet standing.

Conclusions: These findings support previous evidence for using head movements to sharpen Romberg testing. This test paradigm may be useful for population-based studies that involve screening people for vestibular disorders. Supported by NIH grant R01DC009031 to HSC and by a grant from the National Space Biomedical Research Institute through NASA NCC 9-58 (SA02001) to APM.

O25

Association of symptom severity and disability in patients with vestibular or psychogenic vertigo

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Introduction: Vertigo and dizziness are among the most frequent symptoms in medical practice. Dizziness is frequently described as a consequence or side effect of cardiovascular, infectious, neurological and otological disease. Nevertheless, vertigo and dizziness are also the key symptom of several distinct disorders. Even though vertigo and dizziness can be severely disabling, it is not known which aspects of functioning are most affected. Aim of this study was to investigate the association between severity of vertigo symptoms, activity limitations and participation restrictions in patients at a specialized outpatient unit.

Materials and Methods: Data originates from a consecutive sample of outpatients at a specialised tertiary care dizziness clinic. Symptom severity was measured using the Vertigo Symptoms Scale (VSS). Limitations and restrictions were measured using the Activities and Participation categories of the WHO's International Classification of Functioning, Disability and Health (ICF). Associations of VSS and ICF categories were examined using logistic regression models adjusting for vertigo type, age and sex.

Results: We included 200 patients (111 women). Mean age was 58.5 years (SD 17.1). Vertigo was classified as central-vestibular in 38 individuals, peripheral-vestibular in 66, psychogenic in 60. Thirty-six individuals had a mixed type. VSS ranged from 0.06 to 3.24 (median 0.92). Aspects of disability most strongly associated with vertigo severity were "Informal social relationships" (OR: 6.6), "Non-remunerative employment" (OR: 4.3), and "Recreation and leisure" (OR: 4.1). Limitations and restrictions did not vary across diagnoses.

Conclusion: Symptom severity in vertiginous diseases comes along with limitations and restrictions in human functioning irrespective of the underlying diagnoses. Domains of social participation were most affected; these may be the most relevant outcomes for evaluating treatment effects.

O26

Vestibular syndromes in emergency medicine: a retrospective analysis

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Introduction: Vertigo and dizziness are commonly seen in emergency departments. Dizziness can be one of the symptoms in a variety of diseases, but it is also the key symptom in a number of distinct syndromes. For emergency medicine, distinction between benign and serious causes of vertigo and dizziness is essential, in particular in acute vestibular syndromes (e.g. vestibular neuritis vs. brainstem stroke). Here we asked which diagnoses present most often as emergencies.

Methods: In this retrospective study we analysed data of 942 patients who presented with the chief complaint of vertigo or dizziness to the emergency department of a university hospital in Germany between January and December 2009. In 658 of these patients (mean age 51y, M:F 38:62) a distinct vestibular syndrome was diagnosed. The database provides information about the initial key symptoms, results of clinical and laboratory testing, initial and final diagnosis, and of the clinical course.

Results: The most common diagnoses were benign paroxysmal positioning vertigo (BPPV, 26%), brainstem or cerebellar stroke (14%), phobic postural vertigo (PPV, 14%), migraine (11%), vestibular neuritis (10%), and Menière's disease (6%). Vestibular neuritis is most common in spring and autumn, BPPV presents most in January. The majority of BPPV patients present to the emergency room between 5 and 12 a.m. In contrast, PPV patients present between 10 a.m. and 5 p.m. but rarely during the night.

Conclusion: BPPV is the most common vestibular disorder not only in general practices but also in the emergency room. Public education about this benign disorder might prevent a number of emergency consultations. Stroke is as common as peripheral vestibular causes of acute vertigo (vestibular neuritis or

Menières disease) and should carefully be ruled out. The analysis of temporal aspects of emergency consultation fits to pathophysiology (inflammatory cause of vestibular neuritis; BPPV after bed rest) and might be one fact

O27

Burden of Disability attributable to vertigo in the aged - Results from the KORA-Age study

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Introduction: Vertigo can be severely disabling, specifically in old age, e.g. adding to the risk of falls, injuries and fractures. Yet, the burden of disability attributable to the presence of vertigo symptoms in the presence of co-morbidities is not known. Recently, a method was proposed that combines prevalence of disease along with its impact on disability and allows investigating the contribution of single health conditions to the societal burden of disability. The objective of our study is to estimate specific burden of disability attributable to vertigo in aged persons.

Materials and Methods: The data originate from the MONICA/KORA study. Disability was assessed with the Health Assessment Questionnaire Disability Index (HAQ-DI). Vertigo was assessed with questions from the NHANES balance section. Additive regression was used to model the hazard of developing disability and to estimate attributable prevalence of disability.

Results: We analyzed a total of 4064 persons (51.1% female) with a mean age of 73.5 years. Disability prevalence of disability was higher in women than men in all age groups. Vertigo was strongly associated with disability (OR = 2.8) and had the highest impact on the prevalence of disability among all health conditions (11% for women and 12% for men aged 65 to 69). There was a significant sex-specific difference in background hazards and disease effects. The vertigo-specific attributable risk for disability in men remained constant with increasing age, while it decreased in women.

Conclusion: We could show that the burden of disability independently attributable to health conditions was highest for vertigo. Current research often neglects the impact of the impact of vertigo as a distinct disease entity on disability, specifically in the aged. This underscores the importance of further research on the epidemiology and burden of vertigo in the general population.

O28

Untreated vestibular schwannomas - symptoms, hearing, posturography and vestibular function in 435 patients

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Aim: Improved availability of MRI has led to earlier diagnosis of small vestibular schwannomas. The population of patients with this diagnosis is therefore changing. The purpose of this study was to review the symptoms, clinical findings and vestibular function tests in patients with untreated vestibular schwannomas.

Methods: 435 patients were included. Median age was 57 (IQR: 48 – 65) years. Median tumor size was 13 (IQR: 9 – 21) mm. Demographical data and symptom scores (VAS) were collected as well as data on quality of life (SF-35), radiological and clinical findings, pure tone audiometry, speech discrimination, posturography and video-nystagmography including bithermal caloric tests.

Results: Preliminary results will be presented. The findings in this well-defined group of patients shed light on the relationships between dizziness symptoms, hearing, objective balance function and vestibular function in chronic unilateral vestibular disease.

O29

Motion sickness in rally co-drivers

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Car sickness is a common and potentially disabling kind of motion sickness (MS), thought to be due to sensory (visuo-vestibular) "mismatch". Special stages, performed with a racing car on different road surfaces, are preceded by a reconnaissance with a standard car, during which the crew elaborates pace notes by detailing and annotating the road book given by the organiser. This study aimed to evaluate MS in rally co-drivers where no data exist. Eighty-five rally co-drivers filled in a questionnaire investigating their MS in 4 situations: special stages, special stages reconnaissance, reading a book in the car and rear-seat passenger. The main causal factors of MS were also investigated. MS is less reported in special stages (2.3%) than during reconnaissance (15.3%) ($p=0.005$), when reading a book in a car (25.9%) ($p<0.001$) or as a rear-seat passenger (25.9%) ($p<0.001$) and no difference was observed between the last three conditions. Stress (63.0%), on-board smells (46.5%) and on-board temperature (43.0%) were the main causal factors related to the occurrence of MS. In special stages, despite stress, on-board smells and temperature, MS decreased. During the special stages, co-drivers focus central vision mainly on pace notes while peripheral vision is limited by the crash helmet, flexed head position and door nets. During reconnaissance, co-drivers move all the time their head to look from the road book to the road and back to write the pace notes. These head motions require frequent modulations of the vestibulo-ocular reflex gain and could generate Coriolis accelerations, in which intervenes alternatively hand (when writing) and head stabilisation. In special stage, head motions are limited by the helmet and the head and neck support (HANS). Body motion is limited by the bucket-seat and the safety belts. Visual information is focused on the pace notes from central retina – aiming to cognitive interpretation – and allows an anticipation of the vestibular stimulation.

O30

Opioid-induced nausea is a vestibular problem

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Introduction: Opioids are among the world's oldest and most used drugs. The World Health Organization considers them to be indispensable for the treatment of moderate to severe pain. Common adverse reactions and limiting factors in the use of opioids are nausea and vomiting. The mechanisms causing these adverse reactions are still under debate. Here we investigate whether an opioid effect on the vestibular system might be causative.

Materials and Methods: Ten healthy men took part in the study that was approved by the Ethics Committee of the Technical University of Munich and in accordance with the Declaration of Helsinki. Horizontal canal function was assessed by video-head-impulse-testing before and thirty minutes after initiation of continuous intravenous administration of 0,15 µg/kg/min of remifentanyl. The presence of vertigo, nausea and vomiting was documented when patients were lying still in a supine position and immediately after sitting up (with eyes closed), and when bending forward and backward.

Results: The gain of the vestibulo-ocular reflex significantly decreased with remifentanyl administration in all subjects. None of the subjects reported vertigo or nausea when lying still. After sitting up and when bending forward and backward (even with their eyes closed) subjects consistently reported a feeling of „free fall“ associated with nausea and sometimes vomiting.

Conclusion: Our findings indicate that opioid-induced nausea is due to an opioid-effect on the vestibular system as documented by a decreased gain of the vestibulo-ocular reflex. Similar to the pathophysiology of motion sickness for example during space flight the vestibulo-vestibular mismatch between canals and otoliths causes nausea and vomiting. These findings will have significant implications for both the clinical prevention of opioid-induced nausea and vomiting and the assessment of astronaut susceptibility to motion sickness.

O31

Vestibular evoked myogenic potential (VEMP) to identify subclinical neurological alterations in different phases of HTLV-1 infection

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The diagnosis of human T lymphotropic virus type 1 (HTLV-1)-associated myelopathy/tropical spastic paraparesis (HAM/TSP) is based on clinical signs and the confirmation of HTLV-1 infection in the Central Nervous System (CNS). Vestibular evoked myogenic potential (VEMP) testing evaluates the vestibulospinal tract which is correlated with the motor tract, the target of damage by HAM/TSP. The aim of the present study was to examine the subclinical neurological alterations related to HTLV-1 infection. VEMP testing was performed at the beginning of the study and repeated every six months over a period of 18 months. Ninety volunteers were selected for the study: 30 were HTLV-1 seronegative (the control group) and 60 were HTLV-1 seropositive (of these, 18 were asymptomatic, 25 had possible HAM/TSP and 17 had confirmed HAM/TSP). The VEMP response was classified as normal or abnormal (latency prolongation or no response). A change in the VEMP response from normal to abnormal was the event of interest. To perform a survival analysis, the subjects with normal VEMP responses at the first assessment were selected. VEMP was measured using short tone bursts as acoustic stimuli (1 kHz, 118 dBHL). The stimulation rate was 5 Hz, and the analysis time for each response was 60 ms; each trial averaged 200 responses. The mean age of the subjects in the control group was 38 ± 11 years (median 35), and 13 (43%) were men. In the study group, the mean age was 51 ± 12 years (median 53), and 12 (20%) were men. An analysis of the survival curve indicated that the median time for a change in VEMP response from normal to abnormal was 18 months, which is in agreement with the slow progression of HTLV-1-associated neurological disease. The survival analysis showed that the change in VEMP response was significantly different between the asymptomatic and HAM/TSP groups ($p=0.02$). In conclusion, VEMP testing was useful for monitoring the development of HAM/TSP in HTLV-1-infected individuals.

O32

VEMP findings and subtypes of idiopathic otolithic vertigo

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Introduction: We have proposed "idiopathic otolithic vertigo" (IOV) as one clinical entity which could cause episodic non-rotatory vertigo. Our study has shown that patients with IOV could be classified into several subtypes according to characters of their symptoms. We studied association of VEMP findings with subtypes of IOV.

Subjects and Methods: Patients who fulfilled the following criteria were enrolled in this study as possible patients with IOV. Patients had to have experienced (a) episodic lateral tilt sensation, (b) episodic moving sensation in the pitch plane, or (c) episodic sensation of undefined unsteadiness. However, patients with the following signs or symptoms were excluded. (1) A medical history of rotatory vertigo, (2) a medical history of loss of consciousness or severe head trauma, (3) symptoms or signs of central nervous system dysfunctions or proprioceptive dysfunctions, or (4) a definitive diagnosis of a disease known to cause disequilibrium, (e.g. Meniere's disease, vestibular migraine, etc.). Patients with symptoms (a) classified as Group A, symptoms (b) as Group B, and symptoms (c) as Group C. Patients who passed the above-mentioned inclusion and exclusion criteria, oVEMP (ocular vestibular evoked myogenic potential) and cVEMP (cervical vestibular evoked myogenic potential) were recorded using 500Hz air-conducted tone bursts (rise/fall time = 1 msec, plateau time = 2 msec, 125 dB SPL). Patients also underwent other neuro-otological tests including caloric tests.

Results: Majority of patients in Group A showed absent responses of oVEMP. Half of Group A patients showed bilaterally normal cVEMP. Although the number of patients in Group B was small, patients in this group showed tendency of abnormal cVEMP. Incidence of abnormal VEMP in Group C was low in comparison with Group A and Group B.

Conclusion: Results in this study suggested that moving sensation without rotatory sensation could be produced by otolithic disorders.

O33

Sensitizing vemp assessment in vestibular patients

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Introduction: It has been postulated (e.g. Lee et al, 2011) that in patients complaining of vague dizziness or imbalance, VEMP testing should be carried out. It is our experience that VEMPs are often normal in patients with genuine complaints, and we wondered how we might sensitize the VEMP test. The saccules parasagittal orientation registers accelerations in the vertical plane. This is a symmetrical response, as the saccular membrane will "droop" to its lowest point in the upright human. If we rotated the saccule 90° during VEMP testing, this would create an "asymmetry" which might stress the saccule, and show a weakness, and a saccule challenged by a vestibular deficit might be less capable of compensating for this asymmetrical input. In a previous pilot study, we showed abnormal VEMPs were

often accentuated by rotated VEMPs, while normal subjects did not show any different results in the side VEMP position. We wished to see if the rotated VEMP results correlated with other assessments we carry out. Perhaps

Materials and Methods: We carry out VEMP assessment in a seated position and activate the SCM by bearing down with the chin. We analyzed 50 patients with posturography, calorics, subjective visual vertical testing, head impulse testing, VEMP's and our rotated VEMP technique. All assessments were carried out by one investigator and the rotated VEP assessment was carried out blinded to all other assessment results. Ten normal subjects with no history of vestibular complaints were also assessed with full VEMPs and our rotated VEMP technique.

Results: VEMP abnormalities were often accentuated and sometimes an abnormal response was extinguished in some patients. We will discuss the correlation that exists between our regular VEMP protocol, rotated VEMP assessment and other assessments carried out. We will discuss the correlation between patients results and the nature of their complaints.

Conclusion: We suggest that there is a certain group of patients whose VEMP abnormalities are accentuated by our new technique.

O34

cVEMP screening for SCD syndrome: 90 dB nHL click stimulation does the job

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Introduction: Cervical vestibular evoked myogenic potential (cVEMP) testing in response to air conducted sounds has its key clinical significance for testing saccular and inferior vestibular nerve function, but also for assessment of vestibular hypersensitivity to sounds in patients with superior canal dehiscence (SCD) syndrome. The routine stimulus used in cVEMP testing is high-intensity 500 Hz tone bursts. The aim of the present study was to compare the high-intensity tone burst stimulation with less intense stimulations as screening tests for SCD syndrome.

Materials and Methods: cVEMP amplitude in response to high-intensity 500 Hz tone bursts (130 dB SPL) and in response to less intense clicks (90 and 80 dB nHL) were studied in 40 patients with SCD syndrome unilaterally.

Results: cVEMP testing using high-intensity 500 Hz tone bursts did not consistently distinguish SCD patients. This non-functioning of high-intensity 500 Hz stimulation is most likely due to saturation. With 90 and 80 dB nHL clicks there is low risk for saturation and both these click stimulations were effective in cVEMP screening for the vestibular hypersensitivity to sounds. Testing with both 80 and 90 dB nHL clicks did not have any significant advantage over just using 90 nHL dB clicks.

Conclusion: Testing cVEMP in response to 90 dB nHL clicks can, in contrast to using high-intensity 500 Hz tone bursts, be used as a screening test for SCD syndrome.

O35

Potential application of ocular and cervical vestibular-evoked myogenic potentials in Meniereis disease

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Introduction. By stimulating the ear with air-conducted sound or bone-conducted vibration stimuli, vestibular-evoked myogenic potential (VEMP) can be recorded on the contracted neck muscles, termed cervical VEMP (cVEMP), and on the extraocular muscles, termed ocular VEMP (oVEMP). These two electrophysiological tests expand the test battery for clinicians to explore the dynamic otolithic function, adding a potential usefulness to the sacculo-collic reflex and vestibulo-ocular reflex, respectively.

Methods. The inner ear monitoring system including audiometry, cVEMP, oVEMP and caloric tests, is designed for complete evaluation of the inner ear function, including the cochlea, saccule, utricle and semicircular canals.

Results. Using this system to study the localization and prevalence of hydrops formation reveals that the declining function in the cochlea, saccule, utricle and semicircular canals mimics the declining sequence of hydrops formation in temporal bone studies.

Conclusion. This study reviewed the physiological results in Meniereis patients from the inner ear monitoring system, especially the potential application of the oVEMP and cVEMP tests, to correlate with the pathological findings of Meniereis disease.

O36

Why do oVEMPs become larger when you look up? Explaining the effect of gaze on the ocular vestibular evoked myogenic potential

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Introduction: The ocular vestibular evoked myogenic potential (oVEMP) is a vestibular reflex recorded from the inferior oblique (IO) muscles, which increases in amplitude when the eyes are elevated. We investigated whether this effect of vertical gaze is due to movement of the IO muscle closer to the recording electrode or to increased tonic IO activity in up-gaze.

Materials and Methods: We simulated an IO muscle movement by holding gaze (i.e. muscle position and activity) constant in up-gaze and moving the electrodes away from the muscle. Using MRI data by Demer et al. (2003) on the anterior-posterior displacement of the IO muscle (4.3 mm) at positions along the vertical meridian (between 24° up and 24° down), we calculated the required matching shift of recording electrodes. We compared oVEMPs recorded at 24° up and down to those recorded with gaze up but electrodes placed at increasing distance from the eyes in ten healthy subjects.

Results: oVEMP amplitude decreased much more with decreasing gaze elevation (9 µV from 24° up to neutral) than with increasing electrode distance (~2.7 µV from baseline to 6.4 mm; P<0.005). The oVEMP recorded with gaze 24° down had delayed latency (by ~4.5 ms).

Conclusions: In up-gaze (when the IO is activated, but the inferior rectus (IR) inactivated) the oVEMP has temporal characteristics of the IO single unit response (Weber et al. submitted). In down-gaze (IO inactivated, but IR activated) the oVEMP peaks later, similar to the IR single unit response, and therefore likely originates in the IR muscle. The effect of vertical gaze on oVEMP amplitude cannot be explained by changes in proximity alone and is likely to be mainly due to increased tonic IO contraction in up-gaze. Our results suggest that oVEMP amplitudes in extraocular muscles scale with tonic muscle activity. Both factors ('activation' and 'distance to electrode') therefore explain the appearance of oVEMPs at different angles of vertical gaze.

O37

Augmentation of ocular vestibular-evoked myogenic potentials via bone-conducted vibration stimuli in Meniere's disease

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Objective: The asymmetry ratio of ocular vestibular-evoked myogenic potential (oVEMP) >40% is interpreted as augmented or reduced response depending on whether the nI-pI amplitude of the lesion ear is larger or smaller than that of the opposite ear, respectively. This study compared unilateral Meniere disease patients with augmented oVEMPs vs reduced oVEMPs to elucidate the mechanism of augmented oVEMP.

Study Design: Case series with chart review.

Setting: University hospital. **Methods:** Forty patients with unilateral definite Meniere disease were enrolled in this study, including 20 patients with augmented oVEMPs and another 20 patients with reduced oVEMPs in the hydropic side. All patients underwent audiometry, caloric test, and oVEMP and cervical VEMP (cVEMP) tests via bone-conducted vibration stimuli. Then, the oVEMP and cVEMP test results were compared with the stage of Meniere disease, respectively.

Results: The augmented group had earlier nI and pI latencies and larger nI-pI amplitude of oVEMPs compared with the reduced group. Caloric test also revealed a significant difference in abnormal responses between the augmented and reduced groups. However, both groups did not differ significantly in the abnormal percentage of cVEMP test results. A significant trend to decline in the prevalence of augmented oVEMPs was noted from stages I to III-IV but not in that of abnormal cVEMPs.

Conclusion: The augmented oVEMPs have earlier latencies and larger amplitudes compared with the reduced oVEMPs, indicating that a relatively larger population of intact utricular afferents is activated during the early stage of Meniere disease.

O38

Fast detection of vestibular evoked myogenic potentials (VEMPs) using a novel trigger mechanism

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Introduction: VEMPs provide an important tool for measuring otolith function. Whereas cervical (c) VEMPs are commonly used for assessing the sacculus, recording of ocular (o) VEMPs as an indicator of utricular function is often compromised by small n10 amplitudes. Therefore, we developed a novel trigger mechanism for fast detection of o- and cVEMPs with large amplitudes and high signal stability.

Materials and Methods: o- and cVEMPs were evoked by head taps to Fz using a Troemner reflex hammer with a stiff arm and a novel trigger mechanism* in 10 healthy individuals. For determination of signal-to-noise ratio (SNR), VEMPs were considered as discrete-time energy signals. Pearson's correlation was employed for calculation of signal stability.

Results: In healthy individuals, mean oVEMP n10 amplitudes of $24.84 \pm 9.71 \mu\text{V}$ and $27.40 \pm 14.55 \mu\text{V}$ (baseline-to-peak) were recorded beneath the right and left eye, respectively ($p=0.649$, 2-way ANOVA). Mean corrected p13-n23 amplitudes of 5.22 ± 4.02 and 5.44 ± 3.93 were obtained for cVEMPs on the right / left side ($p=0.902$, 2-way ANOVA). The signal-to-noise ratio (SNR) of the oVEMP n10-p16 amplitude was 15.0 ± 5.32 dB (right) and 19.63 ± 6.56 dB (left). The cVEMP p13-n23 amplitude yielded an SNR of 10.70 ± 6.64 dB (right) and 11.22 ± 5.48 dB (left). For oVEMPs, a signal stability > 95% was reached after 5 (right side) and 5.6 (left side) head taps. For cVEMPs, 10 (right) and 10.5 (left) measurements were necessary to achieve this level of signal stability.

Conclusions: Symmetrical o- and cVEMPs with a good SNR were recorded in healthy individuals using the novel trigger mechanism. In particular, consistently higher n10 amplitudes were reached with a smaller number of head taps (5 / 5.6) for oVEMPs compared to the literature. Thus, the novel trigger constitutes a time- and cost-effective method for the detection of o- and cVEMPs. *Due to a pending patent, details are confidential at the moment.

O39

Influence of head acceleration on ocular vestibular-evoked myogenic potentials via bone vibration at Fz versus Fpz

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Introduction: Bone-conducted vibration (BCV) stimuli applied to various mid-sagittal cranial sites revealed that tapping at the forehead (Fpz or Fz) elicits larger ocular vestibular-evoked myogenic potential (oVEMP) waveforms than tapping at the vertex (Cz) and inion sites. However, whether tapping at the Fz or Fpz site is more suitable for screening the presence of oVEMP, it remains unclear. This study applied BCV stimuli to the Fz and Fpz sites to investigate the influence of head acceleration on the oVEMPs.

Method: Fourteen healthy subjects underwent oVEMP tests using a hand-held vibrator at the Fz and Fpz in a randomized order. Acceleration magnitudes along the x-axis (antero-posterior), y-axis (inter-aural) and z-axis (rostral-caudal) were measured via an accelerometer tightly attached at left mastoid tip.

Results: Under BCV stimulation from a vibrator to the Fz and Fpz sites, acceleration magnitudes along x-, y- or z-axis did not significantly differ between the two sites. The mean nI and pI latencies of the oVEMPs stimulated at Fz were significantly earlier than those at Fpz. However, no statistical differences existed in the nI-pI interval and amplitude between the two sites. A blunt or double peak nI configuration was noted in three subjects (22%) when tapping at Fpz, but not at Fz, likely because of different muscles involved in contribution to the oVEMPs.

Conclusion: While both Fz and Fpz are effective sites for generating an oVEMP, the variation in human skull shapes and properties will lead to different acceleration profiles being transmitted to the vestibular apparatus. These differing stimuli may lead to different oVEMP profiles, so if one site does not produce the expected response, the clinician should try the other site.

O40

Ocular and cervical vestibular-evoked myogenic potentials in Tumarkin falls

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Introduction: This study applied ocular vestibular-evoked myogenic potential (oVEMP) and cervical VEMP (cVEMP) tests in Meniere's patients with Tumarkin falls to investigate the etiologic role of the saccule/utricle in the event of Tumarkin falls.

Method: Twenty unilateral definite Meniere patients were divided into two age- and gender-matched groups. Ten patients had a history of drop attacks, and ten had no history of drop attacks. All patients underwent audiometry, and caloric, oVEMP and cVEMP tests.

Results: No significant differences were observed between the fall and non-fall groups in terms of Meniere staging, and caloric and cVEMP test results. In the fall group, oVEMP test via Fz tapping showed

augmented, reduced and absent responses in 1, 1, and 8 patients, respectively. In three of the latter 8 patients, however, oVEMPs could be obtained by lateral mastoid tapping. Thus, 100% of patients in the fall group had abnormal oVEMPs, which significantly differed from 50% oVEMP abnormalities in the non-fall group. Comparison of the abnormal results for the caloric, oVEMP and cVEMP tests revealed that poorer residual vestibular function in the fall group than the non-fall group.

Conclusion: Absence of oVEMP by Fz tapping and presence of oVEMPs via lateral tapping indicates a residual utricular function. With residual canal function (canal paresis) and absent cVEMPs, subsequently residual utricular function may trigger the Tumarkin falls in Meniere's patients.

O41

A novel signal-processing algorithm for the assessment of vestibular function by ocular vestibular evoked myogenic potentials (oVEMPs)

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Introduction: oVEMPs are regarded as a response of irregular otolith afferents to bone-conducted vibration. However, the averaged signals used in clinical practice do not contain any information about the synchrony of the vestibular nerve response. Therefore, we developed a signal-processing algorithm in order to determine the phase shift between VEMP signals.

Materials and Methods: oVEMPs were evoked by head taps to Fz using a novel trigger mechanism* in 31 healthy individuals and 16 patients with vestibular neuritis (VN). Averaged signals were used for calculation of the n10 amplitude and the asymmetry ratio (AR). A phase vector indicating synchrony of the VEMP response was obtained by the novel signal-processing algorithm*. The phase shift between oVEMP signals was defined as the difference between phase vectors.

Results: In the control group, mean oVEMP n10 amplitudes (baseline-to-peak) of 19.9 ± 9.2 and 20.7 ± 11.4 μ V were measured beneath the right and left eye. The AR was $6.4 \pm 5.8\%$ with a 95% confidence interval (CI) of 4.4 to 8.5%. Mean values of 21.4 ± 4.7 (right) and 20.7 ± 5.0 (left) were obtained for phase vectors resulting in a phase shift of 3.4 ± 2.7 (95% CI: 2.4 to 4.3). The 16 patients with VN showed n10 amplitudes of 8.84 ± 5.58 on the contralesional and 17.6 ± 8.2 μ V on the ipsilesional side leading to an AR of $38.4 \pm 22.7\%$ (95% CI: 27.3 to 49.6%). Mean values of 15.6 ± 9.1 and 23.2 ± 6.7 were calculated for phase vectors of contralesional and ipsilesional oVEMPs, the phase shift was 12.6 ± 9.8 (95% CI: 7.8 to 17.4).

Conclusions: 1.) The n10 amplitude evoked by the novel trigger is suitable for discrimination between normal vestibular function and a unilateral vestibular deficit. 2.) Unilateral vestibular hypofunction results in an increased phase shift between VEMP signals. Thus, this novel parameter offers an evaluator-independent approach for a fast detection of vestibular loss. * Due to a pending patent, details are confidential at the moment

O42

Ocular vestibular evoked myogenic potentials induced by bone-conducted vibration in patients with unilateral inner ear disease

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Introduction: The ocular vestibular evoked myogenic potential (oVEMP) is a recently described clinical measure of the vestibulo-ocular reflex and is induced by bone-conducted vibration. However, its clinical usefulness has not been elucidated. In this study we attempted to correlate the oVEMP results with those of cVEMP, subjective visual vertical (SVV) and clinical course in patients with various vestibular disorders.

Materials and methods: Eighteen patients with vestibular neuronitis (VN), forty-nine with sudden sensorineural hearing loss (SSHL), seven with Ramsey-Hunt syndrome, eighteen with Meniere's disease, and four with BPPV were enrolled in this study. We analyzed and compared the results of oVEMP with those of cVEMP, and SVV. The oVEMP results were compared with caloric test results in the patients with VN. Furthermore, the oVEMP results were compared with and the initial hearing threshold, vertigo and hearing recovery in the patients with SSHL.

Results: The VN patients with complete caloric CP showed a higher rate of abnormal oVEMP than those with partial CP. There were no significant differences in the incidence of abnormality between cVEMP and oVEMP in the patients with unilateral inner ear disease. In the patients with SSHL, the hearing recovery rate was lower in the patients with abnormal oVEMP. Abnormal oVEMP rates were 77.8% in VN, 57.1% in Ramsey-Hunt syndrome, 18.4% in SSHL, 5.6% in Meniere's disease, and 0% in BPPV.

Conclusion: The VN patients with complete CP showed a higher rate of abnormal oVEMP than those with

partial CP. From these results, it is speculated that the superior vestibular nerve function mainly affects oVEMP. Significant correlation was found between the grades of the hearing outcome and oVEMP in the SSHL.

O43

Differentiating aminoglycoside ototoxicity via inner ear test battery in guinea pigs

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Introduction: Long-term use of aminoglycosides can cause either cochlear or vestibular toxicity. Various aminoglycosides induce unequal levels of cochlear or vestibular deficits. The intensity of toxicity is also dissimilar in different aminoglycosides. Previous reports failed to investigate this aspect thoroughly, possibly due to lack of appropriate diagnostic tools. Clinical evaluation of aminoglycoside ototoxicity often underscores vestibular dysfunction, since the symmetric nature of vestibular toxicity to both ears prevents evident vestibular symptoms. We utilized a battery of inner ear tests to investigate the cochlear and vestibular toxic nature of different aminoglycosides in guinea pigs.

Materials and Methods: Male Hartley guinea pigs were used to establish an animal of aminoglycoside ototoxicity. Gentamicin, tobramycin, amikacin, neomycin and streptomycin of different concentrations (50-200 mg/ml) were instilled intratympanically in anesthetized animals. The animals underwent an inner ear test battery including auditory brainstem responses (ABR), cervical and ocular VEMPs, and caloric tests.

Results: Among all aminoglycosides, tobramycin induced shift of hearing threshold at the lowest concentration (50 mg/ml), followed by amikacin, and then streptomycin, neomycin and gentamicin. The sacculotoxicity, assessed by the cVEMP test, was also strongest by tobramycin. The response rate of caloric test decreased by streptomycin at lowest concentration (50 mg/ml), followed by tobramycin, then amikacin and neomycin. The response rate of oVEMP also decreased at higher concentrations.

Conclusion: Tobramycin induces ototoxicity at lowest concentration in the guinea pigs through intratympanic injection. Organ-specifically, most aminoglycosides produces both cochlear and vestibular toxicity, but at different concentrations. Tobramycin produces strongest cochlear and saccular toxicity while streptomycin induces strongest toxicity in the lateral semicircular canals.

O44

The interpretation of new clinical tests of peripheral vestibular function

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Introduction: New clinical tests of peripheral vestibular function allow testing of all vestibular sense organs. The present study sought to show how the results of these tests, together with neuroanatomical evidence about vestibular afferent projections allow conclusions to be drawn about the functional state of all vestibular sense organs. Semicircular canal function is tested by the video head impulse test (vHIT) (MacDougall et al 2009) and otolithic function by the vestibular evoked myogenic potentials (VEMPs) in response to 500Hz bone conducted vibration of the midline forehead. This stimulus selectively activates irregular primary otolithic afferents in guinea pigs at low threshold and high sensitivity.

Materials and Methods: The n10 component of the ocular VEMP recorded by electrodes beneath the eyes as the patient looks up is used to test utricular function. The p13-n23 component of the cervical VEMP recorded by electrodes on tensed SCM muscles is used to test saccular function. Anatomical and physiological evidence strongly implicates type I receptors at the striola as being responsible for these VEMPs to BCV.

Results: Selective loss of individual vestibular sense organs is shown by the various dissociations which have been published in the literature – e.g. the very different patterns of loss in superior vestibular neuritis, inferior vestibular neuritis, isolated utricular loss. The differential projections of utricular and saccular afferents means that although BCV activates both utricular and saccular afferents, measuring the myogenic responses allows the differential assessment of utricular and saccular function- utricular afferents have a strong projection to the oculomotor system, whereas saccular afferents have a strong projection to cervical motoneurons

Conclusion: All vestibular sense organs can now be tested safely simply and quickly even in very young and very senior patients.

O45

Single motor unit recordings of ocular vestibular evoked myogenic potentials in human extraocular muscles

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Introduction: The ocular vestibular evoked myogenic potential (oVEMP) is a vestibular-dependent reflex measured from the extraocular muscles. It begins with a negative potential with peak at ~10 ms, and is best measured with surface electrodes beneath the eyes. As it is not known which muscles contribute to the reflex, we wished to determine the myogenic source of the oVEMP.

Materials and Methods: Three healthy subjects were stimulated with bursts of head vibration and sound. Motor units from the inferior oblique (IO) and inferior rectus (IR) muscles were recorded with concentric needle electrodes. Standard oVEMPs were recorded simultaneously with electrodes placed below the eyes. Single motor units were extracted from multi-unit recordings and quantified in peri-stimulus histograms.

Results: Following vibration, an initial increase in IO single motor unit discharge was seen at a mean peak latency of 10.5 ms, with discharge up to 10 times the level seen during the pre-stimulus period. The initial peak was followed by an inhibition, then subsequent peaks and troughs at intervals of ~5 ms. In the IR muscle a similar pattern of alternating activity was found, but was delayed by ~5 ms. Following sound stimulation, an increase in IO activity was seen in the muscle contralateral to the stimulus at 13.3 ms. The latency and polarity of the simultaneous surface oVEMP were similar to the needle recordings.

Conclusions: The study identified excitation of the IO as the source of oVEMP signals in response to sound and vibration and demonstrated the physiological basis of this test. Impulsive otolith stimulation produced a series of peaks and troughs of activity in both muscles, but this activity was delayed by a half cycle in the IR. These muscles therefore show reciprocal activation, consistent with their role as vertical antagonists. Single motor unit recordings in human extraocular muscles demonstrate the contribution of individual muscles to the vestibulo-ocular reflex.

O46

Ocular vestibular evoked myogenic potential to air conduction in patients with benign paroxysmal positional vertigo

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Introduction: Two decades have passed since the first publication on vestibular evoked myogenic potential on the sternocleidomastoid muscle (cVEMP). Since the response originates from the ipsilateral saccular organ, measurement of cVEMP is an established examination for saccular organs. Short-latency myogenic responses have also been recorded from around the eye (ocular VEMP: oVEMP). In contrast to cVEMP, this response originated from the contralateral utricular organ. However, the clinical usage of oVEMP has not been established. The purpose of this study was to clarify whether oVEMP could detect utricular dysfunction in patients with benign paroxysmal positional vertigo (BPPV).

Material and Methods: We included 29 patients with BPPV who underwent oVEMP. Sixteen patients were examined by secondary oVEMP after the symptoms disappeared.

Results: Abnormal results were obtained for 25 patients (86%). In the secondary examination, results were normal for 11 patients (69%); however, 5 patients (31%) continued to show abnormal results.

Discussion: Previous studies showed otolith dysfunction in patients with BPPV. Our study also indicated abnormal results of oVEMP in 86% of BPPV cases. Therefore, oVEMP can be used to detect utricular dysfunction in patients with BPPV. In our study, 31% of BPPV cases showed abnormal results even after the symptoms disappeared. Utricular function is independent of the existence of particles in the semicircular canal. Hence, the oVEMP recording showed abnormal results in cases with residual utricular lesions.

Conclusion: oVEMP can be used to detect utricular lesions in patients with BPPV.

O47

Multi-frequency vestibular evoked myogenic potentials (VEMP)

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Introduction: Human vestibular-otolith organs are sensitive to a range of acoustic frequencies, facilitating the evaluation of otolith function using Vestibular Evoked Myogenic Potentials (VEMP) to air-conducted sound. Most clinics record VEMP in response to a single air-conducted tone-burst or click stimulus. However, there is no consensus as to which stimulus is optimal for the assessment of otolith

function in different peripheral vestibular disorders.

Methods: Cervical and ocular vestibular-evoked myogenic potentials (cVEMP and oVEMP) were simultaneously recorded in response to AC tone-bursts (250-2000 Hz) from 32 controls, 14 patients with Superior canal dehiscence (SCD) and 20 patients each with vestibular migraine (VM) and Meniere's disease (MD). Reflex amplitudes and thresholds were compared across tone-burst frequency, age and reflex modality (cVEMP and oVEMP). The sensitivity of cVEMP and oVEMP in identifying pathological ears was also compared across AC frequency.

Results: On average, a 500 Hz tone-burst produced the largest cVEMP amplitudes in control ears, while oVEMP amplitudes were equally large for 500 Hz and 1 kHz tone-bursts. A similar pattern of tuning was observed for the VM group. Compared to healthy controls, the greatest amplitude reduction for MD ears was recorded in response to a 500 Hz stimulus, and the 500 Hz cVEMP asymmetry ratio proved to be the most sensitive parameter for identifying otolith dysfunction. Amplitude and threshold measurements in patients with SCD indicated broad frequency tuning. In contrast to MD, low frequency (250 Hz and 500 Hz) cVEMP amplitude measurements provided poor separation between SCD ears and young controls.

Conclusion: The recording of VEMP in response to different tone-burst frequencies can reveal the dynamic properties of vestibular-otolith function. For patients with MD and SCD, abnormal otolith function is best detected when using a low and high frequency stimulus, respectively.

O48

Promontory electrical vestibular evoked myogenic potentials in awake patients

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Introduction: The proper function of the vestibular nerve is essential for transmission of vestibular cues. Even during the loss of labyrinth end organ function stimulation of the vestibular nerve might provide inputs to the vestibular system. The present study examines the feasibility to test the vestibular nerve function in an awake patient.

Materials and Methods: During the routine promontory test in cochlear implant candidates electrical stimulation was applied to the vestibular organ. Cervical and ocular vestibular evoked myogenic potentials (VEMP) were recorded during electrical stimulation.

Results: Promontorial electrical stimulation of the labyrinth could be performed in all patients without complications. Most patients showed promontorial electrical VEMP, but also patients without responses were seen. In the patient group with promontorial electrical VEMP patients with and without labyrinth function were noticed.

Discussion: Promontorial electrical stimulation is feasible in awake patients. The loss of vestibular end organ function does not necessarily mean the total loss of the vestibular neural system.

O49

Otolithic assessment in whiplash and head injury

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Introduction: Past work in our lab has shown that patient histories and vestibular assessments are similar in patients suffering whiplash type of injury whether or not they suffered head injury. We wondered if the new otolith assessments might help to differentiate these patients. It has been postulated otolith dysfunction is a cause of vague nonspecific dizziness after head trauma (Lee et al, 2011). Patients suffering whiplash and head injury undergo sudden decelerative forces, which could damage otolith structures, but patients suffering only whiplash type injuries often give similar histories, suggestive of possible otolith involvement. We hypothesize that the decelerative force they have experienced may also potentially cause trauma, and the variety of otolith assessments available to us might help to distinguish these patients, especially when the otolith assessments can be correlated with results of standard vestibular tests. We hypothesize that some of our "regular" patients with no history of trauma may also exhibit similar results.

Materials and Methods: We analyzed 50 patients with posturography, calorics, subjective visual vertical testing, head impulse testing, VEMP's and our rotated VEMP technique. Extensive histories were taken and patients were grouped into whiplash and head injury, whiplash only, and no trauma.

Results: In our previous work (prior to the availability of otolith assessments) we showed that whiplash only patients and head injury groups showed similar results. We will report results in our three groups of patients, which will clarify whether our new battery of otolith assessments can distinguish these three groups of patients.

Conclusion: We suggest that head injury and whiplash injury both cause strong decelerative forces to the head, which can be injurious to the otoliths and can also simulate the pathology suffered by many of our non trauma patients.

O51

Early cortical responses during vestibular neuritis

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Introduction: Cortical changes induced by acute unilateral vestibular failure are various and undergo variations over time, revealing different cortical involved areas at the onset and recovery from symptoms. This study aimed to analyze the cortical metabolic changes in patients affected by vestibular neuritis (VN) during the first few days from the onset of symptoms and after one month, to better depict the cortical involvement in the early phase of VN.

Materials and Methods: [18F]fluorodeoxyglucose positron emission tomography (FDG-PET) brain scan data concerning the cortical metabolic activity associated to symptoms onset (within 48 hours) in a group of eight right handed patients presenting with the first and sole episode of right-sided VN are reported. This activity during the first two days from the onset of symptoms was compared to that recorded one month later and to a control healthy group.

Results: Beside the known cortical response associated to VN, we show for the first time the involvement of Entorhinal (BAs 28, 34) and Temporal (BA 38) cortices in early phases of symptoms onset.

Conclusion: The Entorhinal Cortex (EC) receives inputs from the vestibular system and lesions to this region determine impaired navigation and spatial memory: we hypothesize that the found EC activation during the acute phase of VN may be interpreted as the cortical counterpart of the attempt to reorient oneself in space counteracting the vertigo symptom. The BA38 seems to play a role in coding emotional saliency after presentation of sensorial stimuli and impairment of BA38 induces a lack of emotional responsiveness: we hypothesize that the found BA38 activation may be interpreted as the cortical representation of the emotional response related to the vertigo symptom, which is particularly expressed during the acute phase of VN.

O50

Visualizing central vestibular compensation - a rat micro-PET study

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Background and aim: The present study aimed to visualize central vestibular compensation (VC) of a unilateral peripheral labyrinth lesion on a whole brain level, over time and in vivo.

Methods: Left-sided unilateral labyrinthectomy (UL) was performed by drilling into the vestibule and removing its contents through aspiration in 3-month old Sprague-Dawley rats (n=12). As a control group animals were given a surgical sham treatment without damage to the inner ear (n=12). Sequential [18F]-FDG micro-PET imaging was done in all animals before and on 4h, 1, 2, 3, 7, 9 and 12d after UL and sham surgery.

Results: In micro-PET dynamic changes of the regional cerebral metabolic rates for glucose (rCMRglc) were found in the vestibular nuclei, the vestibulocerebellum, midbrain tegmentum, thalamus, multisensory cortex and hippocampus in the UL but not in the sham group. Based on characteristic rCMRglc patterns four consecutive stages of VC were defined: 1) Stage of vestibular imbalance (4h): A significant asymmetry of rCMRglc appears in the vestibular nuclei, vestibulocerebellum, midbrain tegmentum and temporoparietal sensory cortex. 2) Stage of early functional VC (2/3d): rCMRglc gradually adjusts between vestibular nuclei and increases bilaterally in the vestibulocerebellum. 3) Transitional stage of VC (5/7d): rCMRglc further increases in the vestibulocerebellum and thalamus bilaterally. 4) Stage of late structural VC (9/12d): rCMRglc reaches baseline level in the vestibular nuclei, thalamus and cortex. Bilateral rCMRglc increase in the vestibulocerebellum persists.

Conclusion: VC may serve as a prototypical model for deafferentation-induced plasticity of the adult brain and can be visualized in vivo by use of serial whole brain micro-PET.

O52

Navigational behaviour and brain activation during real navigation in bilateral vestibulopathy

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Introduction: Patients with bilateral vestibulopathy show deficits in virtual spatial orientation tasks. The present study aims to investigate behaviour and brain activation during real navigation in patients with complete vestibular loss in comparison to healthy controls.

Methods: 12 normal persons and 8 patients with bilateral vestibulopathy had to perform a navigation paradigm in a complex unknown spatial environment of an outpatient clinic. The area, in which five items had been placed, was shown to the subjects first. Afterwards FDG was injected and subjects had to find the items in a pseudo-randomized order over the next 10 min. Subjects carried a gaze-controlled head-camera throughout the experiment to document their visual exploration behaviour. As a control condition all subjects had to perform a steady-state locomotion paradigm without navigation following FDG injection at a second time point. Brain activation patterns were compared for the navigation vs. locomotion paradigm and correlated with the recorded visual exploration behaviour during navigation.

Results: During navigation in normal persons brain activation was found in the pontine brainstem tegmentum and the anterior hippocampus (right>left). The comparison of navigation-induced brain activation in normal persons and patients with bilateral vestibulopathy showed a significantly higher activation of the right anterior hippocampus as well as the posterior insula bilaterally in controls, whereas an increased activation of the posterior parahippocampus was found in patients with bilateral vestibulopathy. Analysis of visual exploration behaviour indicated a navigation strategy following a cognitive spatial map for normal persons, whereas patients with bilateral vestibulopathy navigated more by a landmark-based strategy.

Conclusion: The navigational behaviour in normal persons and patients with complete vestibular loss is significantly different. A navigational strategy using a cognitive spatial map in normal persons correlates with an activation of the anterior hippocampus, while a landmark-based strategy in patients with bilateral vestibulopathy goes with an increased activation of the posterior parahippocampus. It can be assumed, that the lack of vestibular information impairs the construction of a spatial cognitive map via head direction and place cells in the hippocampus, which is compensated by visually-guided parahippocampal navigation.

O53

Static graviceptive function in patients with cervical dystonia

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Background: Previous data suggest that we might abandon the idea of a single „reference frame“ for perception of verticality. When the head or body is tilted, otolithic and somatosensory signals can have opposite sign effects during perceiving verticality. Recent data suggest somatosensory cues thereby have a prominent role. Cervical dystonia (CD) is a syndrome characterized by sustained cervical muscle contractions, causing abnormal head posture. When treated with botulinum toxin (BoNT), head posture of CD patients improves within a short period of 3 weeks to upright position. The dynamic alterations of head posture over time, in CD patients treated with BoNT, is a unique model to study effects of altered somatosensory and otolithic input on static graviceptive function.

Methods: Static graviceptive function was assessed by means of the subjective visual vertical (SVV). Thirty patients suffering from idiopathic CD and, for control, thirteen healthy individuals were included. All participants were investigated in an upright, sitting position, in a dark room with a dim light bar in the front and adjusted the bar 6 times for parallel alignment with the perceived gravitational vertical. At baseline and three weeks after injection, patients were investigated at six different head positions (no fixation, fixed upright (0°), fixed deviation at 15° and 30° to the left and right, respectively). The control group was investigated at five head positions (0°, 15° and 30° to the left, and right, respectively).

Results: At baseline, SVV judgement vs. controls at 0° was significantly deviated ($p=0,0166$), three weeks after injection, there was no significant difference. At baseline, at head fixation 15° to the left, and 30° to the right, patients SVV was significantly deviated, compared to controls. Three weeks after injection, no significant difference in the SVV judgements was found. We noticed a general trend of major SVV errors of CD patients in contrast to healthy subjects.

Conclusion: Altered cervical muscle tone activity of CD patients with distinct symptoms influences the perception of verticality. Static graviceptive function improves after BoNT therapy.

O54

Intermittent positional downbeat nystagmus of cervical origin

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Introduction: Downbeat nystagmus (DBN) is associated with a variety of clinical disorders, most commonly in the posterior fossa. We studied a case with intermittent DBN associated with dizziness due to transient vertebral artery (VA) ischemia induced by cervical bone compression was most likely as

origin. We report this case by using movies of the DBN.

Case report: A 59-year-old man who presented with positional vertigo visited our clinic. He complained of positional vertigo with 1 year duration when he turned his head to the left side or bend forward. He had no hearing loss or other neuro-otological dysfunction. There was no gaze nystagmus. DBN was observed in the positional nystagmus test. In the left ear down position, DBN occurred after the latency of several seconds, and disappeared gradually. The DBN continued intermittently while he maintained left ear down position. The eye tracking and optokinetic nystagmus tests were normal. Brain MRI was normal. MRA revealed that the left side of VA was narrower than the right side, but the blood flow was maintained. The DBN seemed to be caused by transient ischemia of VA due to cervical bone compression, because the nystagmus occurred only by the left ear down position and anteflexion position.

Discussion: Positional DBN is a clinical sign of central disorders. It develops with lesions in the vestibulocerebellum, or in the craniocervical junction. In our case, DBN was precipitated by head-turn to the left. MRA revealed that the left VA was narrower than the right. Therefore, we assume that head-turn to the left narrowed left VA due to bony compression. The ischemia caused vestibulocerebellum disfunction and the DBN.

O55

Reprogramming of cochlear cells: a novel strategy for regeneration

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Introduction: Once cochlear cells are lost, their spontaneous regeneration rarely occurs in mammals. Therefore, it has been a key element how to induce regeneration of cochlear cells in mammals in the field of inner ear research. In this study, we focused on cell reprogramming, which has been established as a method for generation of pluripotent stem cells from somatic cells. We examined whether reprogramming occurred in mouse cochlear cells by transduction of iPS cell-factors or not.

Materials and methods: Cell spheres derived from postnatal day 1 (P1) mouse cochleae, namely otospheres, and cochlear explants of P1 mice were used. Four transcription factors, Oct3/4, Sox2, Klf4 and c-Myc, were introduced into dissociated cells of otospheres using retrovirus, and three factors, Oct3/4, Sox2 and Klf4, were introduced into cochlear explants using electroporation. We analyzed full or partial reprogramming in transfected cochlear cells.

Results: After transduction of four factors, otosphere-derived cells formed colonies with the morphology of ES cell-colonies, which expressed several ES cell-markers. ES cell-like colonies derived from otospheres were able to differentiate in three embryonic germ layers in vitro. In addition, transplantation of these cells in nude mice generated teratoma. These findings demonstrated generation of iPS cells from otospheres-derived cells. In cochlear explants, transfection of three factors by electroporation was observed in some supporting cells, of which 90% cells showed expression of Oct3/4 and 50% showed forced expression of Sox2. In transfected cells in the greater or lesser epithelial ridge of cochleae, Prox1 expression was identified, suggesting that partial reprogramming had occurred in transfected cells.

Conclusions: The present findings indicate that full or partial reprogramming of cochlear cells may be induced by introduction of iPS cell-factors.

O56

Magnetic resonance imaging of the guinea pig following gadolinium application Duan M, Bjelke B, Counter SA, Borg E, Laurell G

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The time course and distribution of the in vivo uptake of the gadodiamide chelate bound paramagnetic Gd ion (GdDTPA-BMA) throughout the membranous labyrinth of normal and impulse noise-damaged guinea pig cochleae were measured by MRI at 4.7T. The ST revealed the most rapid and extensive enhancement throughout the period of active Gd uptake, while the SV showed comparatively slower and less enhancement, and the intact scala media (SM) indicated insignificant enhancement. The in vivo Gd penetration and enhancement of the membranous SM increased significantly in the noise-damaged cochlea, suggesting lesioning of the cochlear membranes. We further based on local application of the paramagnetic contrast agent gadolinium. Using a 4.7 T MRI scanner, high contrast images of all four cochlear turns were obtained 3.5 h after placing gadolinium on the round window membrane. Gadolinium cleared from the cochlea within 4 days. Auditory brainstem response measurements performed on a separate group of animals showed no significant threshold shifts after the application, indicating that gadolinium is non-toxic to the guinea pig cochlea indicating that there is potential clinical application.

O57

The striated organelle in inner ear hair cells

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We have previously described the striated organelle (SO) in vestibular hair cells where it is particularly well developed (Vranceanu et al., PNAS, 2012). The SO is located in the subcuticular region of hair cells and consists of alternating thick and thin bands (Friedman et al., Nature, 1965; Ross & Bourne, Science, 1983). In type I hair cells, it is shaped like an inverted open-ended cone that contacts the cell membrane along its entire circumference and is separated from the cuticular plate by a layer of large mitochondria. Stereociliar rootlets have been observed bending at an angle of 110 degrees, traversing the cuticular plate and inserting in the plasma membrane in the vicinity of the SO, opposite the kinocilium. The SO is also present in cochlear inner hair cells. In hair cells other than vestibular type I hair cells, it seemed a much smaller structure and appeared to be free-floating. We have now studied it in more detail with EM tomography and confocal microscopy and find it more extensive (in height, breadth and radial depth) in type II hair cells than in type I hair cells. In a 3-D tomographic reconstruction, we have not yet found a connection to actin rootlets in type II hair cells, as there was with type I cells, but it is closely associated with mitochondria, although these are smaller in volume and surface area than in type I cells. EM immunogold experiments have demonstrated that antibodies to actin-binding proteins α 2- and β 2-spectrin (also called fodrin or non-erythroid spectrin) label the SO. Confocal immunolabeling shows that the SO in type II hair cells extends down from the cuticular plate as two large sheets. Unlike the SO in type I hair cells, those in type II cells are not associated with a constriction in the neck of the hair cell, although thick filaments do form cross-links and occasionally, "morph" into thin filaments. We continue to study the structure, protein composition, and function of this intriguing organelle.

O58

Habituation to repeated Galvanic vestibular stimulation as an analog of sensorimotor adaptation to microgravity

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Orbital insertion, or landing on a planetary body after extended exposure to microgravity, requires a period of sensorimotor adaptation lasting days to weeks. The aim of this study was to identify biomarkers that predict an individual's sensorimotor adaptation ability, using a validated ground-based analog of the sensorimotor effects of spaceflight. The analog utilizes Galvanic vestibular stimulation (GVS), applying a small pseudorandom transmastoidal current to safely and temporarily interfere with vestibular input. Subjects (10) received 12 weekly 10-min GVS exposures (total 120 min), as well as follow-up sessions at week 18 and 36. Prior to first exposure subjects performed computerized dynamic posturography (CDP) and were tested for static and dynamic visual acuity. During each 10-min weekly GVS exposure subjects performed CDP and tandem walking, and torsional eye movements were measured with video-oculography. CDP scores were essentially unchanged over the 36 weeks of testing in the baseline (no-GVS) condition. During GVS there was a significant decrease in CDP scores at week 1, which returned to baseline over a period of weeks, and this improvement was maintained at week 18 and 36. The pattern of postural recovery was remarkably similar to that observed in shuttle astronauts post-flight. Each subject's weekly CDP score during GVS were fit with an exponential recovery and time constants calculated, and a regression analysis demonstrated that individual adaptation time constants were significantly correlated with baseline CDP sensory indices (proprioception and vestibular) as well as visual acuity - better baseline performance was related to faster adaptation to GVS. Reflex mediolateral sway and ocular torsion were unchanged in response to GVS over the 12 weeks, whereas CDP scores and tandem walking recovered to baseline. Habituation occurred at the central level and was apparent only in complex tasks involving sensory integration. Support: NSBRI SA01603.

O59

The effect of microgravity on gene expression in the vestibular end-organs. Otoconin 90 was up-regulated by microgravity.

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Introduction: The exposure of the human body to microgravity, a condition that occurs during space flight, causes significant decrease in vestibular inputs, and may be one of the most important causal factors in space motion sickness. The vestibular end-organs detect linear and angular accelerations of the body and send the information to the brain via the primary afferent neurons. Upon exposure to a

microgravity environment, the decrease in vestibular inputs may produce gene expression changes in the vestibular system to adapt to the different environment. In this study, we analyzed the gene expression changes in the mouse vestibular system exposed to microgravity during space flight.

Materials and Methods: Mice from the biospecimen sharing program (BSP) of STS-131 Discovery were used in this study. The flight was a 15-day orbital mission and during the flight the mice were exposed to microgravity. Temporal bones were dissected out from flight mice after landing as well as from ground control mice and kept in "RNA later" at -80°C. The vestibular end-organs (otolith organ semicircular canals and vestibular ganglion) and cochlea were dissected out from temporal bones and mRNAs extracted from them for DNA microarray technology. Quantitative real-time PCR was used to confirm expression changes observed in the microarray analysis.

Results and Conclusion: We demonstrated the up and down regulation of gene expression in vestibular end-organs after a 15-day space flight. From the large number of results of DNA microarray, we focused on the otoconia related gene, Otoconin 90 (Oc90), the principal soluble protein of mammalian otoconia. Oc90 was up-regulated in the flight mice. Our results support the hypothesis that in adaptation to microgravity, animals may increase the mass of the otoconia, and this proposal will contribute information towards our final goal of accelerating human adaptation to the space environment and prevention of space motion sickness.

O60

Enhancement of electrically-evoked vestibulo-ocular reflex in Meniere's disease

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Introduction: Meniere's disease is an inner ear disorder characterized by episodes of spontaneous vertigo, nystagmus, fluctuating sensorineural hearing loss, tinnitus and aural fullness. As Meniere's disease affects different parts of the vestibular labyrinth, electrical vestibular stimulation (EVS) may be a useful test because it stimulates the entire vestibular labyrinth. We investigated if the electrically-evoked vestibulo-ocular reflex (eVOR) to EVS was altered in Meniere's disease.

Materials and Methods: Thirteen unilateral Meniere's patients who satisfy the AAO-HNS criteria for Meniere's diagnosis were recorded with dual-search coils to measure the 3D binocular eVOR to EVS using a bipolar 100ms current-step at intensities of [0.9, 2.5, 5.0, 7.5, 10.0]mA. Results were compared to 17 normal subjects.

Results: Normal eVOR had tonic and phasic spatio-temporal properties best described by the torsional component. At 8.8ms latency after EVS onset and offset, there were phasic eVOR initiation (1120deg/s/s) and cessation (1600deg/s/s) acceleration pulses, whereas during the 100ms EVS-step, there was a tonic eVOR (8.5deg/s) at 10mA EVS. In Meniere's disease, eVOR onset latency was normal at 9.0ms. However, mean tonic eVOR exhibited a ramped enhancement to about twice (18.6deg/s) normal eVOR at 10mA EVS. The tonic eVOR was different to normal with EVS 5mA. The phasic eVOR initiation was broadened and showed a bimodal response. Unlike normal eVOR, phasic cessation did not return the eVOR velocity past baseline in ~70% of patients.

Conclusion: The enhanced tonic eVOR in Meniere's disease may explain the frequent vertigo attacks even in the presence of declining mechanically-evoked vestibular responses. It suggests that Meniere's disease may have increased the vestibular hair cell excitability or reset the vestibular nerve activation threshold. These tonic and phasic eVOR abnormalities may be useful indicators of Meniere's disease.

O61

Short-term efficacy of semicircular canal occlusion in the treatment of intractable Meniere's disease

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Objective: To explore the efficacy and safety of triple semicircular canal occlusion (TSCO) in the treatment of intractable Meniere's disease (MD) so as to provide a alternative surgical procedure for treating this disorder.

Methods: Data from 17 patients, who were referred to our hospital and diagnosed with unilateral MD from Dec. 2010 to Jul. 2011, were retrospectively analyzed in this work. 17 patients, in whom the standardized conservative treatment was given at least one year and frequent vertigo still occurred, underwent TSCO. Vertigo control and auditory function were measured. Pure tone audiometry, caloric test, and vestibular evoked myogenic potential (VEMP) were performed for evaluation of audiological and vestibular function. Postoperative follow-up time was 8-15 months, with an average of 12 months.

Results: According to the preoperative staging of hearing, among these 17 patients, there were 2 cases in stage çò (with an average hearing threshold of 25-40dB) and 15 in stage çó (41-70 dB). No vertigo was found during the follow-up period, with 100% control rate of vertigo. Three months after surgery, 12 patients showed no significant change in comparison with primary status and, 5 patients presented with an increase in the average hearing threshold, with 29.4% of hearing loss rate. Post-operatively, All patients suffered from postoperative balance disorders, of whom 10 patients recovered in 1 to 2 weeks after surgery, and the remaining 7 patients recovered within 2 months. Three months after treatment, loss of semicircular canal function by caloric test was found in the operation side of all patients and no change in VEMP test was noted.

Conclusions: TSCO, which can reduce vertiginous symptoms in patients with intractable MD, represents an effective and safe therapy for this disorder. TSCO is expected to be used as an alternative procedure for the treatment of MD in selected patients suffering from moderate to severe hearing loss.

O62

Genetically determined ionic and fluid disorders in Menière's Disease

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Introduction: In previous works we published data supporting the hypothesis that a ionic imbalance in the endolymph, related to a missense mutation (Gly460 Trp, rs4961) of Adducin 1 gene (ADD1) or sodium homeostatic mechanisms (plasma Endogenous Ouabain, EO levels) may act as a predisposing factor to develop Menière's Disease (MD). We present now data on a larger sample and considering other genes related to both ionic and fluid control.

Materials and methods: we genotyped 100 patients affected by definite MD. Delayed hydrops were excluded. Results were compared with those from a control group (n=96). Since migraine is often comorbid with MD, results have been assessed in both groups of MD with and without migraine.

Results: Forty-one MD out of 100 subjects presented migraine. The age of the first attack of vertigo was lower in migraineurs than in non migraineurs (37 and 43 years old respectively; $p < 0.05$). ADD1 Trp mutated allele frequency was increased only in the subgroup of MD subjects with migraine ($p = 0.001$) but not in MD subjects without migraine ($p = 0.3$) compared to controls. A difference between MD and controls has been detected for polymorphism of PKD2 gene (rs2725230), that encodes polycystin 2, a Ca²⁺-permeable non-selective cation channel ($p = 0.005$). Endogenous Ouabain was lower in MD subjects than in controls (Mann-Whitney, $p < 0.05$). Statistics demonstrated that EO, ADD1 and PKD2 act as independent factors. No statistical difference has been detected for other polymorphisms previously found associated in an hypertensive cohort characterized for salt-sensitivity (NCX1, TRPC6, NCKX3, NEDD4L, WNK1, Cyp11B2, SIK1) or related to EO metabolism and catabolism (LSS2, MDR2, HSD8).

Conclusions: Our data support the hypothesis that MD is a complex disorder and mechanisms related with ionic and fluid homeostasis may act as predisposing factors.

O63

Transtympanic membrane massage stimulation for the treatment of Meniere's disease

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We treated patients with Meniere's disease by a new middle ear pressure device, which directly stress the oval window by way of the tympanic membrane and auditory ossicle without insertion of the ventilation tube.

The new device is a tympanic pressure equipment used for the treatment of otitis media with effusion in Japan, and is able to produce pressure stimulation similar to the Meniett device. Without insertion of the tympanic ventilation tube, pressure is directly applied through the earplug inserted into the external auditory canal to the tympanic membrane, and transmits to the inner ear by way of both the oval and round window. Pressure treatment is three minutes per one cycle, two or three times per day.

By this method, we treated 13 patients with Meniere's disease or delayed endolymphatic hydrops suffering from intractable vertiginous attacks, which could not be controlled by the conventional treatment including osmotic diuretics. The medications taking before the pressure treatment were used together. Average vertiginous attacks before the pressure treatment were from 1.5 attacks per months to 14 attacks per months.

In all 13 patients treated by this device, we could observe useful effects. In five patients, we finished the pressure treatment because their vertiginous attacks disappeared. In eight patients, their vertiginous attack improved, the numerous values of which were below 40. In all patients, the vertigo control occurred within one month, which might be shorter than that of the Meniett device in our hospital. We did not observe any harmful complications.

Based on our result, we could expect that our tympanic pressure treatment by the new device might come into wide use in the future. Therefore, we would continue the treatment for a larger number of Meniere's disease or delayed endolymphatic hydrops patients.

O64

3D-FLAIR MRI after Intratympanic Administration of Gd-DTPA in Diagnosis of Meniere's Disease

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Objective: To study the feasibility of endolymphatic visualization and the diagnosis of Meniere's disease by applying intratympanic gadolinium administration through the tympanic membrane and three-dimensional fluid-attenuated inversion recovery magnetic resonance imaging (3D-FLAIR MRI). **Methods:** With a 3 Tesla magnetic resonance imaging (MRI) unit, 3D-FLAIR imaging was performed 24 hours after intratympanic gadolinium through the tympanic membrane in 19 patients (9 males and 10 females, age 24-62 years, median age 44.6 years) with clinically diagnosed unilateral definite Meniere's Disease. We visualized the enhanced imaging of perilymphatic space in bilateral cochlea, vestibular and (or) canal, scoring scala tympani and scala vestibule of bilateral cochlear basal turn respectively and measuring the developing area of bilateral vestibule and the signal intensity ratio (SIR) between the vestibule and the brain stem subjectively. Scoring scala tympani, scala vestibule and developing area of vestibule in MD patients was evaluated and correlated with caloric stimulation, electrocochleography, and vestibular evoked myogenic potentials results. **Results:** The gadolinium appeared in almost all parts of the perilymph in cochlea, vestibular and (or) canal, so the endolymphatic space was clearly shown on 3D-FLAIR imaging. The scala vestibuli score value and the developing vestibular area (5.77±2.33 mm² and 8.11±3.32 mm²) between the affected side and the healthy side were statistically significant (P<0.05) in all 19 patients' inner ears. Abnormal vestibular evoked myogenic potentials were significantly correlated to the developing vestibular area of the affected side. **Conclusion:** 3D-FLAIR MRI with intratympanic gadolinium injection through the tympanic membrane can show the border between the perilymph and the endolymph and confirm endolymphatic hydrops, providing radiographic evidence for diagnosis of Meniere's disease.

O65

Saccular otoconia as a cause of Meniere's disease?

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Introduction: Saccular otoconia could be dislodged by some causes such as aging as the natural fate, infection, disturbance of blood circulation, trauma, etc. and the dislodged otoconia from the sacculle can disperse into the surrounding membranous labyrinth. If otoconia fall into such narrow pathway, reuniting duct (ductus reuniens) (RD), saccular duct (SD) and endolymphatic sinus (ES) to the endolymphatic duct, they could disturb the endolymphatic flow. This study was designed to visualize and assess the RD, SD and ES in Meniere's disease (MD) patients using three-dimensional (3D) CT.

Subjects and Methods: Sixty-two patients with definite diagnosis of unilateral MD, based on criteria proposed by the committee on hearing and equilibrium of the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), were compared with contralateral ears and normal controls (26 ears) using 3D CT. The RD, SD and ES were scrutinized for patency on 3DCT images.

Results: MD ears showed loss of continuity of RD, SD and ES based on evaluation of 3D CT images, and differed significantly from normal healthy control ears (p<0.01).

Conclusion: Significant reduced visualization of RD, SD and ES in MD compared to normal control ears on 3D CT imaging suggest the blockage of endolymphatic flow there with radiodense substances, which may be explained by dislodged otoconia from the sacculle. These structures could be involved in the pathogenesis of MD.

O66

Familial aggregation and Familial Meniere's disease in Spain

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Introduction Meniere's Disease (MD) is a complex disorder where combined genetic and environmental factors determine its development. MD has a clinical heterogeneity and incomplete clinical variants are missed according to the AAO-HNS guidelines for diagnosis of MD. We estimated the familial aggregation in a series of patient with definite MD including relatives with incomplete phenotypes.

Material and methods A case series including 372 patients with diagnosis of MD, according to the AAO-HNS criteria were investigated for familial history of episodic vertigo and sensorineural hearing loss (SNHL) to identify relatives with possible MD. Clinical records from all patients were revised and personal interviews with patients and their relatives were carried out to obtain all relevant information for diagnosis of MD. Familial MD (FMD) was defined if a patient with definite MD had a relative in the first, second or third degree with diagnosis of MD. Familial aggregation was estimated by the sibling recurrence-risk ratio (λ_s), after calculating the prevalence of MD between siblings and using intermediate and high prevalence values for MD in European descendent population. Incomplete phenotypes were considered in the relatives of FMD cases presenting SNHL or episodic vertigo.

Results Sixteen of 372 patients with MD had a sibling with MD and λ_s was 22-57. FMD has a prevalence of 8.6% in our cohort. There was 32 cases (16 men, 16 women) from 25 multicase families. The mean age of onset was 42 years old (range 11-64). Anticipation was observed in 6 of the 8 evaluated families and bilateral MD was found in 13 cases (41%). Migraine was a comorbid condition in 6 cases but no association with FMD was found.

Conclusions MD has a strong familial aggregation and FMD is associated with anticipation in successive generations.

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O67

Endolymphatic hydrops detected by inner ear Gd-enhanced MRI, ECoChG or glycerol test.

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Gadolinium (Gd) -enhanced MRI has been introduced to detect visually endolymphatic hydrops by Nakashima and his colleagues (Laryngoscope 2007, Acta Otolaryngol 2010). However, since the image depends on the hardware, pulse sequence or the way of Gd administration, the protocol and the evaluating criteria have not yet been standardized.

In this study, we assessed hydrops on MRI in 26 patients with Meniere's disease or delayed endolymphatic hydrops. Two types of Gd administration were used; injection into the tympanic cavity (IT) in 17 patients or intravenous injection (IV) in 9 patients. Axial 2D-FLAIR images were obtained by 3.0T GE MRI unit, 24h after IT, or 4h after IV.

The endolymphatic space was detected as a low signal intensity area, while the surrounding perilymphatic space showed high intensity by Gd contrast. Normally the cochlear duct is not apparently detected. If low signal areas corresponding to the cochlear duct could be clearly noticed, we classified it as cochlear hydrops. On the other hand, the vestibular part of endolymphatic space is apparent in normal ear. If the most part of vestibule was occupied by a low signal area in more than half of the images, we classified it as vestibular hydrops. In 2 cases of IT method applied, the inner ear (perilymph) was not well contrast-enhanced, probably due to the problem of permeability through the round window.

Generally the IV method gives less contrast-enhancement than IT method, causing more difficult in assessing hydrops. Nevertheless, endolymphatic hydrops was detected in 88% (15/17 cases) by IT, and 78% (7/9) by IV. As a conventional test, ECoChG showed a relatively high detection rate (14/16) if the wave could be observed. In cases of profound hearing loss, ECoChG and the glycerol test could not be applied. And the detection rate in the glycerol test was low (6/16).

Even though technical problems still exist, inner ear Gd-enhanced MRI is an effective tool to assess the endolymphatic hydrops.

O68

Proteomic analysis of human endolymphatic sac fluid in Meniere's disease: pilot study for biomarkers of Meniere's disease

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Introduction: This study was performed to identify unique proteins exist only in the endolymphatic sac (ES) luminal fluid of Meniere's disease patients. Authors also tried to suggest main pathophysiology of Meniere's disease that induces final pathology of endolymphatic hydrops and to suggest biomarkers for the definite diagnosis of Meniere's disease.

Materials and Methods: The ES luminal fluid was sampled from definite unilateral Meniere's disease patients (n=4) during endolymphatic sac surgery and from control (n=4) during acoustic tumor surgery via translabyrinthine approach. Protein profiles of each sample were analyzed with liquid chromatography-mass spectrometry (LC-MS/MS) followed by 1-DE. Then, each protein profiles were compared and proteins exist only in Meniere's disease were analyzed.

Results: Total ~3400 proteins and ~4100 proteins were identified in control and Meniere's disease after LC-MS/MS, respectively. Proteins commonly detected only in the samples of Meniere's disease were 180 proteins. Among them, immunoglobulin was most common (76 %), and then albumin (5.5 %), keratin (5.5 %), globin (5 %), protease inhibitor (1.7 %), complements, actin, filbrillin, tissue factor and interferon regulatory factor. Proteins only exist in the luminal fluid of Meniere's disease but not in the control were 9 proteins; 8 of them was immunoglobulin and 1 was interferon regulatory factor, which were all involved in immunologic reaction.

Conclusion: This result implies that immunologic reaction (or autoimmune reaction) is likely to be involved in the pathophysiology of Meniere's disease. This is the first study for the complete analysis of protein profiles of ES luminal fluid of Meniere's disease patients and can be the basic information of biomarker study for the diagnosis of Meniere's disease.

O69

Significance of the development of the inner ear third window effect after endolymphatic sac surgery in Meniere's disease patient

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Introduction: Low-frequency air-bone gaps (LFABGs) are observed in patients with inner ear third window effects. If a third window is created on the endolymphatic sac during endolymphatic sac surgery, either by the decompression of the bony covering of the endolymphatic duct and sac or by an endolymphatic sac shunt, a LFABG is apparent after the surgery. In the current study, we examined the development of LFABGs in Meniere's disease patients who underwent endolymphatic sac surgery, and we investigated the significance of the third window effect in relation to surgical outcome.

Materials and Methods: 16 patients who had been diagnosed with definite Meniere's disease and underwent endolymphatic sac surgery were studied. The surgical outcome was evaluated based on the 1995 guidelines of the AAO-HNS. The number of patients who developed LFABGs (a mean air-bone gap > 10 dB HL in at 250, 500, and 1000 Hz) after the surgery was determined, and the significance of the LFABGs was evaluated by analyzing their relationship with the surgical outcome.

Results: The vertigo spells of 9 patients were completely controlled (class A). The number of vertigo spells was reduced by 60 % - 99 % in 6 patients (class B) and by 20 % - 59 % in 1 patient (class C). Postoperative LFABGs were observed in 13 patients. The mean LFABG of the patients in class A was significantly larger than those of the patients in classes B and C (25.0 ± 7.6 dB nHL in class A vs. 10.0 ± 7.5 dB nHL in class B and C; $P = 0.005$).

Conclusion: Based on the data of current study, we conjectured that the correlation of large LFABGs with excellent vertigo control in this study may be due to a third window phenomenon related to bony decompression of the endolymphatic sac and duct, and may serve as a favorable prognostic marker.

O70

Albumin-like protein is a main osmotic regulator of endolymphatic sac luminal fluid volume

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Introduction: The endolymphatic sac (ES) is an inner ear organ that is connected to the cochleo-vestibular system through the endolymphatic duct. The luminal fluid of the ES contains a much higher concentration of proteins than any other compartment of the inner ear. This high protein concentration likely contributes to inner ear fluid volume regulation by creating an osmotic gradient between the ES lumen and the interstitial fluid.

Materials and Methods: We characterized the protein profile of the ES luminal fluid of patients (n = 11) with enlarged vestibular aqueducts (EVA) by proteomics. In addition, we investigated differences in the protein profiles between patients with recent hearing deterioration and patients without hearing deterioration.

Results: The mean total protein concentration of the luminal fluid was 554.7 ± 94.6 mg/dl. A total of 58 out of 517 spots detected by 2-DE were analyzed by MALDI-TOF MS. The protein profile of the luminal fluid was different from the profile of plasma. Proteins identified from 29 of the spots were also present in the MARC-filtered human plasma; however, the proteins identified from the other 25 spots were not detected in the MARC-filtered human plasma. The most abundant protein in the luminal fluid was albumin-like proteins, but most of them were not detected in MARC-filtered human plasma. The concentration of albumin-like proteins was higher in samples from patients without recent hearing deterioration than in patients with recent hearing deterioration.

Conclusion: The protein of ES luminal fluid is likely to be originated from both the plasma and the inner ear and considering that inner ear fluid volumes increase abnormally in patients with EVA following recent hearing deterioration, it is tempting to speculate that albumin-like proteins may be involved in the regulation of inner ear fluid volume through creation of an osmotic gradient during pathological conditions.

071

Effects of bilateral vestibular deafferentation on hippocampal morphology in rats

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Bilateral loss of vestibular function has been shown to cause spatial memory deficits in both animals and humans. In patients with bilateral vestibular loss a significant bilateral atrophy of the hippocampus was reported. More recently, patients who had recovered from unilateral vestibular neuritis have been reported to exhibit a significant atrophy of the left posterior hippocampus. Therefore, we investigated whether bilateral vestibular deafferentation (BVD) would result in a decrease in neuronal number or volume in the rat hippocampus, using stereological methods. In addition, changes in neuronal dendritic structure in the CA1 region of the hippocampus were also investigated using Golgi staining and Sholl analysis. At 16 months post-BVD, we found no significant differences in hippocampal neuronal number or volume compared to sham controls, despite the fact that these animals exhibited severe spatial memory deficits. By contrast, BVD caused a significant reduction in the number of intersections of the basal and apical dendrites of neurons in CA1, which suggests an atrophy of the dendritic trees. This may partly contribute to the underlying mechanisms of spatial memory deficits following BVD.

072

Decrease in hippocampal cell proliferation following galvanic vestibular stimulation in rats

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In addition to its common use in the diagnosis of vestibular dysfunction, galvanic vestibular stimulation (GVS) has been used as an experimental treatment for spatial memory deficits, various forms of chronic pain, and other neurological disorders such as Parkinson's disease. However, there is a very limited understanding of the effects of GVS on areas of the brain such as the limbic system. Hippocampal cell proliferation/neurogenesis has been shown to be affected by loss of vestibular function; therefore, in theory, it could also be affected by artificial activation of the vestibular system. In the present study, we investigated cell proliferation in the hippocampus in rats following GVS under anaesthesia, with the cathode in the right tensor tympani muscle and the anode in the left tensor tympani muscle, or vice versa (n = 8 per group). A sham control group had the electrodes implanted and was subjected to anaesthesia without GVS (n = 8). The animals were injected with the cell proliferation marker, bromodeoxyuridine (BrdU), at 72 h after GVS (0.4 mA) for 1 h, judged as subthreshold using video microscopic analysis of nystagmus. The animals were sacrificed at 2 h after the BrdU injection. BrdU immunopositive cells in the hippocampus were counted using stereology and the optical disector method. GVS resulted in a significant decrease in the number of BrdU positive cells at 72h post-stimulation, in the left and right hippocampus, compared to sham controls, irrespective of whether the cathode was on the left or right sides (P < 0.001). Double immunolabelling revealed that over 90% of the BrdU positive cells were co-labelled with Ki67, another cell proliferation marker. The results demonstrate, for the first time, that GVS, at this amplitude and duration, decreases cell proliferation in the hippocampus. Further studies are required to determine the impact of this type of GVS on hippocampal neurogenesis and long-term neuronal survival and function.

073

Julius Ewald - The man and his famous book

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Introduction: In the early nineteenth century the bony structure and some membranous structure of the inner ear were anatomically well described but their functions unproven. A common notion was that the semicircular canals were for the transmission of bone conducted sound and the perception of sound direction. In 1824 Marie Jean Pierre Flourens had published the results of his experiments in pigeons which showed that the semicircular canals were associated with eye and head movements. Julius Ewald (1855-1921) was Professor of Physiology at the University of Strassbourg (now Strousberg). His work on the inner ears of frogs, pigeons and dogs was published as *Pysiologische Untersuchungen uber das Endorgan des Nervus Octavus* in 1892. Although the book is widely referred to by vestibular system investigators few have ever seen it.

Materials and Methods: A short biography of Ewald is presented. An full English translation of the book was accomplished. Unfortunately much of the book deals with ablative experiments on pigeon inner ears, but it conveys Ewald's ingenuity in experiment and equipment design, long before the operating microscope.

Results: The most elegant and important findings are not until page 264 as Experiment 81 and Experiment 82. Selective cannulation of the canals enabled the application of positive and negative pressures. These correctly implied a direct connection between the canals and eye muscles except to lateral rectus, which was the only error.

Conclusions: Ewald's important but perfunctory description of eye movements has come to be known as Ewald's Laws of canal function. At the some inconsistencies were perplexing (Ewald's Paradox) and were not explained for another 60 years by the electron microscope. Ewald's observations have become a quoted cornerstone of vestibular physiology and are now clinically relevant in explaining the eye movements of BPV.

074

Eye-head-trunk coordination during time-optimal large horizontal gaze reorientations in standing humans

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Introduction: Shifting the direction of the line of sight in everyday life involves rotations not only of the eyes and head but also of the trunk. We investigated the covariation of eye-in-orbit, head-on-trunk and trunk-in-space angular horizontal displacements during time optimal (i.e. executed as fast as possible) whole-body rotations to targets of up to 180° eccentricity.

Materials and Methods: Subjects (Ss) stood in the centre of an array of 8 LEDs placed at 45° intervals at eye level, in darkness. Ss were required to fixate and align their bodies with the central LED. After a delay of 20s the central target was extinguished indicating that another LED in one of the seven eccentric locations (45, 90 and 135° either right or left as well as at 180°) had been lit. The subject had to fixate the lit LED by turning and aligning his body with it. After 30 s the eccentric LED was turned off cueing Ss to return to the initial, central position (inbound trials with predictable target location). The central LED was however again lit after additional 5.5 s, so that Ss performed the task without visual feedback.

Results: Ss were able to execute single-step gaze shifts (at least 85% of the target eccentricity) in 45%, 70% and 15% of inbound trials to 90°, 135° and 180° targets respectively. In these occasions peak eye-in-orbit displacement approached the mechanical 50° eye-in-orbit limit while head-on-trunk displacement saturated at 30° (showing thus a 'neural limit'). The combined movement in single-step gaze shifts was stereotyped such that the first two principal components accounted for the data variance up to 480 ms. Thus, the three mechanical degrees of freedom under consideration were reduced to two kinematic degrees of freedom until target acquisition.

Conclusion: During fast whole-body reorientations the incidence of single-step gaze shifts is increased and up to the end of the single-step gaze shift the combined movement has features of a motor synergy.

075

Topical application of FGLM-NH2 plus SSSR is effective for vestibular disorder induced by AMPA.

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Introduction: The tetrapeptide FGLM-NH₂ derived from Substance P (SP) can be used to treat corneal disorders when combined with SSSR, a tetrapeptide derived from insulin-like growth factor-1 (IGF-1). We examined the influence of FGLM-NH₂ plus SSSR when locally applied to the unilateral inner ear of guinea pigs with vestibular disorder induced by AMPA.

Materials and Methods: Eighteen Hartley white guinea pigs were assigned to groups administered with FGLM-NH₂ plus SSSR, artificial perilymph and no treatment. A hole was drilled adjacent to a round window and AMPA was infused into the hole to induce vestibular disorder. Thereafter, FGLM-NH₂ plus SSSR or artificial perilymph was delivered via an osmotic pump inserted into the hole. We observed spontaneous nystagmus and measured vestibulo-ocular reflexes (VOR) using sinusoidal rotation tests. Two animals from each group were immunohistochemically examined At 24 h after treatment.

Results: Spontaneous nystagmus decreased immediately after FGLM-NH₂ plus SSSR infusion. The recovery of VOR gains was statistically faster than that in the control group at 3 and 7 days after treatment. Immunohistochemical examination revealed that many synaptic ribbons, a marker of the synapse, were stained in the FGLM-NH₂ plus SSSR group compared with the untreated group.

Conclusion: Topical application of FGLM-NH₂ plus SSSR accelerates functional recovery from AMPA-induced vestibular disorders by facilitating synaptic regeneration in guinea pigs.

O76

Ocular vestibular-evoked myogenic potentials to high frequencies show superior semicircular canal dehiscence(SSCD)

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Introduction:To investigate the effect of SSCD on the n10 component of the ocular vestibular-evoked myogenic potential (oVEMP) evoked by air conducted sound and by bone conducted vibration at the midline forehead at the hairline (Fz) at several frequencies. Can the oVEMP n10 to high frequency ACS or BCV indicate SSCD?

Materials and Methods:23 SSCD patients were tested and 27 healthy subjects. BCV was delivered by hand-held Bruel & Kjaer 4810 minishaker at Fz or at the vertex of the skull (Cz).The oVEMP n10 was measured using surface EMG electrodes beneath both eyes. The stimuli were tone bursts of several frequencies (ranging from 125 Hz to 8000Hz)

Results:In response to ACS and Fz BCV even at low intensities in SSCD patients the oVEMP n10 amplitude beneath the contraSSCD eye was substantially and significantly larger than the oVEMP n10 beneath the ipsiSSCD eye. In SSCD patients there was a significant relationship between the size of the CT-verified dehiscence and the amplitude of the contralateral oVEMP n10 potential. The oVEMP n10 to BCV stimulation at Cz was still present in SSCD patients, but was small or absent in normals.In healthy ACS oVEMP n10 is present and reproducible up to 1000 Hz while in SSCD ACS oVEMPs n10 is present up to far higher frequencies.In healthy subjects BCV oVEMPs n10 can be evoked up to 750 Hz while in the Fz BCV oVEMPs n10 is present until 8000 Hz in 23 SSCD patients. This sequence can be obtained very easily even in senior patients and avoids the lengthy procedure of finding ACS cVEMPs threshold with repeated stretching of the neck

Conclusion:In response to ACS and Fz BCV at several frequencies an asymmetrical oVEMP n10 with a significantly increased amplitude of contralesional oVEMP n10 (compared to population values of healthy subjects) is a simple useful indicator of SSCD.oVEMP testing with high frequency ACS and BCV allows very simple,very fast identification of a probable unilateral SSCD

O77

Functional expression of TRPA1 and TRPV1 in rat vestibular ganglia

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Introduction:Transient receptor potential ankyrin (TRPA)-1and transient receptor potential vanilloid (TRPV)-1 are both cation channels co-expressed in sensory neurons such as dorsal root ganglia (DRG) and trigeminal ganglia (TG). TRPA1 is activated by noxious cold stimuli (<17°C), alkaline pH (>8.5),

cinnamaldehyde, mustard oil, menthol and icilin, while TRPV1 is activated by capsaicin, noxious heat (>43°C), and protons. TRPV1 has been reported to be expressed in vestibular ganglia (VG) and suggested to be associated with vestibular function and/or dysfunction. On the other hand, in DRG and TG neurons, TRPV1 is co-expressed with TRPA1, but expression of TRPA1 in VG neurons has not been reported yet. We studied the expression of TRPA1 as well as TRPV1 in rat VG neurons through the histological and physiological methods.

Materials and Methods: We examined the mRNA expression and localization by RT-PCR and *in situ* hybridization experiments and the functional expression by Ca²⁺-imaging experiments.

Results: RT-PCR specifically amplified TRPA1 and TRPV1 transcripts from rat VG. *In situ* hybridization experiments showed TRPA1 expression in majority of ganglion neurons and also TRPV1 expression. In Ca²⁺-imaging experiments, cinnamaldehyde, a TRPA1 agonist, induced significant increases in intracellular calcium ion concentration ([Ca²⁺]_i) in rat primary cultured VG neurons, which were almost completely blocked by HC030031, a TRPA1 specific antagonist. Capsaicin, a TRPV1 agonist, also caused [Ca²⁺]_i increase, which were completely inhibited by capsazepine, a TRPV1-selective antagonist. Moreover, in some VG neurons, [Ca²⁺]_i increase was evoked by both capsaicin and cinnamaldehyde in the same neurons.

Conclusion: In summary, these data showed histological and functional expression of TRPA1 and TRPV1 in VG neurons. It is suggested that TRPA1 and TRPV1 in VG neurons might participate in vestibular function and/or dysfunction such as vertigo

O78

Utricular and saccular afferents respond to both bone conducted vibration and air conducted sound

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Introduction: New clinical tests of human otolithic function use 500Hz bone-conducted vibration (BCV) and air-conducted sound (ACS) and measure ocular vestibular evoked myogenic potentials (oVEMPs) from surface EMG electrodes beneath the eyes. This study asked the questions: are some utricular afferents activated by both 500Hz BCV and ACS? To answer that we identified the peripheral sense organ of origin of guinea pig irregular primary vestibular afferent neurons activated by both ACS and BCV then staining these neurons with neurobiotin and then tracing their site of origin in the periphery.

Materials and Methods: Single primary vestibular neurons which were activated with high sensitivity were recorded extracellularly in ketamine anaesthetized guinea pigs. Juxtacellular neurobiotin injection was used to label these afferent neurons. Whole mounts of the entire utricular and saccular maculae were processed with ABC Elite and reacted with diaminobenzidine DAB, cleared with MSBB, to show the site of origin of the receptors synapsing on the recorded afferent. The location of the striola was shown by calretinin staining.

Results: Canal neurons were not activated at low threshold and high sensitivity as we have reported before. However irregular vestibular afferents, identified histologically as originating from the utricular macula or the saccular macula, responded to both ACS and BCV with low threshold and high sensitivity. The fibres originated from calyx endings on presumed type I receptors at the region of the striola.

Conclusion: Some vestibular afferents activated by both ACS and BCV originate from the utricular macula and some from the saccular macula. The presumption that ACS only activates saccular afferents in the inferior vestibular nerve - is not correct: these results show that some highly sensitive primary utricular afferents activated by BCV are also activated by ACS, just as some saccular afferents are.

O79

Missing sense of gravity without a pathogenetic explanation

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We will describe a patient who has no sense of gravity since birth. He is extremely dependent on visual orientation and experiences a complete loss of orientation under water with eyes closed. We performed testing of semicircular canals (SCC) by Video-Head-Impulse-Test, Dynamic-Visual-Acuity and caloric testing as well as otolith receptor testing by Subjective Visual Vertical (SVV) and ocular counterroll (OCR) in different roll tilt positions up to 90°. We also obtained SVV measurements during eccentric rotation. SCC function was normal on all tests. Trial to trial variability of SVV was normal when upright but considerably increased when roll-tilted to either side compared to 29 control subjects, although it has normal mean values also for tilted positions. At the same time, static OCR is markedly reduced compared to controls. On the other hand c- and oVEMP are reproducible bilaterally. This tells us that for high

frequency otolith tests (VEMP) he shows normal reactions but not for low frequency tests (SVV & OCR). He also has a high frequency hearing loss on the left since birth. We suggest two possible explanations. The patient may either have no or markedly reduced otoconia, like some knockout mice, which have similar lifelong balance problems or an isolated loss of regular firing haircells on his maculae.

O80

The stress response in anxious patients with balance dysfunction

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Introduction: In patients with balance dysfunction anxiety is known to have a significant negative impact, possibly affecting vestibular compensation, although the pathophysiology is unclear. Anxiety may affect the stress response, which is important for learning and memory, and studies have shown that it may be important for vestibular compensation. Studies also suggest a neuroanatomical linkage between brain substrates for anxiety, balance and stress. This however remains to be clearly substantiated clinically. This study aims to determine if anxiety results in an abnormal stress response in patients with a vestibular deficit.

Methods: Patients with a balance deficit on Calorics, CVEMP or OVEMP were recruited from a Vestibular Schwannoma cohort. Anxiety was assessed using the Hospital Anxiety and Depression Scale. Patients were divided into high-risk anxiety (A) and low-risk anxiety (B) groups using a score of 8, and underwent salivary cortisol analysis (5 samples 45 minutes apart) before, during vestibular stimulation (rotation & caloric) and thrice afterwards.

Results: Out of 46 patients 37 had a vestibular deficit. Ten patients had a HADS score of ≥ 8 (mean 11 ± 3). There were 5 men and 5 women (mean age = 52.2). Patients were age and sex matched (5 men and 5 women) from group B with a mean HADS of 4 ± 2 (mean age = 52.5). At the onset of vestibular stimulation there was a significant difference between groups with group B having a significantly lower cortisol than group A ($p < 0.05$), following which there was no significant change in salivary cortisol in group A. In group B salivary cortisol increased after vestibular stimulation and declined subsequently, resembling a normal cortisol response to a stressful stimulus, a change that approached significance ($P = 0.06$).

Conclusion: Our results suggest that balance dysfunction patients with anxiety may have an abnormal stress response to vestibular stimulation. This may affect their ability to undergo compensation.

O81

Effect of the ischemia on the vestibule: model experiment using bullfrog

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Introduction: Inner ear disorder is one of the main causes of vertigo. Though it has not been proved, many of the inner ear disorders are probably induced by the ischemia or virus infection. It is not easy to evaluate the circulation of the vestibule because of its anatomical location.

Objective: To establish the vestibular ischemia model using bullfrog, and to investigate changes of the vestibular organ in the ischemic condition.

Materials and Methods: Bullfrogs (*Rana catesbeiana*) were used. Under anesthesia with ether, the unilateral temporal bone was opened from the oral cavity by drilling, and the vestibular artery was cut (vestibular ischemia model). In some cases, the vestibular artery was not cut (sham surgery). The intact temporal bones served as control. Two to 7 days later, the semicircular canals and utricle were removed. Cupula was stained with India ink and was investigated in frog Ringer solution. The ampullae and utricle were fixed, cut in 4 μ m thickness, stained with hematoxylin-eosin. Neuroepithelia of the ampulla and utricular macula were investigated under light microscope.

Results: In vestibular ischemia model, 30~50% of cupula in each semicircular canal was damaged more or less. In the sham surgery and control groups, no cupula was damaged. Neuroepithelia of the ampulla were damaged in 50~80% of vestibular ischemia model and 1 sham surgery, and was intact in control. Cupula was damaged easily when the damage of the neuroepithelia were extensive.

Conclusion: The vestibular ischemia model was made using bullfrogs. The vestibular ischemia damages the neuroepithelia and cupula.

O82

Magnetic field-induced nystagmus in mice

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Introduction: Recent work by Roberts et al. suggests that static magnetic fields induce nystagmus in humans by peripheral vestibular stimulation and that this effect may be mediated by a magnetohydrodynamic force. This hypothesis can be tested by changing head orientation within static magnetic fields, but MRI magnet bore dimensions limit the ability to do this with humans. A mouse model would allow greater flexibility in assessing multiple head orientations. The aim of this study was to demonstrate magnetic field-induced nystagmus in mice.

Materials and Methods: Wild-type C57BL/6J mice were exposed to a 4.7T Earth-horizontal magnetic field. Prior to exposure, the mouse's head was secured to a non-ferromagnetic post and positioned so the horizontal semicircular canals were in the approximate earth-horizontal position. Monocular eye movements were recorded via video camera from the mouse's right eye in darkness with infrared illumination. Mice were positioned in the center of the magnet bore for at least 1 minute in each of several head orientations. Slow-phase nystagmus velocity (SPV) was calculated.

Results: When placed in the bore nose-first, all mice demonstrated robust left-beating nystagmus lasting approximately 20 seconds on first entry. SPV ranged between 50 and 120°/s with beat frequency of 5 beats/s over the initial interval within the bore. Duration and frequency appeared to decrease with repeat trials. When placed in the bore tail-first, nystagmus direction reversed. When placed in the bore left-ear-first, right-ear-first, or ventral-first, few eye movements were observed. Beats of nystagmus direction reversal were seen on a few trials after exiting the bore.

Conclusions: Mice exposed to high-strength magnetic fields demonstrate robust magnetic field-induced nystagmus that is dependent on the magnetic field orientation. These findings support the hypothesis that static magnetic fields induce peripheral vestibular stimulation through a Lorentz force.

O83

Effect of Transcranial Magnetic Stimulation (TMS) on perceptual vertical

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Introduction: In human and non-human primates several distinct areas of the parietal and temporal cortex receive information from the vestibular, visual and somatosensory systems, which is integrated into a perception of spatial orientation. These cortical regions are referred to as temporo-peri-Sylvian vestibular cortex (TPSVC). Here we investigated whether theta burst repetitive transcranial magnetic stimulation (TBS) of the TPSVC can alter egocentric spatial orientation in healthy humans. For this purpose, we measured perception of line orientation in space or subjective visual vertical (SVV).

Materials and Methods: SVV recordings were obtained before and after TBS and sham stimulation of the right inferior parietal lobule in eight healthy subjects. The SVV was measured using a forced-choice paradigm with subjects seated upright in otherwise complete darkness. The task was to report perceived orientation of a luminous line moved in steps of 2° in both clockwise and counterclockwise directions (up to 16° from earth vertical). The measurements were performed with head tilted either 20° to the right or to the left, away from vertical.

Results: With left head tilt, there was a significant difference between the shift in SVV after TBS (mean of 4° away from earth vertical) and sham stimulation (mean of 0.5° toward earth vertical) ($p < 0.05$). With the right head tilt, the shift of SVV after TBS (mean of 5° away from earth vertical) was also significantly different than sham stimulation (mean of 1° away from earth vertical) ($p < 0.05$).

Conclusion: The subjective visual vertical can be altered by transcranial magnetic stimulation of a focal area in the multisensory temporoparietal cortex (TPSVC). This effect is more pronounced with the head tilted away from upright in which the brain must perform a remapping among different sensory inputs to optimize the perceptual estimate. Thus, TMS is a useful tool to probe how cerebral cortex processes vestibular information.

O84

The characteristics of body perturbation in standing and stepping caused by artificial rotation of the visual field

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Introduction: Visual field image is known to affect sensation of inclination, cooperating with vertebral and proprioceptive sensations. However, the details of the effect of visual field image to body balance are not fully uncovered. In this study, movements of each of body components to artificially rotated visual

field were observed.

Materials and Methods: Five healthy volunteers were participated. Fluctuation of the visual field was realized with real-time processing of captured image in front of the subject and presentation with a head-mount display (Z800, eMagin). Visual field image was rotated between +30 and -30 degree with periods of 2, 4, and 8 second. Body movement during 1 minute of standing and stepping was measured using optical motion capture and analysis system (VICON Nexus). Center positions and inclinations of head, thorax, and pelvis were calculated from positional information of 4 markers in each of the body parts.

Results: In general, both center positions and inclinations of all of the body parts showed periodic perturbation according to the periods of the visual field rotation. The amplitudes of perturbation were larger in stepping than standing. In both conditions of standing and stepping, the movement of the center position of the head was largest, and that of the thorax was the next. The phases of movements of each of the center positions were nearly the same in the conditions of 4 and 8 second period of visual field rotation. In 4 seconds period condition, the phases of body perturbations were less than 90 degree delay to the phase of visual field rotation, whereas 110 to 190 degree delay in 8 seconds period condition.

Conclusion: To rapid visual field inclination (4 second period in this study), the body moved for catching up the inclination. On the other hand, more slow inclination (8 second period in this study), the body moved for correcting the visual field inclination with moving for the opposite direction. The adequate information of proprioceptive and vestibular sensation is considered to be utilized in the condition of slow visual field inclination, but information of these senses is minimized in that of fast visual field inclination.

O85

Mobile Posturography: Posturographic analysis of daily-life mobility

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Introduction: Mobility is crucial to maintain independence and quality of life. Posturography should therefore investigate daily-life activities to determine the mobility of an individual patient ("Mobile Posturography"). Nowadays, postural control is often estimated during stance tasks on a force plate by an indirect approximation of the centre-of-body-mass and is not related to tasks required for mobility. An alternative approach would be the direct measurement of body sway on the centre-of-body-mass during daily-life conditions. However, due to the increased degrees of freedom during more complex activities, the individual results should be analyzed very carefully. Beside the task selection, a detailed age and gender related analysis of the measurement is a crucial factor for the reliable estimation of daily-life mobility. The present study was therefore aimed at investigating the influence of those factors on the "Mobile Posturography". Furthermore, the reliability of this method was determined.

Materials and Methods: The "Mobile Posturography" was carried out with the Vertiguard-D system in 338 healthy volunteers and 79 patients which suffered from different vestibular disorders.

Results: In healthy volunteers an increase in body sway with ageing could be only observed under those conditions which require a highly developed musculoskeletal reactivity and/or coordinative action. A non-linear relationship between age and body sway was found in the majority of all conditions. Furthermore, large gender-related differences in body sway were observed. The overall sensitivity (including all conditions) for the detection of a vestibular disorder was 83%.

Conclusion: The "Mobile Posturography", as applied here, is an exact and reliable method for the estimation of postural control in daily-life conditions. Regardless of the increased degrees of freedom during the measurement, we found the highest sensitivity of all currently published posturographic data.

O86

Balance workshop: Synchronized head and force plate measurements. The potential for diagnostic yields

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Introduction: Currently only footplate measurements are used in posturography. Head movement offers other information that is not routinely measured. Given that the vestibular end-organs are situated within the temporal bone of the skull, recording the movement of the head can provide additional information to body sway alone. We describe the use of an accelerometer/gyroscope-based device to measure head movements that are recorded synchronously during posturography and investigate their potential additional value.

Materials and Methods: A device was designed that ran bespoke software to capture information from the head-mounted accelerometers and gyroscopes, allowing movements and position to be accurately measured in three dimensions of space. Analysis was undertaken alone and in conjunction with force plate data. Ten normal participants, ten patients with bilateral vestibular loss (BVL) and ten patients who

were instructed to malingering were tested using the modified clinical test of sensory interaction on balance (mCTSIB). Results The new device accurately synchronized with the force plate and allowed precise sway data to be calculated for the head. Normal controls showed a strong correlation between the head and foot measurements: path length mean r score =0.57($p<0.001$). This correlation became negative in BVL patients (mean r score =-0.48($p<0.001$)). Patterns of head movement changed in malingerers in unique ways, which were not apparent from the force plate recordings.

Conclusions: Head sway data have not been used consistently to measure balance owing to the technical difficulties that have now been overcome by this device. This study suggests that head data are related to footplate data, but in pathologic conditions also provide different information from which diagnoses can be made. Given the small size of the device, it has the potential to be used, without discomfort over long periods. This may pave the way to the telemetry of longitudinal data on sway.

O87

Is there a difference between right and left vestibular neurectomy?

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Meniere disease is a very disabling pathology especially in the cases of frequent crisis. The different treatments, medical or surgical, target the principal symptom: the vertigo crisis. The vestibular neurectomy, for the most disabled patients, is an appropriate and effective surgical approach. We did a prospective study from 2003 to 2009, at Reims university hospital (France), 87 patients underwent vestibular neurectomy by retrosigmoid approach, by the time of the study 43 patients were evaluated at 19 months (average period). The follow up included clinical and electrophysiological studies. We performed a clinical examination, hearing test, caloric, kinetic, vibration induced nystagmus under videonystagmography recording, vestibular evoked myogenic potentials recording, video head impulsive test and measure of the vertical visual subjective. In our study, the complete nerve section rate was 93%. We showed a significant difference between the right and the left vestibular nerve sections. The patients operated on the left side presented almost normalized vertical visual subjective compare to the patients operated on the right side. In the sub group: women operated on the left side, we found vertical visual subjective average values within the normal range. Vertical visual subjective test allowed us to show a significant difference between right and left vestibular neurectomies, and especially in the cases of women operated on the left side compared to others patients. Women operated on the left side presented better performances during the vertical visual subjective test. The others vestibular tests confirmed the complete nerve section but did not participated in this demonstration. We can hypothesize that the vestibule has a different value depending on its side and the gender of the patient is important.

O88

Vestibular rehabilitation from the clinical and experimental point of view.

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Introduction: Patients with uni- or bilateral deficit of the vestibular organ represent a long course of vertigo, dizziness, and balance disorders. In combination of an increase postural instability and a higher risk of fall, these patients mostly represent an increase morbidity and a significant reduction of their quality of life. In consequence of the vestibular deficit, the mechanism of central compensation is consecutively initiated. In recent studies, the effectiveness of a sensory feedback signal as a helpful tool in the rehabilitation process has been shown. The feedback applications can be presented as a visual, galvanic or vibrotactile stimulus.

Materials and Methods: Patients which chronically experienced dizziness (longer than 3 months) were recruited within 15 months from the Department of Otolaryngology and Head- and Neck Surgery at the University hospital. They underwent a program of vestibular rehabilitation with several forms of feedback applications. Before and after the training the following tests including dizziness handicap inventory (DHI) and sensory organisation test (SOT) were applied to investigate the effectiveness and tolerance of the feedback devices.

Results: There was a significant improvement of the DHI and SOT scores before and after the trainings course. There was no significant difference between the treatment and the verum group.

Discussion: Actual studies show similar effect of vestibular rehabilitation with biofeedback devices. But the long term benefit of them is still unclear. In order to evaluate the effect of biofeedback devices during the course of vestibular rehabilitation, there are two important findings, which have to be regarded. The training setup, in which the biofeedback signal is used, has been distinguished in static and dynamic procedures. The advantage of dynamic training procedures is nevertheless their parallelism to daily-life situation.

Pediatric dizziness improved with prism treatment of vertical heterophoria

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Objective: Recently described in adults, Vertical Heterophoria (VH) is a binocular vision disorder with symptoms of dizziness, motion sickness, headache, and reading disorders. This study's objective was to quantify symptom reduction after treatment with prismatic lenses in pediatric patients.

Methods: Retrospective analysis of 21 children presenting to an optometric binocular vision subspecialist treated with prismatic lenses. Patients were selected for suspicious and persisting symptoms not otherwise explained by standard evaluation. Suspicious physical findings include: vertical eye misalignment, head tilt, disconjugate gaze, and precipitation of symptoms with eye movements and convergence. Patients with successful trial framing of prism were included. The VH Symptom Questionnaire (VHSQ, validated and awaiting publication) was given pre & post treatment to measure treatment effect.

Results: Average pre-treatment VHSQ 17.9 versus 6.9 post treatment. There was a 61% decrease in the VHSQ. Using a paired t-Test $p < 0.0001$. Domains of dizziness, headache, and reading were all improved. Twenty of 21 patients required bifocals.

Conclusions: Treatment of VH resulted in marked reduction of symptoms in pediatric patients. Almost all patients needed bifocals. Pediatricians should screen patients for farsightedness and binocular vision symptoms in patients with dizziness, headache and reading disorders.

Discussion: Although visual vertigo has been described in the past, etiology, treatment and physiology have not been fully delineated. Theories to explain this disorder may include the following terms: utricle dysfunction, head tilt, vertical eye misalignment, vertical optokinetic nystagmus, retinal slip and, failure to compensate vestibular imbalance. Disparate sensory input from the visual, vestibular, and sensory afferents may induce symptoms. Further prospective studies, and physiologic studies will need to be performed.

Adrenergic signaling in the rat eighth nerve after labyrinthectomy

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In the present study, to elucidate the role of vestibular ganglion (VG) after the unilateral labyrinthine damage, we examined quantitative changes in mRNA expression of beta-adrenergic receptors (bARs) and AMP-activated protein kinase alpha catalytic subunits (aAMPKs) in VG after unilateral labyrinthectomy (UL) in rats. Using the real-time PCR method, beta2 AR mRNA expression in bilateral VG and AMPK alpha2 mRNA expression in the ipsilateral VG were significantly up-regulated with the maximum increase at the postoperative 7 day and 1 day, respectively. The up-regulation of beta2 AR in bilateral VG was long-lasting until 28 days after UL and that of AMPK alpha2 in the ipsilateral VG was just transient within 7 days after UL. These mRNA changes were supported by immunohistochemical data. According to previous reports, both of bARs and aAMPKs could regulate mitochondrial uncoupling protein (UCP) mRNA expression in several kinds of tissues and therefore might have thermogenic neurotransmission and antioxidant neuroprotective roles in neuronal tissues. UL requires not only long-lasting response of VG for central vestibular neuro-plasticity around 2-4 weeks but rapid response of VG against apoptosis of peripheral vestibular epithelia-neuronal synapses. The present findings suggest that beta2 AR in bilateral VG and AMPK alpha2 in the ipsilateral VG might play important signaling roles after the unilateral labyrinthine damage.

Improvement of body balance by noisy galvanic vestibular stimulation

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Stochastic resonance is a phenomenon whereby the response of a non-linear system to weak periodic input signal is optimized by the presence of a particular non-zero level of noise. Continuous application of

noisy vestibular stimulation (GVS) has been shown to improve autonomic responses of heart rate and vasomotor sympathetic activity to hypovolemic stimuli in healthy individuals and autonomic and motor responsiveness in patients with neurodegenerative disorders. We investigated whether noisy GVS improves balance performance in healthy subjects and patients with vestibular dysfunction.

Methods: Eighteen healthy subjects (11 male and 7 female; age range 23-60 years) and 5 patients (2 male and 3 female; age range 15-58 years) with bilateral vestibular dysfunction were enrolled. Two-legged stance tasks were performed with eyes closed on a foam rubber in normal subjects. The same tasks were performed on a firm platform in patients. Using a portable GVS device, a zero-mean, noisy current with a 1/f type power spectrum (1/f noise) or white noise stimulation was applied through electrodes placed over the subject's bilateral mastoid process. The amplitude range of GVS was 0 to 700 microA and given in random order. The trials were 60 s in duration with two periods lasting for the first 30s: baseline period without GVS followed by stimulus period with GVS.

Results: In 14 of 18 subjects (77.8%), 1/f noise stimulation improved balance performance whereas the other 3 subjects the stimulation did not improve balance performance. The optimal amplitude of the stimulus ranged from 100 to 300 microA. White noise GVS improved vestibular performance in 14 of 18 subjects (77.8%) with the optimal amplitude ranging 100 to 500 microA. In 4 of 5 patients (80%) with bilateral vestibular dysfunction, white noise GVS improved balance performance.

Conclusion: Noisy GVS might be useful for improving balance performance in normal subjects and patients with vestibular dysfunction.

O92

Psychometric properties of the falls efficacy scale-international (FES-I) in patients with dizziness and imbalance

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Introduction: Individuals with vestibular dysfunction have an increased risk of falling. The Fall Efficacy Scale International questionnaire (FES-I) is a measure used to quantify an individual's concern of falling during different tasks. The purpose of the study was to establish the reliability, validity, and responsiveness of the FES-I in people with vestibular disorders.

Materials and Methods: In order to determine the reliability of the FES-I, 53 individuals with vestibular disorders completed the FES-I twice during an initial examination by a neurologist. The concurrent validity was measured by administering the Activities-specific Balance Confidence (ABC) scale, Dizziness Handicap Inventory (DHI), 4-item dynamic Gait Index (DGI-4), and gait speed at the initial evaluation. Responsiveness was determined by administering another FES-I four to six weeks after their initial visit, in concert with a self-reported Likert Global Rating of Change (GRC).

Results: The FES-I demonstrated high reliability (intraclass correlation coefficient, model 3,1: 0.90; 95% confidence interval, 0.86–0.96) and had concurrent validity with other self-report and physical performance measures (correlation coefficients for the ABC: -0.84; DHI: 0.76; gait speed: -0.52; and DGI-4: -0.59). The FES-I, ABC scale, and DHI all showed statistically significant correlations with the GRC. The Pearson product moment correlation between the FES-I and the GRC was ($r = 0.39$). The DHI displayed the strongest correlation with GRC, effect size, and standardized response mean.

Conclusion: The FES-I is reliable in persons with balance and vestibular disorders, and demonstrates concurrent validity with other commonly-used outcome measures in this population. However, perceived change in condition may not relate well to change in an individual's falls efficacy.

O93

What is the optimal duration of vestibular rehabilitation?

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Introduction: Vestibular rehabilitation has been found to be effective and safe in patients with instability. There is insufficient evidence, however, for distinguishing between the efficacies of different rehabilitation techniques and the lengths of the therapies. Our earlier study demonstrated that computer dynamic posturography (CDP) and optokinetic stimulation are effective for improving balance in patients with chronic unilateral peripheral disorders. Actually the aim of the present study is to verify whether there are differences between two different lengths of CDP therapies, in order to establish the optimal strategy.

Materials and Methods: We conducted a prospective, comparative study of two different lengths of

CDP therapies (one group of 5 sessions and another of 10 sessions) in patients with instability due to chronic unilateral peripheral vestibular disorder. We randomly included 13 patients in each group, performing the evaluation with Dizziness Handicap Inventory and the CDP with the sensorial organization test (SOT) and limits of stability (LOS).

Results: We found a statistically significant improvement in both groups in average balance score, visual and vestibular input (according to the SOT) ($p < 0.05$); and in reaction time, distance and directional control of LOS ($p < 0.05$). If we compare the groups regarding these improvements, we find greater benefit in the "long group" in distance ($p = 0.033$) and directional control ($p = 0.001$) of LOS.

Conclusion: Patients with instability due to chronic unilateral peripheral vestibular disorder are good candidates for an exercise protocol with CDP. Since the improvements are significant with only five sessions, we believe that is the optimal duration in most of our patients. Only those patients who have very reduced limits of stability, and consequently are more likely to fall as a result of their diminished base of support, are candidates for rehabilitation protocols with a greater number of sessions.

O94

Vestibular Physical Therapy Rehabilitation comparing the CAREN: Computer Assisted Rehabilitation Environment with Clinical Vestibular Physical Therapy rehabilitation

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Specific vestibular/visual/cognitive deficits are seen mild traumatic brain injury (TBI) patients before and after clinical vestibular physical therapy and computer assisted rehabilitation environment (CAREN) treatment.

Objectives: 1) to determine vestibular/visual/cognitive deficits test results in mTBI balance disorder patients pre and post vestibular therapy treatment. 2) to determine if improvement is different in traditional vestibular physical therapy TVPT patients and patients treated on the CAREN (CVPT)

Methods: Self reports included Dizziness Handicap Inventory (DHI) and Activities Balance Confidence Scale (ABC). Scored tests included Computerized posturography sensory organization test (SOT), functional gait test (FGA), and vestibular/visual/cognitive tests included target acquisition, target tracking, dynamic visual acuity (DVAT), and gaze stabilization (GST). There baseline (income) results were compared to outcomes taken at 3 weeks and again at 6 weeks after beginning therapy. TVPT exercise programs included vestibulo ocular reflex (VOR) exercises, cervico ocular reflex (COR) exercises, depth perception training, somatosensory exercises, dynamic gait tasks, and aerobic exercises. CVPT employed four interactive applications designed to integrate visual and tactile inputs for processing by the patient. Patients were trained by the vestibular physical therapist twice weekly for both groups.

Results: Self-reports of DHI and ABC were improved in both groups and were not significantly different. The mean post-treatment sensory organization test scores were significantly better for the TVPT group, but improved in both groups. FGA reached optimal scores at 3 weeks in the CVPT group, but were not significantly different from the TVPT group by week 6. Target tracking, DVA, and GST significantly better in the TVPT group, but did improve in the CVPT group.

Conclusions: Both TVPT and CVPT groups improved after six weeks of training

O95

Vestibular rehabilitation in acute central vestibulopathy due to posterior circulation stroke: a randomized controlled trial

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Objective: To investigate the effects of two different rehabilitation programs in acute central vestibulopathy secondary to posterior circulation stroke.

Method: Twenty-five patients diagnosed with posterior circulation stroke were enrolled in this prospective, randomized controlled trial. Patients were instructed in routine balance and mobility exercises during the acute hospitalization period. At discharge, subjects were assigned to either a rehabilitation or home exercise group. The home exercise group was instructed to perform the same exercise program provided during hospitalization period. The rehabilitation group were randomized into the visual feedback posturography training or vestibular rehabilitation group. The balance and gait performance were assessed with clinical [Berg Balance Scale, the Timed "Up & Go" test, the Dynamic Gait Index and the Dizziness Handicap Inventory] and objective measurements [modified Clinical Test of Sensory Interaction on Balance –mCTSIB] before and after 6 weeks of training.

Results: The balance and gait scores were significantly improved in both rehabilitation groups and in the

home exercise group ($p < 0.05$), but no significant difference was found between the groups in terms of post-treatment values ($p > 0.05$).

Conclusion: The improvement of balance and gait function in rehabilitation groups did not differ from the home exercise group. The all rehabilitation programs equally effective to improve the recovery in acute central vestibulopathy.

O96

Vestibular migraineurs: the role of neural habituation in the outcomes of vestibular rehabilitation

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Aims: This study aimed to investigate if deficits in neural habituation, as previously evidenced in interictal migraineurs, were the basis for poorer outcomes of vestibular rehabilitation in vestibular migraineurs.

Methods: The outcomes of a 6 month vestibular rehabilitation program for 2 groups, vestibular migraineurs and non vestibular migraineurs, were correlated with interictal measures of N1-P2 auditory evoked potential (AEP) amplitude habituation.

Results:

- At 2010 Barany meeting: It was established that vestibular rehabilitation is an effective treatment option for vestibular migraineurs who subjectively perceive their symptoms more severely than other patients despite similar peripheral vestibular function and physical performance.
- Analyses on the AEP measures confirmed poorer habituation of the N1-P2 auditory evoked potential over time in migraineurs.
- Rehabilitation outcomes did not correlate with the measures of habituation.

Conclusion: The improvement in symptoms is not related to the interictal levels of cortical excitability as measured by lack of habituation to auditory evoked potentials. Instead it is proposed that symptom severity may be due to constant fluctuations in central vestibular excitability as an expression of the underlying pathogenesis related to migraine.

O97

4-aminopyridine improves gait variability in patients with cerebellar syndromes

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Introduction: The fall risk of patients with cerebellar disorders is markedly increased. Falls cause immobility due to serious injuries or a fear of falling. Therefore, the major goal in symptomatic treatment of cerebellar gait disorders is to reduce the fall risk. We retrospectively examined the effect of the potassium channel blocker 4-aminopyridine (4-AP) on the gait performance of patients with different cerebellar syndromes. In animal experiments, 4-AP has shown to improve Purkinje cell function.

Materials and Methods: Thirty-one patients with different cerebellar gait disorders (16 downbeat nystagmus, 8 sporadic adult-onset ataxia, 3 CACNA 1A mutation, 2 cerebellar stroke, 2 multisystem atrophy) received 4-AP as an individual treatment attempt. Gait performance was measured using a sensor carpet system (GAITrite®) under different speed conditions.

Results: The coefficient of variation of stride time decreased during therapy with 4-AP under the condition of slow walking ($p < 0.001$), preferred walking ($p < 0.05$) and maximal fast walking ($p < 0.01$). A high coefficient of variation of stride time during fast walking before treatment correlated with the improvement of objective gait parameters ($p > 0.001$) whereas subjective scores before treatment did not show any significant correlations.

Conclusion: This retrospective study indicates that the gait variability of patients with different cerebellar disorders improves during therapy with 4-AP. Temporal gait variability at baseline has a predictive value for the improvement of gait during treatment. Gait variability correlates to the risk of falls. Treatment with aminopyridines might be a promising approach for the symptomatic treatment of cerebellar syndromes.

O98

Specialized vestibular physical therapy tests for tracking recovery of amputees with vestibular impairment

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Objective metrics of recovery of balance function are needed for evaluation of amputees with vestibular impairment. Failure of recovery of visual vestibular interaction and vestibular spinal postural control can be an objective indicator of unsteadiness. The aim of the study was to assess changes in visual vestibular, and postural performance at the initial vestibular physical therapy (VPT) visit and again at the week 8 visit in amputees with vestibular impairment.

18 subjects with lower limb amputation from blast injury completed a standardized battery of tests during the initial visit and again after eight weeks of (VPT). Tests included computerized dynamic posturography (CDP) in which the sensory organization test (SOT), the dynamic gait index (DGI) test. Tests of vestibular-visual-cognitive function included the test battery of static visual acuity, perception time (PT), target acquisition (TA), target following (TF), dynamic visual acuity (DVA), and gaze stabilization tests (GST). VPT included traditional VOR, head-shake with visual display, somatosensory, vibrotactile cueing with and without visual display and gait exercises.

Statistical Analysis: Group mean pretreatment scores on SOT, MCT, DGI, PT, TA, TF, DVA, and GST were compared with group mean posttreatment scores using a 2-way analysis of variance with standard statistical software (GB-STAT). Significance was defined as $P < .01$.

Results: Across all groups, mean PT, TA, TF, and DVA values achieved expected normative levels after 8 weeks of VPT. Group mean PT decreased from 43 msec to 27 msec (normal \approx 20 msec). TF increased from 12 degrees/sec to 14 degrees/sec (normal \approx 12 degrees/sec). Horizontal TA time decreased from 280 msec to 260 msec, whereas vertical TA time remained nearly constant at 250 msec. DVA logMAR loss decreased from 0.23 logMAR right to 0.13 logMAR right; 0.2 logMAR left to 0.1 logMAR left; 0.2 logMAR down to 0.13 logMAR down, and 0.18 logMAR up to 0.11 logMAR up, (normal \approx 0.20 logMAR or less). However, GST returned to the normed levels (ie, horizontal GST: increased from 160 degrees/sec to 210 left and 150 degrees/sec to 210 right; vertical GST: 154 degrees/sec to 220 down and 152 degrees/sec up to 220).

SOT test results revealed a reduced vestibular profile in participants on initial testing which improved to normative values after VPT. Mean DGI increased from 16 to 18 points at the week 8 test point. Conclusion: amputees with vestibular impairment caused by blast injuries may benefit from VPT. A battery of vestibular-visual-cognitive tests is valuable for establishing initial functional levels and can be used to document improvement. These outcome measures may also be useful to determine return to duty/work status.

O99

Strategies and synergies underlying replacement of vestibular function with prosthetic feedback.

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Introduction: This study investigated changes in movement strategies and muscle synergies when bilateral peripheral vestibular loss (BVL) subjects are provided prosthetic feedback of their pelvis sway during stance.

Materials and Methods: 6 BVL subjects performed 3 stance tasks: standing eyes closed on a firm surface, on a foam surface, and standing eyes open on foam. Roll and pitch, upper and lower body, velocities were recorded with body-worn gyroscopes. Surface EMG recordings were taken from two pairs of antagonistic, lower leg and trunk muscles. Subjects were first assessed without feedback, then provided training with vibro-tactile and auditory feedback of pelvis angle sway under various stance conditions, and finally reassessed with the same feedback active. For analysis of movement strategies, angle values integrated from angular velocity samples, were split into 3 frequency bands (<0.7 , $0.7-3.0$, and >3.3 Hz).

Results: Feedback caused a reduction in pelvis sway angle displacements to values of age-matched healthy controls (HC) for all tasks. Pelvis sway velocity was only reduced for the task with largest angle displacements, standing eyes closed on foam. Movement strategies were unaltered by feedback, except for amplitude, and were not different from those of HCs before or after use of feedback. Low frequency motion was in-phase as if the body moved as an inverted pendulum, high frequency motion anti-phasic. Amplitudes of EMG were reduced with feedback. Synergies recorded in the form of activity ratios of antagonistic muscle pairs were also reduced.

Conclusion: This is the first study that demonstrates how VL subjects achieve a reduction of sway during stance with prosthetic feedback. Unchanged movement strategies with reduced amplitudes are achieved with reduced antagonistic muscle synergies. This study has implications for the choice of feedback parameters and patient groups when using prosthetic devices.

O100

The modified ampullar approach for vestibular implant surgery: Feasibility and its first application in a human with a long-term vestibular loss

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Objective: To assess, for the first time in a human with a long-term vestibular loss, a modified approach to the ampullae and the feasibility of evoking a VOR by ampullar stimulation. Material and methods: Peroperative stimulation of the ampullae, using the ampullar approach, was performed under full anaesthesia during cochlear implantation in a 21-year old female patient, who had experienced bilateral vestibular areflexia and sensorineural hearing loss for almost twenty years.

Results: The modified ampullar approach was performed successfully with as minimally invasive surgery as possible. Ampullar stimulation evoked eye movements containing vectors congruent with the stimulated canal. As expected, the preliminary electrophysiological data were influenced by the general anaesthesia, which resulted in current spread and reduced maximum amplitudes of eye movement. Nevertheless, they confirm the feasibility of ampullar stimulation.

Conclusion: The modified ampullar approach provides safe access to the ampullae using as minimally invasive surgery as possible. For the first time in a human with long-term bilateral vestibular areflexia, it is shown that the VOR can be evoked by ampullar stimulation, even when there has been no vestibular function for almost twenty years. This approach should be considered in vestibular surgery, as it provides safe access to one of the most favourable stimulus locations for development of a vestibular implant.

O101

Management of suspected autoimmune inner ear disease with abnormal eye movement

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Introduction: Autoimmune inner ear disease (AIED) is a clinical syndrome of uncertain pathogenesis. We encountered 2 cases of bilateral hearing loss and vertigo with inner ear antibodies. These cases presented with very peculiar eye movement. The neuro- otological findings and the clinical course are presented.

Method: The first patient (Case 1), a 34 year-old woman, came to our clinic on May 2001 complaining of right tinnitus. The second patient (Case2), a 22 year-old man who had right cochlear implant at the age 14, visited our clinic with dizziness on Dec 2005.

Results: In the case 1, the hearing progressively dropped despite of intensive treatments. She became deaf and underwent right cochlear implantation on June 2004. Dizziness and abnormal eye movement developed from August 2004. Bilateral vestibular function was reduced. The abnormal eye movement and dizziness improved by the left intratympanic injection of betamethasone. She had inner ear antibodies against 68 kDa etc and was treated with combination of steroid and immunosuppressive agents which was not effective. She underwent the left endolymphatic sac surgery with high dose steroid insertion in November 2007, but its effect was minimum. She further had gentamicin injection into the left ear which controlled the dizziness and eye movement. In 2 years, the dizziness and the abnormal eye movement recurred. Infusion of high dose steroid controlled these symptoms. She has stayed on low dose steroid up until now. The case 2 also showed bilaterally reduced vestibular function and abnormal eye movement from June 2006. He had the inner ear antibodies. Steroid combined with an immunosuppressive agent successfully controlled the dizziness and abnormal eye movement.

Conclusion: Diagnosis of AIED is based on clinical picture and the laboratory tests for autoimmunity which are still supplemental. The pathogenesis and best treatment option should further be studied.

O102

Characterization of compensatory eye movements while walking

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Introduction: The purpose of this study was to characterize and compare head and eye movements while walking, both in healthy subjects and in patients with bilateral vestibular loss (BVL).

Materials and Methods: Five normal subjects and 7 BVL patients participated in the study. Subjects had to read sequences of 25 Sloan letters while walking on a treadmill. Eye and head movements were recorded using a video eye tracker with integrated head motion sensors (EyeSeeCam VOG, Germany). Testing was performed at 3 different walking speeds (2, 4, and when possible 6 km/h) and repeated at 3

different viewing distances (1, 2.8, and 6m). Differences were assessed with a multivariate analysis of variance (MANOVA; independent variables: subject group, viewing distance, and walking speed).

Results: The results of the MANOVA were statistically significant ($F_{5,99} = 29$, $p < 0.001$; Wilks' Lambda = 0.99; partial eta squared = 0.59). When considered separately, three variables reached statistically significant difference between groups (Bonferroni adjusted): mean amplitude of vertical eye movements ($F_{23,103} = 10.58$, $p = 0.002$, partial eta squared = 0.09), mean head pitch amplitude ($F_{23,103} = 4.12$, $p = 0.04$, partial eta squared = 0.04), retinal slip ($F_{23,103} = 46.41$, $p < 0.001$, partial eta squared = 0.31), and measured visual acuity (VA) ($F_{23,103} = 100.34$, $p < 0.001$, partial eta squared = 0.49). Viewing distance had a significant effect on the amplitude of vertical eye movements. Walking speed influenced significantly all variables except for VA. The interaction between subject group and walking speed had a significant effect on retinal slip ($F_{23,103} = 8.99$, $p < 0.001$, partial eta squared = 0.09).

Conclusion: Eye movements in BVL patients only partially compensate for head movements while walking. A consequence of these observations is the decrease of dynamic visual acuity of BVL, for example making face recognition and sign reading difficult while walking. A vestibular origin for the compensating head pitch cannot be excluded.

O103

Electrical stimulation of the vestibular system: generation of controlled eye movements and effects on visual acuity

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Introduction: There is no evidence of an effective treatment for patients with bilateral vestibular function loss (BVL). During the past years, our research group has completed all the crucial steps to demonstrate the feasibility of a vestibular neuroprosthesis for rehabilitating these patients. Advances and current status of research will be presented.

Materials and Methods: Four cochlear implant (CI) candidates with bilateral severe hearing loss and concomitant BVL received a modified CI with one extracochlear electrode put in the vicinity of the posterior ampullary nerve using an extralabyrinthine approach. For each experimental session, patients were first adapted to a supra-threshold stimulus pulse train of constant current amplitude. Then, sinusoidal amplitude modulation of the ongoing stimulation was evaluated by recording the eye movements with a video-eye-tracker, at different modulation depths. In addition, we are developing protocols to measure the functional rehabilitation provided by the device. As a first approach, we measured each patient's visual acuity (VA) without stimulation (system OFF) and during sinusoidal modulation of the stimulation (system ON).

Results: Sinusoidal amplitude modulation generated controlled smooth eye movements of amplitudes ranging from 0.2° up to 4° peak to peak, depending on the depth of the modulation and on the level of adaptation current amplitude. In all patients, we measured a significant decrease in VA when comparing results with the system OFF versus results obtained with the system ON. The VA decrease ranged from 0.1 to 0.4 logMAR and correlated to the amplitude of eye movements generated by the stimulation.

Conclusions: We have fulfilled fundamental steps demonstrating the feasibility of vestibular neuroprosthesis. Our future efforts will concentrate on developing a first wearable prototype suitable for human use and to test if this device can provide functional rehabilitation to patients with BVL.

O104

Evaluation and rehabilitation of vestibular balance deficits in the military setting: recommendations from expert working groups

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Introduction: Vestibular dysfunction has been documented following barotrauma and head acceleration due to improvised explosive devices (IEDs). To identify optimal tests and treatments following such injuries, expert consultations were sponsored by the Coalition Warfare Program, Office of the Undersecretary of Defense (Acquisition, Technology, and Logistics).

Methods: The authors consulted with approximately 50 vestibular researchers, scientific advisors, clinicians, and biomedical engineers working for government agencies, universities, clinics/hospitals, and businesses. Tests appropriate for early (post-injury) military assessment were considered, along with the optimal application of multisensory balance feedback technologies being developed by the authors and others to enhance vestibular rehabilitation. A preliminary meeting (n=6) and a formal, invitational workshop (n=16) were held in the U.S., followed by informal consultations in Europe involving individual and small-group meetings with experts (n=30).

Results: The domestic workshop experts agreed that current tests require modification to apply

following IED exposure, and that enhanced tests should emphasize dynamic, functional, and occupation-relevant aspects of standing balance, gait, visual acuity, perception of visual vertical, and vertigo. A list of candidate tests and testing needs was generated. Preference was given to portable, field-ready tests which could become semi-automated and capable of rapid administration by a non-specialist. Corroborating feedback obtained from additional consultations in Europe supported the findings of the workshop, although a few differences emerged concerning some aspects of the tests.

Conclusions: Better balance tests and treatments are needed for military personnel following IED exposure. Specific testing and rehabilitation recommendations from the consultations will be summarized from a 100-page government report (in press).

O105

Inferior vestibular neuritis

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Background: Vestibular neuritis (VN) mostly involves the superior portion of the vestibular nerve and labyrinth. This study aimed to describe the clinical features of VN involving the inferior vestibular labyrinth and its afferents only.

Methods: Of the 703 patients with a diagnosis of VN or labyrinthitis at Seoul National University Bundang Hospital from 2004 to 2010, we retrospectively recruited 9 patients (6 women, age range: 15-75) with a diagnosis of isolated inferior VN. Diagnosis of isolated inferior VN was based on torsional downbeating spontaneous nystagmus, abnormal head-impulse test (HIT) for posterior semicircular canal (PC), and abnormal cervical vestibular evoked myogenic potentials (VEMP) in the presence of normally functioning horizontal (HC) and anterior semicircular canals, as was determined by normal HIT and bithermal caloric tests.

Results: All patients presented with acute vertigo with nausea, vomiting and imbalance. Three patients also had tinnitus and hearing loss in the involved side. The rotation axis of torsional downbeating spontaneous nystagmus was best aligned with that of the involved PC. HIT was also positive only for the involved PC. Cervical VEMP was abnormal in 7 patients and ocular VEMP was normal in all 4 patients tested. Ocular torsion and subjective visual vertical were mostly within normal range.

Conclusion: Since isolated inferior VN lacks the typical findings of much more prevalent superior VN, it may be mistaken for a central vestibular disorder. Recognition of this rare disorder may help avoiding unnecessary work-ups in patients with acute vestibulopathy.

O106

Unilateral vestibulotoxicity due to systemic gentamicin therapy

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It is not a well recognized fact that systemically administered gentamicin can cause severe unilateral (rather than the usual bilateral) selective vestibular loss.

We reviewed the data of patients presenting with imbalance and oscillopsia due to a compensated, selective, severe unilateral vestibular loss on caloric and impulsive testing, who denied ever having experienced vertigo, but who had, we were able to discover later, been given systemic gentamicin during a hospital admission just before their symptoms began.

From 1998-2010, 18 such patients were identified in the records of our tertiary referral Balance Disorders Clinic. The fact that they had been given gentamicin was confirmed only when the treatment charts from the hospital where the gentamicin was given were requisitioned and scrutinized; none of the patients had been given the gentamicin at our hospital. Only 4/18 patients knew or suspected that they had been given gentamicin.

The clinical meaning of these results is that patients presenting with imbalance due to a compensated, selective unilateral vestibular loss should, if they have never experienced vertigo, be closely questioned about any hospital admission just before symptoms started and the hospital records for that admission requisitioned and scrutinized for possible gentamicin therapy.

How a systemically administered ototoxin might cause unilateral vestibular loss (without or with vertigo) is intriguing but not obvious. It is possible that the gentamicin did at first cause bilateral vestibular loss but that only one side recovered.

O107

Coordination of the head with respect to the trunk, pelvis, and lower leg during quiet stance after vestibular loss

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Introduction: This study examined the relationship between head and trunk sway during quiet stance in subjects with long-standing bilateral peripheral vestibular loss (BVL) and compared this relationship with that of age-matched healthy controls (HC).

Materials and Methods: 7 BVL and 7 age-matched HC participated, performing four different sensory tasks: standing quietly on a firm or foam support surface, with eyes open or closed. Data was recorded with 8 body-worn gyroscopes; at the head, upper trunk, pelvis and lower-leg. The roll and pitch angular velocities recorded were spectrally analysed and integrated for angle correlation analysis in three frequency bands: below 0.7Hz (LP), above 3 Hz (HP) and in between (BP).

Results: Greater motion was observed at all measurement locations, except the head, for BVL subjects during eyes closed tests, especially on foam. Head motion was greater than trunk, pelvis, and lower-leg motion. Angle correlation analysis indicated the head was more locked to the trunk for BVL subjects for LP and BP regions and moved relatively independent of trunk in the HP region. The power spectral density (PSD) ratios, and transfer functions (TFs) also showed that head on trunk movement was relatively less up to 3Hz in all tests for BVL subjects. Furthermore the resonant frequency of head-on-trunk motion at 3Hz was shifted to a higher frequency in both the pitch and roll planes. The movement strategies of the pelvis with respect to the leg were not different between BVL and HC subjects, involving greater lower-leg motion than pelvis motion in roll and vice versa in pitch.

Conclusion: This data indicates that during quiet stance BVL subjects change the characteristics of head on shoulder motion in to reduce relative motion of the head below 3Hz and absolute head motion in space, but at the cost of increased high frequency motion. Presumably these changes are accomplished using neck proprioceptive reflexes.

O108

Aplasia of bilateral semicircular canals with normal cochlear development and stapedia fixation

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Introduction: Children with congenital hearing difficulty account for one out of 1,000 births, and 5~25% of those show inner ear deformity. Most of the inner ear deformities accompany cochlear anomaly. We encountered a case that presented with aplasia of bilateral 3 semicircular canals with normal cochlear development and stapedia fixation.

Case report: A 11 year-old girl, complaining of hearing loss, visited our clinic on August 2010. She had a history of right congenital cataract and bilateral iris loss. The bilateral eardrums were normal. The right auricle appeared as "cup ear", and the left ear lobe was hypoplastic. The CT showed normal cochlear turns and auditory ossicles in both ears. However, inner ear malformations including aplasia of bilateral 3 semicircular canals and left enlarged vestibular aqueduct were observed. The audiometry showed moderate mixed type hearing loss with a dip of 2000 Hz on both sides. No reaction was observed on caloric test. She complained of no dizziness, but showed congenital nystagmus. We suspected symptomatic congenital hearing loss such as Alport or Usher syndrome from the associated hearing loss and the ophthalmologic disease, but diagnostic criteria was not met. As ossicular malformations were suspected from the hearing and the imagings, surgery was performed for the right ear on February 2011. The stapedia foot plate was found to be immobile. Stapedectomy was performed, and the hearing improved after the operation.

Conclusions: Among the semicircular canal malformation, "Vestibule-lateral semicircular canal dysplasia" and "Aplasia of all semicircular canals with CHARGE association" are widely known. To our best knowledge, only 10 cases (18 ears) including the present case with aplasia of all semicircular canals with normal cochlear development had been so far reported. Hearing improvement in the present case has become a great asset to her daily activity. Surgery for the other ear should be encouraged.

O109

Temporal spatial parameters of gait measured with three dimensional gait analysis: comparison of vestibulopathic gait with healthy controls

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Introduction: Gait problems are common in patients with vestibular disorders and are usually assessed subjectively or with stop watches. Computerised three dimensional gait analysis (3DGA) offers opportunities to investigate gait impairment in more depth. The aim of this study was to compare the temporal spatial parameters of gait in patients with unilateral vestibular hypofunction (UVH) to healthy subjects using 3DGA.

Materials and Methods: 17 subjects with uncompensated UVH (12F:5M; Mean age 52±15 years), underwent 3DGA using a 5 camera Vicon system. Diagnosis was acoustic neuroma, n=4; vestibular neuritis, n=13. Each subject was paired with an age and sex matched healthy subject from the normative database of the laboratory. Temporal spatial parameters investigated included cadence, gait speed, step and stride parameters, and single and double support parameters (time/percentage of gait cycle). Variables were assessed for normality using the Shapiro Wilk test and paired t-tests used to calculate any differences.

Results: Subjects with UVH walked significantly slower than their healthy controls (mean diff, -0.17m/sec; p=0.007). Stride time and step time were significantly longer (p= 0.01 and 0.004 respectively). They had a significantly lower cadence (mean diff -5.39 steps/min p=0.01), and shorter step (p= 0.02) and stride length (p=0.02). Subjects with UVL spent a significantly longer percentage of the gait cycle in double support (mean diff 3.33% p=0.005) with a corresponding reduction in the percentage of the gait cycle in single support (mean diff -1.89%, p=0.01). Step width was not significantly different (mean diff 0.02m; p=0.09).

Conclusion: This study has confirmed the abnormalities of temporal spatial parameters of gait in patients with unilateral vestibular loss using 3DGA. 3DGA provides more detailed and sensitive analysis of vestibulopathic gait than can be obtained from subjective gait impairment.

O110

Re-considering the risk of vestibular loss after Cochlear implantation

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Background: Cochlear Implantation will lead to auditory perception of speech and sounds. Surgical risks are involved, such as vestibular loss. Therefore, adequate information of risks is necessary for preoperative counselling of candidates.

Aim of present study: is to investigate risk of vestibular loss after implantation and find out whether central adaptation will take place postoperatively. A review of other previous studies will be compared with present data.

Methods: In addition to the audiological- and MRI findings, electronystagmography was performed in CI candidates and patients. Pre- and postoperative caloric dysfunction of horizontal semicircular canal is compared and asymmetry in rotational testing is evaluated. Besides vestibular functional variables also 'cause of deafness', 'age at implantation', 'surgical procedure', 'type of electrode', 'surgeon', 'time between surgery and ENG' and 'postoperative deterioration in pure tone threshold' are taken into account. Dizziness Handicap Inventory (DHI) was used to assess postoperative vestibular handicaps in the functional, physical and emotional domain.

Results: 25% of CI subjects lost their vestibular function after cochlear implantation; 8% completely lost their vestibular function. Regression analyses suggest that candidates beyond age of 49 years are more susceptible to vestibular deterioration after implantation. Other variables do not play a significant role. Rotational chair data reveal that subjects postoperative show central adaptation that is in agreement with behavioral DHI results. Present data show no relationship between objective caloric test results and subjective handicap.

Conclusion: Adequate preoperative counseling of patients for possible vestibular function loss after CI is of importance, especially beyond the age of 49 years.

O111

The effect of dosing regimens on the onset of gentamicin vestibulotoxicity

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Introduction: The safety of different gentamicin dosing regimens has been studied extensively in the context of nephrotoxicity. By comparison gentamicin-induced vestibulotoxicity appears insufficiently documented and is under-recognized clinically.

Materials and Methods: A review of 46 patients who presented to a tertiary neurotology clinic between 1993 and 2009 was performed. Patients with gentamicin vestibulotoxicity were identified from clinical records and the effects of single daily dosing (SDD) versus multiple daily dosing (MDD) regimens in the causation of their clinical presentation assessed. Time to ototoxicity and dosing levels were used as

primary outcome measures.

Results: Nineteen of 44 patients (43.1%) were identified to have gentamicin vestibulotoxicity without accompanying nephrotoxicity; of these, only two patients had complaints of tinnitus or deafness. Eighteen had substantial imbalance and oscillopsia. All patients (n=19) had a clinically significant loss of dynamic visual acuity and a bilateral positive head impulse test. The time delay from the beginning of treatment to the onset of vestibulotoxicity was significantly shorter in patients who received SDD gentamicin than those who received MDD regimens (mean 15.7 vs. 33.0 days, $p < 0.04$), despite a significantly lower total cumulative dose (4.99 vs. 7.95 grams, $p < 0.003$)

Conclusions: Gentamicin vestibulotoxicity can occur in the absence of nephrotoxicity. Although single daily dosing strategies are now more commonly used owing to their reduced nephrotoxicity and convenience, SDD is more damaging to the vestibular organs than MDD and causes damage at an earlier stage. Traditional methods of detecting inner ear toxicity were rare findings. Most patients with vestibulotoxicity complained of imbalance and oscillopsia that could be identified with simple bedside testing. Early recognition of vestibulotoxicity is important to prevent the high levels of morbidity inherent from a bilateral vestibular loss.

O112

Physiologic device-based diagnosis of stroke in acute vertigo: proof-of-concept

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Introduction: Most stroke patients presenting with acute vestibular syndrome (AVS) have no focal neurologic signs, and many are misdiagnosed. Experts distinguish central from peripheral causes of AVS using oculomotor findings ('HINTS'—Head Impulse test, Nystagmus, Test of Skew). We sought to generalize this bedside approach by using a quantitative, portable video-oculography device.

Methods: Prospective, observational study at two centers (08/2011-03/2012). Convenience sample of adult emergency department (ED) patients with AVS defined as >24hrs of acute dizziness/vertigo, nausea/vomiting, head motion intolerance, gait unsteadiness, and nystagmus. We measured usability, tolerability, and diagnostic oculomotor findings according to a standard protocol ('HINTS'). Funding limitations precluded uniform gold standard neuroimaging (MRI DWI >48hrs after onset) in all patients, but was available clinically in most. Oculomotor findings were assessed by two masked neuro-otologists with differences adjudicated by a third.

Results: 88 screened; 14 eligible; 13 AVS patients enrolled (mean age 61 years, 46% female). Eye movement recordings were performed at the bedside on all enrolled patients with a mean research assistant-reported usability of 8.4/10. All patients completed testing; none vomited. Mean patient-reported comfort was 8.9/10. Among 11 patients with definitive neuroimaging, there was initial disagreement between raters in three. Final adjudicated accuracy of stroke (n=6) versus peripheral vestibular (n=5) diagnosis by video-oculography-assisted 'HINTS' exam was 91% (n=10/11), with incorrect adjudication of the quantitative head impulse result in one discordant case with brisk spontaneous nystagmus in primary gaze.

Conclusion: It is feasible to perform the 'HINTS' battery in the ED using a physiologic video-oculography device. Preliminary results show promising diagnostic accuracy for detecting posterior circulation stroke, and further study is warranted.

O113

Clinical significance of positional and orthostatic dizziness in regard to BPPV and orthostatic hypotension

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Introduction: Dizziness induced or aggravated positional change is frequently encountered symptom in dizziness clinic. BPPV is the most common etiology of the positional dizziness. Although most patients present with typical symptoms of vertigo, some patients complain dizziness aggravated by head or body movement toward various directions, including sitting-up or stand-up from supine position which are generally considered as symptoms of orthostatic hypotension (OH). We aimed to evaluate the clinical significance of the positional and orthostatic dizziness in diagnosing BPPV and OH.

Materials & Methods: One hundred-ten patients who visited Incheon St. Mary's Hospital with complaint

of dizziness induced or aggravated by positional change were included in this study. Questionnaires regarding the effect of position change on the dizziness were taken. The patients were divided into 3 groups according to the result of the questionnaire. 1) Group P: patients with dizziness aggravated by positional change but do not feel dizziness on orthostatic position, 2) Group PO: patients whose dizziness aggravated by positional change including orthostatic position, 3) Group O: patients whose dizziness is aggravated by orthostatic position. Thorough history taking, physical examination, and vestibular function tests were performed to identify the etiology of the dizziness. To evaluate orthostatic hypotension, 3-positional vital sign measurement was used.

Results: The majority (80.9%) of patients had orthostatic as well as positional dizziness. In Group P, 75% of patients were finally diagnosed as BPPV, suggesting that dizziness aggravated solely by positional change highly indicate BPPV. In group O, most patients (53.8%) were neither BPPV, nor OH. Only 23.1% was diagnosed as OH. In group PO, 37.1% was BPPV, 7.9% was OH, and 56.2% showed various etiologies.

Conclusion: Dizziness aggravated by positional change is significant sign of BPPV. On the other hand, orthostat

O114

3D analysis of induced vestibulo-ocular reflex in superior canal dehiscence syndrome: symptomatic and radiologic correlation

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Introduction: The superior canal dehiscence (SCD) syndrome presents diverse pattern of vestibular symptoms, such as sound-induced and/or pressure induced vertigo, disequilibrium, motion intolerance, in around a half of the patients. We recorded the induced VOR to diverse stimuli and analyzed if their axis of eye movements vary according to stimuli. Clinical symptoms, size and location of the dehiscence were also reviewed to investigate the correlation with nystagmus.

Materials and Methods: Nine symptomatic SCD patients (1 bilateral) confirmed by TBCT and vestibular evoked myogenic potentials were recruited. SCD size was measured on reformatted image in the plane of the superior semicircular canal. VOR were recorded using 3-D VOG at sitting position in the dark room. Stimuli were short tone bursts of 500 Hz and 1 KHz, mastoid vibration (100 Hz) and external ear canal pressure using Politzer bag. The median 3D velocity of induced VOR was measured and three dimensional vector trajectory of the vertical, horizontal and torsional position was plotted for reference against the axis of human semicircular canals (Della Santina et al., 2005).

Results: Transient vertigo on motion was the most frequent type of dizziness (67%) and disequilibrium was the most annoying symptom to decide surgery. Sound-induced and pressure-induced VOR were evoked in 33%, respectively and vibration induced VOR was recorded in 89% with variable intensity. The rotation axes of the induced eye movement to sound were closely aligned with the affected superior canal, while those of vibration induced eye movement were not.

Conclusion: Seventy-eight percent of the patients presented diverse pattern of vestibular symptoms. Sound stimulation showed directional characteristics expected based on excitation of the affected semicircular canal, but mastoid vibration showed those expected based on excitation of the affected semicircular canal as well as the affected side horizontal canal.

O115

Inner ear hemorrhage. Clinical, biological and imaging aspects in three adults

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Introduction: The occurrence of a sudden sensorineural hearing loss with vertigo is a diagnostic challenge for the clinician. While in most cases the etiology and pathogenesis remain unknown, meticulous biological and Magnetic Resonance Imaging (MRI) evaluation might reveal a specific cause such as an inner ear hemorrhage. The latter is often the result of a bleeding disorder and is usually associated with a complete and irreversible damage to the labyrinth.

Materials and Methods: We report clinical investigations, particularly otoneurological examination, as well as audio-vestibular, biological and MRI evaluation in three adults.

Results: Unilateral hearing loss and vertigo suddenly occurred to three adults aged 77, 75 and 32. They had bleeding disorders with respectively a recent anticoagulant treatment (increased INR at 6), a

thrombocytopenic purpura (decreased platelet count at 5000/mm³), an anticoagulant treatment for a giant angioma (4-day-delayed INR at 3 which was in the expected therapeutic range). In all three patients, a pre-contrast T1-weighted axial MRI image showed a high signal in the labyrinth in keeping with an hemorrhage. The first two patients had a complete and irreversible hearing loss. They also complained of vertigo, the amelioration of which was the result of vestibular compensation. The last patient had a sensorineural hearing loss of approximately 40 dB hearing level with a quite complete resolution over time. He also complained of vertigo, the amelioration of which was essentially due to recovery of the peripheral vestibular function rather than vestibular compensation.

Conclusion: We should search for an inner ear hemorrhage in case of the sudden occurrence of a complete and irreversible unilateral hearing loss associated with vertigo. However, inner ear hemorrhage may also present with a mild/moderate hearing loss, that recover over time, with vertigo. The diagnosis relies on biological and MRI imaging studies.

O116

Vestibular findings in patients with persistent geotropic nystagmus

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Introduction: There are a few reports about a persistent geotropic nystagmus in patients with peripheral vestibular disorders. We have analyzed the nystagmus characteristics and vestibular tests during acute vestibular disability in 22 patients with persistent geotropic nystagmus resistant to repositioning treatment.

Materials and Methods: The group comprised 22 patients with a mean age of 54 years. All patients demonstrated a persistent non-paroxysmal geotropic nystagmus when the head was turned sideways in supination. The nystagmus direction with head straightforward in supine and prone position was studied. Connected to examination the patients were submitted to caloric test. The patients were free from signs of CNS engagement (MRT included). Nystagmus slow phase velocity was recorded with (VNG).

Results: SPV of the geotropic nystagmus was recorded in 20/22 patients and varied between 1-29°/s. The preponderance of the geotropic nystagmus was directed to the left in 55% of the patients to the right in 15% and absent 35% and was less than 30% in 75 % of the patients. A unilateral reduction of caloric response was found in 13/21 patients. The degree of caloric impairment was not correlated to the sum or to the degree of preponderance of the geotropic nystagmus. Direction changing nystagmus in pitch plane was recorded in 15/22. Five of the patients had a simultaneous onset of unilateral auditory symptoms at the start of dizziness. In four of five patients the caloric impairment was located at the same side as the auditory symptoms. There was no correlation between nystagmus preponderance or nystagmus pattern in pitch plane respectively and the side with auditory symptoms.

Conclusion: In a majority of patients the persistent geotropic nystagmus was symmetrical and a majority of the patients also had a pitch dependent nystagmus. The combination of a position induced nystagmus and impaired caloric response speak for a mechanical dysfunction affecting possibly the cupula.

O117

Vestibular and saccadic abnormalities in Gaucher's disease

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Introduction: The hallmark eye movement abnormality in Gaucher's disease is selective horizontal saccade slowing, but vestibular abnormalities and vertical-torsional eye movement are not well recognized. We aim to characterize the vestibular and saccadic abnormalities in Gaucher's disease using three-dimensional (3D) vestibular and ocular motor testing.

Materials and Methods: 3D eye movements evoked by head impulses, electrical vestibular stimulation and ocular motor tests of saccades were recorded using the search coil technique, and ocular and cervical vestibular myogenic potentials evoked by air-conducted sound were recorded using surface electrodes in two brothers with genetically confirmed Type III Gaucher's disease.

Results: Global impairment of vestibular function was observed in Gaucher's disease. Angular vestibulo-ocular reflex deficits to head impulses in individual semicircular canal planes suggest decline of horizontal and vertical semicircular functions, but was accompanied by a paucity of refixation saccades. The prolonged electrically-evoked vestibulo-ocular reflex onset latency and attenuated phasic responses also characterized the vestibular abnormalities. Diminished ocular and cervical vestibular evoked myogenic potentials suggest impairment of otolith-ocular reflex. Initiation of horizontal saccades triggered excessive vertical-torsional saccades with abrupt decelerating velocity. Eye velocity profile of the

saccades suggests desynchronization of burst neuron discharges with multiple bursts in Gaucher's disease.

Conclusion: Abnormal 3D eye movements during horizontal saccade initiation suggest loss of inhibition to midbrain excitatory burst neurons due to disinhibited pontine omnipause neurons. Both semicircular canal and otolith abnormalities are prominent in Gaucher's disease, and indicate that vestibular nuclei and their interneurons may also be affected in addition to the pontine saccadic generator.

O118

High-frequency Vestibular Loss: An under-recognized clinical entity

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Introduction: Determine the prevalence of high-frequency/high velocity vestibular loss (HFVVL) in patients with otherwise normal vestibular tests.

Materials and Methods: 184 patients who attended a Multidisciplinary Neurotology Clinic for magnetic scleral search coil studies (MSSC) were assessed. This represented one year of scleral coil studies. Patients were sent for advanced vestibular testing including MSSC studies, audiometry, electronystagmography and c-VEMP.

Results: The mean age was 54.3 (SD=13.9). 44.1% of patients presented with rotatory vertigo, 75.7% with unsteadiness; 48.6% with unsteadiness only. ENG testing yielded 68 normal results; of these, 60 had normal c-VEMP and hearing tests. MSSC testing was positive in 32 patients. Although low frequency gains were normal, high frequency gains for the left and right ears were 0.84(SD=0.15) and 0.78(SD=0.14) respectively, well below normal. Clinical evaluation of the 32 patients showed a positive head thrust test or reduced DVA in 30 patients; showing that the abnormality was clinically detectable in 30/32 patients.

Conclusions: Patients presenting with non-rotatory symptoms who go on to have normal vestibular function testing, who are often dismissed as having imbalance of non-organic origin. These patients are often dismissed or sent for inappropriate psychological management. These patients may have high frequency vestibular loss. Although the best way to determine HFVVL is testing with MSSCs, clinical signs are usually sufficient to make this important, but relatively unknown, diagnosis. Making clinicians aware of this diagnosis is an important step to ensure the correct management of patients with vestibular lesions that are otherwise likely to be missed on routine vestibular function testing.

O119

Electrically evoked VOR (eVOR) and ocular vestibular evoked myogenic potentials (OVEMP) in internuclear ophthalmoplegia

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Introduction: Internuclear ophthalmoplegia (INO) is due to lesion of the medial longitudinal fasciculus (MLF) which carries vestibular projections. Electrically evoked vestibulo-ocular reflex (eVOR) and ocular vestibular evoked myogenic potentials (OVEMP) are modern tests that examine the integrity of the VOR. We aim to characterize the eVOR properties and OVEMP measures in INO.

Materials and Methods: We studied 24 MS patients all with confirmed INO (15 bilateral and 9 unilateral). 3D binocular eye movements evoked by bilateral, bipolar, 100ms current-step at 5 different intensities (0.9-10.0 mA) were measured with the dual search coil technique. OVEMP and cervical VEMP (CVEMP) to both air- and bone-conducted (AC- and BC-) sound were recorded using surface electrodes. Results were compared to normal subjects.

Results: In bilateral INO the onset latency was prolonged (Cathodal: 12.4±0.6ms; Anodal: 13.4±0.6ms). Torsional tonic eVOR amplitude was comparable to normal but horizontal and vertical oscillations were lost. Phasic eVOR initiation and cessation were severely attenuated to 30% of normal amplitude with a dispersed pattern. In unilateral INO the onset latency was normal (~9.0ms) when cathodal stimulation was directed at the unaffected MLF, but prolonged (~11.2ms) when the affected MLF was stimulated. The horizontal tonic eVOR in the adducting eye lagged behind the abducting eye by ~2.2ms. Tonic and phasic eVOR responses were comparable to normal. During OVEMP in bilateral INO, N1 responses were absent in 77% to AC-sound, and prolonged in 69% to BC-sound (left: 11.1±0.3ms; right: 10.2±0.2ms). P13 latency was prolonged in AC-CVEMP (39%) and BC-CVEMP (23%).

Conclusion: Onset latency prolongation and phasic eVOR impairment are the hallmark vestibular deficits in INO. The eVOR may be a sensitive test for binocular latency difference. Dissociation between O-CVEMP should lead to consideration of upper brainstem lesion.

O120

A preliminary study identifying the psychological variables associated with Phobic Postural Vertigo (PPV)

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Introduction: Phobic Postural Vertigo(PPV) includes specific but relatively broad inclusion criteria[1]. We were interested to see if more defining criteria can distinguish these subjects from those with other vestibular conditions.

Methods: This study used 7 neurological/psychological questionnaires (the Dizziness Handicap Inventory, Vestibular Rehabilitation Questionnaire, Anxiety Sensitivity Index-3, Symptom Checklist-90-Revised, Beck's Depression Inventory-II, Social Readjustment Rating Scale, World Health Organisation Quality of Life–Brief version) and a set of questions derived from practice-based evidence, to obtain psychometrically quantifiable results from separate samples of 12 presumed PPV, 12 Benign Paroxysmal Positional Vertigo(BPPV) patients and 12 other neurological controls. PPV subjects were selected on the basis of persistent dizziness with predominant secondary anxiety and avoidance behaviour and the major impact that such symptoms had on daily activities.

Results: The majority of PPV patients: Experienced persistent dizziness and imbalance Have a preceding vestibular disorder, somatic illness or psychological stressor that has a reasonable temporal proximity to the onset of PPV Are able to identify situations/stimuli that aggravate their dizziness Report avoidance behaviours due to dizziness All PPV participants fit Brandt's criteria as per elevated scores compared to norms for depression, anxiety, obsessive compulsiveness and impaired quality of life. The PPV sample quality of life and perceived handicap means are higher than literature reported means for all vestibular disorders combined. Results of a preliminary comparative analysis between PPV patients, BPPV patients and control subjects will be presented and a screening questionnaire proposed as a useful clinical tool with which to screen presumed PPV patients.

Conclusion: Results of the questionnaires assessing neurological, vestibular and psychological symptoms in patients with PPV demonstrated several consistent features suggesting that PPV patients may be able to be distinguished from other patients with vestibular complaints.

O121

Perilymph fistula can cause inability to walk without hearing disorder -A case report -

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Introduction: Trauma and poststapedectomy have been well established etiologies which can cause perilymph fistula(PLF). In contrast, the existence of idiopathic or spontaneous, possibly related to episodes of Valsalva maneuver, nose blowing, or physical exertion remains controversial. The cochlinotomoprotein (CTP) detection test has been recently proposed to make a definite, objective diagnosis of PLF. We will present a patient who could not walk without any hearing loss. Based on the positive result of CTP test, she was diagnosed to have PLF and her complaint has been alleviated after the surgery for PLF.

Case Presentation: A case was a 54-year-old woman who complained of inability to walk, nausea and vomiting, and inability to watch TV. She has experienced persisting dizziness for the previous four months, and her complaint of inability to walk occurred on November 6, 2011. She blew nose before her complaint appeared, but her nose blowing was reported not unusual. Vestibular testing demonstrated decreased function on the right ear, normal response on the left ear by caloric testing, and downward nystagmus on positional testing. Pure tone audiometry showed normal hearing level. The temporal bone CT demonstrated suspected bony dehiscence of the left superior semicircular canal. Because of CT findings, we planned to perform closure of the left superior semicircular dehiscence. However, based on the positive result of CTP detection test, we performed closure of vestibular and oval window on the left ear on February 1st, 2012. She gradually began to walk following the surgery and downward nystagmus became decreased. Postoperative CTP test demonstrated negative finding.

Conclusion: From the clinical findings of the present case, PLF should be included in differential diagnosis of patients with severe dysequilibrium without hearing loss and CTP detection test can be an objective test to identify the PLF.

O122

Estimation of passively travelled rotations in darkness by vestibular patients

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Introduction: The aim of this study was to evaluate the consequences of vestibular canal paresis on spatial perception with simple clinical spatial task. In a previous study (abstract 2004 Barany) we found under-estimate of passive rotations in bilateral vestibular loss. We have now repeated this study with a motorized turning-chair, which allows perfectly reproducible rotations.

Materials and Methods: The subjects sitting in darkness are submitted to 8 successive trials in both clockwise (CW) and counterclockwise (CCW) directions (90°CW; 180°CCW; 270°CW, 360°CCW, 90°CCW, 180°CW, 270°CCW and 360°CW). At the end of each rotation (acceleration and deceleration 60°/s², constant velocity 70°/s), he has to estimate verbally the travelled rotation angles. We recorded 4 groups of subjects: Control Group with no vestibular anomalies (n=12); patients with acute Canal Paresis (AcUCP) (n=7); patients with Chronic Unilateral Canal Paresis (ChUCP) (n=24); patients with clear Bilateral Canal Paresis (BilCP) (n=8).

Results: There is a very good correlation between the travelled angle and its estimation in the control group, a lesser correlation with the Ac- and Ch-UCP and a really poor one for the bilateral group. In term of numbers of correct and incorrect responses: 1/ Control Group: 80% of correct responses, 18% overestimated and 2% underestimated; 2/ BilCP group: 33% of correct responses, 8% overestimated and 58% underestimated; 3/ AcUCP group: 58% of correct responses, 12% overestimated and 30% underestimated; 4/ Ch UCP: 66% of correct responses, 18% overestimated and 16% underestimated. So, if we consider our protocol (8 trials per patients) as a clinical test to detect vestibular pathology, one response which underestimates the travelled angle, would indicate a vestibular pathology with a good specificity (97%) but a low sensitivity (22,5%).

Conclusion: We have confirmed with vestibular patients that the vestibular system plays an important role in estimation of passive rotation with. This task could be useful to detect or confirm unilateral and moreover bilateral vestibular deficit. It could also show to the patients as well to the physician the vestibular handicap.

O123

Could tympanometry represent a suitable method to detect intralabyrinthine impedance changes in Superior Semicircular Canal Dehiscence Syndrome (SSCDs)?

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Introduction: The diagnostic role of audioimpedancemetry in SSCDS is well known. A mild-low frequency air-bone gap (ABG) with evoked reflexes has represented a determining finding in differential diagnosis with other middle ear affections since the first reports. Though HRCT with parasagittal reformatted images still represents the gold standard, several instrumental tests can support the suspect of otic capsule dehiscence when suggestive symptoms occur. While VEMPs study has assumed by now a crucial role, audiometric testing often represents the starting point of the diagnostic course aimed at investigating the cause responsible of an "intralabyrinthine conductive hearing loss". In this study further evocative audioimpedancemetric exhibits proper to SSCD are assessed

Materials and Methods: Clinical records of 60 patients with unilateral dehiscence selected from 160 subjects diagnosed as affected by SSCD at our institution from 2003 to 2012 were reviewed. ABG amplitude on the dehiscent side and bilateral tympanometric measurements were collected in each patient belonging to the study group. An asymmetry between tympanometric peak compliance of the involved side and that of the healthy side was investigated by calculating the interaural difference (ΔC) and the asymmetry ratio ($\Delta C\%$) of compliance. Correlations between tympanometric findings and both electrophysiological and radiological data were performed

Results: A statistically significant correlation ($p < 0.05$) between $\Delta C\% \geq 14\%$ in favour of the pathologic ear and an $ABG > 20$ dB nHL on the same side was obtained

Conclusion: When evocative SSCD symptoms associated with an important ABG occur, interaural difference in tympanometric peak compliance in favour of the "suspected" side could suggest an intralabyrinthine origin for this asymmetry. Tympanometry would prove to be an useful instrument in SSCD diagnosis being able to detect, as well as cervical VEMPs, those cases associated with alterations of inner ear impedance

O124

Transmastoid surgery for dehiscent superior semicircular canal

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Introduction: Dehiscent superior semicircular canal syndrome is an unusual disease. It causes many different symptoms such as balance problems, vertigo, autophonia, tinnitus and hearing loss. It is diagnosed by a battery of audiological and vestibular tests in combination with high resolution CT. Patient with disabling symptoms may be relieved by surgery.

Material and Methods: Eight patients have been operated. Seven of the patients had plugging of the canal and one had capping done. In all operations a transmastoid approach was used. Indications for surgery was disabling symptoms such as autophonia, oscillopsia, balance problems and pulsative tinnitus. No patient with hearing loss as their main symptom was operated.

Results: All eight patients have been partly or permanently relieved from their most disabling symptoms. Three patients still have some balance problems. Four patients have improved hearing and two worsening hearing. Though, none of these two, have become deaf.

Conclusion: Patients with disabling symptoms caused by dehiscent superior semicircular canal syndrome can be helped by surgical therapy. Transmastoid approach offers a safe non-intracranial surgical possibility. Postoperatively some patients need physiotherapy.

O125

Serial assessment of the hypoactive vestibular ocular reflex in patients with acute labyrinthine dysfunction

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Introduction: It is recognised that semicircular canal function as assessed on caloric testing, and saccule function as assessed on cVEMPs, may recover with time following acute labyrinthitis. Only limited studies with occasional patients have reported on the recovery of the vestibular ocular reflex (VOR) velocity gain using the video head impulse test. This is a natural history study looking at the recovery of the horizontal VOR gain following labyrinthitis.

Methods: 9 patients with labyrinthitis have been tested to date in a serial assessment of the hypoactive VOR in patients with acute labyrinthitis. The protocol included testing patients at 0-24 hours and serially post onset of their acute peripheral vestibular (APV) lesion using the EyeSeeCam video oculography (VOG) goggle system. Manual unpredictable head rotations (in direction and time) were performed and VOR gain was analysed over a 20ms window centred at 80ms. Patients were also tested using bithermal calorics as close to onset as possible and again at 3 months to provide comparison to results obtained with the VOG HIT.

Results: All 9 patients had an impaired VOR gain (from 0.00 to 0.55) 4 patients have made a full recovery of their VOR gain within 6 weeks to 9 months while the other 5 patients are still under study. The return of the VOR gain preceded the recovery of bithermal calorics. The severity of the abnormality on caloric testing did not preclude the recovery of the VOR. Contralesional impairment of the VOR gain was seen in 1 of 4 patients tested acutely (less than 24 hours) with return to a normal contralesional VOR gain in 3 days (from a gain of 0.51 to 0.89). Covert saccades were seen within 24 hours post onset of APV. A Meniere's patient with an attack of vertigo was tested using VOG at 21 hours post onset and again at 48 hours. A full recovery in the VOR gain (from 0.12 to 0.88) was documented at 48 hours.

Conclusion: In acute labyrinthitis the rate of VOR gain recovery on the HIT does not depend on the severity of the caloric deficit. The recovery of the VOR gain in the patient with Meniere's disease was substantially more rapid than that of the APV patients.

O126

Is a vertigo attack due to Ménière's disease or vestibular neuritis ? Fast, simple, objective tests provide the answer

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Introduction: Ménière's Disease or vestibular neuritis both cause severe attacks with vertigo and nystagmus, but how is it possible to distinguish between them? By applying new validated, published clinical tests it is possible to distinguish between MD as opposed to VN simply and quickly in a way which is not distressing for the patient

Materials and Methods: Four patients (2 MD, 2 VN) were tested at attack with 1) the video head impulse test which quantifies dynamic horizontal semicircular canal function by measuring the eye movement response to brief, passive unpredictable natural values of horizontal head acceleration using a lightweight, high-speed, head-mounted video camera measure. 2) The ocular vestibular-evoked myogenic potential (oVEMP) in response to brief (7 ms, 500Hz) bone conducted vibration delivered to Fz. The n10 component of the oVEMP recorded by surface EMG electrodes on the skin just beneath the eye indicates

the functional status of the contralateral utricular macula

Results: Vestibular neuritis caused reduced or absent horizontal semicircular canal responses to high acceleration ipsilesional head rotations whereas in MD patients at attack, horizontal canal dynamic function is normal or enhanced. So if vHIT indicates reduced VOR gain for head rotations towards the affected ear, then the likely diagnosis is VN. In vestibular neuritis the oVEMP n10 response is reduced or absent beneath the eye opposite the affected ear. In contrast, in the MD attack the oVEMP n10 is usually enhanced

Conclusion: A normal or enhanced VOR gain to high acceleration head impulses points to the attack being due to MD. A reduced ipsilesional VOR gain points to VN. In response to Fz BCV, the contralesional n10 is smaller or absent, then it is likely to be VN rather than MD. On the other hand if the contralesional oVEMP n10 is enhanced it is likely to be MD rather than VN. The results from vHIT and oVEMP n10 are complementary.

O127

Mastication-induced vertigo and nystagmus

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Background: Even though trigemino-vestibular connections are well established in animals, mastication-induced dizziness has been described only as a vascular steal phenomenon in human.

Methods: Two patients with mastication-induced vertigo underwent recording of the nystagmus and evaluation of other vestibular function. We also determined induction or modulation of nystagmus in 12 normal controls and 53 additional patients with peripheral (n=39, 27 with vestibular neuritis/labyrinthitis and 12 with Meniere's disease) or central (n=14, 11 with Wallenberg syndrome, two with cerebellar infarction, and one with pontine infarction) vestibulopathy during their acute or compensated phase.

Results: Both index patients developed mastication-induced vertigo after near complete resolution of the spontaneous vertigo from presumed acute unilateral peripheral vestibulopathy. The nystagmus and vertigo gradually built up during mastication and dissipated slowly after cessation of mastication. Brain MRI and cerebral angiography were normal in these patients. Mastication did not induce nystagmus in normal controls. However, mastication induced nystagmus in five (24%) of the 21 patients without spontaneous nystagmus (SN), and either increased (22/32, 69%) or decreased (9/32, 28%) SN in almost all patients (31/32, 97%) with SN.

Conclusion: Mastication may induce significant vertigo and nystagmus in certain patients with a prior history of acute vestibulopathy. The induction or modulation of nystagmus by mastication in both peripheral and central vestibulopathies supports trigeminal modulation of the vestibular system in human. The gradual build-up and dissipation suggest a role of the velocity storage mechanism in the generation of mastication-induced vertigo and nystagmus.

O128

Acute, selective utricular macula impairment objectively verified

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Introduction: The presence of spontaneous nystagmus in darkness with a strong horizontal component has been taken to indicate that there is asymmetrical function of the horizontal semicircular canals. If this horizontal spontaneous nystagmus can be suppressed by vision then it is regarded as due to peripheral horizontal canal dysfunction

Materials and Methods: However we report evidence from 30 patients (8 male), who came to Cassino clinic, Italy, reporting acute, severe vertigo, postural unsteadiness, nausea and vomiting. In addition 49 healthy subjects were tested as controls. Patients and healthy subjects were submitted to instrumental audiovestibular test to obtain objective measurements of their inner ear receptors

Results: At the time of the attack all patients showed spontaneous nystagmus mainly with horizontal and vertical components (3D i.r. VO). Tests of dynamic horizontal canal function in normals and patients, using the video head impulse test, showed that the functional status of both horizontal canals was within the normal range. Both groups were tested with bone conducted 500 Hz Fz ocular and cervical VEMPs. All patients showed normal results to cVEMPs while to oVEMPs they revealed asymmetrical function with an asymmetry ratio >40%. For this reason they were diagnosed as having unilateral selective utricular macula lesion

Conclusion: There is abundant evidence for pure linear acceleration generating or modulating horizontal nystagmus. Such stimuli will activate otoliths and in these patients, their unilateral utricular deficit appears to result in spontaneous nystagmus. There is considerable evidence of convergence of neural input from the otoliths onto horizontal canal neurons in the vestibular nuclei. The firing of such neurons could reflect either asymmetrical horizontal canal function or asymmetrical utricular function. The problem with these patients was due to asymmetrical UT macula function, demonstrated by oVEMP results.

O129

Spontaneous plugging of the horizontal semicircular canal with reversible canal dysfunction

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We report on a 42-year-old man who had acute spontaneous vertigo with spinning vertigo and persistent left-horizontal nystagmus. The nystagmus intensity, but not its direction, changed with positional testing. The most probable diagnosis was benign paroxysmal positional vertigo (BPPV) caused by an otoconia plug in the horizontal semicircular canal. In the time interval from 40 to 90 ms the video head-impulse test (vHIT) revealed an eye velocity cut-off at 80 °/s during head impulses to the right. This normalized within 2 days after liberatory maneuvers, documenting for the first time a reversible modification of the cupular-endolymph high-frequency system dynamics. Cervical and ocular vestibular myogenic potentials (cVEMP and oVEMP) were absent during stimulation of the affected side before and two days after liberatory maneuvers, but they normalized within 30 to 80 days. This case is special in four aspects: 1) the nystagmus properties which can be explained by a canal plug, 2) VEMP asymmetry before and shortly after liberatory maneuvers, 3) VEMP recovery after day 30, and 4) recovery of vHIT asymmetry. These observations challenge the common belief that VEMPs are evoked by otolith stimulation. Instead, the assumption of a reversible canal plug offers a more plausible explanation for all effects.

O130

Middle ear pressure stabilization deficits in Meniere syndrome

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Introduction: The pressure transfer from middle to the inner ear is objective of studies in animals and men. There is no common consensus about the impact of middle ear function in Meniere's disease. 24 hours registrations of middle ear impedance revealed less than 1 hour pathologic intervals in Meniere patients. Therefore diagnostic provocative manoeuvres for clinical use were evaluated.

Materials and Methods: An analysis of cochlear and vestibular function parameters in 150 patients with definite Meniere's disease according to the criteria of the AAO-HNS was performed. 22% (n=33) were selected due to history or findings of Eustachian tube dysfunction. The patients were investigated with a body worn impedance unit in an equilibrated pressure situation over 24 hours with 60 min intervals. Exposure towards small pressure changes were performed by lift elevations over 12 floors. Samples were taken before, during and after the lift motion and 1, 2 and 5 min after. Cut-off normal values of ± 50 daPa were defined during a previous study. Patients with definite Meniere's disease and normal individuals are compared.

Results: Significant lower impedance before exposure and prolongation of return to normal after pressure exposure are seen in Meniere patients. Overflow of normal impedance value was registered in all cases. Influence of age, gender and side are excluded. Static middle ear pressure and dynamic stabilization with a range between ± 50 daPa under external minimal atmospheric pressure exposure are out of range. More than 20% of patients with Meniere symptoms and findings can be selected with middle ear mediated Meniere syndrome by use of sophisticated audiology.

Conclusion: It is concluded, that short-term Eustachian tube dysfunction and long-term impairment of pressure stabilization is pathogenetic in 22% of Meniere patients. Only long-term registration (24 hours) or provocative pressure exposure are able to identify these patients, who can be treated.

O131

What is vertigo in healthy humans after sudden stop of constant velocity vertical axis rotation and factors modifying perception for motion

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Introduction: Vertigo is generally described as a whirling or spinning movement. Generally three types of vertigo are described by patients: objective - environment is moving around the patient; subjective patient feels as if moving himself; pseudovertigo - intensive sensation of rotation inside the patient's head. Concerning healthy humans it is considered that vertigo is caused by unusual vestibular stimulation like sudden stop of rotation.

Purpose: The aim of this study was to investigate the characteristics of vertigo in healthy humans caused by sudden stop of constant rotation on Barany chair and factors that modify the sensation of motion.

Materials and Methods: Thirty healthy volunteers seated on a Barany chair were rotated with constant velocity of 70 °/s to the left. After sudden stop of rotation they were asked to describe the sensation of rotation. Several experimental series randomized between the subjects were conducted with three tasks: 1. What is moving and in which direction? (spontaneous perception); 2. Are you moving and in which direction? (insinuated perception); 3. Is the environment moving and in which direction? (insinuated perception).

Results: The results obtained indicate dependence on the task. First task: self-motion perception reported 6 of 30 subjects, environment is moving - 18 of 30 subjects. Second task: self-motion - 27 of 30 subjects. Third task: environment is moving - 24 of 30 subjects. The reported direction of motion perception was not equal for all subjects in each task. It varied according to the task.

Conclusion: Vertigo caused by sudden stop of constant vertical axis rotation in healthy humans shows difference depending on whether spontaneous or insinuated perception task was used. In spontaneous perception to qualify it either as self-motion or environment motion depends on which modality dominated perceptually in each subject during the test.

O132

A new test of dynamic visual acuity using immersive virtual reality eyewear

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Introduction: Reduced dynamic visual acuity (DVA) can be a disabling symptom and is important to measure from a clinical and medicolegal perspective. All current tests of DVA rely on the principle that an intact VOR will keep the visual field on a distant target during head movements, whereas with an absent VOR the eyes will move from the target as a result of being more fixed in the head. The reverse is also true: If a target is coupled to the head, an absent VOR will not move the eyes and allow the retinal image to be stable relative to the coupled target and an intact VOR will cause the eyes to move relative to the target, reducing acuity. We measured the relative improvement a reduced VOR brings to DVA for head-coupled optotypes.

Materials and Methods: Eight patients with BVL and eight age and sex-matched controls, without vestibular pathology were recruited. Virtual reality LCD glasses were used to present 'Illegible E' optotypes on video screens in front of the subjects' eyes. The ratio of correct identification of optotypes during head rotation at 2Hz to correct identification at rest was calculated.

Results: Participants with BVL had reduced movement of their eyes in relation to head movements (reduced gain). This pathology increased acuity for viewing the head-mounted screen during head movement compared to normal controls. Ratios for BVL subjects were higher at a median ratio of 0.972 (IQR=0.953-0.980) correct compared to normal subjects who scored a median of 0.742 (IQR=0.593-0.774)($p < 0.001$).

Conclusions: All current measures of DVA are subject to misreporting of acuity, as feigning of results will result in a positive test. This test uses the principle that a reduced VOR will improve acuity for head-coupled targets. As a result, patients with an impairment of their VOR will score better than normals, making the test impossible to fake. This has important implications for medicolegal assessments.

O133

Investigation of presbyastasis patients using the cross test

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Objective: To investigate the equilibrium function of elderly patients experiencing dizziness caused by age-dependent physiological vestibular dysfunction (presbyastasis) and evaluate the effects of a vestibular rehabilitation program the author conducted a new balance training program, the cross test.

Methods: Thirty patients aged over 65 years with presbyastasis who had complained of equilibrium dysfunction for at least 3 months were enrolled in this study. The standing balance training system with gravicorder was used to examine their equilibrium. The cross test indicates the equilibrium function based on ankle mobility and the center of gravity when individuals move forward, backward, right and left in turn on the gravicorder. The cross test was carried out once a month at least more than 5 times, and the results were subjected to statistical analysis.

Results: After undergoing the vestibular rehabilitation program, the range of ankle motion improved in 28 out of 35 patients compared with the pretraining values ($p < 0.05$).

Conclusions: These findings suggested that the cross test is a reliable method to estimate the equilibrium function and the effects of a balance training program for patients with presbyastasis. Furthermore, it appears that it is associated with prompt improvement of equilibrium dysfunction and thus is an effective therapeutic option along with medication and conventional vestibular training programs.

O134

Identification of BPPV in a community, integrated falls prevention service.

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Introduction: BPPV is a significant risk factor for falls in older persons but under diagnosed. The North Tyneside Falls Prevention service aims to identify and modify risk factors for falls in a large community based population working as an integrated care model with primary and secondary care, GP based IT expertise and the third sector- AGE UK.

Materials and Methods: An audit of GP computerized records followed by simple postal questionnaire identified all older persons over 60 with recognized risk factors for falls. This group underwent a comprehensive community based assessment including: Senior physiotherapy assessment and treatment Nurse review: ECG, Lying and standing BP, MMSE, GDS, FES, visual acuity Medical assessment- targeted history and examination for dizziness, vertigo and syncope, FRAX score / bone health. Recommendations given to GP on new diagnoses made, referrals to secondary care, and referrals to AGE UK strength and balance classes if required.

Results: 2450 patients assessed in first 2 years 95 new diagnoses of posterior canal BPPV 3.8% prevalence. Mean age 74.3 years. Range 60-89 76 females. 53% fallers 50 right BPPV, 37 left BPPV and 8 bilateral. The commonest additional diagnosis made was lower level gait disorder in 48% with 20 patients referred to AGE UK balance group, rest given customized exercises. Additional new diagnoses made in this group included 5 recommended medication for osteoporosis, 14 referred on for DEXA on basis of FRAX tool, 7 had orthostatic hypotension, 3 bradycardia requiring medication review, 1 atrial fibrillation, 1 cognitive impairment and 3 with depression.

Conclusion: Active identification and treatment of BPPV must be part of falls prevention services. Any service seeing older persons with BPPV should consider additional modifiable risk factors for falls including gait disorders, osteoporosis screening, cardiovascular diagnoses with the aim of reducing falls related hospital admissions

O135

Vestibular findings in patients with persistent apogeotropic nystagmus

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Introduction. Benign positional vertigo with apogeotropic nystagmus can be separated in two types; paroxysmal and non-paroxysmal. The latter is believed to be caused by a "heavy" cupula in the lateral semicircular canal. Two nystagmus patterns indicating the affected side has been reported; a) directional preponderance of the apogeotropic nystagmus towards the unaffected ear (Ewalds law) and b) nystagmus directed to the affected side in supination (ampullopetal cupula deviation). We have analyzed the characteristics of the nystagmus in patients with a heavy cupula, irresistible to treatment.

Material and Methods: The group comprised 29 patients (mean age 64 years) free from symptoms of CNS disorders and alcohol intake. Direction and slow phase velocity (SPV) of nystagmus as well as preponderance of apogeotropic nystagmus (difference between left and right beating nystagmus divided by sum of nystagmus) was calculated. **Results:** SPV of the apogeotropic nystagmus varied between 1-

98°/s. The preponderance of the apogeotropic nystagmus was directed to the left in 52% of the patients, to the right in 41% and was absent in 7%. The preponderance was higher than 30% (considered pathologic) in 52 % of the patients and lower in 48%. In 26% of patients the directional preponderance was opposite to the direction of nystagmus in supination. In 48% of the patients the directional preponderance of the apogeotropic nystagmus and the nystagmus direction in supination was the same. Conclusion. Not more than half of the patients displayed a directional preponderance of more than 30%. In a minority of the patients the nystagmus in supination. was directed opposite to the directional preponderance of the apogeotropic nystagmus. Hence, the affected side is difficult to judge as there is no consistent pattern between the directional preponderance of the apogeotropic nystagmus and the direction of nystagmus in supine position.

O136

The natural course of positional down-beating nystagmus and vertigo in patients without CNS involvement

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Introduction: To assess the natural course of patients with positional down-beating nystagmus (pDBN) without central nervous system findings.

Materials and Methods: Between January 2011 and March 2012, were assessed 45 patients suffering from pDBN. All subjects showed no additional neurological signs or symptoms, and normal brain imaging (CT/MRI). Patients were instructed to self-administrate habituation exercises. Patients were followed-up after 24 hours and then weekly up to the complete resolution of the pDBN. At every follow-up visit, symptoms and positional nystagmus under Frenzel's goggles were assessed.

Results: More than 95% of patients showed pDBN in Rose and Dix-Hallpike positions. A torsional component was present in more than 31% of subjects. Despite 68% reported vertigo without nystagmus during these maneuvers only 3 patients demonstrated an up-beating nystagmus when returning sitting from the Rose position. pDBN mean latency and duration were respectively 12 ± 6 and 38 ± 23 seconds. At the 24 hours follow-up 4 patients recovered from the pDBN. At the one-week control, the pDBN was absent in 46% of patients and 35% had pDBN with residual dizziness. 18% of subjects showed a PC BPPV typical nystagmus during follow-up and was treated with Semont liberatory maneuver. After two weeks the pDBN was still present in 24% patients despite a significant reduction in duration. The mean time from onset to natural remission of the pDBN was 10 ± 6 days. The mean time from onset to symptoms recovery was 13 ± 7 days. At the latest follow-up (90 days) only one subject presents an asymptomatic pDBN.

Conclusion: To the best of our knowledge this study describes for the first time the natural course of the pDBN of peripheral etiology providing important key features for the differential diagnosis. This disorder has distinctive clinical characteristics (duration, latency, resolution) and seems in close relation with PC-BPPV. Habituation exercises may play a role in pDBN recovery.

O137

Long-term evaluation of static and dynamic balance after treatment of BPPV

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Introduction: Benign paroxysmal positional vertigo (BPPV) is one of the most common causes of vertigo. The prognosis is good, usually with spontaneous remission within three months, but symptoms may last. Some subjects who are free of BPPV still have unsteadiness and avoid vertigo by avoidance behaviour. To our knowledge, no previous study have investigated long term outcome of vertigo and balance in patients treated for a severe BPPV in the posterior vestibular canal (>3 months).

Aims: To evaluate long-term effects (12 months) of the Semont maneuver and Brandt-Daroff exercises in patients with long-lasting BPPV (>3 months) with reference to static, dynamic balance performance, vertigo, physical exercise habits, neck-and shoulder pain.

Methods: Seventeen patients were consecutively evaluated before treatment and after 1, 6 and 12 months. Patients with remaining BPPV after two Semont manoeuvres were instructed to perform Brandt & Daroff exercises. Follow-up was done by the Dix-Hallpike test, measurement of static/dynamic balance and a health questionnaire including questions concerning vertigo (VAS), physical exercise habits, headache, neck-and shoulder pain.

Results: Six of 17 patients were free from vertigo after a single Semont maneuver and 3/17 required a second Semont maneuver. Thus, 8/17 patients continued to suffer from BPPV and were subsequently given Brandt & Daroff exercises. After 12 months 14/17 patients were symptom free. Three patients still suffering from vertigo had a shorter duration of nystagmus during the Dix-Hallpike. Thirteen of the 17

patients had neck-shoulder pain prior to treatment. We found however that 9/17 patients still experienced unsteadiness with pathological static and dynamic tests.

Conclusions: It is of importance to assess static and dynamic balance abilities in patients with BPPV and in many cases perform vestibular rehabilitation including static/dynamic balance exercises in order to reduce unsteadiness.

O138

Fluid dynamics of BPPV fatigue

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Introduction: Free-floating particles (canaliths) in the semicircular canals (SCCs) of the inner ear are believed to be the cause of Benign Paroxysmal Positional Vertigo (BPPV). Several mechanical models have been formulated for the prediction of the cupula displacement induced by free-floating particles in SCCs. These models can explain typical features of the positional nystagmus observed during a BPPV attack, e.g. the duration of the nystagmus. However, they cannot explain BPPV fatigue, i.e. the typical attenuation of the positional nystagmus induced by repeated head maneuvers. This phenomenon has been associated to the disintegration of lumps of canaliths, but was never investigated quantitatively. We propose a new model for the cupula displacement due to canalith clusters in SCCs and discuss conditions and mechanisms that can lead to BPPV fatigue.

Materials and Methods: The governing equations for the fluid, the particles, and the cupula are solved numerically by coupling the multilayer method of fundamental solutions to the force coupling method (F. Boselli et al. 2010, *Proc Appl Math Mech*). We will support our conclusions by in-vitro experiments (D. Obrist et al. 2010, *J Biomech*) and in-vivo nystagmus measurements.

Results: As previous models, the proposed model can explain typical features of the BPPV nystagmus, such as its onset latency and its duration in time. In addition, our model predicts a more pronounced nystagmus when many canaliths (e.g. twenty) are lumped together rather than when they are dispersed along the canal wall. This result agrees with the classical interpretation of BPPV fatigue and is consistent with our in-vitro and in-vivo measurements.

Conclusion: In contrast to previous models, the proposed model can properly treat the hydrodynamics of canalith clusters in SCCs and supports the idea that BPPV fatigue is due to fluid-particle dynamics rather than to neural mechanisms.

O139

Perception of vertigo during the Dix-Hallpike maneuver

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Introduction: Perception of motion is difficult to measure although it may be a useful indicator of vestibular function. Patients with benign paroxysmal positional vertigo (BPPV) are known to experience vertigo during Dix-Hallpike testing. Therefore they provide a good example of the problem. The goal of this experiment was to determine if patients with positive responses on the Dix-Hallpike maneuver can use static diagrams, or dynamic cartoon movies, to indicate their perceptions of motion in the three cardinal planes in space.

Materials and Methods: Patients with unilateral BPPV of the posterior semicircular canal were tested with Dix-Hallpike maneuvers. Immediately afterward they viewed either static diagrams indicating motion in pitch, roll and yaw or video cartoons illustrating head motion in pitch, roll and yaw. They were asked to select which diagrams or videos best illustrated their sensations during testing.

Results: Most patients selected images that reflected at least two planes in space. Patients were variable in their responses, however, and some people indicated more or less sensations in the different planes.

Conclusion: These data suggest that although most responses indicated a sense of motion through more than one plane people did have some variability. Variability may have been due to minor variations in final head position during testing or other, intrinsic factors. Supported by NIH grant R15-DC008311.

O140

Benign paroxysmal positional vertigo-prognostic factors

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BPPV It's characterized by brief, episodic, attacks of vertigo and typical nystagmus produced by certain head movements. Canalith repositioning procedure (CRP) is a recognized form of treatment but although it was described in 1992, there are very few studies who evaluate prospectively the prognostic factors, for the success of the maneuver. We conducted a prospective study between 2009-2011, with the aim to identify prognostic factors for therapeutic success, of the Epley maneuver for posterior BPPV as well as the success rate and recurrence of disease. Patients included, met the diagnostic criteria for posterior semicircular canal BPPV, elicited by the Dix-Hallpike maneuver. The eye movements were evaluated by infrared videocamera. These patients were submitted to CRP, as described by Epley, repeating the Dix-Hallpike maneuver at the end. If it was positive, CRP was repeated as necessary at each session until the Dix-Hallpike was negative. Patients were reevaluated one week apart, and the CRP was repeated as necessary if the Dix-Hallpike was still positive. During the CRP, the presence (liberatory nystagmus-NL), or absence of nystagmus was monitored. Other variables were analyzed, age, sex, etiology, disease duration and number of treatment sessions. Long-term follow-up for the study population after the initial treatment has been from 6 to 35 months. Successful treatment is defined as the absence of nystagmus and positional symptoms. Statistical significance was defined as $P < 0.05$. A total of 220 patients were selected with a successful treatment of 88% and a 6% recurrence rate. In 82% no precise etiology was found, and no relationship was found between etiology and number of maneuvers and recurrence. NL showed, after a session with a positive predictive value of 68%. The presence of nystagmus in the second position of the Epley maneuver, although it has a positive predictive value, it's absence does not exclude successful therapeutic.

O141

Differential diagnosis of pseudo-anterior canal type of benign paroxysmal positional nystagmus originating in posterior canal from true anterior canal type of benign paroxysmal positional nystagmus

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Introduction: We show a case whose positional nystagmus looked like anterior semicircular canal (ASCC) type of benign paroxysmal positional nystagmus (A-BPPN) originating from posterior semicircular canal (PSCC) (pseudo A-BPPN). In this paper we discuss the pathophysiology of pseudo A-BPPN and show the method to distinguish pseudo A-BPPN from true A-BPPN.

Materials and Methods: We analyzed positional nystagmus in a patient with true A-BPPN and in a patient with pseudo A-BPPN during reverse Epley maneuver three dimensionally.

Results: In the patient with true A-BPPN, the direction of positional nystagmus during reverse Epley maneuver was constant that is the same direction of the nystagmus induced by excitement of ASCC. In contrast, in the patient with pseudo A-BPPN, the direction of positional nystagmus reversed and the direction of the positional nystagmus became the direction of nystagmus induced by the excitement of PSCC during reverse Epley maneuver.

Conclusion: When otoconial debris is existed at other than the bottom of PSCC in patients with PSCC type of benign paroxysmal positional nystagmus and the debris moves to the direction that inhibits PSCC during Dix-Hallpike maneuver, the patients show nystagmus that is seen in patients with A-BPPN. The nystagmus should be diagnosed as pseudo A-BPPN. It's possible to distinguish pseudo A-BPPN from true A-BPPN by observation of the reverse of the direction of positional nystagmus during reverse Epley maneuver.

O142

Decreased serum vitamin D in idiopathic benign paroxysmal positional vertigo

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Objective: Our previous study demonstrated an association of osteopenia/osteoporosis with idiopathic benign paroxysmal positional vertigo (BPPV). Since vitamin D takes part in the regulation of calcium and phosphorus found in the body and plays an important role in maintaining proper bone structure, decreased bone mineral density in patients with BPPV may be related to decreased serum vitamin D.

Methods: We measured the serum levels of 25-hydroxyvitamin D in 100 patients (63 women, mean age±SD=61.8±11.6) with idiopathic BPPV and compared the data with those of 162 age- and sex-matched controls (87 women, mean age±SD=59.4±11.0) who had lived in the same community without dizziness or imbalance during the preceding year.

Results: Serum level of 25-hydroxyvitamin D was lower in the patients with BPPV than in the controls (mean±SD=14.4±8.4 vs. 18.9±6.7 ng/ml, p=0.001). Furthermore, patients with BPPV showed higher prevalence of decreased serum vitamin D (<20 ng/ml, 80.0% vs. 60.5%, p=0.001) than the controls. Multiple logistic regression analyses adjusted for age, sex, body mass index, and the existence of osteopenia/osteoporosis demonstrated that vitamin D insufficiency (10-20ng/ml) and deficiency (<10ng/ml) were associated with BPPV with the odds ratios of 2.4 (95% confidence interval=1.1-5.5, p=0.038) and 19.9 (95% confidence interval= 6.3-63.1, p <0.001). The odds ratio of osteoporosis was also 8.1 (95% confidence interval= 2.7-23.6, p<0.001).

Conclusions: Our study indicates that vitamin D insufficiency and deficiency increase the risk of idiopathic BPPV. Supplementation of vitamin D should be considered in patients with recurrent idiopathic BPPV and vitamin D deficiency.

O143

Singular neurectomy, results about 12 cases

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Objectives: To describe indications, complications and results to the singular neurectomy in posterior canal benign paroxysmal positional vertigo (BPPV)

Material: 12 patients operated between 07/2006 and 10/2010 with an intractable posterior canal BPPV.

Method: The 12 patients were evaluated before surgery by clinic history, positional videonystagmography, posturography and symptomatic scales; they were reevaluated at one week, one month and one year after surgery.

Results: Average age was 49 years. The average length of duration of vertigo before surgery was 40.83 months. Average symptomatic results reached 54.83 on Vertigo Symptom Scale (N =13.46), 64.5 on Dizziness handicap inventory (N= 1.46) and 64.50 on Short form 36 (N=16.73). In 1 case operation could not be performed for anatomic reasons. All the 11 other patients presented a post-surgical deafferentation nystagmus. Recovery of walking occurred on average after 5.33 days. Post-surgical complications were: 1 deafness with immediate vestibular areflexia, 2 vestibular areflexias without deafness. All our patients recovered from their Bppv. The average post-surgical decline attains 32.16 months. The average symptomatic results reached 40.36 on VSS (less than 35.85 %), 46.90 on DHI (less than 37.52 %) and 46.81 on SF36 (less than 37.79 %).

Conclusion: Surgery of singular nerve have an acceptable vestibular and cochlear risk, if we consider the arduous path of our patients.. Indications have to be fixed and balanced by a medico surgical team. Result upon positional vertigos is notable: 100 %, but global result upon subsidiary vestibular symptoms or general health is close to 30%.

O144

Vestibular testing in patients with acoustic neuroma (AN)

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Introduction: Nowadays, early diagnosis of AN, which seems to correlate to a better auditory function, has become relevant for hearing preservation surgery. So, the role of electrophysiological testing is to identify early alterations that may be mandatory for the assessment of MRI. The aim of our study is to assess the usefulness of newer vestibular tests in AN patients, concerning both diagnostic sensitivity of each test and analysis of vestibular nerve involvement by the tumor

Materials and Methods: We studied 40 patients affected by small unilateral AN (size 1-25 mm, mainly intracanalicular type), previously examined by MRI; for all patients we performed Pure Tone Audiometry, Caloric Bithermal Test (CBT), Vibration-Induced Nystagmus Test (VINT), Air Conducted (AC) and Bone Conducted (BC) CVEMPs and OVEMPs. In a subgroup of patients, video head impulse test (VHIT) was performed.

Results: CBT showed the greatest diagnostic sensitivity (about 70%); OVEMPs were globally altered in 60% of cases, while CVEMPs in less than 40%. VINT showed a pathological pattern in 45% of cases. 15% of patients did not show any alteration on vestibular testing. Five patients showed a single selective alteration on vestibular tests suggesting a clear involvement of a single vestibular nerve branch. In one surgical patient results of pre-operative vestibular tests overlapped with intra-operative findings and

post-operative examinations.

Conclusion: This multilevel selective analysis of vestibular function could be crucial in a complete diagnostic and clinical picture of patients with AN, even if sensitivity of these tests could not determine strict criteria for performing MRI in patients with non specific cochlear-vestibular symptoms (instead as unilateral sensorineural hearing loss or unilateral tinnitus). An alternative role for these examinations could be a better planning of surgical strategy or post-surgical monitoring of vestibular compensation

O145

Computerised assessment of Dynamic Visual Acuity: reliability of the micromedical technologies DVA system

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Introduction: Dynamic visual acuity (DVA) is commonly measured in patients with vestibular disease to assess the ability of the vestibular ocular reflex to maintain stable vision during head movement. Routine clinical measures using Snellen and ETDRS charts lack sufficient validity and reliability. Computerised assessment of DVA uses rate sensors to accurately measure head velocity which may improve test accuracy. The aim of this study was to investigate the reliability of the Micromedical Technologies (Chatham Illinois) computerised DVA system in patients with unilateral vestibular hypofunction (UVH).

Material and Methods: Horizontal DVA was assessed twice by the same assessor on n=13 subjects (age 47.9±14; range 28-74, 10F:3M) with a diagnosis of UVH. Subjects were seated 10ft from a monitor with the rate sensor secured to their head. Static visual acuity (SVA) was assessed first using "U" shaped optotypes of predetermined sizes. Subjects were required to accurately identify the orientation of the optotype (up/down/left/right). DVA was then assessed at 50/100/150 deg/sec of head rotation (left and right). Reliability for absolute LogMAR values was assessed using the intraclass correlation co-efficient (ICC), the standard error of measurement (SEM), the minimal detectable change (MDC) and the 95% limits of agreement (Bland and Altman).

Results: ICCs were all above 0.70 indicating good reliability and the SEM was low for SVA and for all head velocities (<0.07 LogMAR unit). Test-retest reliability for DVA at head rotation of 150 deg/sec was excellent (ICC = 0.90). The MDC was less than 0.1 LogMAR for DVA at 50 and 150 deg/sec head rotation and 0.15-0.16 LogMAR for 100 deg/sec.

Conclusion: In this sample of subjects with UVH, the reliability of DVA measured with the Micromedical Technologies DVA system was very good. The SEM was less than 0.1 LogMAR units and the minimal detectable change was only slightly higher.

O146

The galvanic whole-body sway response in health and disease

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Objective: To explore the galvanic-evoked vestibulospinal reflex in health and disease.

Methods: Vestibular-evoked whole-body movement was measured in 60 controls and seven patients with bilateral vestibular failure, using 1mA/2second galvanic vestibular stimulation (GVS). The displacement (D) and velocity (V) of 7 markers placed on the head, neck, shoulders, mid-thorax and hips and ground reaction forces (F) were recorded. For each condition, responses to ten stimuli were averaged.

Results: Monopolar GVS evoked anterolateral whole-body movement away from the cathode. For controls, peak response magnitudes were 22.36±12.40mm, 24.86±14.27mm/s and 3.11±1.31N for D, V and F. Although average response amplitudes were lower in subjects >60 years of age, this effect was not significant. Left right asymmetry measured using the Jongkee's formula was 12.59±8.64%, 11.94±11.09% and 11.68±8.99% for D, V and F. Subjects with bilateral vestibular failure (BVF) had absent or attenuated responses. The ("R/B") ratio between the "response period" and baseline body-sway for D, V and F were 8.44±7.18, 5.02±2.86 and 3.36±1.57 for controls and significantly lower at 1.57±0.71, 1.22±0.22 and 1.27 ±0.27 for vestibular failure. The area under the ROC curve for D, V and F were 0.938, 0.983 and 0, indicating that all three measures were highly effective in discriminating between controls and patients with BVF. Using cut off values of 2.8, 1.79 and 1.65, sensitivities of 100% were reached for all 3 measures and specificities were 90%, 95% and 95% for D, V and F.

Conclusions: GVS enables non-invasive assessment of the vestibulospinal responses. Their preservation

in older subjects may be due to enhancement of the vestibulospinal reflex by decreased proprioceptive inputs as age advances.

Significance: The galvanic body-sway response is a quantitative and lateralizing test of the vestibulospinal pathways.

O147

Long latency vestibular evoked potentials (VsEPs) of cortical origin produced by air-conducted (AC) sound

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Introduction: Short-latency VsEPs in response to 500-Hz AC stimuli are predominantly a manifestation of vestibular ocular pathways [1]. We report an experiment to map late vestibular evoked potentials (LVsEPs) produced by the same stimuli with fifteen healthy volunteers.

Materials and Methods: The stimuli were 2-ms, 500-Hz tone pips from which subjects' thresholds for vestibular activation (VT) were defined using vestibular evoked myogenic potentials (VEMPs). Evoked potentials (EPs) were recorded using a 70-channel EEG montage, at supra-threshold intensities, i.e. from -6 to +18 dB re VT, and at sub-threshold intensities, i.e. from -24 to -6 dB re VT. EPs were obtained over an epoch of 350 ms with a band-pass between 0.16 Hz and 1 kHz.

Results: In the sub-threshold conditions both mid-latency (MLRs) and late-latency auditory evoked potentials (LAEPs) were observed, consisting sequentially of wave V, Na, Pa, Nb/P1, N1 and P2 potentials. In the supra-threshold conditions a change in morphology was observed. This consisted of short-latency VsEPs, i.e. prefrontal N15/P21 and parietal P10/N17 complexes, followed by later waves, i.e. a prefrontal N42 wave and a fronto-central N74 coincident with the LAEP Nb and N1 waves. The N42 and N74 potentials appeared to plateau and then increase steeply above VT.

Conclusions: The recruitment observed for the Nb/N42 and N1/N74 measurements as a function of intensity suggests that the N42/N74 waves are due to excitation of additional, presumably vestibular receptors occurring above the VEMP threshold. Brain electrical source analysis (BESA) suggests it is likely that cortical sources contribute to the later N42/N74 waves. These potentials, when evoked above VT, should be regarded as probable late vestibular evoked potentials (LVsEPs).

References: 1. Todd NPM, Rosengren SM, and Colebatch JG. Clin Neurophysiol 119, 1881-1894, 2008. Acknowledgement. Work supported by a grant from the Wellcome Trust.

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Vestibular modelling - education and public outreach using mobile device (iPad or iPhone) applications.

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Introduction: Since 2003 we have been using miniature inertial measurement units (IMUs) or attitude, heading reference systems (AHRS) for vestibular research. Analogous to a bionic vestibular labyrinth these small (4x3x2cm, 30g) units incorporate 3-axis linear accelerometers („I otoliths), 3-axis gyroscopes („I semicircular canals), and a sensor fusion algorithm to determine spatial orientation („I nuclei and CNS). We were able to use fast (~100Hz) real-time measures of natural head movements, to model stimulation of the peripheral vestibular sense organs and predict compensatory eye movement responses. With steady reduction in cost and size these sensors are now commonly used in most game controllers, smart phones, and tablet computers. In October 2011, we translated the results into free education and public outreach apps for iPad/iPhone devices.

Materials and Methods: The first app, which we have called aVOR (the angular Vestibulo Ocular Reflex) demonstrates the stimulation of the balance sensors of the inner ear by rotation (angular velocity) and models the reflexive eye movement responses that serve to stabilize gaze. It is available for free at <http://itunes.apple.com/app/avor/id497245573>

Results: The aVOR app allows manipulation of the functional state of the semicircular canals, the influence of cerebellar function, the type of visual fixation, saccade characteristics, canalithiasis, etc., The user can interactively explore the consequences of these settings by moving the subjects' head (the device) and observing the eye movement responses. A quiz mode introduces unknown settings so the user can practice diagnosis.

Conclusion: The aVOR app has begun to facilitate a number of research objectives, improve awareness

of the vestibular system in the general public; educate medical practitioners to provide accurate and timely diagnosis and treatment, and improve outcomes for patients.

O149

Long latency vestibular evoked potentials (VsEPs) of cortical origin produced by impulsive acceleration (IA) applied at Nz

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Introduction: IA is an effective stimulus for activating the vestibular apparatus [1]. We report an experiment with ten healthy volunteers to map late vestibular evoked potentials (LVsEPs) produced by IA.

Materials and Methods: The IA waveform was a third-order gamma distribution with 4-ms rise-time delivered by minishaker at a fixed intensity of about 0.1 g. IA was applied to the nasion and in a somatosensory control to the index fingers, both separately to left and right with positive and negative polarity. Evoked potentials (EPs) were recorded using a 70-channel EEG montage over an epoch of 350ms, with a band-pass of between 0.16 Hz and 1k Hz.

Results: Finger EPs were characterized by a frontal negativity at 47ms, the somatosensory N50, which was invariant to the polarity of the impulse and could be explained in source analysis (BESA) by bilateral peri-central generators. Nz EPs included large infra-ocular and prefrontally distributed potentials, as well as central and posterior waves, which were not invariant with polarity. Among the central waves N38/N66 and N48/N72 complexes were obtained respectively with +ve and -ve polarity, which may be analogous to the N42/N74 waves obtained with AC stimulation. About 90% variance could be accounted for with a three regional source model, made up of bilateral ocular and a central midline generator fitted over an interval of 20–200 ms. More complex models suggested additional areas, including frontal, thalamic and cerebellar generators.

Conclusions: The complexity and directional sensitivity of the nasion EPs indicate that they are not primarily somatosensory and likely vestibular in origin, i.e. LVsEPs. Although the BESA model included strong bilateral ocular sources a large central source, possibly cingulate cortex was also indicated.

References: 1. Todd NPM, Rosengren SM, and Colebatch JG. Clin Neurophysiol 119, 1638-1651, 2008. Acknowledgement. Work supported by a grant from the Wellcome Trust.

O150

Clinical observation on acute low frequency hearing loss without vertigo: the Role of cochlear hydrops analysis masking procedu

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Objectives: Our hypothesis is that if cochlear hydrops (CH) is responsible for acute low frequency hearing loss (ALFHL) without vertigo, it alters the mechanical property of inner ear, which in turn affects the results of different initial neurotologic tests and that cochlear hydrops analysis masking procedure (CHAMP) measuring traveling wave velocity could provide useful prognostic information for patients with this initial clinical presentations.

Design: A prospective clinical study of 28 patients who initially presented with ALFHL without vertigo was conducted. Detailed neurotologic findings were recorded on a period prior to the occurrence of secondary audio-vestibular symptoms. A regular follow up was conducted according to planned protocol. The progression rate into Meniere's disease (MD) or CH was determined by the log-rank test and relative risk. A receiver operating characteristics (ROC) curve was plotted to determine value of neurotologic parameters would optimally predict patient outcome.

Results: Fourteen patients (50%) showed improvement in their hearing. 7 patients (25%) showed a hearing fluctuation. Of them, 3 patients experienced vertigo in addition to a hearing fluctuation. 9 patients (32%) developed a vertigo attack. Patients with abnormal complex amplitude ratio (CAR) on CHAMP had a 2.6-fold increased risk of progression into a CH or MD. The hazard ratio of developing MD for patients with normal CAR as compared to those with abnormal CAR was 0.137, which indicates an 84.3% reduced risk of developing MD in those with normal CAR. A CAR value ≤ 0.975 indicates the possibility of developing either a CH or MD with a sensitivity of 82% and a specificity of 73% by the ROC curve.

Conclusions: Our results suggest that the CHAMP may serve as a useful parameter indicating prognosis

in patients with ALFHL without vertigo. A CAR value ≤ 0.975 indicates the possibility of showing either a hearing fluctuation or vertigo attack.

O151

Translations are processed slower than rotations: reaction times for self-motion stimuli predicted by vestibular organ dynamics

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Reaction times (RTs) to purely inertial self-motion stimuli have only infrequently been studied, and comparisons of RTs for translations and rotations, to our knowledge, are nonexistent. We recently proposed a model [1] which describes direction discrimination thresholds for rotational and translational motions based on the dynamics of the vestibular sensory organs. This model also predicts differences in RTs for different motion profiles (e.g., trapezoidal versus triangular acceleration profiles or varying profile durations). The model calculates a signal akin to the change in firing rate in response to a self-motion stimulus. In order to correctly perceive the direction of motion the intrinsic noise level of the firing rate has to be overcome. Based on previously identified model parameters from perceptual thresholds, differences in RTs between varying motion profiles can be predicted by comparing the times at which the firing rate overcomes the noise level. To assess these predictions we measured RTs in 20 participants for 8 supra-threshold motion profiles (4 translations, 4 rotations). A two-alternative forced-choice task, discriminating leftward from rightward motions, was used and 30 correct responses per condition were evaluated. The results are in agreement with predictions for RT differences between motion profiles. In order to describe absolute RT, a constant is added to the predictions representing both the discrimination process, and the time needed to press the response button. This constant is calculated as the mean difference between measurements and predictions. It is approximately 160ms shorter for rotations, thus indicating that additional processing time is required for translational motion. As this additional latency cannot be explained by our model based on the dynamics of the sensory organs, we speculate that it originates at a later stage, e.g. during tilt-translation disambiguation. [1] Soyka et al. (2011) *Exp Brain Res* 209: 95-107

O152

Gait abnormality detected by 3-D analysis in patients with acoustic neuroma

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Introduction: Peripheral vestibular lesion should cause gait abnormality in addition to nystagmus, postural abnormality, abnormal space orientation, and decreased mental function. In previous studies, we have reported that this gait abnormality is shown by increment of coefficient of variation of gait phase related variables, irregularity of trajectories of center of force and so on by the use of tactile sensor. Our next concern is what kind of additional abnormal gait performance is to be detected by three dimensional whole body gait performance analysis in those cases.

Materials and Methods: Seventeen acoustic neuroma patients (seven males and ten females with an age of 64.1 ± 11.1) were enrolled for the present study. Seven age and height matched healthy subjects served as a control. Fifteen markers were placed from subject's head to feet, and subjects were asked to walk straight freely at a distance of about four meters with eyes open or closed. Variables are gait shift, head movement, walking speed, stride length, stride duration, forefoot motion, foot flexion angle and so on.

Results: In AT group, greater walking shift, lesser foot flexion angle and shorter stride were shown. In addition to those changes, pitch and roll movement became greater under gait with eyes closed. No significant change was found in toe clearance, highest position of foot and head movement in yaw plane.

Conclusion: Thus by 3-D gait analysis, it has been shown that acoustic neuroma does affect gait performance, although mild. These changes could reflect vestibulo-spinal abnormality caused by the tumor.

O153

How to uncover the overt saccade during the bedside head impulse test

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Introduction: The development of covert saccades in patients with vestibular loss may confound the interpretation of the head-impulse test.

Materials and Methods: Patients with known vestibular loss that have covert saccades. Video-head impulse tests.

Results: By repeating head impulses of similar amplitude and velocity and then suddenly, without anticipation of the patient, increase the amplitude (degree of head-turn) of the impulse in the bedside test, may produce overt eye-saccades.

Conclusion: By performing head impulses of varying amplitude an overt eye-saccade can be uncovered and detect a vestibular weakness.

O154

Neuro-otological findings in psychiatric patients with nystagmus

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Introduction: To evaluate whether neuro-otological tests have clinical significance in psychiatric patients with nystagmus who have inner ear and/or brain dysfunction, we performed neuro-otological tests.

Methods: The subjects were 56 psychiatric patients (38 men, 18 women) (age range, 40-97; mean age \pm SD 61.6 \pm 10.5 years) with nystagmus in the gaze, positional and positioning nystagmus tests. Patients were classified according to the underlying diseases: schizophrenia (25 cases), organic psychiatric disorders (14 cases), alcoholism (16 cases), excited mental retardation (1 case). The tests included caloric tests, vestibular ocular reflex (VOR) tests in rotation, eye tracking tests (ETT), visual suppression (VS) tests, pure tone audiometry and stabilometry tests.

Results: Caloric test results showed a normal response in 30 (75%) cases, right canal paresis (CP) in 4 (10%), left CP in 4 (10%) and bilateral CP in 2 (5%). Therefore, 10 (25%) cases had CP. VOR test results showed a normal response in 40 (78.4%) cases, right CP in 4 (7.8%), left CP in 6 (11.8%) and bilateral CP in 1 (2%). Therefore, 11 (21.6%) cases had CP. The results of the ETT were sorted into 5 categories: 4 (8.2%) cases smooth (normal), 8 (16.3%) slightly saccadic, 28 (57.1%) saccadic, 8 (16.3%) ataxic, and 1 (2%) no tracking ability. Therefore, 45 (91.8%) cases had abnormal ETT results. Pure tone audiometry showed normal hearing in 24 (47.1%) cases, hearing loss in 27 (52.9%) cases. The stabilometric tests showed normal results in 23 (41.0%) cases, moderate in 13 (23.2%), severe in 8 (8.9%) and in 15 (26.8%) the results could not be measured. The patients were classified as organic or functional groups. In ETT there was a significant difference between these 2 groups.

Conclusions: These results indicate that neuro-otological tests with video-oculography are very important not only for neurological or neuro-otological patients with nystagmus, but also for psychiatric patients with nystagmus

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The effect of translation time between eccentric positions on ocular counterroll patterns and Subjective Visual Vertical (SVV) obtained during unilateral centrifugation testing

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Unilateral centrifugation (UC) involves the eccentric displacement of an individual after high velocity rotation around a central axis. This off-center placement permits discrete stimulation of each utricle, allowing individualized evaluation of utricles. This study describes the effects of different translation times between eccentric positions during UC testing on ocular torsion and perceived verticality for 20 adults with normal vestibular function. UC was performed on a Neuro-Kinetics, Inc. (Pittsburgh, PA USA) Neuro-Otologic Test Center (NOTC) rotational chair with high speed monocular infrared goggles at the Bloomsburg University of Pennsylvania Vestibular Clinic (PA, USA). Each UC trial used a rotational velocity of 300°/s with 4 cm eccentric lateral displacements that were maintained for 60 seconds in each position. UC tests were performed with randomized translation times of 10, 15, 20, 25, and 30 seconds per trial. Initial accelerations were 5°/s² over 60 seconds until maximum velocity was reached; which was maintained for 90 seconds before UC testing. Each trial concluded by decelerating subjects at a rate of 3°/s². Multiple estimations of subjective visual verticality (SVV) were performed for each eccentric position. Unilateral centrifugation testing elicited mild ocular counterroll for each of the different eccentric

positions. Preliminary analysis found that overall torsion versus gravito-inertial acceleration was lower with longer translation times, suggesting that translation time does impact ocular torsion during UC testing. This finding may impact the clinical implementation of UC testing, such that long translations will not elicit sufficient torsion to be useful for accurate assessment of the utricles. SVV data yielded inconclusive results, therefore, the effect of translation time on SVV needs further investigation. Clinical implications of these data will be discussed.

POSTER PRESENTATIONS

P1

Lack of neurological pattern for the Neuro-otological manifestations of the Fabry Disease.

Analysis in 36 patients

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Fabry disease (FD) is an X-linked lysosomal storage disease caused by inherited deficiency of the lysosomal enzyme α -galactosidase.

Objectives:

- 1) To evaluate the presence of auditory and vestibular symptoms
- 2) correlate vestibular function with hearing loss
- 3) assessing the clinical and neurophysiological features of peripheral neuropathy and correlate with the presence of neuro-otological abnormalities

Material and Methods:

We studied 36 consecutive patients with FD, 15 males and 21 females, mean age 36.6 years, diagnosed by enzyme assay or DNA analysis, during the years 2007-2011.

- 1) We investigated signs and symptoms of FD.
- 2) Evaluation by a Neuro-otologist included caloric tests and VEMP's
- 3) Pure Tone Audiometry with speech discrimination and BAER.
- 4) Quantitative Sensory Testing (QST) was performed by the method of Limits using a Medoc TSA-2001 NeuroSensory Analyzer equipment. Results were compared with those of a control group matched for age and gender using Mann-Whitney Rank Sum.

Results: Cochlear and vestibular compromise isolated or in combination was found in 50% of the cases. 70% of the patients refers spontaneous crisis of vertigo. When the results of the different tests and the different ears are analyzed we didn't find a vascular or neurological pattern. Compared with the control group patients with FD presented significantly altered CDT and WDT ($p=0.0001$), HP ($p=0.043$) and vibration ($p=0.0001$). Abnormal QST was identified in 22 patients (84.6%). The most frequent thermal modality affected was CDT (73%) followed by WDT (46.1%) and HP (34.6%). Vibration was abnormal in 38.4%. There was no significant association between QST and either cochlear or vestibular involvement.

Conclusions: Neuro-otological symptoms are common in FD, even in asymptomatic subjects. There is no pattern which looks like a pathognomonic feature. Neuropathy with small fiber predominance is an early and frequent finding in patients with FD that can be assessed non invasively by QST.

P2

Congenital nystagmus may be not conjugate eye movements in our two cases?

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Background/Objectives: Congenital nystagmus (CN) is almost always conjugate? Often, CN may be not conjugate, in smooth pursuit and OKN in our cases. To clarify this discrepancy, we examined CN patients' ocular dominance (OD) and stereopsis as a near vision, because CN is usually accentuated by the attempt to fixate an object, a near target can evoke CN and OKN can influence the intensity of CN. We investigate CN by using each eye recording ENG and a goggle with bilateral infra-red CCD cameras (ON-1), we have developed, which can record bilateral eye movements simultaneously.

Methods: We asked two healthy male CN (born in 1972 and 1981) volunteers. We examined OD and stereopsis by using the fly test. We employed each eye recording ENG under the condition of smooth pursuit and OKN for them. We also use ON-1 and eye movements were recorded under gazing on the imagery target, around 10 seconds, in front of them at the primary position. We analysed whether or not each eye movement is different and alteration of each pupil's area (pupillary constriction) by use of the Image J.

Results /Discussion: Both volunteers possess right OD and borderline stereopsis about circle evaluation 4/9 and 3/9, respectively. There can be a sort of fusion problem (FP). Recessive eye performed rather smooth eye movements and loafed, occasionally, notwithstanding just a short time. On the other hand, analysing ON-1 data revealed almost synonymous but not the same waveform on each eye movement. As to pupil's area of right eye is almost always smaller (ranging from 2,588 to 4,051 pixel, 4,045 to 4,126 pixel) than left eye (ranging from 3,020 to 4,838 pixel, 4,790 to 5,112 pixel). Never has been discussed the relationship amongst OD, nature of each eye's PC and eye movements of

CN, and also a sort of FP for CN. The relationship could make the maze in which we have to deliberate on nature of CN. So we here just mentioned the maze may influence conjugate eye movements for CN.

P3

Effects of visual perturbation on gait depend on locomotion speed

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Introduction: Patients with sensory loss show a pathological increase of gait variability which is associated to an increased risk to fall. The purpose of this study was to investigate the influence of vision on gait variability at different locomotion speeds.

Material and Methods: Nine healthy subjects (31.0 ± 8.4 years, 2 females) participated in the study. For each subject the walking pattern was recorded while walking with normal vision (EO) and while walking without visual input (EC). For EC subjects were artificially blinded with light-impenetrable glasses. For EO and EC subjects had to walk at five different locomotion speeds on a pressure-sensitive treadmill system (Zebris®). The magnitude of the fluctuations of stride time (ST), stride length (SL) and base width (BW) was analyzed by calculating the coefficient of variation (CV).

Results: For EO the gait variability in the longitudinal plane (i.e. ST and SL) and the lateral plane (i.e. BW) was in the normal range and did not show any significant speed effects. For EC longitudinal gait parameters showed significant speed effects ($p < 0.001$) with highest variability at slow locomotion speeds. Lateral gait variability, however, did not show significant speed effects but was increased at all speeds ($p < 0.05$).

Conclusion: EC has an effect on the magnitude of stride-to-stride fluctuations in the human walking pattern which depends on walking speed. The interaction between gait variability and visual processing is differentially regulated for the longitudinal (sagittal) and the lateral (frontal) plane. These results are highly comparable to the effects of vestibular loss on gait variability (Schniepp et al. 2011). Sensory signals in general seem to interact with the walking pattern in a speed dependent manner. This has an impact on the physical therapy of patients with sensory loss.

P4

Normal horizontal VOR gain with video-oculography (EyeSeeCam VOG)

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Introduction: The head impulse test is a recognised clinical sign of the high frequency vestibulo-ocular reflex (VOR). This can be quantitated with video-oculography (VOG) and measures VOR gain as the ratio of angular eye velocity to angular head velocity. This study established normative data using VOG in sixty control subjects aged 20 to 80 years.

Methods: Subjects were seated 1.5m from a fixation target at eye level. Eye and head velocity was measured while the examiner applied unpredictable (in direction and time) horizontal head rotations (peak head velocity 150 °/s to 300 °/s). Head accelerations (2,300 °/sec² to 5,900 °/sec²) were controlled so that peak head velocity occurred 80±15 ms into each rotation. This was achieved with angular head displacements of small amplitude (6° - 12°). Gain was analysed over a 20 ms window centred at 80 ms. Data was manipulated using the EyeSeeCam VOG software backed by Matlab scripts for data analysis.

Results:

- The mean horizontal vestibular-ocular reflex (HVOR) velocity gain of 60 normal subjects was 0.97 (SD=0.09, 2SD lower limit=0.79)
- No gain fell below 0.76
- A test for repeatability showed consistency in results (repeatability coefficient=0.12)
- It was found that the gain declined by 0.012 per decade as age increased ($p=0.028$)
- The mean gain was 0.06 higher when testing was carried out in a predictable manner in direction and time ($p=0.014$)
- As target fixation distance d was decreased, gain was seen to increase with $0.0X/\log(d)$ on a log scale ($p < 0.0001$)

Conclusions: A distribution of normative data for a populations HVOR velocity gain was obtained. Results were similar to those found in a previous study comparing search coils and VOG [1]. EyeSeeCam VOG overcomes the clinical problem of a false negative HIT when a seemingly normal HVOR may be observed due to covert saccades, and of a false positive HIT with the occurrence of normal catch up

saccades. With attention paid to technical factors including goggle slip, a consistent and reliable method of quantitatively assessing HVOR velocity gain can be obtained with EyeSeeCam VOG goggles.

P5

Vestibular behavioral analysis and otolith-ocular response in Casp3 deficient mice

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Introduction: Casp3 deficient (Casp3KO) mice show circling behavior suggestive of vestibular dysfunction. We characterized the vestibular function in Casp3KO mice using a combination of behavioral tests and vestibulo-ocular reflex (VOR) analysis, and correlated with histology.

Materials and Methods: Wild-type C57BL6 (WT) and Casp3KO mice, two to seven months of age, were compared. Circling, air-righting, and tail hanging tests were performed to assess vestibular behavior. Lateral semicircular canal VOR function was evaluated during sinusoidal rotation about an earth vertical axis. Otolith-ocular function was evaluated using both the synchronized counter-rotation paradigm (CR) and with sustained angular rotation of the main axis independent of the eccentric axis using various angular velocity profiles (pseudo-off vertical axis rotation, pOVAR). Horizontal eye velocity and vertical eye position were evaluated as a function of acceleration. Hair cell numbers in each vestibular sensory patch were assessed using whole mount preparations.

Results: Behavioral vestibular tests were abnormal in Casp3KO mice. In WT mice, modulation of slow phase eye velocity and vertical eye position increased proportionally to CR and pOVAR stimulus intensity. In Casp3KO mice, responses to angular stimuli was greatly attenuated but response to pOVAR was similar to WT mice. Hair cell numbers were significantly decreased in the anterior- and lateral cristae in Casp3KO mice (ANOVA, $P < 0.05$). The utricle had decreased number of hair cells, but had relatively normal appearance.

Conclusion: Casp3KO mice have severely impaired lateral semicircular canal VOR function, but have normal otolith-ocular function. The behavioral test results and histology studies correlate well. Our results suggest that Casp3KO mice may provide a unique model of canal dysfunction with relatively intact otolith responses.

P6

Vestibulo-ocular reflex adaptation to moving virtual sound source

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Introduction: Location perception includes multi modal process. To investigate integration of auditory and vestibular perception, we examined changes of vestibulo-ocular reflex (VOR) caused by adaptation with rotating virtual sound source.

Materials and Methods: Seven healthy adults participated in the present study. Eye movements were recorded by video oculography before and after the adaptation, which were composed of two conditions. In the condition 1, the sound source was rotated sinusoidally in opposite direction to head rotation. In the condition 2, the sound source was rotated in same direction to head rotation at twice velocity. The adaptation duration was 15 minute and 30 minute. The rotating chair was rotated on yaw-axis sinusoidally at 0.32Hz and maximum amplitude 60°. The subject was in complete darkness during the experiment.

Results: Condition 1; The VOR gain in post-adaptation for 30 min. (mean: 0.45, SD: ± 0.25) decreased significantly compared to those in pre-adaptation (0.77, ± 0.24) (Shirley-Williams test $p < 0.05$). The gain in post-adaptation for 15 min. (0.63, ± 0.31) did not change significantly. The percentage gain change in post-adaptation for 15min. decreased by -20.5% in average, and the percentage in post-adaptation for 30min. decreased by -42.5% in average. There was no significant difference between duration conditions. The phase delay of VOR in both duration conditions, which showed 15min. (31.15° , $\pm 18.30^\circ$) and 30min. (40.55° , $\pm 31.52^\circ$), increased significantly compared to delay in pre-adaptation (19.50° , $\pm 3.13^\circ$) ($p < 0.05$). Condition 2; There was no significant difference in gain and phase in pre- and post-adaptation, in which four subjects took part.

Conclusion: We examined influence of the adaptation on VOR to rotating sound source. The gain reduced and the phase delay increased in post-adaptation with the sound rotating opposite direction to head rotation. Results were different from adaptation to visual input.

P7

Prism glasses as a therapy for Ménière 's vertigo evaluated. Pilot study

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Purpose: Evaluate the use of weak asymmetric base-in prism spectacles (WABIPS) as described by Utermöhlen 2,5 by a randomized double-blind placebo controlled study with unilateral Ménière 's disease (MD) patients, and the influence of vergence.

Method: 21 unilateral MD patients, as laid down in the AAO-HNS criteria 1 . 14 female and 7 male. Their age ranged from 40 to 72 years with an average of 53 years. The duration of the disease ranged from 1 to 14 years, with an average of 5 years. All patients were ophthalmological investigated 4&5 by the first author and the ENT diagnosis and statistical evaluation by the second⁷.

Experiment: In this double-blind randomized placebo-controlled trial all patients were prescribed prism glasses, 14 patients with base-in prisms as described by Utermöhlen, and 7 with base-out prisms (control).

Results: Of the 21 patients, 3 abandoned the experiment because the glasses caused them too many problems . One patient was excluded from the experiment for not keeping a diary. This left 17 patients; 11 with base-in prisms and 6 with base-out prisms. Ten out of 11 patients (91%) with base-in prisms experienced a favorable result (fewer vertigo attacks) of the glasses compared to 2 out of 6 (33%) of the control group. It was surprising that 18 of the 21 patients (90% had a convergence insufficiency and in 10 (48%) of them the convergence insufficiency was larger than 4 prism diopters. This is more than in the normal population⁷. In this group of 10 patients, 5 wore base-in prisms and 5 base-out prisms. All 5 patients (100%) with base-in prisms and a significant convergence insufficiency had subjectively fewer vertigo attacks. Only 1 of the 5 (20%) in the control group (base-out prisms) with a significant convergence insufficiency had subjectively fewer vertigo attacks. On evaluating the diaries, there was a decrease in the frequency of the attacks with an average of 37% and 20% respectively.

Discussion: Subjective vertigo symptoms were ameliorated in 91% of MD patients wearing Utermöhlen prism glasses compared with 33% in the control group.

In patients with a convergence insufficiency of 4 diopters or more, the subjective symptoms improved in 100% of the patients wearing Utermöhlen glasses compared to 20% of controls. It was also found that frequency and severity of attacks diminished in the experimental group. This finding might be of clinical importance for the success of prism glasses therapy in MD and should at least be considered before deciding on chemical or surgical ablation of the vestibular system. The chronic use of WABIPS developed by Utermöhlen is a harmless effective treatment of Ménière vertigo, immediate applicable in clinical practice, and deserves a more serious place amongst Ménière research than is currently the case.

P8

Analyzing congenital nystagmus using high-speed video-oculography with 240Hz sampling rate

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Introduction: To analyze human ocular movement 3 dimensionally, the standard is to use the scleral search coil system (SSCS) or video-oculography (VOG) system. We must admit that SSCS is superior in space and time resolution than VOG system, however, it may be invasive in a way, in respect of attaching coil directly on the eyeball. In contrast, VOG system, wearing goggle with camera, is non-invasive method. The problem is its time resolution. The time resolution for ordinary VOG system is 30 or 60 frames/s, much poorer than that of SSCS. Nowadays, development in hardware technology enabled the camera system to improve to higher standard, capturing pictures in digital with better time resolution, far more than 60 frames per second. Here, we introduce the advantage of recording and analyzing nystagmus using our new VOG system with new camera.

Method: We developed a new VOG system with sampling rate at 240Hz, by combining the camera that captures 310000pixel pictures at the speed as fast as 240 frames per second. We recorded ocular movement of congenital nystagmus using this new VOG system and analyzed the profile of its slow phase (T.Imai, et al. *Auris Nasus Larynx*. 2005). The frames were analyzed by computer image analyzing system (T.Imai et al. *Acta Otolaryngol*. 1999).

Results: Congenital nystagmus beat at more than 6Hz, thus 30Hz VOG system turned out to be incapable of capturing no more than 5 frames during a single beat, not enough to analyze the profile of nystagmus. However, our new 240Hz VOG system enabled us to make more precise analysis on the slow phase of congenital nystagmus. The slow phase velocity of congenital nystagmus proved to be accelerated, while usual nystagmus has uniform velocity.

P9

Development of quantitative analysis of eye movement by original video-oculography, HI-VOG

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Introduction: Using an infrared CCD camera for recording eye movement is widely accepted and analysis of eye movement is essential for investigating vestibular disturbances. We devised an original eye movement image analysis technique using an infrared CCD camera, a personal computer and public domain software.

Materials and Methods: The analysis was performed using the public domain software ImageJ program (developed by the U.S. National Institutes of Health). The video image from an infrared CCD camera was captured at 30 frames per second in 320*240. For analysis of the horizontal and vertical components, the X-Y center of the pupil was automatically calculated using the original macro. For analysis of torsional components, the whole iris pattern, which was rotated each 0.1 degrees, was overlaid with the same area of the next iris pattern, and the angle at which both iris patterns showed the greatest match was calculated. For quantitative analysis, slow phase velocity of each nystagmus, average of slow phase velocity, the visual suppression value, were analyzed automatically.

Results & Conclusion: Using this technique, it is possible to inexpensively perform eye movement analysis, including in 3-dimension, from video images recorded by many types of infrared CCD cameras.

P10

Developments of the vestibular function in severe hearing loss children

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Introduction: The relationship of vestibular function with severe hearing loss in children has been discussed, because the cochlear and vestibular organs are closely related anatomically and phylogenetically. Many studies have revealed the delayed development of motor and balance function in the severe hearing impaired children. We studied vestibular function of these children using the rotatory chair test before CI operation and some of these deaf children were demonstrated poor vestibular function and we found their vestibular ocular reflex(VOR) appeared after CI operation. The purpose of this study is to investigate changes of VOR before CI and after CI, in severe hearing impaired children using the rotational chair test.

Material and Method: The patient's vestibular function was investigated in 70 children with bilateral severe hearing loss whose threshold of hearing is around 80dB or more. Their ages are 3 month to 6 year-old (average 2 years 6 month). Electronystagmography(ENG) was recorded for VOR for the damped rotational chair test. Electrodes are applied just lateral to both eyes to record horizontal eye movements. For the damped-rotational chair test, the chair was accelerated to a maximum rotational velocity of 160°/S², then decayed by 4°/S². Congenitally deaf children with poor response of the VOR were retested after 1 year after the first test.

Result: Among seven children with poor or no response of the VOR, four children had inner ear malformation but three children had normal inner ear. Four children showed new appearance of the VOR or better response of VOR with age.

Conclusion: There is a possibility of new appearance or better response of VOR after CI operation with age, even if there were poor or no response before CI operation in infant. It is necessary to record VOR regularly for check, especially in congenitally deaf children with poor or no response of VOR.

P11

Efficacy of rotating chair test and caloric test for the diagnosis of acute unilateral vestibular neuritis

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Background and Objectives: The acute unilateral vestibular neuritis is fairly a common disease and the precise diagnostic tool is needed for the selection of effective treatments. Therefore, we studied the clinical usefulness of the rotatory chair test and caloric test which have been commonly used in patient of acute unilateral vestibular neuritis.

Materials and Methods: One hundred and sixty four patients who were diagnosed with acute unilateral vestibular neuritis. Their medical records of the rotating chair test and caloric test were reviewed retrospectively to study the correlation of the two tests.

Results: Of 164 patients, 101 patients(61.6%) and 88 patients(53.7%) showed significant canal paresis(CP) and directional preponderance(DP) on the caloric tests that corresponded with the physical examination. One hundred and thirty patients(79.3%) and 84 patients(51.2%) showed significant asymmetry and the time constant(Tc) on the rotating chair test that correspond with the predictive direction with spontaneous nystagmus.

Conclusions: For acute unilateral vestibular neuritis patients, the asymmetry of the rotation chair test nor caloric test yields a specific correlation with the physical examination. Especially, single test only may too many false negative results. For these tests can reduce false positive cases of the physical examination and raise the specificity of the diagnosis, the planning of proper treatments should be followed thereafter.

P12

Gait analysis of acute peripheral vestibular loss

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Introduction: Locomotion requires the integrated sensory information; it relies on vision, somatosensory, and vestibular information. The regulation of vestibular information has not been fully understood. In this study, we attempted to find the contribution of vestibular information to locomotion by comparing the gait cycle of acute peripheral vestibular disorder to healthy people.

Materials and Methods: Motionnode system was used to quantify gait cycle. Four sensors were fixed on the head, waste, and ankle to record the movement of each part. Vestibular autonomic reflex change is also recorded by the electrocardiography. The time of dizziness was recorded with an integrated button that subjects can subjectively push. Subjects walked on 40m rectilinear course for three times at a normal walking speed; twice with their eyes opened and once with closed. Data from gyroscope and accelerometer are compared and analyzed with swing and stance phase of both legs. Statistical analysis was performed by using MS Excel.

Results: Frequency analysis showed that all the patients had more than two dominant frequencies especially in pitch rotation. In vestibular loss patients, swing-phase prolongation was observed. The graphs of each cycle were well overlapped while the ones of acute peripheral vestibular loss patients showed otherwise. The angular velocity ratio of the interested part to the sum of all parts was used to standardize the data. Significant results were only appeared on both legs' pitch motion.

Conclusion: Motionnode system is thought to be remarkable tool for vestibular screening test. The frequency analysis of gait cycle by using 3-axial gyroscope can distinguish vestibular disorders in the consideration of gait rhythm, gait phase, gait patterns and each individual gait characteristic. It was found that the walking pattern of acute vestibular loss patients was highly phase-dependant, especially for the pitch.

P13

Three-dimensional vestibulo-ocular reflex in eccentric rotation can evaluate the otolith function in humans

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Introduction: In addition to angular acceleration, pendular rotation in the@eccentric position (eccentric rotation, ECR) imparts tangential and centrifugal liner acceleration to the head of the subject. Since angular acceleration stimulates the semicircular canals to induce angular vestibulo-ocular reflex (a-VOR) and linear acceleration stimulates the otolith organs to induce linear VOR (l-VOR), ECR induces both VORs simultaneously. The purpose of this study is to examine if l-VOR modulates a-VOR during ECR in humans.

Subjects and methods: Ten normal healthy volunteers were seated on a computer-controlled rotating chair and were rotated in dark at three different positions, positioned the head centered (centric rotation, CR), at 100cm from the axis (ECR) facing nose-out (NO-ECR), or facing nose-in (NI-ECR). The chair was rotated sinusoidally at 0.1Hz, 0.3Hz, 0.5Hz or 0.7Hz with the maximum angular velocity of 50 degree/sec. We analyzed the rotation vector of eye movement in three dimensions and then calculated VOR gain and phase.

Result: VOR gains in NO-ECR or NI-ECR at 0.1Hz and 0.3Hz were not different from those in CR. VOR gains in NO-ECR at 0.5Hz and 0.7Hz were significantly higher than those in CR. On the other hand, VOR gains in NI-ECR at 0.5Hz and 0.7Hz were significantly less than those in CR. Both in CR, NO-ECR, and NI-ECR, the phases were out of phase at all frequencies.

Discussion: In ECR at high frequencies, tangential acceleration along the interaural axis stimulates the utricle to induced horizontal eye movements (I-VOR) in addition to those induced by lateral semicircular canal (a-VOR). At high frequencies, it is suggested that VOR gain in NO-ECR was enhanced by the synergistic modulation of I-VOR to a-VOR and that VOR gain in NI-ECR gain was suppressed by the subtractive modulation of I-VOR from a-VOR. All these findings suggest that ECR is a useful test to evaluate the otolith function.

P14

Measurements of trunk sway for stance and gait tasks 2 years after vestibular neurectomy

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Introduction: The aim of the study was to measure the long-term evolution of trunk sway patterns for stance and gait tasks after vestibular neurectomy (VN) performed in patients suffering from intractable Meniere's disease. We examined if specific patterns of stance and gait deficits were correlated to the clinical evaluation using the functional level scale of AAO, 2 years after VN.

Method: Amplitudes of trunk sway angle and angular velocity in the roll and pitch directions were measured for 6 stances, 3 simple and 4 complex gait tasks in 10 patients (5 men, 5 women; 32-65 years old) with the Sway Star system. Measurements were performed before VN, 2 weeks, 1-6 months, 1-2 years after surgery.

Results: AAO score before VN: 4 patients were classified into the level 5, and 6 patients into level 6; 2 years after VN: 3 patients were free of symptoms (level 0), 2 patients were classified into level 1, 1 patient into level 2; 1 patient with recurrent attacks of vertigo was in level 5. In level 6, 2 patients developed a contralateral Meniere's disease, the central compensation failed in 1 patient. Two different postoperative AAO groups are distinguished. For patients in the AAO 0-2, all parameters of the stance ($p < 0.001$) and the simple gait ($p = 0.0281$) tasks were improved compared to the preoperative data; In contrast, the performances were worse for patients into AAO levels 5-6. For the stance tasks, the postop. results of AAO 0-2 were similar to those of normal control

subjects: It was not the case for patients AAO 5-6 ($p = 0.0001$).

Conclusion: Our data suggest that normal trunk control 2 years after VN, is reached for stance and simple gait tasks. Trunk sway remains abnormal for complex gait task which need the control of posture, head and eye movements. Amplitude of trunk sway is well correlated to the postop AAO score and might represent a tool to objectively measure the remaining symptoms of patients.

P15

Postural habituations to repeated optic flow stimulation in gait termination

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Introduction: Since human is surrounded by the civilized and complex environment, the refined mechanism is indispensable to maintain stable walk and standing. Especially gait termination puts special demands on postural control, as a transition occurs from a dynamic situation (walking) to a quasi-static situation (standing). In this study, we investigated the effects of rotational or horizontal visual optic flow stimulation on head displacement and eye movements during gait termination.

Materials and Methods: Twenty nine healthy subjects (age twenties) completed the study. We used the VR system, a projection-based system (CAVE). First, subjects performed baseline trials. Subjects were instructed to start walking as the signal sounded and stop after recognizing visual stimulation. The baseline trials had eight-time walking session. They were followed by two experimental trials: Horizontal Movement (HM) and Rotational Movement (RM). During condition HM, the front screen constructed with random-dot pattern started moving horizontally to the right, and during condition RM, it started rotating

clockwise as soon as subjects walked more than 0.9m in length. They were instructed to stop immediately with their feet side after recognizing the flow of the image. Two conditions were repeated four times each in mixed random order as the first set. The second set and the third set were respectively resumed after three-minute rest.

Results: In both condition (HM & RM) mediolateral sway (ML) was detected but reduced significantly in the second set than the first set ($p=0.0415$). In the anterior-posterior direction, however, there was no significant change of the body sway between the sets.

Conclusion: Horizontal and rotational visual stimulation caused body sway during gait termination in humans. Postural habituations to repeated optic flow stimulation was observed in gait termination.

P16

The anxiety affects the antero-posterior postural stability in patients with dizziness

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Introduction: The purpose of this study was to investigate the effect of anxiety on the postural stability of a variety of dizzy patients during upright standing. The degree of anxiety in patients was evaluated on the basis of a routine vestibular examination together with their hospital anxiety and depression scale (HADS) scores.

Methods: Fifty-four patients complaining of dizziness were enrolled in this study. The patients were divided into 3 groups. If there was no vestibular dysfunction, they were defined as psychogenic (PSY, $n = 16$). The remaining subjects were further divided on the basis of their HADS score. If the score of a (anxiety) was less than 5, they are defined as organic (ORG, $n = 25$), and the rest were defined as a combination of psychogenic and organic (PSY + ORG, $n = 13$). Posturographic measurements were performed in a quiet standing on a force platform. The some parameters were registered. Spectrum analyses of the left-right axis and A/P axis were also performed by using the fast Fourier transform (FFT) method of body sway.

Results: We found a significant correlation between anxiety and postural instability in the A/P axis in all subjects as a group (Fig.1) and in either group PSY or PSY + ORG. Using power spectrum analysis, we identified 3 frequency components of postural sway: group A (0.02-0.21 Hz), group B (0.22-2.01 Hz), and group C (2.01-10 Hz). Group C reflected somatosensory inputs, and group A reflected vestibular inputs. The power of group C decreased in the high anxiety group, whereas the power of group A increased in the high anxiety group. These phenomena disappeared in the eyes-closed condition. Our study shows that the effect of visual input on vestibular and somatosensory input is affected by anxiety.

Conclusions: Our results indicate that anxiety affects the postural perturbation in the A/P axis and the interactions of visual inputs with vestibular and somatosensory inputs.

P17

Vertigo in childhood: differential diagnosis of migraine and somatoform syndromes

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Introduction: Chronic vertigo in children is most often related either to migraine or to somatoform syndromes. The differential diagnosis can be challenging as current diagnostic criteria are difficult to apply to children and most patients present in attack free interval.

Materials and Methods: Retrospective analysis of data on 138 children (3-16y, 78 female) that presented to the Munich dizziness clinic in 2010 and 2011. All patients received a structured history taking, clinical examination, neuro-orthoptic testing, calorics, subjective visual vertical, and static posturography.

Results: The most frequent diagnoses was migraine related vertigo (MRV 28%), migraine associated with somatoform vertigo (MSV 19%) and pure somatoform vertigo (PSV 14%). In boys MRV was more frequent (23 vs. 16%); in girls MSV/PSV was most common (31 vs. 14%). Subtle central ocular motor signs (saccadic pursuit) were observed preferentially in MRV (29%), less commonly in MAS (19%) and PSV (15%). Abnormal findings in static posturography with improvement when eyes are closed were found in 64% of patients with PSV (MSV 53%, MRV 39%). Results of caloric-testing, head-impulse-test, and subjective visual vertical did not differ between groups.

Conclusions: Migraine-related vertigo and somatoform vertigo are the most common diagnoses in dizzy children and adolescents. There is a substantial overlap between both groups. In the differential diagnosis, subtle central ocular motor signs point to migraine-related vertigo. Abnormal postural control with paradoxical improvement with eyes closed is typical for somatoform vertigo (phobic postural

vertigo). Ocular motor testing and tests for balance control together with strong diagnostic criteria will help to categorize and treat the young patients correctly.

P18

Abnormality of cervical vestibular-evoked myogenic potentials and ocular vestibular-evoked myogenic potentials in patients with recurrent benign paroxysmal positional vertigo

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Objectives: Degeneration of otolith organs is the suspected pathogenesis of benign paroxysmal positional vertigo(BPPV). Although BPPV generally responds well to treatment, there is a significant rate of BPPV recurrence after initial resolution. Cervical vestibular evoked myogenic potentials(cVEMP) and ocular vestibular myogenic potentials(oVEMP) has been used as a clinical test for evaluating otolith function. The purpose of study was to identify whether abnormality of VEMP may be a risk factor in patients with recurrent BPPV

Methods: cVEMP and oVEMP tests using 500-Hz tone-burst stimuli were performed on 16 patients with recurrent BPPV between March 2010 and December 2011. Both VEMP tests were performed in 20 patients with non-recurrent BPPV. We compared the VEMP results between recurrent BPPV group and non-recurrent BPPV.

Results: The difference of age, sex and involved canal between recurrent and non-recurrent BPPV group was not significant. . Abnormal cVEMP responses were detected in 6 of 16(37.5%) in the recurrent BPPV group and 2(10%) of 20 in non-recurrent group. Abnormal oVEMP responses were detected in 6 of 16(37.5%) in the recurrent BPPV group and 2(10%) of 20 in non-recurrent group. When we defined VEMP abnormalities as an abnormal cVEMP or abnormal oVEMP, VEMP abnormalities were detected in 9(56.3%) in the recurrent BPPV group and in 3(15%) in the non-recurrent BPPV group; the difference between groups was significant($p = 0.014$, Fischer's exact test).

Conclusion: Our results showed that abnormalities of cVEMP or oVEMP in recurrent BPPV groups are significantly higher than non-recurrent BPPV group. Therefore, we can infer that abnormality of VEMP is one of risk factors in BPPV recurrence.

P19

Age-related changes in ocular VEMPs via galvanic vestibular stimulation and bone-conducted vibration modes

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Objective: This study applied galvanic vestibular stimulation (GVS) and bone-conducted vibration (BCV) modes for eliciting ocular vestibular-evoked myogenic potentials (oVEMPs) in healthy subjects to define the effect of aging on the vestibulo-ocular reflex pathway.

Methods: Sixty-nine healthy subjects with the ages ranging from 22 to 69 years were divided into five groups by decade. Each group consisted of 12 subjects in one decade, except 14 subjects in the group of 50 to 59 years and 19 subjects in the group of 60 to 69 years. All subjects underwent oVEMPs using GVS and BCV modes.

Results: The prevalences of GVS-oVEMPs had nonsignificant differences among all age groups, whereas that of BCV-oVEMPs in the over-60 group was significantly lower (63%) than those in the under-60 groups. In GVS-oVEMPs, the mean nI, pI latencies, and nI-pI amplitudes differed significantly among the five groups. The group over 60 years had significant longer nI, pI latencies, and smaller amplitudes when compared with those under 60 years. In BCV-oVEMPs, the mean nI and pI latencies also differed significantly among the five age groups. The nI and pI latencies in the over-60 group were significantly longer than those of the under-60 groups, while the nI-pI amplitudes of groups over 50 years were significantly smaller than those of groups under 50 years. In comparison of characteristic parameters between GVS- and BCV-oVEMPs in all age groups, the nI, pI latencies, nI-pI intervals, and nI-pI amplitudes all exhibited significant differences.

Conclusion: The age-related changes in GVS- and BCV-oVEMPs might be attributed to the morphological degeneration of the vestibular system.

P20

Aging effect on the ocular vestibular evoked myogenic potentials with special reference to frequency-tuning characteristics

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Introduction: According to our previous study, the peak amplitude shifted to a high frequencies with aging by cervical vestibular evoked myogenic potentials (cVEMP). The purpose of this study was to measure the aging effect on the ocular VEMP (oVEMP)

Materials and Methods: Subjects were 47 ears of 24 normal volunteers with age ranging from 23 to 75 years. The oVEMP generated by tone bursts of 135 dB SPL at 250, 500, 700, 1000, 1500, 2000, and 4000 Hz was measured in each subject. Peak-to-peak amplitudes of n1-p1 waves were detected, and the frequencies of the largest amplitude were identified in each subject. Characteristics of the frequencies at various ages were obtained.

Results: Of the subjects aged less than 50 years, the peak amplitude was 500Hz in one ear, 700Hz in 17 ears and 1000Hz in 6 ears. Of the subjects over 50 years-old, they were 500Hz in 4 ears, 700Hz in 12 ears, 1000Hz in 6 ears and 1500Hz in one ear, therefore, the most frequent peak amplitude of oVEMP was 700Hz regardless of age. Aging did not influence the frequency tuning of oVEMP, which was different from cVEMP in our previous report. The following hypothesis was speculated to explain the difference. Considering the characteristics of resonant frequencies, the globular structure of the saccule can be modeled as an elastic string with fixed ends. The frequency depends on the elasticity of the string. When the elasticity decreases with aging, the resonant frequency shifts to high. On the other hand, the characteristic resonance frequency of the tubular structure of the utricle does not depend on the composition of the tubular wall, therefore, frequency tuning of oVEMP was not influenced by aging.

Conclusion: Frequency tuning of oVEMP was not influenced by aging, suggesting that the aging effects on oVEMP were different from those on cVEMP.

P21

Clinical value of vestibular evoked myogenic potential in assessing the stage and predicting the hearing results in Ménière's disease

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Objective: Our goal was to find clinical value of cervical vestibular evoked myogenic potential (VEMP) in Ménière's disease (MD) and to evaluate whether the VEMP results can be useful in assessing the stage of MD. Furthermore, we tried to evaluate the clinical effectiveness of VEMP in predicting hearing outcome.

Methods: The amplitude, peak latency and interaural amplitude difference ratio (IAD ratio) was obtained using cervical VEMP. The VEMP results of MD were compared with normal subjects and MD stages were compared with IAD ratio. Finally, the hearing changes were analyzed according to their VEMP results.

Results: In clinically definite unilateral MD (n=41), the prevalence of cervical VEMP abnormality in IAD ratio was 34.1%. Compared with normal subject (n=33), the VEMP profile showed low amplitude and similar latency. The mean IAD ratio in MD was 23%, and was significantly different from normal subjects (P =0.01). As the stage increased, IAD ratio was significantly increased (P =0.078). After stratification by initial hearing level, stage I and II subjects (hearing threshold, 0~40 dB) with abnormal IAD ratio showed a decrease in hearing over time compared to those with normal IAD ratio (P =0.065).

Conclusion: VEMP parameters have an important clinical role in MD. Especially, IAD ratio can be used to assess the stage of MD. An abnormal IAD ratio may be used as a predictor of poor hearing outcomes in subjects with early stage MD.

P22

Correlation between acceleration magnitude and ocular vestibular-evoked myogenic potential

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Introduction: This study combined bone-conducted vibration (BCV) stimulation with triaxial accelerometry to correlate the acceleration magnitudes of BCV stimuli with ocular vestibular-evoked myogenic potential (oVEMP) test results. **Methods:** Fourteen healthy volunteers underwent oVEMP test using BCV stimuli with simultaneous monitoring the triaxial acceleration. **Results:** All (100%) subjects exhibited clear oVEMPs in response to BCV stimuli from a vibrator. The lowest acceleration magnitudes for eliciting oVEMPs along the x-, y- and z-axes were 0.05 ± 0.01 g, 0.16 ± 0.08 g, and 0.04 ± 0.01 g, respectively, exhibiting significantly higher acceleration magnitude along the y-axis than those along the

x- and z-axes. In addition, significantly positive correlations were noted between the acceleration magnitude along each axis and the oVEMP amplitude. Conclusion: Measuring the acceleration magnitude throughout oVEMP testing revealed a significant correlation between linear acceleration and oVEMP responses. Restated, increasing acceleration magnitude may have more synchronization of firing of vestibular afferents, resulting in more synchronized evoked potentials and greater oVEMP amplitude.

P23

Enhanced oVEMP with combined air conducted and bone conducted stimulation

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Introduction: Ocular vestibular evoked myogenic potentials (oVEMPs) can be evoked with different stimuli: air-conducted (AC) sounds, bone-conducted (BC) vibration, head tapping and galvanic current. The VEMP origin is not fully understood: evidences suggest a mainly utricular origin, but a saccular origin is also discussed, especially for oVEMPs in response to AC sounds. The purpose of this study was to explore possible oVEMP integration of two similar stimuli presented in two different manners: AC sounds presented monaurally and BC skull vibration presented to the midline forehead.

Materials and Methods: oVEMPs were studied in healthy subjects without any history of hearing/vestibular problems. Stimuli were either AC 500 Hz tone bursts presented monaurally via ear phone, or BC 500 Hz tone bursts presented to the forehead in the midline using a Mini-shaker. AC and BC stimuli were presented either alone or combined. Stimuli intensity varied for both AC (90-120 dB SPL) and BC (90-120 dB FL). The AC and BC stimuli were integrated temporally by means of a latency delay correction. Parameters of interest were amplitude and latency of the first reproducible negative deflection.

Results: Monaural AC sounds evoked oVEMP from the contralateral eye and BC vibration evoked oVEMP from both eyes. At simultaneous stimulation with BC and monaural AC the oVEMP contralateral to AC showed enhanced amplitude compared with the oVEMP from the eye ipsilateral to AC.

Conclusion: It is possible to evoke enhanced oVEMP amplitude by simultaneous AC and BC stimulation. An interpretation of the results could be that AC sounds and BC vibration are comparable stimuli to the sensory section of the vestibular organ that initiates oVEMP. Otherwise AC and BC stimulate different parts that both have connections causing enhanced oVEMP amplitude. Studying AC BC interaction in patients with partial lesions could possibly reveal whether oVEMP has one or more origins.

P24

Ocular vestibular evoked myogenic potentials to bone conducted vibration (BCV) measured with Fz versus chin stimulus location

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Introduction: The study aimed to further develop the BCV oVEMP as a reliable clinical test and establish normative data. Results from two stimulus locations, Fz and mid chin were compared. Current understanding is that testing this vestibular-ocular pathway provides an insight into the functioning of the utricle and superior vestibular nerve. The clinical interpretation of the response is based on the latency of the n10 and p15 component of the response recorded from below each eye and the asymmetry ratio of the amplitudes between the recordings. Fz is the common site for stimulus placement but an alternative was sought for patients with skull trauma/surgery.

Method: Surface electrodes measured the response to BCV from beneath both eyes whilst a supine subject looked at a calibrated bar to give an upward gaze of 30°. The stimulus was 6 msec bursts of 500Hz vibration delivered by a Bruel and Kjaer 480 Minishaker (50 stimuli, 11/sec) presented at Fz and mid chin. 40 normal volunteers aged 18-65 years (mean = 39) were tested (20M: 20F). 16 patients with a unilateral vestibular deafferentation (uVD) were tested following vestibular schwannoma resection. A calibration procedure measuring vertical saccades was performed pre and post recording.

Results: oVEMPs were recordable from 40 consecutive normal subjects. N10 latency was 10.3-13.0 msec and P15 latency was 14.0-17.3 msec using Fz stimulus placement. An asymmetry ratio of > 34% indicates abnormality of the response. There was a significant delay in latency for N10 and P15 using the chin placement but no significant change in the amplitude of the response. All patients with uVD showed absent contralateral oVEMPs. A correction factor to account for underlying eye asymmetry did not significantly improve the reliability of the test.

Conclusion: Fz is the preferred stimulus location but the chin is a feasible alternative with variation caused by the temporomandibular joint.

P25

Overview of galvanic cVEMPs in guinea pigs: functional, morphological and immunocytochemical assessments

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Objectives: This study applied galvanic vestibular stimulation (GVS) to elicit cervical vestibular-evoked myogenic potentials (cVEMPs) in gentamicin-treated guinea pigs. Morphological and immunocytochemical assessments were used to clarify the relation between GVS-cVEMPs and the vestibular afferents.

Methods: An amount of 0.05mL of gentamicin (40mg/mL) and normal saline were respectively injected directly overlaying the round window membrane of the left and right ear in guinea pigs. Four weeks after surgery, cVEMP tests using GVS mode (5mA/1.0 ms) were performed in 10 guinea pigs, and then the animals were sacrificed for morphological and immunocytochemical studies. **Results:** In 10 right ears of guinea pigs treated with saline, all displayed present GVS-cVEMPs. On the contrary, in 10 left ears of guinea pigs treated with gentamicin, all showed absent GVS-cVEMPs. Absent GVS-cVEMPs were correlated with significantly lower percentage of voltage-gated sodium channel Nav1.8-like immunoreactive vestibular ganglion (VG) neurons (38.9i00.7%), when compared with the control ones (53.6i03.2%). Moreover, dramatic up-regulation of growth associated protein-43 (GAP-43) expression was detected in the treated VG neurons. The mean percentage of substance P-like immunoreactive (SP-LI) neurons in the treated VG (81.8i01.9%) was significantly higher than that in the control VG (68.6i03.3%). Conversely, the mean percentage of neuropeptide Y-like immunoreactive (NPY-LI) neurons in the treated VG (13.7i03.8%) was dramatically lower than that in the control VG (49.0i03.8%). Double labeling results shown 82% of SP-LI and 16% of NPY-LI neurons coexpressed with GAP-43, suggested that SP accumulating coincided with NPY decreasing in regenerating VG neurons after gentamicin treatment. **Conclusions:** Gentamicin-induced dysfunction of the saccular afferents of guinea pigs can be evaluated by recording GVS-cVEMPs. Absent GVS-cVEMPs are attributed to the damage of the vestibular afferents.

P26

The effect of stimulus rise-time on the ocular vestibular-evoked myogenic potential to bone conducted vibration

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Introduction: The negative potential at a latency of 10 ms (called n10) of the ocular vestibular myogenic potential (oVEMP) in response to bone-conducted vibration (BCV) delivered to the skull at the midline in the hairline (Fz) is a new indicator of otolithic, and in particular utricular, function. Our aim is to find the optimum combination of frequency and rise time for BCV stimulation, in order to improve the sensitivity of oVEMP testing in the clinic.

Materials and Methods: We tested 6 healthy subjects (2 male, 4 female, average age 48) with 6 ms tone bursts of BCV at three stimulus frequencies, 250, 500 and 750 Hz, at rise times ranging between 0 and 2 ms. The BCV was delivered to Fz using a Bruel and Kjaer minishaker 4810. The oVEMP was recorded by surface electrodes beneath the eyes as the subject looked up. The stimulus amplitude was adjusted to keep rms power of the stimulus constant as rise time was changed.

Results: The n10 response was significantly larger at the shorter rise times, being largest at zero rise time. In addition we examined the effect of stimulus frequency in these same subjects by delivering 6 ms tone bursts at zero rise time at a range of frequencies from 50 to 1200 Hz. The n10 response tended to be larger at lower frequency, being largest between 250 and 500 Hz. The slope of n10 as a function of frequency was found to be flatter than in earlier studies, probably because of the short rise time, as tests in 3 subjects with rise times of 1 and 2 ms showed functions which declined rapidly with frequency, consistent with the earlier studies.

Conclusion: The most effective stimulus for eliciting oVEMP n10 to BCV at Fz was found to be a low frequency tone burst (500Hz or 250Hz) with a rise time of 0 ms.

P27

The etiological implication of vestibular function tests in benign paroxysmal positional vertigo

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Background and significance: Since the liberated otoconia from the degenerated utricle has been postulated as the cause of the benign paroxysmal positional vertigo (BPPV), the relationship of the utricular function and the generation of BPPV have been studied. In addition, abnormal bone metabolism and vascular risk factors resulting in insufficient circulation to the utricle have been reported to be related to the utricular degeneration in BPPV. We investigated the relationship between the alleged risk factors, bone mineral density (BMD) and recurrence for the BPPV and the vestibular function tests.

Methods: 84 consecutive patients with BPPV were recruited in a dizziness center. Caloric test, cervical and ocular VEMPs were tested in all the patients in the acute phase of BPPV. At the same time, vascular risk factors and BMD were performed. All the data were analyzed for the relationship between abnormal results of vestibular function tests and the risk factors.

Result: 58 patients (69%) showed abnormal cervical VEMPs that were related to decreased bone density, having more than one vascular risk factor, and older age (>55 years). Abnormal ocular VEMPs were shown in 53 patients (63%) that were related to older age and vascular risk factors, but not statistically related to bone mineral density. Caloric tests failed to show any statistically significant results.

Conclusion: We found abnormal results of cVEMPs and oVEMPs is related to the BMD, vascular risk factors and age. VEMPs could be used for the demonstration of presumptive otolith degeneration in BPPV.

P28

Threshold properties of vestibular evoked myogenic potentials (VEMPs) to impulsive head acceleration

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Introduction: We report the results of a study to determine threshold properties for VEMPs produced by IA [1,2].

Materials and Methods: VEMPs, from the sternocleidomastoid muscles, and ocular VEMPs (OVEMPs), from infraocular electrodes, were recorded in fifteen healthy subjects in response to sound and IA. The sound stimuli were 2 ms, 500 Hz pips delivered by headphones and the IAs were third order gamma distribution pulses with 4 ms rise-time delivered at the mastoid by a mini-shaker. Both VEMP and OVEMP thresholds were obtained for intensities in the range 0 to -30 dB re 135 dB LLpk for sound and re 0.2 g for IA. Sensory thresholds for IA stimulation were also assessed.

Results: For sound stimulation, our results are consistent with the earlier literature in showing that VEMP thresholds are lower than OVEMP thresholds, by 5 - 10 dB [3]. In contrast thresholds for OVEMPs and VEMPs produced by IA are similar, within 2 dB, and higher than the sensory threshold, by about 10 dB.

Conclusions: Whereas 500 Hz sound stimulation is less effective in evoking OVEMPs than VEMPs [3], IA stimulation seems similarly effective for the two reflex pathways. These differences likely reflect the different connectivity of saccular vs. utricular projections to the neck and eyes, the saccular-ocular projection (as activated by 500 Hz sound) being relatively weak. The relatively high IA threshold compared with our previous study for 100 Hz vibration [4] suggests that the low thresholds previously observed were due to a specific utriculo-ocular resonance mechanism.

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P29

Vestibular evoked myogenic potential as a test of vestibular function in congenitally blind individuals

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Introduction: Usual balance tests such as electro/videonystagmography require vision and are not applicable in blind people. As VEMP is independent of vision, it can be used for balance evaluation of blind individuals. The purpose of this study was to investigate VEMP parameters such as occurrence of response, latencies of p13 and n23 components, and amplitude between congenitally blind subjects and sighted subjects.

Materials and Methods: Myogenic potential was evaluated utilizing 500 Hz tone burst with 95 dBnHL

intensity in twenty blind and sighted individuals aged 18-30 years.

Results: VEMP was observed in all (100%) subjects. There was no significant difference among the two groups for mean latencies of p13 and n23 and mean asymmetric ratios. Amplitude among blind subjects was lower than sighted individuals.

Conclusion: VEMP would be a useful test for evaluation of vestibular activity in blind people; however, in blind persons, enough contraction of stercleidomastoid muscle should be evaluated by surface electromyography.

P30

Head Impulse test: bedside and video evaluation

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The assessment of the vestibulo-ocular reflex is one of the main steps in the evaluation of patients with dizziness. It has been usually performed at the bedside with common head-impulse test in which eye position is analyzed at the end of the head-thrust. Recently a major contribution has been provided with the use of special video recording systems. The purpose of this work is to analyze the results under both modalities of assessment. This work was done on 188 patients with different types of peripheral vestibulopathy. The clinical test was classified as normal or abnormal according to the absence or existence, respectively, of refixation saccades once the head-thrust was ended. The video head-impulse test was performed with the vHIT by GN Otometrics (Denmark) and the results were classified according to the gain of the VOR and presence of refixation saccades. The velocity of the slow phase of spontaneous nystagmus was also quantified as well as the result in the caloric test. There were significant differences (chi-square test, $p=0$) for the findings in the clinical evaluation and with the vHIT. In the latter the differences were due to the finding of normal gain with saccades; in these patients the amount of canal paresis was significantly higher than in patients with a normal vHIT result to both sides. The distribution of findings in the bedside examination of the VOR and with the help of a video system are significantly different, as such the video head-impulse examination is not simply an added system of detection and registration of the VOR. The difference realies mainly in a vHIT response characterized as of normal gain but with refixation saccades. These have been considered as the cause for the low sensitivity of the bedside VOR examination and sometimes regarded as normal responses: we have demonstrated that these findings are abnormal according to the findings of a higher canal paresis in the caloric test.

P31

Normal gain VOR with refixation saccades.

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Introduction: We have recently shown that the pattern of eye response to head impulses is quite different once the gain of the vestibulo-ocular reflex (VOR) and the existence of refixation saccades are evaluated as the response to high velocity head impulses.

Study, design, setting and patients: This study was conducted at a tertiary care center in which 375 patients were subjected to the video head-impulse test with the vHIT system by GN Otometrics, Denmark. We shall focus our study in those patients with normal gain of the VOR that have additional unexpected refixation saccades comparing demographic and vestibular function studies. **Results:** A normal gain (>0.6) with refixation saccades was found in 23% of the patients evaluated and occurs independent of the age, sex or type of disease of the patients. Patients show a significantly different amount of canal paresis with regards to patients with normal gain VOR without saccades or low gain VOR with/without saccades.

Conclusion: The video head-impulse test allows to identify patients with moderate amount of canal paresis by the unique finding of normal gain with saccades.

P32

Refixation saccades after vestibular schwannoma surgery

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Introduction: Measurement of saccadic responses to high acceleration head turns during human vestibular compensation can show the changes in the recovery after unilateral vestibular loss. After surgery for Vestibular Schwannoma the recovery process in each patient is different. One of the aspects implicated in this process are the refixation saccades. The purpose of this study is to characterize this finding after Vestibular Schwannoma surgery in a preliminary group of patients.

Materials and Methods: Eight patients who underwent Vestibular Schwannoma surgery between January 2012 and March 2012 are studied. For the assessment of the vestibulo-ocular reflex we have used the vHIT by Otometrics. Before surgery the caloric test and the vHIT were performed and the latter at the time of hospital discharge, 1 and 3 months after surgery.

Results: Changes in vestibulo-ocular response after surgery are observed in all patients. These are severe gain reduction after impulses to the operated side and moderate gain reduction with impulses to the healthy side; this finding is kept constant through this short time of follow-up. However the refixation saccades obtained show significant changes along the follow-up; initially there are clearly overt and covert but become mainly overt after 3 months. However we have seen differences between subjects and there is not a unique pattern.

Conclusion: Each patient has a particular saccadic strategy after Vestibular Schwannoma surgery in order to get vestibular compensation. Refixation saccades show a dynamic behaviour in this small group of patients.

P33

Testing the vertical VOR with video oculography

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Introduction: The head impulse test is a recognized clinical sign of a deficient vestibulo-ocular reflex (VOR). With new video-oculography (VOG) devices, objective head impulse testing became feasible even in standard clinical setups, but, in contrast to the gold standard 3D search coil, examination is restricted to horizontal canals. Vertical head rotations remained a challenge for VOG because designs are based on off-the-shelf goggles with stabilization for horizontal rotations only. We here introduce a new head mount that also stabilizes for rotations in pitch and we validate it against the search coil.

Methods: We used 3D rapid prototyping for manufacturing a novel head mount that abandons goggles as a model. Instead, we use a flexible head band with stabilization for pitch rotations. Ten patients with either bilateral or unilateral vestibular deficits served as subjects. They sat in front of a fixation target at eye level. After calibration of VOG and search coil eye and head rotations were measured by both systems simultaneously while passive head impulses were applied in pitch. Gain was analyzed during the head movement as the instantaneous ratio of eye and head angular velocities.

Results: Direct comparison of eye velocity and gain trajectory in both the VOG and search coil signal traces revealed no difference between the two methods. In particular, we observed no "bump" artifact as reported previously for goggle-based VOG systems. A paired comparison of the instantaneous VOG and search coil gains measured at 60 ms after the start of the movement were essentially the same.

Conclusion: We present a novel VOG head mount that allows to quantitate the VOR with head impulses in vertical directions. A direct comparison with the gold standard method revealed no difference. For the clinician, this is a useful tool for testing and differentiating between vestibular deficits of all six semicircular canals.

P34

The clinical usefulness of EyeSeeCam in assessing vestibulo-ocular reflex

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Introduction: The head impulse test is a routine clinical examination of the horizontal vestibulo-ocular reflex (VOR). In healthy subjects, the VOR evokes a compensatory eye movement in the opposite direction; however if the VOR is deficient, a catch-up saccade is observed in the head impulse test. The EyeSeeCam is a device designed for the measurement and analysis of head and eye movements. The purpose of this study was to examine the catch-up saccades found in head impulse tests by using the EyeSeeCam.

Materials and methods: Six healthy controls and 22 patients with disequilibrium (10 with Ménière's Disease; 5, vestibular neuritis; 3, acoustic tumor; 2, unilateral vestibular deficit; and 2, bilateral vestibular deficit) were recruited to the study. The subjects underwent caloric testing and head impulse tests using the EyeSeeCam. In the head impulse tests, we checked the VOR gain (defined as eye velocity divided by head velocity).

Results: Catch-up saccades were observed in all patients with vestibular neuritis, unilateral vestibular deficit, and bilateral vestibular deficit, 2 of 3 patients with acoustic tumor. In contrast, although all patients with Ménière's Disease were found to have canal paresis in caloric testing, catch-up saccades were observed in only 3 of 10 patients. No catch-up saccade was noted in the healthy controls. No correlation was observed between the degree of canal paresis and the VOR gain. The average VOR gain was 1.02 in the healthy controls, and it was 1.22, 0.76, 0.90, 0.72, and 0.37 in patients with Ménière's Disease, vestibular neuritis, acoustic tumor, unilateral vestibular deficit, and bilateral vestibular deficit, respectively.

Conclusions: The head impulse test using the EyeSeeCam can be used to detect the deficit of VOR at bedside without the need for large-scale search-coil recording.

P35

Otolith-ocular responses in patients with acute brainstem lesions using ocular vestibular evoked myogenic potentials

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Objective: The ocular vestibular-evoked myogenic potential (oVEMP), a recently documented otolith-ocular reflex, is considered to manifest the central projections of the primary otolithic afferent fibers to the oculomotor nuclei. The aim of our study is to define oVEMP abnormality in patients with acute brainstem lesions and to determine the brainstem structures involved in the generation of oVEMPs. Design: One-year prospective study of oVEMP characteristics and lesion mapping in patients with acute brainstem lesions.

Setting: Dizziness clinic at Chonbuk National University hospital

Patients: Fifty-two patients with acute brainstem lesions from March to December 2010.

Outcome Measure: Ocular VEMP was measured in response to air-conducted tone burst sound (ACS). Individualized brainstem lesions were analyzed by means of MRI-based voxel-wise lesion-behavior mapping and the probabilistic lesion maps were constructed.

Results: More than half (n=28, 53.8%) of the patients with acute brainstem lesions showed abnormal oVEMP. The majority of patients with abnormal oVEMPs showed lesions in the dorsomedial brainstem that contains the medial longitudinal fasciculus, the crossed ventral tegmental tract and the oculomotor nuclei and nerves.

Conclusion: It seems that these structures are responsible for otolith-ocular responses in the brainstem. Complemented to the cervical VEMP for the uncrossed otolith-spinal function, oVEMP to ACS can be applied to evaluate the crossed otolith-ocular function in the central vestibulopathy.

P36

Vestibular evoked myogenic potentials in early stage of multiple sclerosis and clinically isolated syndrome

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Purpose: The aim of the study was to investigate the sensitivity of vestibular evoked myogenic potentials (VEMP) in early stages of multiple sclerosis (MS) and in clinically isolated syndrome (CIS).

Background: Brainstem and cerebellar lesions are common in CIS and early MS. VEMP is thought to be a marker for brainstem dysfunction.

Material and methods: A group of 20 MS outpatients was compared to 20 age-matched healthy volunteers. 25% of the patients had some oto-neuro-ophthalmological complaints, 75% did not have any infratentorial lesion on MRI and clinical examination.

VEMPs were evoked by forehead taps with a triggered reflex hammer (tap-VEMP). Responses were registered over the middle part of the muscle belly of the sternocleidomastoid muscles (collic VEMP) and over the middle part of the lower eyelid, on top of the inferior orbital edge (ocular VEMP). During the collic VEMP, subjects were asked to push their chin downward against an inflated blood pressure cuff. During ocular VEMP subjects had to deviate the eyes 25 degrees upward. Peak latencies and standardized amplitudes were measured

Results: Collic and ocular VEMP latencies of the patients were significantly prolonged compared to

healthy volunteers. The ocular n2p2 amplitude was significantly reduced, while the standardized p13n23 amplitude was significantly enhanced. When ocular and colic VEMPs were combined, a sensitivity of 60% and a specificity of 90% could be obtained.

Conclusion: These findings suggest that VEMP is a rather sensitive test, able to detect subclinical dysfunction or lesions beneath detection threshold of MRI in patients with early MS and clinically isolated syndrome.

P37

A new hypothesis for Alexander's Law of vestibular nystagmus

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Following a unilateral vestibular deficit (UVD), the intensity of the resulting spontaneous nystagmus becomes a function of eye position; slow-phase velocity is larger when looking in the direction of fast-phases and decreases when looking in the direction of slow-phases. This behavior is referred to as "Alexander's Law". According to Hess (1982) and Robinson's (1984) theory, the eye position effect results from adaptive changes in the neural integrator; following a peripheral lesion, the integrator becomes leaky and causes gaze-evoked nystagmus which counteracts the spontaneous nystagmus in part of the gaze field. In contrast, according to Doslak's theory (1979), following a peripheral lesion a gaze dependent command is added to the VOR central circuit thereby directly modulating the vestibulo-ocular reflex (VOR) without affecting the neural integrator. We propose that a physiologically plausible transformation in the population response of the secondary vestibular neurons in the vestibular nuclei is sufficient to cause Alexander's Law. We then test this hypothesis on a simple control system model for the VOR.

Such a response transformation from quasi-linear to a sigmoidal function could be a direct consequence of the UVD without having to resort to extra triggering or guiding neural signals from higher order brain structures. This response transformation could happen immediately following a lesion and can be useful to stabilize gaze in part of the gaze field. Plus, since this transformation occurs in the vestibular nuclei both the VOR system and the neural integrator are affected.

P38

Age-related vestibular pathology in CBA/N mouse utricular type II hair cell

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Introduction: Falling and dizziness are the major medical problems in old age. Aging may be the major factor causing functional decline of the central nervous system, such as loss of neuronal connections. We aim to investigate if there is any decrease and electrophysiological dysfunction of utricular hair cell in adult using CBA/N mouse as an animal model.

Materials and Methods: Male CBA/N mice were used in this study. Two groups of CBA/N mice were divided into different ages (5-week-old and 26-week-old respectively). Cell counting by immunohistochemistry

The utricles were removed. The otoconial membranes were removed. After fixation, specimens were incubated with Rhodamine-phalloidin to label F-actin, and then viewed with a laser-scanning confocal microscope. Two frames were set in the striola region and other two frames were set in the extrastriola region respectively. The average of hair cell numbers in each frames were compared. Differences in hair cell numbers between young and adult mice were statistically tested by Student's t test.

Electrophysiology

The utricle were excised and immersed in solutions containing papain. Utricles were then brushed with a fine probe for hair cells dissociation. The dissociated cells were viewed at x600 with an inverted microscope. The whole-cell patch clamp method was used for recording membrane potentials and currents of type 2 hair cells.

Results: In cell counting, significant difference in number of hair cells was found between two groups, that the number of hair cells was lesser in the adult group than in the young group. In electrophysiology of type 2 hair cell investigated by whole cell patch clamp method, the size of the large outward K currents evoked by depolarizing voltage steps are different between adult and young. The current of adult group are lower than that of young group.

Conclusions: In addition to hair cell loss, the electrophysiological dysfunction is occurred in the adult mouse utricle.

Classification of vestibular examination signs and techniques, part 1: nystagmus

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Objectives: Vestibular research and patient care have been hindered by the lack of standardized terminology and a formal disease classification system. In 2009, the Committee for the Classification of Vestibular Disorders of the Bárány Society published a Classification of Vestibular Symptoms. Subsequently the Committee has commissioned a group to develop a classification system and definitions for vestibular examination signs and techniques, with the goal of establishing a consistent universal nomenclature.

Methods: The Committee was created to develop classification criteria to support standardization for vestibular research and patient care. A multi-layer structure guides its development, consisting of: symptoms/signs, syndromes, diseases/disorders, and mechanisms. An international group of neurologists and otolaryngologists was commissioned to classify and define vestibular examination signs and techniques. This group reviewed the literature and drafted an initial classification organized around vestibulo-ocular, ocular motor, otologic, and balance examination signs and techniques. The draft was discussed and revised by email exchange among the authors to reach consensus.

Results: Characterizing nystagmus is vital to the vestibular examination. Given its complexity and lack of universal nomenclature, we initially addressed only nystagmus in this Part 1 document. We created definitions that were as purely phenomenological as possible, while also categorizing terms that imply etiology or pathophysiology. Necessary attributes for a complete description of nystagmus were elaborated. Where nomenclature was confusing, we suggested preferred, alternative, and rejected terminology.

Conclusions: Establishing a consensus classification of vestibular examination signs and techniques, beginning with nystagmus, should facilitate the Bárány Society's effort to define diseases and disorders in its development of an International Classification of Vestibular Disorders.

Functional near-infrared spectroscopy (fNIRS) during vestibulo-ocular and postural challenges

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Introduction: Functional near-infrared spectroscopy (fNIRS) is a non-invasive brain imaging method that uses light to record regional changes in cerebral blood flow during functional tasks. fNIRS uses portable and wearable sensors to allow measurements of brain activation during participant movement.

Methods: A 32-channel, fNIRS device was used to record brain activation during a series of vestibular experiments. Images of brain activity were estimated from statistical regression analysis.

Results: Caloric stimulation: A bilateral fNIRS probe was used to record brain activity from the frontal and temporal regions of 20 healthy persons: (N=10 young; N=10 older). Brain responses were recorded during warm (44°C) and cool (30°C) caloric irrigations. The older group showed increased bilateral activations of the superior temporal gyrus (STG) compared to the younger population. fNIRS recordings showed that the evoked brain changes in the STG matched the onset and duration of nystagmus.

Dynamic

Posturography: fNIRS was recorded during sensory organization testing (SOT) on an Equitest platform in ten young healthy volunteers. Brain areas in STG, frontal cortex (FC) and the supramarginal gyrus (SMG) were activated during the SOT conditions. We found that loss of proprioception showed a dominant left SMG activation while loss of vision showed a dominant right SMG activation. Bilateral STG and SMG activation was observed when both proprioception and visual inputs were removed.

Rotational testing: A 4-channel wireless fNIRS system was built to allow measurements in STG during earth-vertical axis rotational testing. Bilateral STG areas were recorded from twenty healthy volunteers (N=10 young; N=10 older) during sinusoidal rotation (0.1 Hz, 60 deg/sec) in the dark. Bilateral activation of STG was observed.

Conclusion: This set of experiments demonstrates the feasibility of using fNIRS imaging for studying cortical activity during vestibulo-ocular and postural challenges.

P41

Objective measures of vestibular function during an acute vertigo attack in a very young child

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Introduction: It is difficult to obtain objective measures of vestibular function from very young children (3 to 7 years old) because very young children are unwilling to receive caloric tests which induce vertigo, or to undergo bedside examination for spontaneous nystagmus because they must be in darkness for some minutes. It is also difficult to obtain an accurate medical history in such young patients in a subacute stage, and in order to understand what really happened the clinician relies on the story told by the parents. These difficulties increase when a child comes to a vertigo clinic or an Emergency Department in the acute stage of a vertigo attack complaining that the world is turning around. We present the case of a 4 year old boy tested at the acute stage of a vertigo attack using 3 new objective measures of dynamic vestibular function, to underscore the value of such objective measurements in diagnosing selective lesions of the vestibular labyrinth. These tests are quick, accurate and not demanding for the patients (i.e. they do not induce vertigo), and can be used to obtain objective measures of the dynamic function of all the vestibular receptors, both semicircular canals and otoliths, even in very young children

Materials and Methods: The tests are the cervical vestibular-evoked myogenic potential to air-conducted sound or bone conducted vibration; the ocular vestibular-evoked myogenic potential to short tone bursts (7ms of 500Hz) of BCV stimulation delivered to the midline forehead at the hairline (Fz) and the video Head Impulse Test

Results: The results showed normal horizontal canal function but reduced saccular and utricular function on the right side. As a result the patient was diagnosed as having impairment of his right otoliths. This is probably due to unilateral labyrinthitis rather than neuritis since the horizontal canal function was unaffected

Conclusion: These new objective tests can be used on very young children

P42

A case of pseudo-vestibular neuritis patient associated with nodular infarction

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Background: The clinical syndrome of acute spontaneous vertigo without other associated neurological and otological symptoms or signs is commonly due to vestibular neuritis. But similar clinical symptoms and signs occur in central nervous system (CNS) lesions so-called pseudo-vestibular neuritis. One of CNS lesion site is nodulus.

Case Report: We report a case of 38-year old male with acute vestibular neuritis-like symptoms and signs, normal head thrust and caloric test, finally demonstrated as nodular infarction. Videonystagmography, rotary chair test, computerized dynamic posturography and brain MRI were checked.

Conclusions: Nodular infarction simulating vestibular neuritis is rare. But recognition of the nodular infarction mimicking vestibular neuritis is important to early treatment of specific management.

P43

A case of vestibular paroxysmia: a report of recording nystagmus during a vertigo spell by oculography

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Objective: Vestibular paroxysmia (VP) attributed to neurovascular cross-compression (NVCC) leads to vertiginous spells. We report a case of VP presenting with the typical feature and nystagmus pattern which was recorded by video-oculography.

Case: A 55-year-old man admitted to our neurology department with a month history of intermittent rotating-natured dizziness lasting for seconds to minutes. He had left hemifacial spasm over ten years. He was on antiplatelet medication as his brain MR angiography revealed a severe stenosis in V4 segment of right vertebral artery. His initial physical examination was unremarkable and neurologic examination showed no deficit except for left hemifacial spasm. Vestibular function tests result were unremarkable. We tentatively diagnosed him as VP and treated him with carbamazepine. And then his symptom improved dramatically. After symptom improvement, we arbitrarily withdrew carbamazepine and five days later, he complained of acute vertigo while talking with standing position. His hemifacial spasm aggravated with left beating nystagmus. On video-oculography, the left beating nystagmus appeared maximum slow phase velocity (SPV) of 15 degrees/second lasting for 90 seconds. Then there was a brief transitional down beating nystagmus and then the right beating nystagmus with maximum SPV of -23 degrees/second with clockwise torsional nystagmus component for 6 minutes. It was terminated by head thrust test. He restarted taking carbamazepine orally and his dizziness has been well-controlled until now.

Conclusions: Our patient is in consistence with the VP criteria suggested by Hufner et al. Along with atypical symptoms we were also able to show NVCC via MRI and with an antiepileptic medication, the patient recovered dramatically. We also recorded the nystagmus during a vertigo spell by video-oculography. We should consider VP with the patients presenting with recurrent atypical dizziness that cannot be explained by vestibular dysfunction.

P44

Abnormal spatial updating in patients with unilateral hippocampal sclerosis

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Introduction: As the hippocampus receives vestibular input and because this structure is thought to play an important role in updating spatial information we asked whether patients with hippocampal sclerosis (HS) exhibit distortions of their internal spatial reference frames due to abnormal processing of neck proprioceptive and/or vestibular input.

Materials and Methods: Subjects were seated on a Barany chair and their head was stabilized by means of a bite-board fixed to a head-holder. The head-holder was attached to the Barany chair. The chair and head-holder could be independently rotated in the horizontal plane by servo-controlled motors. Ten patients with unilateral HS and eleven healthy, age-matched controls were instructed to reproduce, by adjusting a light pointer in the dark, a remembered target location in space (space centric reference). They did so before and after horizontal head and trunk rotations, which evoked isolated or combined vestibular and/or neck stimulation.

Results: In HS patients, unlike in normal controls, pre-stimulus estimates of their subjective straight ahead (baselines) showed a pronounced variability with essentially normal mean values. Though poststimulus estimates, after correction for the individual baseline errors, were normal with respect to amplitude, their variability was also significantly increased, independently of stimulus direction, modality and rotation dynamics.

Conclusion: Our findings suggest that HS patients can only inaccurately update the location of an object in space after vestibular cues and / or neck proprioceptive input in the absence of visual landmarks.

P45

Acute demyelinating disease in the brainstem: Initial manifestation of Neuromyelitis Optica Spectrum Disorder (NMOSD) associated with Sjogren syndrome

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Background: Optic neuritis or longitudinally extensive myelitis in Sjogren syndrome suggests a neuromyelitis optica disorder (NMOSD), which include recurrent isolated optic neuritis, and optic neuritis or myelitis in the context of certain organ-specific and non-organ-specific autoimmune disease. Recently, patients with NMO have asymptomatic and symptomatic brain MRI lesions, of which several lesions have been suggested as characteristic findings of brain abnormalities in patients with NMO and AQP4-Ab. We report a patient with sudden vertigo and dysequilibrium who showed acute demyelinating lesion in the pontomesencephalic area associated with positive antinuclear antibody, Sjogren syndrome A (SSA) antibody and NMO-IgG.

Case: A 40-year-old woman presented with sudden vertigo and disequilibrium from five days ago. Initial

neurological examination showed spontaneous upbeat nystagmus and bilateral gaze evoked nystagmus (GEN) and bilateral truncal ataxia. Brain MRI showed irregular marginated mild brain swelling lesion in midbrain and pons with suspicious mild enhancement suggesting acute demyelinating disease. Laboratory study showed a positive result of anti-SSA antibody (1:500) and antinuclear antibody. In addition, low titer of anti-AQP4 antibody was detected in the patient's serum. Steroid pulse therapy was applied during five consecutive days. However, There was no improvement of clinical symptoms such as vertigo and total ophthalmoplegia was developed after steroid therapy. After that event, She was transferred to other urban university hospital.

Conclusions: This case demonstrates that SS patient with CNS involvement have brain abnormalities characteristic of NMOSD. The presence of AQP4-Ab in SS patient with only brain involvement may suggest that the coexistence of NMOSD should be explored in SS patient even without optic neuritis or myelitis.

P46

Computerized Square Drawing Test

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Introduction: Fukuda developed a blindfold vertical writing test in which imbalance in upper extremities was evaluated by the deviation and/or the deformity of vertically written characters by subjects with eyes closed (1943). Sekitani further modified Fukuda's self-writing test and designed a Square Drawing Test (SDT) (1975), in which subjects wrote squares instead of characters for better quantitative estimation. To further improve the objectivity and quantitativity of SDT, we developed a computerized SDT (cSDT), in which a pen tablet input device was used instead of papers.

Subjects and Methods: Subjects wrote three rows of four squares on a pen tablet(Wacom Intuos4 PTK-1240, Japan), in one row with eyes open, and in the other two rows with eyes closed. Program recorded the position above the pen tablet together with the time in the computer. We analyzed following parameters; (1) Deviation of rows, (2) Size of squares, (3) Distance between the start and the stop point in each square, (4) Total time of writing, (5) Time for writing each line.

Fifteen of normal subjects with no experience of vertigo or dizziness were recruited for establishing normal range. Also, 36 patients with vertigo and/or dizziness (22 with peripheral vestibular disorders, and 14 with central disorders) were evaluated with this cSDT.

Results: cSDT was performed without difficulty in daily clinics. Among 14 of central vertigo patients, 11 patients had abnormal values in least one parameter. On the other hand, only 5 patients of 22 peripheral vertigo patients had abnormal values. For detecting central disorders among patients with vertigo, the sensitivity of this cSDT was calculated as 78.6% and the specificity was 77.3%.

Conclusions: Since cSDT can be easily performed in daily clinical practice, cSDT would be useful in many respects, including screening central disorders, estimating the disequilibrium and evaluating the efficacy of treatments.

P47

Evoked potential characteristics of common vestibular disorders

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Introduction: It is sometimes difficult to distinguish between different causes of vertigo based on the clinical examination and history alone. We sought to define the characteristic ocular and cervical vestibular evoked myogenic potential (oVEMP and cVEMP) profile of vestibular Migraine (VM), Ménière's disease (MD) and vestibular neuritis (VN). The relationship between VEMP and other vestibular function test results was explored and compared between the three groups.

Methods: oVEMPs were recorded from unrectified infra-orbital surface electromyography (EMG) during upward gaze. cVEMPs were recorded from rectified and unrectified sternocleidomastoid EMG during head elevation against gravity. Responses to AC clicks delivered via headphones, and BCV forehead taps delivered with a mini-shaker (bone-conduction vibrator) and a triggered tendon-hammer, were recorded.

Results: There was no significant difference in VEMP amplitudes, latencies or asymmetry ratios for VM

patients compared to age matched controls. Ménière's disease was associated with a high prevalence of unilateral AC VEMP abnormalities; whereas patients with VN had fewer AC cVEMP abnormalities and demonstrated a higher rate of unilateral oVEMP abnormalities to BCV stimuli. Compared to VM, subjects with MD and VN were more likely to have an abnormal caloric and subjective visual horizontal test result. **Conclusion:** Vestibular migraine, ménière's disease and vestibular neuritis are characterised by different VEMP profiles, reflecting differences in receptor and neural pathway involvement. A vestibular test battery that includes VEMP, caloric and subjective visual horizontal tests, establishes a diagnostic profile of each disorder, which can assist in the differential diagnosis of acute vertigo.

P48

HTLV-1 associated myelopathy with gaze-evoked nystagmus and cerebellar ataxia

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Introduction: HTLV-I is endemic in well-defined geographical regions: southern Japan, the Caribbean Central, South America, the Middle East, Melanesia and equatorial regions of Africa. HTLV-I associated myelopathy/tropical spastic paraparesis (HAM/TSP) is characterized by spastic paraparesis in the lower extremities, and urinary disturbance. HAM/TSP has also been less frequently associated with cerebellar syndromes and nystagmus. We report a case of HAM/TSP presenting with cerebellar ataxia and nystagmus.

Case report: The patient was a 73-year-old woman who was born in southern Japan. At age 41, she developed pain and spasticity in the bilateral lower limbs and gradually progressive gait disturbance. At age 57, she was diagnosed with HAM/TSP based on spastic paraparesis in the lower limbs, urinary disturbance and positive anti HTLV-I antibody in serum and cerebrospinal fluid. In June 2008, she hospitalized for rehabilitation. Twenty days later, she experienced rotatory vertigo sensation. Magnetic resonance imaging revealed pontocerebellar atrophy. The patient presented with cerebellar signs in the upper limbs, gaze-evoked nystagmus in the sitting position and right-beating horizontal nystagmus in the supine and head-hanging positions. Electronystagmography (ENG) showed horizontal saccadic overshoot dysmetria and horizontal saccadic pursuit.

Conclusion: Nystagmus in the patients with HAM/TSP is rare. The patterns of nystagmus in previous reports are varied. Neuro-otological examinations using ENG are helpful to evaluate and confirm cerebellar syndromes of HAM/TSP.

P49

Influence of vestibular disease on psychological distress - multicenter study

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Introduction: Some of the patients with dizziness show a high comorbidity with psychiatric disorders. But, the relation of vestibular deficit with psychological symptom are still controversial. Thus we investigated the psychological distress (depression and anxiety) of patients with vestibular disease, and investigated factors modifying the development of the psychological distress in the patients, including age, sex, severity of dizzy symptom and vestibular disease

Materials and Methods: This study enrolled 407 patients with dizziness. Dizziness and the psychological symptoms of the all patients were measured using the Korean version of the dizziness handicap inventory (DHI), the Beck Depression Inventory (BDI), and the Spielberger State-Trait Anxiety Inventory (STAI). We evaluated the influence of the type of vestibular disease, the symptom scale of dizziness (DHI) and other factors such as sex and age on the psychological scales (BDI, STAI) through multiple regression analysis

Result: Only DHI score and Vestibular neuritis were related significantly with the BDI score of patients with vestibular disease, and only DHI scores were associated with the STAI score of the patients.

Conclusion: DHI scores and psychological distress were closely associated. And psychological distress might be a consequence of high DHI scores rather than the types of vestibular disease, though depressive symptoms were related to the vestibular neuritis.

P50

Mutation spectrum and clinical characteristics of hearing loss patients caused by SLC26A4 mutations: a large cohort study

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Introduction: Based on our genetic screening, *SLC26A4* is the second common responsible gene in Japanese deafness patients. Until now, more than 160 mutations have been reported in *SLC26A4*, and are reported to have different mutational spectrums among different ethnic groups. For such clinical application, updated information regarding mutation spectrum, clinical characteristic, genotype-phenotype correlations, based on large cohort is needed. In addition to our previous reports, the present study was performed to collect updated data and summarized these data toward the precise decision making for ENT clinician using large cohort of the patients.

Materials and Methods: Data on 3056 Japanese subjects of 1511 independent families were collected. A total of 100 Japanese probands had bilateral sensorineural hearing loss associated with EVA regardless of the presence of the goiter, participated in this study. To identify *SLC26A4* mutations, direct sequencing was applied. Clinical data were collected by anamnestic evaluation.

Results and Conclusions: There were a total of 38 *SLC26A4* mutations found in the probands with bilateral EVA. As a result of sequencing, mutations were identified in 82 patients. 92% of Pendred syndrome and 80% of non-syndromic hearing loss associated with EVA were associated with EVA. The most frequent mutation was H723R which account for 35.2%, and the second was 919-2A>G for 4.5%. Mutations in the *SLC26A4* gene are known to be responsible for a broad phenotypic spectrum, from typical Pendred syndrome to nonsyndromic hearing loss with Enlarged vestibular aqueduct (NSEVA). We determined the phenotypic range in the patients with biallelic *SLC26A4* mutations: congenital/prelingual (88%), fluctuated (55%), and progressive (67%) hearing loss, usually associated with vertuously associated with vertigo (41%) and/or goiter (13%) during long-term follow-up.

P51

Oculopalatal tremor in a patient with basilar invagination

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Basilar invagination is a developmental anomaly of the cranio-vertebral junction in which the odontoid abnormally prolapses into the foramen magnum. Although congenital basilar invagination may remain asymptomatic, patients frequently present with neurologic symptoms including vertigo, hyposthesia, unsteady gait, dysarthria and diplopia. Here we demonstrate a case of basilar invagination with Bruns' nystagmus and oculopalatal tremor (OPT). A 51-year-old man visited for intermittent oscillopsia with left clicking tinnitus for 2 months. On measurement he had dwarfism; height was 135cm and weight was 45kg. He experienced gradual progress of right side motor weakness which began 5 years ago. Though he had a profession as a painter, his right hand felt gradual skilllessness. Video-oculography showed that small amplitude, high frequency left beating nystagmus (slow phase velocity = 2.3°/sec, 1Hz) was seen when left gaze, and large amplitude, low frequency right beating nystagmus (slow phase velocity = 6.4°/sec, 3Hz) was seen when right gaze. Frenzel goggles test revealed the see-saw nystagmus presenting that right eye elevated with intorsion and left eye depressed with extorsion. Regular clicking sound was heard on his left ear. See-saw nystagmus with tinnitus persisted for about 6~8 seconds and then disappeared. This repeated see-saw nystagmus with clicking tinnitus which synchronized with oscillopsia occurred every 30~60 seconds. The investigations disclosed that the patient had the Bruns' nystagmus with OPT. Brain and cervical MRI showed the brainstem was compressed by atlas at the level of pontomedullary junction as known as the basilar invagination, but did not reveal acute or old lesion in brainstem and cerebellum, hydrocephalus, syringomyelia, Chiari malformation and abnormal signal of inferior olivary nucleus. After he took gabapentin, his intermittent oscillopsia with clicking tinnitus disappeared.

P52

Prevalence and severity of health anxiety in patients undergoing consultation for vestibular symptoms

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Introduction: Anxiety and depression have been studied extensively in patients with vestibular disorders, but health anxiety has not. Health anxiety includes heightened awareness of bodily sensations, excessive worry about causes and consequences of physical symptoms, catastrophic fears about sickness, and difficulty being reassured about health status. It is an empirically validated concept that

ranges from transient worries about medical problems to chronic hypochondriacal fears. Vestibular disorders could be potent triggers of health anxiety because of their dramatic onset (e.g., acute vertigo) and potential threat to life (e.g., stroke). This study measured the level of health anxiety and prevalence of severe health anxiety in patients undergoing consultation for vestibular symptoms.

Materials and Methods: Health anxiety was measured with the Short Health Anxiety Inventory (S-HAI) in 162 consecutive patients undergoing multi-disciplinary evaluations for vestibular symptoms and 516 patients being examined for other medical problems in a tertiary care clinic. The S-HAI is a validated 14-item self-report with scores ranging from 0-42. Means and rates of severe scores were compared between patients with vestibular and non-vestibular problems and across patients with five neurotologic conditions: peripheral vestibular deficits (PVD), Meniere's disease, vestibular migraine (VM), chronic subjective dizziness, and other vestibular disorders.

Results: 1 in 8 patients had severe health anxiety (S-HAI>25) with no difference between vestibular (13.6%) and non-vestibular patients (11.0%). Mean S-HAI scores were mild and did not differ between vestibular (15.1) and non-vestibular (15.8) patients. Among vestibular groups, mean S-HAI scores ranged from 12.2 (PVD) to 16.2 (VM), a non-significant difference.

Conclusion: On average, neurotology patients have only mild worries about their health, regardless of vestibular diagnosis, but 1 in 8 have severe levels of health anxiety.

P53

Superior canal dehiscence & concomitant otosclerosis: a case study

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The diagnosis of a third window in the inner ear becomes particularly important when considering treatment possibilities for a patient with bilateral conductive hearing loss initially attributed to otosclerosis.

A 37 year old female was referred to ENT clinic complaining of fluctuating bilateral hearing loss, more noticeable in the past 3 years. She also reports constant tinnitus, more pronounced in the left ear, that is intermittently pulsatile. The patient complains of autophony, aural fullness worse in the left ear and intolerance to loud sounds. She denies vertigo, otalgia, otorrhea, head trauma but reports that a second cousin lost his hearing in his twenties.

Clinical examination showed normal tympanic membranes bilaterally. Rinne test was positive and patient could hear a tuning fork on her lateral malleolus. The bone conduction sounds were reported as uncomfortably loud and nausea provoking.

The audiogram showed a mild to severe inverted U-shaped conductive hearing loss bilaterally but worse in the left ear. Word discrimination is excellent bilaterally. Immittance audiometry revealed normal middle ear pressure and static compliance bilaterally. The resonant frequency and F45 are also normal but acoustic reflexes are absent bilaterally. Patient did not report vertigo but felt nauseated with 110 dB tones presented via supra-aural headphones.

Otoacoustic emissions and air-conduction VEMPs were also absent bilaterally. Bone-VEMP testing was attempted but patient could not tolerate the testing stimuli. There was no nystagmus under videonystagmography goggles for air and bone conduction tones, pressure on the tragus, Valsalva maneuver against closed glottis and pinched nostrils. CT scan of the temporal bones showed classic findings of otosclerosis with an obliterated foot plate bilaterally and the classic "halo sign" of cochlear otosclerosis. There was frank dehiscence of the superior semicircular canal on the left with possible dehiscence on the right.

The presence of these two conditions leads to a management dilemma. Stapedotomy would likely worsen the superior canal dehiscence symptoms and leave the patient with a persistent hearing loss. Options therefore include surgical repair of the dehiscence followed by Stapedotomy at a later date, or a conservative approach employing a hearing aid trial.

P54

Superior canal dehiscence, Meniere and otosclerosis. Can they coexist?

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The superior canal dehiscence (SCD) was described by Minor and al in 1998. It is characterized by auditory and vestibular symptoms such as chronic disequilibrium, pressure or sound-induced vertigo, with an elicited nystagmus in the plane of the dehiscence. Patients may complain of hipoacusia, with an air-bone gap on their audiogram, simulating otosclerosis. The differential diagnosis is laborious and must include Ménière disease, perilymphatic fistula, neurosiphilis, enlarged vestibular aqueduct, Eustachian tube dysfunction and Otosclerosis. The last it's of primordial importance because of the air-

bone gap presentation on the audiogram, that may mimic otosclerosis and may lead to unnecessary surgery. The authors present 2 cases.

Patient 1: Woman of 55 years old, with a previous history of bilateral stapes surgery. After the surgery she had a hearing improvement with closure of the air-bone gap. Six years after the last surgery, she started to complain of disequilibrium and episodic vertigo associated with loud sounds, with bilateral hearing decrement, without any known traumatic event. The cVemp were present bilateral but with a characteristic bilateral low threshold. The HRCT scan confirms the diagnosis of bilateral SCD.

Patient 2 45 year old male, patient with definitive Meniere disease, complains of episodes of rotatory vertigo, induced by loud sounds and the ability of ear is own footsteps. The Vemp and HRCT scan confirm the diagnosis of SCD. The differential diagnosis with otosclerosis should be suspected if the stapedic reflexes are present, but the absence does not completely exclude the diagnosis of SCD. To our knowledge this is the first presentation that considers the presence of both diagnoses in simultaneous. As well the coexistence of Ménière disease and SCD as not been reported until know. These 2 cases support that though they should be considered as differential diagnosis these entities may coexist.

P55

Assessment of pure-tone hearing thresholds for bone-conducted vibration at vertex and malleolus in patients with superior canal dehiscence syndrome

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Introduction: A key feature of the superior canal dehiscence (SCD) syndrome is conductive hyperacusis. SCD patients are known to have enhanced hearing of "internal sounds", for example hearing their eye movements, but also being troubled from hearing their own footsteps. Bone-conducted (BC) thresholds at pure tone audiometry are also significantly lowered in the low frequency range. Further, some of these patients can hear a tuning fork placed at the malleolus. However, measuring BC thresholds at the malleolus are hindered by the dynamic range of the commonly used clinical bone vibrators. We were interested in testing whether a more powerful vibrator can be used for this purpose. The attempt of the present study was to quantify the conductive hyperacusis in SCD patients and also to ascertain whether testing BC threshold at different sites can distinguish SCD patients.

Materials and Methods: Pure-tone BC hearing thresholds in response to stimulation at vertex and at the medial malleolus were tested in 10 patients with SCD syndrome unilaterally and in 10 controls. The testing was done in a sound-treated room and both patients and controls had ER-3A insert earphones bilaterally. In addition, narrow-band masking (40 dB HL) was presented to the non-tested ear. Low-frequency BC stimuli (125, 250, 500, 750 and 1000 Hz) were presented to each of the two stimulation sites using a Mini-shaker 4810 (Bruel & Kjaer).

Results: SCD patients had lower thresholds for BC stimulation compared with controls for both sites (vertex and malleolus). The difference was most pronounced for the lower of the tested frequencies, amounting to approximately 20 dB threshold differences for 125 and 250 Hz. The difference in BC threshold between SCD patients and controls were about the same for both stimulation sites.

Conclusion: Measuring BC thresholds in response to vibration at vertex and malleolus can quantify conductive hyperacusis and also distinguish SCD patients from controls.

P56

Evaluation of vestibular function in patients' with electric acoustic stimulation (EAS)

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Conclusion: This is the report about detailed vestibular function in patients who have received electric acoustic stimulation (EAS) cochlear implantation. The round window approach and soft electrode is preferred to decrease the risk of impairing vestibular function.

Objectives: The aim of our study was to examine the features of vestibular functions before and after implantations in patients receiving EAS.

Materials and Methods: Vestibular functions in thirteen patients who received EAS implantation were examined by caloric testing and vestibular evoked myogenic potential (VEMP) before or after implantation or both.

Results: Pre-operative evaluation showed that of the 11 patients, three (27%) were associated with areflexia or hyporeflexia in caloric testing, and one (9%) had abnormal VEMP results. There was no hypofunction in post-operative VEMP and caloric testing when compared with before the operation in the implanted side.

P57

Vestibular function assessment in idiopathic sudden sensorineural hearing loss

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Introduction: Idiopathic sudden sensorineural hearing loss (ISSHL) is defined as a sensorineural hearing loss of 30 dB or more and covering at least three contiguous audiometric frequencies, which occurs within 3 days or less. Vestibular involvement is common in cases of ISSHL, in the form of unsteadiness or vertigo. It has been reported that recovery of hearing is poorer in patients with vertigo than in those without vertigo. We investigated whether different vestibular function tests such as vestibular evoked myogenic potential (VEMP) and caloric test were correlated to severity, pattern and prognosis in ISSHL.

Materials and Methods: Thirty six patients with ISSHL were enrolled into this study. We identified VEMP and bithermal caloric test in patient with ISSHL, and analyzed the correlations between caloric and VEMP test result, initial hearing threshold, the type of audiogram, and hearing recovery. Pure-tone averages were calculated by averaging the pure-tone hearing levels at 500Hz, 1kHz, 2kHz, and 3kHz. Hearing loss was categorized as descending, ascending, flat and profound type, and classified into four degrees; mild, moderate, severe, and profound. VEMPs were recorded from sternocleidomastoid muscle that was activated bilaterally by maintaining an elevated head in the supine position. Caloric responses were recorded using electronystagmography. Canal paresis (CP) was calculated using the maximum slow-phase eye velocity of caloric nystagmus.

Results: Overall, abnormal VEMP responses occurred in 41.7% of patients, whereas abnormal caloric test results occurred in 40%. Both VEMP and caloric test results were abnormal in 15 percent of patients. Statistically significant relationship was found between result of vestibular function assessment and severity of hearing loss.

Conclusion: The extent of vestibular dysfunction correlated with the cochlear lesion severity. Vestibular function assessment is valuable in patients with ISSHL.

P58

Expression of pejvakin in human cochlea - an immunohistochemical study

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Introduction: Auditory neuropathy is characterized by a preservation of the outer hair cell integrity and an impaired neuronal transmission evident in an absent ABR. DFN59 gene encodes protein pejvakin (PJVK) and its mutation causes autosomal recessive auditory neuropathy. Since Delmaghani and colleagues identified the gene DFN59 and its product in 2006, observation of the distribution of pejvakin protein in human auditory system has not been reported. Our research on the expression of PJVK in human cochlea was based on adult human specimens.

Materials and Methods: study on human materials was approved by the local ethics committee and patient consent was obtained. Three cochleae belonging to three adult patients (1 male, 2 females; age 40–56 years) were dissected out, during petro-clival meningioma surgery. The cochleae were fixed and the sections subjected to immunohistochemistry (IHC). IHC was performed using primary antibodies against pejvakin and Tuj 1. Laser confocal microscopy was used for analyzing and imaging the immunostaining.

Results: The pejvakin labeling was seen in the neuron cell bodies rather than the nerve fibers (both dendrites and axons) that were labeled with Tuj 1 antibody. As Tuj 1 antibody stained the cytoplasm of type 1 cell, pejvakin antibody labeled both type 1 and type 2 cells. The nuclei of the neurons were also PJVK-positive. No labeling was seen in the structures within the organ of Corti, the stria vascularis, etc.

Discussion: The mutation of PJVK was found to be linked to auditory neuropathy in both patients from affected families and dfnb59 knock-in mice. Our study demonstrated for the first time the expression of PJVK in human spiral ganglion. Its role for neural synchrony and the implication of its nuclear localization needs further elucidation although a functional role in the propagation of action potentials has been proposed

P59

Surgical and radiological anatomy of cochleostomy via posterior tympanotomy during cochlear implantation using three-dimensional reconstruction of temporal bone CT

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Introduction: To evaluate surgical and radiological anatomy of cochleostomy via posterior tympanotomy during cochlear implantation. Three-dimensional image of middle ear cavity, facial nerve, chorda tympani and endocochlear were reconstructed for the using temporal bone CT.

Materials and Methods: Twenty temporal bone CT of aged between 20 and 60 were selected. Inclusion criteria were radiologically normal temporal bone CT. Exclusion criteria were temporal bone fracture, history of middle ear and mastoid surgery, pathologic findings in middle ear and other systemic disease affecting development of skull. Three-dimensional reconstruction image were obtained with V-works 4.0 software program (Cybermed, Seoul, Korea) using axial scan of high-resolucional temporal bone CT. 5 points (A: point where imaginary line of round window niche meets to the mastoid segment of facial nerve with right angle, B: point where the chorda tympani nerve braches out from facial nerve, C: point where imaginary vertical line from point A meets the chorda tympani., D: point where imaginary line of round window niche meets anterior end of bony cochlear. S: drilling point for cochleostomy anteroinferior to round window niche) were selected for evaluate the surgical anatomy.

Results: The mean length of line AB (the superior-inferior lengths of posterior tympanotomy for CI) was 6.05mm. The mean length of line AC (the widths of chorda tympani and facial nerve) was 3.2mm. The mean angle of ABC (the angle of chorda tympani branches from facial nerve) was 18.0° The mean length of line AD (the distance from facial ridge to cochleostomy point) was 9.85 mm.

Conclusion: The three-dimensional image of facial recess and round window gave us a imaginary hint facial recess before surgery. This might be helpful not only avoid injury of chorda tympani nerve during posterior tympanotomy, but also make it easy to insertion of electrode by enough room of posterior tympanotomy to the inferiorly.

P60

Three-dimensional planar analysis of bilateral semicircular canal using temporal bone

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Introduction: The semicircular canal is sensory organs that are sensitive to angular acceleration of the head. The accurate knowledge of planer orientation of semicircular canals is essential for treatment and testing of dizzy patient.

Materials and Methods: : Using the three-dimensional reconstruction method of ten normal temporal bone MRI, Planes were reconstructed using 3 points method. The angles between each pair of both semicircular canals were measured.

Results: The mean angles between the anterior semicircular canal plane to lateral semicircular plane, lateral semicircular plane to posterior semicircular plane, and anterior semicircular plane to posterior semicircular plane were 86.3, 88.3 and 94.3. The mean angles between the head sagittal plane and posterior canal planes were 60.2. The mean angles between the head sagittal plane and anterior canal planes were 25.8. Pairs of contralateral synergistic canal planes were forming 18.2 between right and left lateral semicircular canal planes, 22.3 between the right anterior semicircular canal and left posterior semicircular canal, 26.1 between the left anterior semicircular canal and right posterior semicircular canal.

Conclusion: Planar analysis using MRI has an advantage of not only non radiation to the patients but also evaluating both canals in living patients. For the treatment of BPPV the planer analysis would help to develop the maneuver individually.

P61

Eye-head-trunk coordination during large horizontal gaze reorientations in patients with bilateral vestibular loss

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Introduction: Shifting the direction of the line of sight often involves rotations not only of the eyes and head but also of the trunk. Vestibular information is important for this task. We investigated how patients with chronic bilateral vestibular loss (BVL) adapt to this situation during whole-body re-orientations.

Materials and Methods: Seven BVL patients were compared with 10 controls. Subjects (Ss) stood in the centre of an array of 8 LEDs placed at 45deg intervals at eye level, in darkness. They were required to fixate and align their bodies with the central LED. The central target was extinguished thus indicating that another LED in one of the seven eccentric locations (45, 90 and 135 either right or left of centre as well as at 180deg) had been lit. Ss had to fixate the lit LED by turning and aligning his body with it. After

15 s the eccentric LED was turned off thus cueing Ss to return to the initial, central position (inbound trials with predictable target location).

Results: In 7% of inbound trials to 90, 135 and 180deg targets, 3 patients were able to execute single-step gaze shifts (at least 85% of the target eccentricity) (controls: 30%). In these occasions gaze displacement was frequently composed of alternating segments of high and low velocity. Only rarely did gaze velocity increase monotonically to a peak and thereafter decreased, again monotonically, until target foveation. In most occasions however, in both patients and controls, the prevailing gaze transfer pattern consisted of repetitive fast gaze displacements interrupted by intervals of gaze stabilization in space.

Conclusion: We conclude that patients can generate fast whole body reorientations but the incidence of them is significantly decreased. The generation of slow eye movements in patients is not dependent on neck-proprioceptive information. Instead, these are thought to be programmed by using a copy of motor outflow to neck, trunk and lower extremity muscles

P62

Idiopathic latent vestibulopathy: a clinical entity as a cause of chronic postural instability.

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Objective: The objective was to reveal a new clinical entity of idiopathic latent vestibulopathy (ILV), in which patients have unilateral or bilateral vestibulopathy with the complaint of unsteadiness without episodic vertigo, auditory disturbance, or medical history that suggests occurrence of vestibulopathy, and to assess static postural stability in patients with ILV.

Methods: This is a retrospective data collection study of 1,233 consecutive new outpatients in our Balance Disorder Clinic. Among them, 827 patients had undergone both caloric testing and cervical vestibular evoked myogenic potential testing. Two-legged stance tasks were performed by all the ILV patients in 4 conditions: eyes open with and without foam rubber, and eyes closed with and without foam rubber. We examined 6 parameters: the velocity of movement of the center of pressure (COP), the envelopment area traced by the movement of the COP, Romberg's ratio of velocity and area, and the foam ratios of velocity and area.

Results: Eleven of the 827 patients (1.3%) were diagnosed as having ILV. Among them, 6 had unilateral vestibulopathy and 5 had bilateral vestibulopathy. In foam posturography, there were significant differences in 4 parameters, i.e. the velocity and area with eyes closed/foam rubber, Romberg's ratio of the velocity and area with the foam rubber, between ILV patients and healthy controls. Even though 6 patients showed only unilateral vestibulopathy, their median value was greater than that of healthy controls in all the 6 parameters.

Conclusion: ILV could be a clinical entity accountable for the postural instability of the patients who complain of unsteadiness without any other symptoms or histories suggesting vestibular disorders. Unilateral ILV as well as bilateral ILV can cause postural instability.

P63

A risk factor for persistent positional vertigo after Epley maneuver in patients with benign paroxysmal positional vertigo

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Introduction: Head trauma, prolonged bed rest and inner ear disease have been reported to be risk factors for recurrent positional vertigo in patients with benign paroxysmal positional vertigo (BPPV). These findings led to the working hypothesis that the risk factors would be the cause of persistent positional vertigo in BPPV. Thus, the aim of the present study was to investigate the risk factors for persistent positional vertigo after Epley maneuver in patients with the posterior semicircular canal type of BPPV (P-BPPV). **Materials and Methods:** In the present study, 213 patients with P-BPPV were included: 173 patients with idiopathic P-BPPV, 8 patients with P-BPPV after head trauma, 14 patients with P-BPPV during prolonged bed rest due to their primary diseases and 18 patients with P-BPPV secondary to inner ear disease such as sudden deafness. The percentage of patients with residual positional vertigo after Epley maneuver was calculated using Kaplan-Meier method.

Results: Elderly patients over the age of 65 years with P-BPPV showed longer positional vertigo after Epley maneuver as compared to younger patients with P-BPPV. Patients with P-BPPV after head trauma and during prolonged bed rest, but not secondary to inner ear disease, showed longer positional vertigo after Epley maneuver than patients with idiopathic P-BPPV.

Conclusion: The findings suggest that advanced age, head trauma and prolonged bed rest are risk factors for persistent positional vertigo in P-BPPV and Epley maneuver is less effective in these patients.

P64

Benign paroxysmal positional vertigo accompanied by sudden sensorineural hearing loss: a comparative study with idiopathic benign paroxysmal positional vertigo

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Objectives: To investigate the clinical characteristics of benign paroxysmal positional vertigo (BPPV) associated with idiopathic sudden sensorineural hearing loss (ISSHL) and to compare them with the characteristics of idiopathic BPPV. Study design: Retrospective case series.

Materials and Method: We retrospectively analyzed 519 patients with ISSHL and 597 patients with idiopathic BPPV (i-BPPV). The ISSHL patients with recent vertigo history before or after admission were tested with video-nystagmography that included the caloric test. BPPV with same-side ISSHL was identified and categorized as secondary BPPV (s-BPPV) using the roll or Dix-Hallpike test. All members of the s-BPPV and i-BPPV groups underwent a daily canalith repositioning procedure (CRP) during the admission periods. We investigated the clinical characteristics, including the number of CRPs performed to achieve successful reposition, canal involvement type, and effect of canal paresis and made comparisons between the s-BPPV and i-BPPV groups.

Results: Of the 519 SSNHL patients, 63 (12.1%) were identified to have s-BPPV. Multicanal involvement was more frequent in s-BPPV than i-BPPV patients ($p < 0.001$). The mean number of CRPs needed to achieve successful reposition was 4.28 in s-BPPV and 1.34 in i-BPPV ($p < 0.001$). The presence of canal paresis was also associated with a greater number of CRPs required for s-BPPV ($p < 0.02$).

Conclusion: In about 12% of SSNHL patients, s-BPPV was concurrent. More CRPs were required for successful repositioning in patients with s-BPPV than in patients with i-BPPV. Also, the presence of canal paresis in s-BPPV was associated with a greater number of required CRPs.

P65

Brandt-Daroff maneuver after Epley's maneuver prevents the recurrence of benign paroxysmal positional vertigo

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Introduction: Recently, the canalith repositioning procedure (CRP) has been the standard treatment for benign paroxysmal positional vertigo (BPPV). Many patients with posterior semicircular canal (PSC)-BPPV recover by Epley's maneuver, however, some patients have a relapse after complete recovery by Epley's maneuver. Several studies have reported that the recurrence rate of CRP was 10 to 50%. To the best of our knowledge, it is not known which treatment reduces the recurrence rate after CRP. The purpose of this study was to clarify whether the Brandt-Daroff (B-D) maneuver prevents the recurrence of PSC-BPPV after Epley's maneuver.

Materials and Methods: Subjects were enrolled as patients with PSC-BPPV who had successful results of Epley's maneuver at the following four medical centers. They were divided into two groups. The B-D group consisted of 27 patients treated at Hyogo College of Medicine and Osaka Central Hospital. Patients were instructed to perform the B-D maneuver everyday from a week after Epley's maneuver. The non-B-D group consisted of 15 patients treated at Takarazuka City Hospital and Maywa Hospital. Patients were not given any instruction about exercise therapy using the B-D maneuver. The difference in the recurrence rate was investigated between the two groups using Kaplan-Meier survival analysis.

Results: The recurrence rate three months after the treatment was 22.2% in patients with the B-D maneuver and 53.3% in patients without the B-D maneuver after complete recovery by Epley's maneuver. There was a significant difference in the recurrence rate of PSC-BPPV between the B-D and non-B-D groups ($P < 0.05$: logrank test).

Conclusion: The B-D maneuver possibly suppresses the recurrence of PSC-BPPV after complete recovery by Epley's maneuver.

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Can we predict the affected semicircular canal by the initial provoking position in benign paroxysmal positional vertigo?

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Introduction: Benign paroxysmal positional vertigo (BPPV) is the most common cause of recurrent vertigo, which is characterized by sudden onset of whirling sensations elicited by positional change. The aim of this study is to evaluate the relationship between the provoking position at the onset of vertigo and the affected semicircular canal (SCC) in patients with BPPV and to predict the side affected by BPPV through the history taking about the provoking position.

Materials and Methods: We conducted a prospective study in patients with BPPV involving the posterior or horizontal SCCs. Of a total of 521 patients diagnosed with BPPV, 45 patients showing signs of simultaneous multiple canal (including bilateral involvement) and anterior canal involvement were excluded from the study. All patients included in the study were asked to choose the provoking position at the onset of vertigo among the 10 positions described according to the three-dimensional planes.

Results: Our study included 239 patients with posterior SCC BPPV (p-BPPV) and 237 patients with horizontal SCC BPPV (h-BPPV). The waking-up position was the most common provoking position in both types of BPPV. Statistically significant correlation was demonstrated between the side of provoking position at the onset of vertigo and the affected side by BPPV ($p < .01$) in patients with p-BPPV as well as h-BPPV (geotropic type). However, no significant statistical correlation was seen between the two variables in patients with h-BPPV (apogeotropic type).

Conclusion: It is possible to predict the side affected by BPPV through the history taking about the provoking position in p-BPPV and h-BPPV(Geo). When h-BPPV(Apo) is suspected, physicians need to perform further detailed examinations using additional localization methods.

P67

Correlation between the head-lying side during sleep and the affected side by BPPV involving the posterior or horizontal SCC

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Instruction: Benign paroxysmal positional vertigo (BPPV) is the most common cause of recurrent vertigo, which is characterized by sudden onset of whirling sensations elicited by positional change. The aim of this study is to evaluate the relationship between the head position during sleep and the affected semicircular canal (SCC) in patients with BPPV.

Methods: We conducted a prospective study in patients with BPPV involving the posterior or horizontal SCCs. Of a total of 425 patients diagnosed with BPPV, 83 patients showing signs of simultaneous multiple canal involvement and those having combined otologic diseases in the same ear were excluded from the study. All patients included in the study were asked to define their preferred head-lying side at the beginning of sleep among the following choices; supine, lateral (right or left), or no predominant side.

Results: Our study included 174 patients with posterior SCC BPPV (p-BPPV) and 168 patients with horizontal SCC BPPV (h-BPPV). Patients habitually adopted a lateral head position during sleep in 105 cases of p-BPPV and 109 cases of h-BPPV. Statistically significant correlation was demonstrated between the head-lying side during sleep and the affected side by BPPV ($p < .01$) in patients with p-BPPV as well as h-BPPV.

Conclusion: There is significant correlation between the head-lying side during sleep and the side affected by BPPV in h-BPPV as well as p-BPPV, which may provide additional clues about the pathophysiology of BPPV. Clinically, this information may be used to provide helpful guidelines for patients with BPPV concerning their sleeping positions in order to prevent recurrence of BPPV.

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Measuring of otolith function in BPPV patients

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Objectives: There are some reports showing abnormal results of VEMP or SVV in BPPV patients, which can explain the pathophysiology that degenerative change of otolithic organ might cause detachment of otolith into the semicircular canals and it account for the dizziness that some patients with BPPV experience even after canalith repositioning practice. The clinical feature and treatment outcome are known to be different depending on type (cupulolithiasis or canalolithiasis) and location of BPPV. We hypothesize that these difference would be result from varying degenerative change of otolith organ.

Methods and Main outcome: Patients with dizziness were diagnosed to BPPV with Dix-Hallpike and head-roll test. 43 patients were categorized to lateral semicircular canal (LSCC) cupulolithiasis, LSCC canalolithiasis, and posterior SCC canalolithiasis. Function of otolith organs was evaluated with VEMP, static SVV and SVV during eccentric rotation. The measured values were compared to those of normal

control. There was no difference of static SVV value between all type of BPPV group and those of normal control. The values of SVV during eccentric rotation to lesional side of all subtypes of BPPV, however, were significant difference compared to those of control. Interestingly, the SVV value during eccentric rotation of LSCC cupulolithiasis was significantly lower than those of canalolithiasis type BPPV. Also, the value of VEMP was also significantly lower in LSCC cupulolithiasis than other canalolithiasis type BPPV.

Conclusion: Dysfunction of otolith organ in BPPV can be re-validated with this study. Also different pathophysiologies could be postulated between cupulolithiasis and canalolithiasis.

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Randomized Clinical Trial for Geotropic Horizontal Canal Benign Paroxysmal Positional Vertigo

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Objectives: To determine the immediate and long term therapeutic efficacies of barbecue rotation and Gufoni maneuvers, a randomized, prospective, and sham-controlled study was conducted in geotropic type of benign paroxysmal positional vertigo involving the horizontal semicircular canal (HC-BPPV). **Methods:** In nationwide 10 dizziness clinics of Korea, 170 consecutive patients (107 women, age range=11-97, mean age \pm SD=61 \pm 15, median=61) with geotropic HC-BPPV were randomized to barbecue rotation (n=56), Gufoni (n=64) or sham maneuver (n=50). Immediate response was determined within one hour after a maximum of two trials of each maneuver in the visit day. We also assessed cumulative results of each maneuver by following up the patients for one month. **Results:** After a maximum of two maneuvers on the initial visit day, barbecue rotation (38/55, 69.1%) and Gufoni (39/64, 60.9%) maneuvers showed better responses than the sham maneuver (17/48, 35.4%). The cumulative therapeutic effects were also better with barbecue rotation (p=0.006) and Gufoni (p=0.031) maneuvers compared with the sham maneuver. However, therapeutic efficacies did not differ between the barbecue rotation and Gufoni groups in terms of both immediate (p=0.46) and long-term (p=0.10) outcomes. **Conclusion:** Using a prospective randomized trial, we demonstrated that barbecue rotation and Gufoni maneuvers are effective in treating geotropic HC-BPPV. **Classification of Evidence:** This study provides Class I evidence that barbecue rotation and Gufoni maneuvers are effective in the treatment of geotropic HC-BPPV. **Clinical trial registration:** NCT01366430.

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Recurrence of benign paroxysmal positional vertigo: does it recur on the same side?

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Introduction: Benign paroxysmal positioning vertigo (BPPV) is the most common cause of vertigo and usually easily treated with repositioning maneuver, Although half of all patients eventually experience a recurrence of symptom, involved side and canal type of recurred BPPV were not studied yet.

Methods: We reviewed the records of 1345 patients with BPPV from Eulji BPPV registry between May, 1999 to March, 2012. Among, 410 patients who experienced recurrence during the follow-up period, typical nystagmus and vertigo were elicited by provoking maneuvers (Dix-Hallpike test or roll test in the supine position) in 179 patients (35 men and 134 women, mean age was 57 \pm 12 years). We compared involved side and canal type of recurred cases with first attack. Because of uncertainty of involved side in horizontal BPPV, we analyzed BPPV involving posterior canal apart.

Results: Among 179 patients, 97 were posterior canal-BPPV (p-BPPV) and 82 were horizontal canal-BPPV (calalolithiasis 52, cupulolithiasis 30). The same side of ears were involved in 144 (80.4%) of 179 recurred cases. 37.4% of cases involved same side and same canal as first one. Among 97 patients with p-BPPV, 76 (64.1%) patients experienced recurrence in the posterior canal. Fifty (65.8%) of 76 patients with p-BPPV experience a recurrence on the same side. The severity of symptoms of recurred cases was milder than first attack in 74.2% of patients.

Conclusion: Although two-thirds of recurrences were occurred on the same side of ear, involved canals seem to be independent of the side of first one. Most recurred cases have less severe symptoms.

Repositioning nystagmus: prognostic usefulness?

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Introduction: Highlight the presence and prognostic relevance of nystagmus on repositioning maneuvers of benign paroxysmal positional vertigo (BPPV) and its weight on patient perceived disability and emotional impact.

Materials and Methods: Patients were selected from tertiary hospital balance disorders centers. This group underwent repositioning maneuvers and their characteristic repositioning nystagmus was registered using videofrenzel goggles. A sequential assessment for patient disability and positional nystagmus was performed for 3 months. Dynamic posturography was performed at the end of the study. All patients were registered with their demographic, clinical data and emotional (CIEV) and quality of life impact (DHI).

Results: The group presented an age average of 58 years old, with a predominance of the female gender (68%). There was no previous history of vestibular complaints in 59% of the patients. Almost 60% of the patients presented complaints of BPPV for more than 3 months in. The posterior CSC was affected in 82% and the horizontal in 8% of the patients. Appropriate Epley and Lempert maneuvers were respectively performed. A presence of a nystagmus similar to the diagnostic maneuver (orthotropic - ON) was observed in 64% of the patients: 28% in the first position and 72% in the second position. In one patient a reverse nystagmus was observed in the Epley's maneuver second position. The overall resolution after the first treatment was of 64%. When ON was observed in the first position success rate was of 75% and of 70% while present in the second position. When no ON was observed the cure rate was of 50%. Three patients were complicated: 2 with an anterior SCC BPPV and 1 with a horizontal SCC BPPV. DHI average before reposition was 48.9 and after 21,1 (13.9 with ON vs. 33.8 without GN). CIEV average before maneuver was 18.1 and after 10.5 (8,5 with ON vs. 14 without ON)

Conclusion: Repositioning maneuvers under videofrenzel supervision are crucial for their success as the presence of an orthotropic nystagmus, not only during the second, but also during the third position of the Epley maneuver, appears to foresee their success in comparison to its nonappearance.

Simulation of positioning nystagmus during the Dix-Hallpike maneuver through a balance control and eye movement simulator using accelerometer and gyroscope sensor data

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Introduction: The Dix-Hallpike (D-H) maneuver is used to help diagnose benign paroxysmal positional vertigo (BPPV). A patient is brought from sitting to a head hanging position with head turned 45 degrees (head rotation angle) to one side and extended about 20 degrees (head extension angle) below the horizontal plane. The positional change may have variations due to examiner's preference and patient's condition. In this paper, we study the influence of variations of D-H maneuver through a balance control and eye movement (BCEM) simulator using accelerometer and gyroscope sensor data.

Materials and Methods: We measure head movement during the maneuver in a normal subject using a 6-axis accel/gyro sensor attached to the pinna. We also simulate positioning nystagmus in P-BPPV with varying three maneuver parameters: head rotation angle, head extension angle and the path of head rotation from sitting to supine position. Nystagmus and particle movement during the maneuver are simulated by repeating the following steps: (1) angular velocity of head movement sensed by vestibular system is estimated from sensor data, (2) motor neurons for eye movements are activated through the neural network, (3) 3D eye movements are determined.

Results: There were two tendencies in the path of head rotation from experiments of 4 specialists: (1) after turning head in the sitting position, move to the supine position keeping the head turn, (2) turn head gradually during the position change. There was little difference in nystagmus simulated at both paths with same head rotation and extension angles. However, when the head rotation angle was less than 45 degrees, particles were likely to remain in the ampulla and induced nystagmus was decreased.

Conclusion: We have been developed the BCEM simulator using accel/gyro sensor data. Experimental results showed induced positioning nystagmus could be decreased by the positional variation of the maneuver, especially head rotation angle.

Translation from continuous horizontal nystagmus to geotropic positional nystagmus

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Introduction: Spontaneous horizontal nystagmus reflects the difference of right and left vestibular function. But spontaneous horizontal nystagmus may be caused by debris in horizontal semicircular canal (HSCC) as shown by Von Brevern (Neurology, 2001). In HSCC type of benign paroxysmal positional vertigo (H-BPPV) free moving debris in HSCC moves according to head position and the movement induces positional nystagmus. When the debris is clogged in HSCC and becomes immobile, spontaneous horizontal nystagmus is induced. In this paper, we show a case whose immobile debris changed to free moving debris in HSCC.

Materials and Methods: The case was 81 female who was suffering from continuous vertigo for four days. We recorded her nystagmus by video oculography and analyzed three-dimensionally (Acta Otolaryngologica, 1999).

Results: In all positions including bowing and leaning head position, continuous leftward horizontal nystagmus was observed. Then in the left head-turning position in supine, the leftward nystagmus gradually declined. Thereafter, she showed a geotropic positional nystagmus when the head was turned to either side in the supine position. Spontaneous nystagmus was not observed after she sat again.

Conclusions: She finally showed typical geotropic positional nystagmus seen in H-BPPV patients, but the direction of her nystagmus did not reverse at bowing state and leaning state. Bow and lean test is used to decide the affected ear in patients with H-BPPV. The direction of nystagmus reverses between bowing state and leaning state in canalolithiasis or cupulolithiasis. Our case is not consistent with this. The possible mechanism is plugging of the right HSCC by debris. As immobile debris within the canal exert a negative endolymph pressure between plug and cupula, the cupula is deviated utriculofugally and spontaneous nystagmus is evoked. Since negative pressure is released when the debris moves to be free, spontaneous nystagmus disappears and geotropic position

P74

Equilibrium impairments in patients who suffered a traffic accident

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Introduction: Many patients complain of equilibrium disorder after they suffered a traffic accident. As they also have often social problems such as insurance and lawsuit, the disorder is thought to be caused by various contributing factors. In many cases, therefore, it is difficult to understand the whole context of clinical state. To extract the clinical characteristics, we had a retrospective review in patients with equilibrium impairment after a traffic accident.

Materials and Methods: We collected the patients with equilibrium disorder who suffered a traffic accident and thereafter visited our department of otorhinolaryngology in Kyushu University Hospital. To evaluate the equilibrium function, spontaneous nystagmus, eye tracking test, saccade, optokinetic nystagmus and caloric test were studied using an electronystagmography. Vestibular evoked myogenic potentials (VEMP) and statokinesigraphy were also measured. We checked on the computed tomography whether the temporal bone was fractured or not. We complied with the declaration of Helsinki in collecting the personal medical information of patients.

Results: The most common symptom was dizziness. A quarter of patients were introduced to our hospital longer than half a year after the traffic accident. Eighty-nine percent of patients had abnormal eye tracking and less than half of patients had abnormal saccade. One third of patients had abnormal caloric response and more than half of patients had abnormal VEMP.

Conclusion: The balance system excluding the vestibulo-ocular reflex was impaired in patients with equilibrium disorder after a traffic accident. These results suggest that dizziness after a traffic accident may not be explained by the impairment of vestibulo-ocular reflex.

P75

Comparison of the diagnostic value of 3T-MRI after intratympanic injection of GBCA in patients with Meniere's disease

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Objective: To investigate the relationship between 3T-MRI after intratympanic injection of gadolinium-based contrast agent (GBCA), glycerol test, and electrocochleography (ECoG) in patients with Meniere's disease (MD).

Method(s): A total of 20 patients with MD were evaluated. Diluted gadodiamide (a kind of gadolinium-based contrast agent) was administered to the bilateral tympanic cavity by injection through the tympanic membrane. After 24 hours, the endolymphatic hydrops was evaluated by a 3.0-T MR scanner. To investigate cochlear hydrops, glycerol test and ECoG were carried out in all patients.

Result(s): A positive result was observed in 11 patients (55%) in glycerol test and 12 patients (60%) in ECoG. The incidence of positive findings when evaluating the same patients with both glycerol test and ECoG increased to 75%. Nineteen of 20 (95%) patients showed positive results for 3T-MRI.

Conclusion(s): 3T-MRI after intratympanic injection of GBCA is more useful for the diagnosis of endolymphatic hydrops compared to glycerol test and ECoG.

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Intermittent pressure therapy of intractable Meniere's disease and delayed endolymphatic hydrops using the transtympanic membrane massage device

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The effects of the tympanic membrane massage (TMM) device were evaluated according to the criteria of the Japan Society for Equilibrium Research (1995) in patients with MD and DEH and compared to those of patients treated with the Meniett device. Twelve ears of 10 patients (MD 8; DEH 2) were treated with the TMM device, while 16 ears of 15 patients (MD 11; DEH 4) were treated with the Meniett device. All of the patients had failed to respond to medical treatment including diuretics prior to each pressure treatment, and were followed up for more than 12 months after treatment. Tympanotomy is necessary before treatment for the Meniett device, not but for the TMM device. With both devices, the frequency of vertigo after treatment was significant lower than before treatment ($p < 0.05$). The time course of vestibular symptoms in the TMM device was not significantly different from the Meniett device ($p > 0.05$). No complications were directly attributable to treatment with the TMM device. Middle ear pressure treatment by the TMM device as well as the Meniett device are effective and minimal invasive options for intractable vertigo in patients with Meniere's disease (MD) and delayed endolymphatic hydrops (DEH).

P77

Morphological changes in stria vascularis in experimental animal models administered arginine vasopressin (AVP) –The second report. Influence of dehydration load

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Introduction In our previous study, the expansion of area that organella in the intermediate cell in the stria vascularis was not present (so called "vacuole") was observed after administering arginine-vasopressin (AVP) that was related to the development of endolymphatic hydrops. In this study, an influence of administering AVP on the morphological change in the stria vascularis under dehydration-load, was investigated.

Methods Fifteen Wistar rats weighing 100-200g were used. In the control group (n=10, 5 rats) the same volume amount of normal saline solution as the volume amount of AVP in the AVP group (see below) was administered by intraperitoneally injection. In AVP group (n=10, 5 rats), AVP (0.02 units/g, pitressin; Arg-vasopressin, Daiichi-Sankyo, Japan) was given intraperitoneally. In AVP after dehydration-load group (n=10, 5 rats), AVP (0.02 units/g) was administered after a water restriction for 24 hours. In one hour after each injection, all animals were sacrificed and temporal bones were removed. The whole of stria vascularis was photographed at the magnification of 2000X under transmission electron microscopy. The films were scanned and saved in a personal computer. The total area of the each vacuole in the whole of the stria vascularis was measured. The ratios between the whole area of the stria vascularis and the total area of the vacuoles were measured and compared among these three groups.

Results The ratio between the total area of the vacuoles in the intermediate cells and the whole area of the stria vascularis in the AVP after dehydration-load group (0.062 ± 0.043) was also significantly increased in comparison with one in the control group (0.011 ± 0.006) or the AVP group (0.031 ± 0.014) (p

< 0.01).

Conclusion The vacuoles in the intermediate cell were caused by the administering AVP. The dehydration-load before AVP injection increased the influence of AVP. These morphological changes would impair the oxygen diffusion in the stria vascularis.

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Objective verification of fluctuation in semicircular canals responses in Menière's Disease around the time of an attack

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Introduction: We tested semicircular canal dynamic function in early Menière's Disease patients both at quiescence and during an attack by using the video head impulse test (vHIT). How does early MD affect the eye velocity response to horizontal canal stimulation during normal values of passive head acceleration (around 4,000 deg/s/s)?

Materials and Methods: Patients meeting the AAO-HNS criteria were enrolled—none of them were long-term patients. 30 early MD patients were tested during quiescence and 13 during an attack. In addition 49 healthy subjects were tested as controls. High speed video techniques provided objective measures of the eye velocity response to the head velocity stimulus during brief, unpredictable, passive head rotations

Results: Most patients showed low velocity spontaneous nystagmus with quick phases directed away from the affected ear. In healthy subjects the eye velocity during a head impulse closely matches head velocity. However in the 13 MD patients at attack all showed an enhanced eye velocity response. This enhanced gain was usually accompanied by altered VOR dynamics. 18 of 30 patients tested during quiescence showed a similar pattern.

Conclusion: In early MD patients, the presence and direction of the spontaneous nystagmus suggests that the affected ear has reduced function whereas the eye velocity response to high acceleration stimuli suggests that the affected ear has increased function (i.e. greater sensitivity). One possible cause is that if the cupula is displaced by increased endolymph volume in an ampullofugal direction, then the quick phase of spontaneous nystagmus will be away from the affected ear. If the cupula were detached then in response to a high acceleration head impulse, the cupula will show an unusual dynamic response, which may involve greater sensitivity and different dynamics. The enhanced peak eye velocity response to high acceleration head rotations may be an early indicator of early MD.

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Predictive value of electrocochleography for determining hearing outcomes in Ménière's disease.

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Objective: To evaluate the clinical effectiveness of performing electrocochleography (ECoG) at the initial visit in predicting hearing outcomes.

Study design: Retrospective study.

Setting: Tertiary hospital.

Patients: Ninety patients with unilateral, definite Ménière's disease.

Interventions: The summing potential (SP)/action potential (AP) ratio was obtained using ECoG at the initial visits. An SP/AP ratio greater than 0.34 was considered abnormal.

Main outcome measures: Audiogram types, hearing fluctuations, hearing thresholds at the initial and last visits, hearing changes, caloric response, and treatment outcomes were analyzed in subjects with normal and abnormal ECoGs. Correlation analyses between the SP/AP ratio at the initial visit, hearing thresholds at each visit, and hearing changes were performed.

Results: The mean follow-up period was 22.6 months. Abnormal ECoGs were found in 50 (55.6%) of the 90 subjects. No significant differences regarding audiogram types, hearing fluctuations, caloric response, or treatment outcomes were observed between subjects with normal and abnormal ECoGs. Ipsilateral SP/AP ratios at the initial visit were correlated with both hearing thresholds at the initial ($r = 0.347$, $p < 0.001$) and last ($r = 0.435$, $p < 0.001$) visits. Furthermore, there was a significant correlation between SP/AP ratio and hearing change during follow-up ($r = 0.280$, $p = 0.008$). After stratification by initial hearing level, Stage 1 and 2 subjects (hearing threshold, 0-40 dB) with abnormal ECoGs at the initial visit showed a decrease in hearing over time compared with those with normal ECoGs ($p = 0.008$).

Conclusion: A high SP/AP ratio at the initial visit may be used as a predictor of poor hearing outcomes in subjects with Ménière's disease, especially with initial hearing Stage 1 and 2.

P80

EVS after vestibular deafferentation and in vestibular schwannoma

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Introduction: Vestibular reflexes, evoked by human electrical vestibular stimulation (EVS), are utilized to assess vestibular function and investigate its pathways. Vestibular schwannoma causes vestibulo-cochlear nerve compression in the internal auditory canal and meatus interrupting the vestibular signal conduction along the vestibular pathway. We investigated the electrically-evoked vestibulo-ocular reflex (eVOR) in vestibular schwannoma and after vestibular deafferentation.

Materials and Methods: The eVORs were recorded as binocular 3D eye rotations evoked by bipolar, 100ms current-step at 0.9-10.0mA with dual-search coils from 4 vestibular schwannoma patients confirmed by MRI, 11 patients after unilateral vestibular deafferentation (UVD) and 5 bilateral vestibular deafferentation (BVD) and 17 normal subjects.

Results: After BVD, the eVOR was completely abolished. After UVD, EVS of the functioning vestibular labyrinth elicited biphasic, maintained, graded eVOR. We showed an excitatory eVOR to cathodal EVS with 9ms latency, and an inhibitory eVOR to anodal EVS, opposite in direction, half the amplitude with 12ms latency. Both excitatory and inhibitory eVORs were maintained with constant direct currents and graded with current intensities, exhibiting excitatory inhibitory asymmetries. In unilateral vestibular schwannoma, the eVOR patterns were similar to UVD responses showing the same latency difference demonstrating loss of function on the lesion side. We found that unipolar stimulation activates both ears due to current spread because when EVS was constrained to stimulating the non-functioning ear, unipolar eVOR was not absent but one-third the bipolar eVOR.

Conclusion: We showed that eVOR from one functioning vestibular labyrinth was biphasic with a latency difference between the normal and lesion side. This EVS test may be utilized to investigate unilateral vestibular dysfunction.

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Clinical relevance of headache to equilibrium disorder

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Introduction: There is a concern about the relevance of headache to equilibrium disorder. Among a variety of headache, the association between migraine and vertigo has been well discussed as migrainous vertigo but the detailed relation remains unclear. Therefore, we had a questionnaire survey focused on headache induced by the vestibular stimulation.

Materials and Methods: We had a questionnaire for the patients with equilibrium impairment who visited our department of otorhinolaryngology in Kyushu University Hospital. The questionnaire consisted of two parts: One was a type of daily headache, and the other was an existence of headache within 24 hours after the clinical tests. The patients filled in the questionnaire at least 24 hours after the clinical tests, and all data were collected at return. Clinical tests included the vestibular stimulation (vestibular evoked myogenic potentials and caloric test on the electronystagmography) and statokinesigraphy. We complied with the declaration of Helsinki in using the personal medical records of patients.

Results: Fifty-one out of 141 patients had headache within 24 hours after the clinical tests. Two-thirds of those complained the same headache as in the vertigo and dizziness attack. The patients with recurrent headache had a headache after clinical tests more often than those without recurrent headache.

Conclusion: These results suggest that vestibular stimulation may be related to the occurrence of headache.

P82

Control of vestibular symptoms in migraine-associated vertigo: our experience with amitriptyline

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Introduction: migraine-associated vertigo is a disease entity of recurrent vertigo attacks unexplained by otologic abnormalities, in patients with a history of migraine headache. Management generally follows the recommended treatment of migraine headaches. Aim of this study was to evaluate the role of amitriptyline in the control of vestibular symptoms.

Materials and methods: in the study were enrolled 18 patients who suffered from recurrent spontaneous or positional vertigo and had a diagnosis of migraine headache. They underwent low dose of amitriptyline therapy for at least 3 months (20 mg/die) and the results were monitored by vestibular

tests and DHI questionnaire before and after the treatment.

Results: 17 females and 1 male were enrolled. 3 patients did not finish the therapy because of adverse drug reaction. 15 patients completed the therapy. 12 patients referred a significant improvement of vestibular condition, confirmed by the DHI test and the bedside examination instead 3 patients referred a persistence of vestibular symptoms.

Conclusions: these early results seems to indicate that amitriptyline is a safe treatment of vestibular symptoms in patients suffering from migraine-associated vertigo.

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Vestibular migraine – 16 cases study in primary practice

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Introduction: Vestibular symptoms occur frequently in patients with migraine. Migraine is increasingly recognized as a cause of benign, recurrent vertigo. To differentiate migraine and vestibular symptoms as integral parts of a single disorder from simply co-morbid symptoms, Neuhauser developed criteria to define vestibular migraine (VM). We investigate the clinical characters of VM in a primary practice.

Methods: We prospectively collected new patients who have migraine according to the criteria of International Headche Society (IHS) at our clinic during a period of three months. Based on a structured questionnaire, each patient was interviewed by a neurologist. Patients who met the criteria of VM were recruited into the study.

Results: Totally 91 new migraine patients visited our clinic during the period of study. All patients are migraine without aura. Sixteen patients (17.6%) met the criteria of VM. Their averaged age is 39.8 ± 15 years. Thirteen patients (81.2%) are female. The average age of first vertigo attack is 25.7 ± 16 . Eleven patients (68.7%) had first headache attack earlier than vertigo. Most patients (75%) complained of rotational vertigo; 58.3% had motion intolerance; 33.3% had ataxic sensation. Ten patients (83.3%) had vertigo lasting for hours to one day, whereas 25% had vertigo lasting for around 5 to 60 minutes. Six patients suffering vertigo had accompanied headache frequently and the other 10 occasionally. No patient had brain stem symptom other than vertigo/dizziness, such as dysarthria or diplopia, which could be found on basilar-type migraine.

Conclusion: Vertigo may not be a non-specific symptom in migraine. Vestibular migraine is common among the migraineurs, but with varied manifestations. Without other accompanied focal neurological deficit, they cannot fulfill current IHS criteria for basilar-type migraine. Therefore, vestibular migraine would better be classified as a subtype of migraine.

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Factors of post earthquake dizziness syndrome in Japan

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Introduction: Japan suffered a huge earthquake of magnitude 9 on March 11 th 2011. After the earthquake, many people felt dizziness, as if they were rocking at a time when no aftershocks were actually occurring. Until now, only a few papers in journals have reported about vertigo after big earthquakes, but recorded no special characteristics. However, after this earthquake, many people in Japan complained of dizziness. So we conducted epidemical clinical research and called those symptoms "post earthquake dizziness syndrome; PEDS". The purpose of this study is to reveal the clinical features of PEDS.

Materials and Methods: We conducted a questionnaire about PEDS after the earthquake and researched in Tokyo.

Results: The majority of the 1,000 respondents had felt dizziness like swaying at times when there were no aftershocks. The vertigo was mainly not rotatory but a dizzy feeling of swinging of the legs, feet and the body. However there were only a few cases of accompanying headaches and nausea. The factors below revealed to suffer: female more than males, young age, the people who had experienced motion sickness earlier, and people who do not do sports in their daily life.

Conclusion: We confirmed that such characterized dizziness occurs after a huge earthquake. Such detailed clinical conditions have not been reported so far. Therefore, we are going to continue to analyze this syndrome, and utilize this for further prevention and treatments.

P85

Post earthquake dizziness syndrome among young people in Japan

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Introduction: After the huge earthquake of March 11 th 2011, many people felt dizziness, as if they were rocking at a time when no aftershocks were actually occurring. We conducted epidemical clinical research and called those symptoms "post earthquake dizziness syndrome; PEDS". In this present report, we reveal the clinical features of PEDS in young people.

Materials and Methods: We made a questionnaire about PEDS after the earthquake and gave it to over 1,800 students of elementary, junior high and high schools in Chiba prefecture.

Results: The majority of them had felt dizziness and it became clear that young people had also suffered PEDS. The prevalence of PEDS was the highest among elementary school students. Girls suffered significantly more than boys. Students who had previously experienced motion sickness revealed a high prevalence. The symptoms mostly occurred indoors and were largely not rotatory vertigo but a dizzy feeling of swinging of the legs, feet and the body.

Conclusion: We confirmed that such characterized dizziness occurs even among young people. Motion sickness, like car sickness, is said to easily occur at a young age and the prevalence of PEDS was the highest in the elementary school students. The mechanism of PEDS is still unclear but we will continue to analyze this syndrome, and utilize this for further prevention and treatments.

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Anterior circulation stroke causing dizziness or vertigo: a systematic review

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Introduction: Dizziness and vertigo are common posterior (vertebrobasilar) circulation stroke symptoms. Less is known about vestibular symptoms in anterior (carotid) circulation vascular disease. We sought to determine the frequency and topography of vestibular symptoms in anterior circulation stroke and transient ischemic attack (TIA) by systematic review of the literature.

Methods: Electronic (MEDLINE) and manual search for English-language studies (1966–2011) of dizziness, vertigo, or syncope due to anterior circulation stroke or TIA. Two independent reviewers selected studies, with differences adjudicated by a third. Study characteristics, patient symptoms, and lesion locations were abstracted. For each class of data, only unbiased studies were analyzed (e.g., studies requiring dizziness or vertigo for inclusion were excluded from analysis of vestibular symptom prevalence).

Results: We identified 522 unique citations, examined 110 full manuscripts, and analyzed 54 studies describing 2114 patients with anterior circulation stroke or TIA and reporting vestibular symptoms. Principal reasons for abstract exclusion were non-English language, no confirmed cerebrovascular diagnosis, and not anterior circulation (73%). Principal reasons for manuscript exclusion were no reported dizziness and no confirmed cerebrovascular diagnosis (48%). The prevalence of vestibular symptoms in unbiased studies of anterior circulation stroke (n=1643) was 11.3% (n=185) (35% vertigo, 15% non-vertiginous dizziness, 10% presyncope, 40% unspecified). The ratio of TIA to stroke was 3:1. Typical stroke locations were the insula, parietal cortex, and adjacent subcortical white matter, with a trend towards right-sided predominance (59% vs. 41%).

Conclusion: Contrary to common wisdom, dizziness and vertigo are not rare manifestations of carotid territory ischemia. A search for anterior circulation vascular disease should be considered in patients presenting with vestibular symptoms.

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Carbamazepine treatment for patients with recurrent episodes of cryptogenic vertigo

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Introduction: One of the pathophysiologies of recurrent episodes of vertigo without cochlear symptoms is believed to be neurovascular cross compression (NVCC) of the eighth cranial nerve. Vestibular paroxysmia (VP) is attributed to NVCC, however, we still need reliable data on the diagnostic features of VP and the efficacy of medical treatment. Thus, we targeted 7 patients with recurrent episodes of cryptogenic vertigo. They were treated with carbamazepine. We compared and discussed the findings obtained from these patients.

Patients and Methods: We report the symptoms, findings, and efficacy of treatment in patients suspected with NVCC or patients with recurrent episodes of cryptogenic vertigo. A follow-up study was performed in 5 patients suspected with NVCC and 2 patients with recurrent episodes of cryptogenic vertigo who were treated with carbamazepine (initial dose, 100 mg/day), and we discussed the duration of vertigo, accessory symptoms, nystagmus, caloric test results, magnetic resonance imaging findings, and side effects of carbamazepine.

Results: The treatment results in a significant reduction in the vertigo attack, duration, and intensity of vertigo in a majority of patients, particularly in those suspected with NVCC. The treatment was discontinued in 1 patient because of severe drowsiness as a side effect of carbamazepine. However, the patients in whom carbamazepine was effective did not show any obvious relationship between the duration and intensity of vertigo, nystagmus, and specific head positions.

Conclusion: Administration of small doses of carbamazepine was useful for patients suspected with NVCC with recurrent episodes of cryptogenic vertigo. This follow-up study shows that we require more data; we have discussed the diagnostic criteria for VP and compared it with clinical findings. We thought to need therapeutic diagnosis with small dose of carbamazepine to the cases with NVCC suspected

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Diffusion MRI and risk factor analysis of dizzy patients in the emergency department

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Background: Dizzy patients are commonly presenting to the emergency department, but the way to final diagnosis is not easy. And, even if dizziness occurs with no other symptoms, central lesion, mostly stroke is almost always a potential concern. This study was aimed to investigate proportion of stroke among dizzy patients in the emergency department based on the result of Diffusion MRI and to evaluate predictable risk factors for stroke in these patients.

Methods: Patients who presented in the emergency department of our tertiary referral center with dizzy symptom as a chief complaint between Jan 2011 and Jun 2011 were identified. Confirmation of central lesion was performed by diffusion MRI. Univariate and multivariate analyses were utilized for factors predictive of central lesion in these patients.

Results: Of 645 eligible patients, 26 (4.0%) presented central lesions based on diffusion MRI, mostly infarction (84.7%) followed by CPA meningioma (7.7%), hemorrhage (3.8%) and multiple sclerosis (3.8%). Univariate analyses revealed that hypertension, atrial fibrillation and combined neurologic symptoms (motor weakness, dysphasia and visual disturbance) were significantly associated with the development of central lesion ($P < 0.05$). Multivariate analyses showed that hypertension ($P=0.006$, odds ratio [OR] = 3.641), atrial fibrillation ($P=0.022$, OR = 5.299) and combined neurologic symptoms ($P<0.001$, OR = 19.568) were independent predictors of central lesion.

Conclusions: Patients with hypertension, atrial fibrillation or combined neurologic symptoms may require close neurologic evaluation and MRI to search for central lesion. Our results may help diagnose and properly manage patients with dizzy symptoms presenting to the emergency department.

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Does deficit in the hippocampus and vestibular function affect path integration and distinction of auditory space map in humans?

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Objective The perceptions of spatial orientation and self-motion can benefit from the integration of multiple sensory cues, including vestibular and auditory inputs. In order to update spatial orientation, it is important to recognize self-motion: "path integration". To investigate whether hippocampal or vestibular function contribute to path integration, we examined path integration in patients with hippocampal or vestibular deficits. Sound is also one of the cues for spatial orientation. However, little is

known about the perception of auditory space maps. In addition, we examined sound lateralization to determine whether hippocampal or vestibular function deficits affect auditory space maps.

Materials and methods

Subjects: Data were obtained from 16 patients with temporal lobe epilepsy (TLE) and 19 patients with vestibular neuritis (VN). Of the 16 TLE patients, 12 who underwent selective amygdalohippocampectomy (SA) were examined again after operation.

Methods: To analyze angular path integration, the subjects walked for 1 m on a straight road and turned 90° to the right or left and then walked straight again for 1 m with eyes open. Subsequently, they traced their track with eyes closed. We measured the angle on their way back. In addition, we performed sound lateralization tests.

Results Angular path integration: The results of subjects with VN and those who underwent SA were worse than those of controls. The results of TLE patients were not different from those of controls. These results show that vestibular and hippocampal deficits affect angular path integration. Sound lateralization test: The insufficiency of sound lateralization test was detected in patients with VN and TLE. No differences were observed in preoperative and postoperative values.

Conclusions: The hippocampus and vestibular system plays a role in path integration in humans. Further, auditory space maps were affected by vestibular and temporal lobe deficits.

P90

Modulation of vertical nystagmus by lateral gazes and convergence

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Introduction: Upbeat and downbeat nystagmus are known to be modulated by lateral gazes or convergence. However, the patterns and mechanisms of these modulations remain to be elucidated.

Materials and Methods: Nine patients with downbeat and five patients with upbeat nystagmus underwent recording of nystagmus using three dimensional video-oculography during attempted primary gaze, both lateral gazes ($\pm 30^\circ$), and convergence. The effect of convergence on vertical nystagmus was determined by asking the patients to look at the target placed 10 cm from the middle of the eyes. Modulation of the nystagmus was evaluated by comparing the maximal slow phase velocities of 10 consecutive nystagmus. Patients with downbeat nystagmus has variable etiologies including idiopathic (n=2), Chiari malformation (n=2), Wernicke's encephalopathy (n=1), cerebellar infarction (n=1), pontine tumor (n=1), immunologic (n=1), and episodic ataxia (n=1). The underlying disorders of upbeat nystagmus were pontine infarction (n=2), cerebellar hemangioma (n=1), immunologic (n=1), and vertebral artery aneurysm (n=1).

Results: Most (n=8, 88.9%) patients with downbeat nystagmus had increase of the nystagmus during lateral gazes while only one showed no change. Convergence either increased (n=5, 55.6%) or decreased (n=4, 44.4%) the downbeat nystagmus. Patients with upbeat nystagmus showed various patterns of modulation during lateral gazes and convergence. Lateral gazes either increased (n=2) or decreased (n=3) the upbeat nystagmus. During convergence, the upbeat nystagmus showed increase (n=1), decrease (n=1), conversion to downbeat (n=2), or no change (n=1).

Conclusion: The various patterns of modulation and the dissociated consequence during lateral gazes and convergence indicate different mechanisms involved in the generation of upbeat and downbeat nystagmus. Correlation of the modulation patterns with the wave forms and underlying disorders should be performed in a large number of patient

P91

Pure upbeat nystagmus in association with bilateral internuclear ophthalmoplegia

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Introduction: Upbeat nystagmus occurs in ventral pontine tegmental lesions affecting the ventral tegmental tract carrying signals for upward vestibulo-ocular reflex (VOR), and in caudal medullary lesions involving the nucleus of Roller, one of the perihypoglossal nuclei which might contribute to vertical oculomotor integration. However, pure upbeat nystagmus has not been described in bilateral internuclear ophthalmoplegia (INO). We report pure upbeat nystagmus in the primary position in a patient with bilateral INO due to dorsomedial pontine tegmental lesions affecting the medial longitudinal fasciculus (MLF). **Materials and**

Methods: A 66-year-old man presented with horizontal diplopia and oscillopsia for three weeks.

Neurological examination showed bilateral INO and upbeat nystagmus with fixation, which disappeared in darkness. It was enhanced during upgaze and convergence, and decreased in downward gaze. Vertical head impulse tests did not reveal any catch-up saccades. The patient underwent eye movements with video-oculography and neuroimaging.

Results: Video-oculography disclosed primary position upbeat nystagmus with exponentially decreasing slow phases. Upward smooth pursuit was continuously interrupted by upbeat nystagmus while the gain of downward smooth pursuit was normal. Brain MRI showed enhancing lesions involving bilateral dorsomedial pons extending from the middle to upper portion. With a suspicion of focal brainstem encephalitis or vasculitis we tried intravenous steroid administration. Upbeat nystagmus and bilateral INO markedly improved.

Conclusions: The decreasing slow phase velocities of the nystagmus, disappearance in darkness, and normal head impulse tests in the vertical plane are more consistent with neural integrator dysfunction rather than imbalance in the vertical VOR. Upbeat nystagmus in our patient may be attributed to the damage of PMT or the projections from INC to PMT, or disruption of connections between INC and the nucleus of Roller.

P92

Rotational vertebral artery occlusion: mechanisms and outcome

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Introduction: Rotational vertebral artery occlusion (RVAO) is characterized by recurrent attacks of paroxysmal vertigo, nystagmus, and syncope induced by horizontal head rotation. Because published reports consist of small case series, its underlying mechanisms remains to be elucidated, and there are no guidelines for diagnosis and treatment. To elucidate mechanism and outcome of RVAO, we conducted a cohort study of 21 patients with RVAO documented by dynamic angiography.

Materials and Methods: We analyzed clinical features, the results of radiological evaluation, patterns of nystagmus, and outcome in 21 patients with RVAO between April 2004 and March 2012 from three Neurology Clinics in Korea. Most of the patients underwent conservative treatment (n=19, 90%). The follow-up periods ranged from 1 to 87 months (35.9±27.0).

Results: Twelve patients (57%) showed typical RVAO that is compression of dominant vertebral artery(VA) by contralateral head rotation at the C1-2 level. The remaining patients showed atypical RVAO including compression of bilateral VA during unilateral head rotation (n=2), each contralateral VA during bilateral head rotation (n=1), contralateral VA terminating posterior inferior cerebellar artery (n=2), unilateral VA at the subaxial level (n=3), and dominant ipsilateral VA during ipsilateral head tilt (n=1). The most common pattern of nystagmus was mixed downbeat torsional and horizontal beating toward the compressed VA (n=12, 60%). Downbeat component of the nystagmus was prominent in most of the patients (n=15, 75%). Patterns of nystagmus were not different between typical and atypical RVAO. No patient developed stroke as a complication of RVAO during the follow-up periods.

Conclusions: The present study demonstrates various patterns of VA compression and nystagmus, and excellent prognosis by conservative treatment of RVAO. Labyrinthine and/or cerebellar ischemia may be underlying mechanism of vertigo and nystagmus in RVAO.

P93

Subjective memory complaints in vertigo patients

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Introduction: Vestibular disease is traditionally considered to cause mainly vertigo, dizziness and postural instability. Beyond these traditionally recognized symptoms, consequences on higher cerebral function like cognition and emotion have recently attracted more attention. Here we investigate the subjective memory complaints (or self-reported cognitive difficulties) in vertigo patients and their

correlation with vestibular symptoms and psychological factors.

Methods: 50 vestibular patients with symptoms lasting > 3 months and 50 controls matched for age and gender and educational level filled in a questionnaire on memory complaints distinguishing various domains 1. Conversations 2. films and books 3. distractibility 4. people 5. use of objects 6. recent events and general knowledge 7. locations 8. actions to be done 9. facts of personal life 10. forgetfulness in presence of distracting factors. Further the Vertigo Symptom Scale, the Beck anxiety inventory (BAI) and the Beck depression inventory (BDI), migraine identifier, motion sickness susceptibility, functional health and well-being survey SF36 and Dizziness Handicap Inventory (DHI) were included.

Results: Patients score worse on most domains of subjective memory complaints without a particular pattern, as well as all the other questionnaires. In a logistic model the most explaining factors for memory complaints were anxiety score (BAI) followed by depression score (BDI) and DHI. Vertigo intensity and vestibular diagnosis, migraine and motion sickness susceptibility had no effect.

Conclusion: Vertigo patients have more subjective memory complaints than controls and score worse on scales of anxiety, depression and general health perception. The subjective memory complaints are not determined by the severity of vertigo but mainly by psychological factors.

P94

Enhancement of cross-planar balance responses using vestibular stochastic resonance

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Introduction: Astronauts experience disturbances in sensorimotor function after spaceflight during the initial introduction to a gravitational environment after long-duration missions. Our goal is to develop a countermeasure based on stochastic resonance (SR) that could improve central interpretation of vestibular input and mitigate postflight balance and locomotor dysfunction. SR is a mechanism by which noise can enhance the response of neural systems. We have previously shown that imperceptible electrical stimulation of the vestibular system across the mastoids enhances balance performance in the mediolateral plane for subjects standing on an unstable surface. The aim of this study was to investigate the cross-planar improvement in balance while stimulating in the mediolateral direction only.

Methods: Fifteen subjects performed a standard balance task of standing on a block of foam with their eyes closed. Bipolar stochastic electrical stimulation in the range of 0–450 μ A root mean square (RMS) was applied to the vestibular system using a constant-current stimulator through electrodes placed on the mastoid processes. Balance performance was measured with a force plate under the foam block and inertial motion sensors placed on the trunk and head.

Results: Preliminary analysis of the data revealed that while experiencing vestibular stimulation, 12 of 15 subjects showed a 15–24% improvement in balance responses across both planes with respect to control trials with vestibular stimulation amplitudes in the range of 30–120 μ A RMS.

Conclusion: The results indicate that stochastic electrical stimulation of the vestibular system can improve cross-planar balance responses. This will have a significant impact on development of vestibular SR delivery systems to aid recovery of function in astronauts after long-duration spaceflight or in people with balance disorders. Supported by a grant from NSBRI through NASA NCC 9-58 (SA02001) to APM and NIH grant R01DC009031 to HSC

P95

Galvanic vestibular stimulation improves the compensation in peripheral vestibular syndromes

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Here, we present findings from a three-step investigation of the effect of galvanic vestibular stimulation (GVS) in normal subjects and in subjects undergoing vestibular rehabilitation (VR). In an initial study, we examined the body sway of 10 normal subjects after one minute of 2 mA GVS. The effect of the stimulation lasted for at least 20 minutes in all subjects and up to two hours in 70% of the subjects. We then compared a group of patients who received conventional VR (40 patients) with a group that received a combination of VR and GVS. Results suggest a significant improvement in the second group. Finally, we attempted to establish the optimal number of GVS sessions and to rule out a placebo effect. Fifteen patients received "systematic" GVS: five sessions, once a week. Five patients received "nonsystematic" galvanic stimulation in a sham protocol, which included two stimulations of the clavicle.

These data were analyzed with Fisher's exact test and indicated that the best results were obtained after three sessions of GVS and no placebo effect was observed.

Key words: galvanic stimulation (GS) ; galvanic vestibular stimulation (GVS) ; vestibular; vestibular rehabilitation (VR); peripheral syndromes

P96

P6 acupressure effectiveness on acute vertiginous patients: a double blind randomized study

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Introduction: The purpose of this study was to evaluate the effectiveness of P6 acupressure on vertigo and neurovegetative symptoms and its interference on Vestibular-Ocular Reflex (VOR).

Materials and Methods: One hundred and twenty-four acute vertiginous patients and 80 patients undergoing labyrinth stimulation were randomly divided in two homogeneous groups: an experimental group A (n=102) and a placebo group B (n=102). Each patient rated severity of vertigo and neurovegetative symptoms through a visuo-analogue scale before and after bilateral placement of the P6 Nausea Control SEA BAND® (P6 device). The latter, an elasticized cloth wristband with a convex button that is worn against the skin, was placed on the P6 acupressure point on the volar surface of the carpus (appropriate placement) in Group A patients and on its dorsal part (inappropriate placement) in the Group B patients. In order to evaluate any possible interference on VOR, qualitative and quantitative nystagmus parameters were analyzed.

Results: Among Group A patients, 85% reported an improvement of symptoms mainly as regards to neurovegetative disturbances rather than to vertigo; on the contrary, only 11% of the Group B patients reported a similar improvement. VOR analysis did not show any significant variation of nystagmus qualitative or quantitative variables in 99% of cases.

Conclusion: This study demonstrated that the application of the P6 device is useful in improving neurovegetative symptoms in patients affected by spontaneous and provoked vertigo. Furthermore, the device placement did not show any significant interference on VOR, allowing its application for the evaluation of vestibular function based on analysis of nystagmus. Thus, due to the low cost and lack of side effects, the P6 device routine application is suggested during acute vertigo and labyrinth stimulation.

P97

Screening for protective effect in supplement drugs using the zebrafish lateral line

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The zebrafish lateral line is a powerful system for studying hair cells and hair cell death. Hair cells can be easily labeled and imaged in vivo with fluorescence microscopy. I have previously described a screening system to rapidly assess drugs for possible ototoxic effects in anti-cancer drugs (Hirose et al., 2011). Also it is possible to screen protective effect against some ototoxicity drugs. There are many kind of supplement in USA, Europe, and Japan, etc. Some of them have anti- antioxidant effect (eg Vitamin A, C, E, beta-carotene) or other. Supplement can be a prophylactic treatment especially against age-related hearing loss. Some countries have trouble against medical expenses, so it can be useful to such countries. We have now screened the supplement drugs for protective effects against aminoglycoside. 5-7 dpf Zebrafish (*Danio rerio*) embryos of the AB wild type strain were used in this study. Zebrafish larvae were exposed to supplement drugs (0, 1, 10, 100, 1000 uM), and aminoglycoside. After that, they were fixed in 4% paraformaldehyde, incubated with anti-parvalbumin, and hair cell damage was assessed by fluorescent microscope. We made dose-response curve to evaluate protective effect against aminoglycoside.

P98

The minimum peptides of IGF-1 and Substance P can protect vestibular hair cells against the neomycin ototoxicity

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Background: It was known that Insulin-like growth factor-1 (IGF-1) could protect mouse cochlear hair cells against aminoglycoside ototoxicity. Recently, we indicated that the minimum peptide derived from IGF-1 (SSSR) and the minimum peptide of substance (FGLM-NH2) promoted the wound healing in the

cornea.

Objectives: In this study, we investigated the role of these peptides in mammalian vestibular hair cell death induced by aminoglycoside.

Methods: Cultured utricles from mature CBA/N mice were used in this study. Cultured utricles were divided to five groups (control group, Neomycin group, Neomycin + SSSR group, Neomycin + FGLM-NH2 group, Neomycin + SSSR + FGLM-NH2 group). Twenty-four hours after exposure to neomycin, the cultured tissues were fixed with 4% paraformaldehyde. To label hair cells, immunohistochemistry were performed using anti-calmodulin antibody. The rate of survival vestibular hair cells was evaluated with the fluorescence microscope.

Results: The rate of survival vestibular hair cells were significantly more in Neomycin + SSSR and Neomycin + SSSR + FGLM-NH2 group than in Neomycin group.

Discussion: These data indicated that SSSR and SSSR + FGLM-NH2 protects sensory hair cells against neomycin-induced death in the vestibular epithelium. These results show that SSSR and FGLM-NH2 can be used as the protective molecules against the aminoglycoside ototoxicity. □@□@

P99

Walking to the toilet in inpatient with vertigo (3rd report)

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Introduction: We investigated the influences of the Atarax P on three factors: hypertension, past history of vertigo, and age.

Materials and Methods: 159 patients (89 with BPPV, 33 with vestibular neuritis(VN), 37 with Meniere's disease(MD)) who were admitted to our department on the. They were divided into two groups according to the status of use of the drug: those who received Atarax P (the use group) and those who did not (the non-use group). These two groups were studied separately for the following items: (1) hypertension, past history of vertigo(PHV), and age (> 65 years, < 65 years). Each subgroup was examined for the number of days taken before restoration of the ability to walk to the toilet. (2) Each group was further divided into two subgroups according to PHV: those with a PHV and those without. Each subgroup was examined for the number of days taken before restoration of the ability to walk to the toilet, the number of days taken before disappearance of fixation nystagmus, the number of days taken before disappearance of voluntary nystagmus, the number of days taken before disappearance of vertigo at rest, the number of days taken before disappearance of vertigo upon moving the head, and the number of days taken before disappearance of vertigo upon moving the body.

Results: The patients in the with PHV subgroup became able to walk to the toilet earlier than those without. Within the without-hypertension subgroup, the age < 65 years subgroup, and the with-PHV group, the patients in the non-use group became able to walk to the toilet earlier than those in the use-group. Within the without-PHV subgroup of patients with BPPV or MD, fixation nystagmus disappeared earlier with use of Atarax P. Within the with-PHV subgroup of patients with VN, vertigo upon moving the head disappeared significantly earlier without the drug.

Conclusion: We believe that the drug should be used for a limited time.

P100

Head stabilization during walking as a predictor of performance in persons with amputation and traumatic brain injury: pilot study

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Introduction: In military personnel with traumatic lower limb amputations many have also incurred some type of head injury. Head injury could have an effect on head stabilization and the ability to recover and ambulate. Stabilization of the head during walking is driven by an active neural program that minimizes head and gaze instability. Such a neural program may be highly sensitive to head injury. Recovery of the neural program can be an important marker of neural status, especially related to the critical function of ambulation. Through existing rehabilitation programs for amputees, data sets now exist where head stabilization records can be readily extracted.

Objectives: To determine if head motion can be correlated to successful rehabilitation and improvements in ambulation for those with lower limb amputation.

Materials and Methods: Gait data from 5 able-bodied controls and data from 9 subjects with lower limb amputation were examined. Amputee subjects were studied at the initiation of training for

prosthesis use and at one and three month follow-ups. Position data of the front of the head, the back of the head, the base of the neck and the sacrum were captured with fixed video cameras with computer recognition systems. Subjects ambulated normally for a distance of approximately 10 m. The 3 dimensional position data was averaged over a full gait cycle.

Results: In the able bodied and the injury groups, normal gait cycles Z-axis (vertical) motion was readily measured. Both groups exhibited movement amplitudes in the range of 2 to 4 cm of these points during walking. Vertical Position of the front of the head compared to the back of the head showed a small cyclic motion as the head tipped up and down anti-phase to the vertical motion of the body. Subjects compared to controls showed the same relative amplitudes of head tipping movement fore-and-aft: approximately 2 to 5 mm. However, there was a greater variability in the cycle-to-cycle stabilization of the head in the subjects and even in their within cycle measurements of motion. Further, subjects showed marked out-of-phase head movement in the initial and one month follow-up session. However, by 3 months, subject head movements showed lower variability and improved gait phase tracking.

Conclusion: Head stabilization during gait is an important neural program that can be readily measured in a modern gait-analysis laboratory. Injury and amputation leads to measureable degradation of the neural program and recovery of the program is a marker of return of functional ambulation.

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