



**Vestibular Rehabilitation SIG  
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## December Topic: The Affect of Vision on VOR

### December 20, 2019

van Dooren TS, Lucieer FMP, Janssen AML, Kingma H1,, van de Berg R. **The Video Head Impulse Test and the Influence of Daily Use of Spectacles to Correct a Refractive Error.** Front Neurol. 2018 Mar 7;9:125. doi: 10.3389/fneur.2018.00125. eCollection 2018.

Gaze stabilization during head movements is provided by the vestibulo-ocular reflex (VOR). Clinical assessment of this reflex is performed using the video Head Impulse Test (vHIT). To date, the influence of different fixation distances on VOR gain using the vHIT has not been explored. We assessed the effect of target proximity on the horizontal VOR using the vHIT. Firstly, we assessed the VOR gain in 18 healthy subjects with 5 viewing target distances (150, 40, 30, 20, and 10 cm). The gain increased significantly as the viewing target distance decreased. A second experiment on 10 subjects was performed in darkness whilst the subjects were imagining targets at different distances. There were significant inverse relationships between gain and distance for both the real and the imaginary targets. There was a statistically significant difference between light and dark gains for the 20- and 40-cm distances, but not for the 150-cm distance. Theoretical VOR gains for different target distances were calculated and compared with those found in light and darkness. The increase in gain observed for near targets was lower than predicted by geometrical calculations, implying a physiological ceiling effect on the VOR. The VOR gain in the dark, as assessed with the vHIT, demonstrates an enhancement associated with a reduced target distance.

PMID: 29599742

Link to free article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5863505/>

### December 11, 2019

Tamás LT, Lundberg YW, Büki B. **Vergence increases the gain of the human angular vestibulo-ocular reflex during peripheral hyposensitivity elicited by cold thermal irrigation.** J Vestib Res. 2018;27(5-6):265-270. doi: 10.3233/VES-170629.

**OBJECTIVE:** The aim of this study was to determine if convergence increases the gain during peripheral hyposensitivity elicited by cold thermal irrigation.

**RESULTS:** Before caloric irrigation, near viewing (15cm) increased the average VOR gain by 28% (from 1 to 1.28). Cold (24°C) water irrigation of the right ear decreased the gain to 0.66 (far viewing) and 0.82 (near viewing) (22% difference). Although vergence also increased the gain for impulses to the left to the same degree before caloric stimulus, the caloric irrigation itself (applied to the right ear) did not influence the gain for contralateral impulses.



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**CONCLUSION:** In our experiments vergence increased the gain of the human angular VOR during peripheral hyposensitivity elicited by cold thermal irrigation. These results suggest that cold irrigation does not abolish the function of the nonlinear/phasic vestibular afferent pathway.

PMID: 29400687

**December 5, 2019**

Castro P, Sena Esteves S, Lerchundi F, Buckwell D, Gresty MA, Bronstein AM, Arshad Q. **Viewing Target Distance Influences the Vestibulo-Ocular Reflex Gain when Assessed Using the Video Head Impulse Test.** *Audiol Neurootol.* 2018;23(5):285-289. Epub 2018 Dec 11.

Gaze stabilization during head movements is provided by the vestibulo-ocular reflex (VOR). Clinical assessment of this reflex is performed using the video Head Impulse Test (vHIT). To date, the influence of different fixation distances on VOR gain using the vHIT has not been explored. We assessed the effect of target proximity on the horizontal VOR using the vHIT. Firstly, we assessed the VOR gain in 18 healthy subjects with 5 viewing target distances (150, 40, 30, 20, and 10 cm). The gain increased significantly as the viewing target distance decreased. A second experiment on 10 subjects was performed in darkness whilst the subjects were imagining targets at different distances. There were significant inverse relationships between gain and distance for both the real and the imaginary targets. There was a statistically significant difference between light and dark gains for the 20- and 40-cm distances, but not for the 150-cm distance. Theoretical VOR gains for different target distances were calculated and compared with those found in light and darkness. The increase in gain observed for near targets was lower than predicted by geometrical calculations, implying a physiological ceiling effect on the VOR. The VOR gain in the dark, as assessed with the vHIT, demonstrates an enhancement associated with a reduced target distance.

PMID: 30537706

## November Topic: Vestibular Hypofunction

**November 29, 2019**

Rinaudo CN, Schubert MC, Cremer PD, Figtree WVC, Todd CJ, Migliaccio AA. **Improved Oculomotor Physiology and Behavior After Unilateral Incremental Adaptation Training in a Person With Chronic Vestibular Hypofunction: A Case Report.** *Phys Ther.* 2019 Oct 28;99(10):

**BACKGROUND AND PURPOSE:** Traditional vestibular rehabilitation therapies are effective in reducing vestibular hypofunction symptoms, but changes to the vestibulo-ocular reflex (VOR) are minimal. This controlled case report describes an increase in VOR after 6 months of incremental VOR adaptation (IVA) training in a person with chronic unilateral vestibular hypofunction.



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**CASE DESCRIPTION:** The participant was a 58-year-old female with a confirmed (Neurologist P.D.C.) left vestibular lesion stable for 2 years prior to entering a clinical trial examining the effects of daily IVA training. She was evaluated monthly for self-reported symptoms (dizziness handicap inventory), VOR function (video head impulse test), and VOR behavior (Dynamic Visual Acuity test). Intervention consisted of 6 months of 15 minutes per day unassisted training using the IVA training regime with a device developed in our laboratory. The take-home device enables the VOR response to gradually normalize on the ipsilesional side via visual-vestibular mismatch training. The intervention was followed by a 6-month wash-out and 3-month control period. The control condition used the same training device set to function like standard VOR training indistinguishable to the participant.

**OUTCOMES:** After the intervention, ipsilesional VOR function improved substantially. The VOR adapted both via a 52% increase in slow-phase response and via 43% earlier onset compensatory saccades for passive head movements. In addition, the participant reported fewer symptoms and increased participation in sports and daily activities.

**DISCUSSION:** Here, a participant with chronic vestibular hypofunction showing improved oculomotor performance atypical for traditional vestibular rehabilitation therapies, subsequent to using the newly developed IVA technique, is presented. It is the first time to our knowledge an improvement of this magnitude has been demonstrated as well as sustained over an extended period of time.

PMID: 31197314

**November 20, 2019**

Hermann R. Pelisson D. Dumas O, Urquizar C, Truy E. Tilikete C. **Are Covert Saccade Functionally Relevant in Vestibular Hypofunction?** *Cerebellum*. 2018 Jun;17(3):300-307

The vestibulo-ocular reflex maintains gaze stabilization during angular or linear head accelerations, allowing adequate dynamic visual acuity. In case of bilateral vestibular hypofunction, patients use saccades to compensate for the reduced vestibulo-ocular reflex function, with covert saccades occurring even during the head displacement. In this study, we questioned whether covert saccades help maintain dynamic visual acuity, and evaluated which characteristic of these saccades are the most relevant to improve visual function. We prospectively included 18 patients with chronic bilateral vestibular hypofunction. Subjects underwent evaluation of dynamic visual acuity in the horizontal plane as well as video recording of their head and eye positions during horizontal head impulse tests in both directions (36 ears tested). Frequency, latency, consistency of covert saccade initiation, and gain of covert saccades as well as residual vestibulo-ocular reflex gain were calculated. We found no correlation between residual vestibulo-ocular reflex gain and dynamic visual acuity. Dynamic visual acuity performance was however positively correlated with the frequency and gain of covert saccades and negatively correlated with covert saccade latency. There was no correlation between consistency of covert saccade initiation and dynamic visual acuity. Even though gaze stabilization in space during covert saccades might be of very short duration, these refixation saccades seem to improve vision in patients with bilateral



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vestibular hypofunction during angular head impulses. These findings emphasize the need for specific rehabilitation technics that favor the triggering of covert saccades. The physiological origin of covert saccades is discussed

PMID: 29248983

Link to free article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5966498/>

**November 13, 2019**

Roller RA, Hall CD. **A speed-based approach to vestibular rehabilitation for peripheral vestibular hypofunction: A retrospective chart review.** J Vestib Res. 2018;28(3-4):349-357. doi: 10.3233/VES-180633.

**BACKGROUND:** Current vestibular rehabilitation for peripheral vestibular hypofunction is an exercise-based approach that improves symptoms and function in most, but not all patients, and includes gaze stabilization exercises focused on duration of head movement. One factor that may impact rehabilitation outcomes is the speed of head movement during gaze stability exercises.

**OBJECTIVE:** Examine outcomes of modified VOR X1 exercises that emphasize a speed-based approach for gaze stabilization while omitting substitution and habituation exercises. Balance training focused on postural realignment and hip strategy performance during altered visual and somatosensory inputs.

**METHODS:** A retrospective chart review of 159 patients with vestibular deficits was performed and five outcome measures were analyzed.

**RESULTS:** All outcomes - self-report dizziness and balance function, dynamic gait index, modified clinical test of sensory interaction and balance, and clinical dynamic visual acuity improved significantly and approached or achieved normal scores.

**CONCLUSIONS:** The combination of modified VOR X1 gaze stability exercises, wherein patients achieved high-velocity head movement (240°/s) during short exercise bouts, with "forced use" gait and balance exercises for postural realignment and hip strategy recruitment, achieved 93-99% of normal scores for all five outcomes. These results compare favorably to the outcomes for current VR techniques and warrant further investigation.

PMID: 29689764

**November 7, 2019**

Michel L, Laurent T, Alain T. **Rehabilitation of dynamic visual acuity in patients with unilateral vestibular hypofunction: earlier is better.** Eur Arch Otorhinolaryngol. 2019 Oct 21.

**PURPOSE:** Patients with acute peripheral unilateral hypofunction (UVH) complain of vertigo and dizziness and show posture imbalance and gaze instability. Vestibular rehabilitation therapy (VR) enhances the functional recovery and it has been shown that gaze stabilization exercises improved the dynamic visual acuity (DVA). Whether the effects of VR depend or not on the moment when it is applied



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remains however unknown, and investigation on how the recovery mechanisms could depend or not on the timing of VR has not yet been tested.

**METHODS:** Our study investigated the recovery of DVA in 28 UVH patients whose unilateral deficit was attested by clinical history and video head impulse test (vHIT). Patients were tested under passive conditions before (pre-tests) and after (post-tests) being subjected to an active DVA rehabilitation protocol. The DVA protocol consisted in active gaze stabilization exercises with two training sessions per week, each lasting 30 min, during four weeks. Patients were sub-divided into three groups depending on the time delay between onset of acute UVH and beginning of VR. The early DVA group (N = 10) was composed of patients receiving the DVA protocol during the first 2 weeks after onset (mean = 8.9), the late group 1 (N=9) between the 3rd and the 4th week (mean = 27.5 days after) and the late group 2 (N = 9) after the 1st month (mean: 82.5 days). We evaluated the DVA score, the angular aVOR gain, the directional preponderance and the percentage of compensatory saccades during the HIT, and the subjective perception of dizziness with the Dizziness Handicap Inventory (DHI). The pre- and post-VR tests were performed with passive head rotations done by the physiotherapist in the plane of the horizontal and vertical canals.

**RESULTS:** The results showed that patients submitted to an early DVA rehab improved significantly their DVA score by increasing their passive aVOR gain and decreasing the percentage of compensatory saccades, while the late 1 and late 2 DVA groups 1 and 2 showed less DVA improvement and an inverse pattern, with no change in the aVOR gain and an increase in the percentage of compensatory saccades. All groups of patients exhibited significant reductions of the DHI score, with higher improvement in subjective perception of dizziness handicap in the patients receiving the DVA rehab protocol in the first month.

**CONCLUSION:** Our data provide the first demonstration in UVH patients that earlier is better to improve DVA and passive aVOR gain. Gaze stabilization exercises would benefit from the plastic events occurring in brain structures during a sensitive period or opportunity time window to elaborate optimal functional reorganizations. This result is potentially very important for the VR programs to restore the aVOR gain instead of recruiting compensatory saccades assisting gaze stability.

PMID: 31637477

## October Topic: Neural Correlates of Dizziness

**October 23, 2019**

Micarelli A, Chiaravalloti A, Schillaci O, Ottaviani F, Alessandrini M. **Aspects of cerebral plasticity related to clinical features in acute vestibular neuritis: a "starting point" review from neuroimaging studies.** Acta Otorhinolaryngol Ital 2016, Apr;36(2):75-84. doi: 10.14639/0392-100X-642. Epub 2016 Apr 29.



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Vestibular neuritis (VN) is one of the most common causes of vertigo and is characterised by a sudden unilateral vestibular failure (UVF). Many neuroimaging studies in the last 10 years have focused on brain changes related to sudden vestibular deafferentation as in VN. However, most of these studies, also due to different possibilities across diverse centres, were based on different times of first acquisition from the onset of VN symptoms, neuroimaging techniques, statistical analysis and correlation with otoneurological and psychological findings. In the present review, the authors aim to merge together the similarities and discrepancies across various investigations that have employed neuroimaging techniques and group analysis with the purpose of better understanding about how the brain changes and what characteristic clinical features may relate to each other in the acute phase of VN. Six studies that strictly met inclusion criteria were analysed to assess cortical-subcortical correlates of acute clinical features related to VN. The present review clearly reveals that sudden UVF may induce a wide variety of cortical and subcortical responses - with changes in different sensory modules - as a result of acute plasticity in the central nervous system.

PMID: 27196070

Link to free article: <http://europepmc.org/articles/pmc4907164>

**October 16, 2019**

Van Ombergen A, Heine L, Jillings S, Roberts RE, Jeurissen B, Van Rompaey V, Mucci V, Vanhecke S, Sijbers J, Vanhevel F, Sunaert S, Bahri MA, Parizel PM, Van de Heyning PH, Laureys S, Wuyts FL. **Altered functional brain connectivity in patients with visually induced dizziness.** Neuroimage Clin 2017, Feb 28;14:538-545. doi: 10.1016/j.nicl.2017.02.020. eCollection 2017.

**BACKGROUND:** Vestibular patients occasionally report aggravation or triggering of their symptoms by visual stimuli, which is called visually induced dizziness (VID). These patients therefore experience dizziness, discomfort, disorientation and postural unsteadiness. The underlying pathophysiology of VID is still poorly understood.

**OBJECTIVE:** The aim of the current explorative study was to gain a first insight in the underlying neural aspects of VID.

**METHODS:** We included 10 VID patients and 10 healthy matched controls, all of which underwent a resting state fMRI scan session. Changes in functional connectivity were explored by means of the intrinsic connectivity contrast (ICC). Seed-based analysis was subsequently performed in visual and vestibular seeds.

**RESULTS:** We found a decreased functional connectivity in the right central operculum (superior temporal gyrus), as well as increased functional connectivity in the occipital pole in VID patients as compared to controls in a hypothesis-free analysis. A weaker functional connectivity between the thalamus and most of the right putamen was measured in VID patients in comparison to controls in a seed-based analysis. Furthermore, also by means of a seed-based analysis, a decreased functional connectivity between the visual associative area and the left parahippocampal gyrus was found in VID patients. Additionally, we found increased functional connectivity between thalamus and occipital and



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cerebellar areas in the VID patients, as well as between the associative visual cortex and both middle frontal gyrus and precuneus.

**CONCLUSIONS:** We found alterations in the visual and vestibular cortical network in VID patients that could underlie the typical VID symptoms such as a worsening of their vestibular symptoms when being exposed to challenging visual stimuli. These preliminary findings provide the first insights into the underlying functional brain connectivity in VID patients. Future studies should extend these findings by employing larger sample sizes, by investigating specific task-based paradigms in these patients and by exploring the implications for treatment.

PMID: 28331800

Link to free article:

<https://europepmc.org/articles/PMC5345975?sessionid=1CA74017DDDEE397C6E41A58EE042669>

**October 10, 2019**

Helmchen C, Rother M, Spliethoff P, Sprenger A. **Increased brain responsivity to galvanic vestibular stimulation in bilateral vestibular failure.** *Neuroimage Clin* 2019, Jul 19;24:101942. doi: 10.1016/j.nicl.2019.101942

In this event-related functional magnetic resonance imaging (fMRI) study we investigated how the brain of patients with bilateral vestibular failure (BVF) responds to vestibular stimuli. We used imperceptible noisy galvanic vestibular stimulation (GVS) and perceptible bi-mastoidal GVS intensities and related the corresponding brain activity to the evoked motion perception. In contrast to caloric irrigation, GVS stimulates the vestibular organ at its potentially intact afferent nerve site. Motion perception thresholds and cortical responses were compared between 26 BVF patients to 27 age-matched healthy control participants. To identify the specificity of vestibular cortical responses we used a parametric design with different stimulus intensities (noisy imperceptible, low perceptible, high perceptible) allowing region-specific stimulus response functions. In a 2 x 3 flexible factorial design all GVS-related brain activities were contrasted with a sham condition that did not evoke perceived motion. Patients had a higher motion perception threshold and rated the vestibular stimuli higher than the healthy participants. There was a stimulus intensity related and region-specific increase of activity with steep stimulus response functions in parietal operculum (e.g. OP2), insula, superior temporal gyrus, early visual cortices (V3) and cerebellum while activity in the hippocampus and intraparietal sulcus did not correlate with vestibular stimulus intensity. Using whole brain analysis, group comparisons revealed increased brain activity in early visual cortices (V3) and superior temporal gyrus of patients but there was no significant interaction, i.e. stimulus-response function in these regions were still similar in both groups. Brain activity in these regions during (high)GVS increased with higher dizziness-related handicap scores but was not related to the degree of vestibular impairment or disease duration. nGVS did not evoke cortical responses in any group. Our data indicate that perceptible GVS-related cortical responsivity is not diminished but increased in multisensory (visual-vestibular) cortical regions despite bilateral failure of the peripheral vestibular organ. The increased activity in early visual cortices (V3) and superior temporal gyrus of BVF patients has several potential implications: (i) their cortical reciprocal inhibitory visuo-



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vestibular interaction is dysfunctional, (ii) it may contribute to the visual dependency of BVF patients, and (iii) it needs to be considered when BVF patients receive peripheral vestibular stimulation devices, e.g. vestibular implants or portable GVS devices. Imperceptible nGVS did not elicit cortical brain responses making it unlikely that the reported balance improvement of BVF by nGVS is mediated by cortical mechanisms.

PMID: 31382239

Link to free article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6690736/>

**October 2, 2019**

Alsaman O, Ost J, Vanspauwen R, Blaivie C, De Ridder D, Vanneste S. **The Neural Correlates of Chronic Symptoms of Vertigo Proneness in Humans.** PLoS One 2016, Apr 18;11(4):e0152309. doi: 10.1371/journal.pone.0152309. eCollection 2016.

Vestibular signals are of significant importance for variable functions including gaze stabilization, spatial perception, navigation, cognition, and bodily self-consciousness. The vestibular network governs functions that might be impaired in patients affected with vestibular dysfunction. It is currently unclear how different brain regions/networks process vestibular information and integrate the information into a unified spatial percept related to somatosensory awareness and whether people with recurrent balance complaints have a neural signature as a trait affecting their development of chronic symptoms of vertigo. Pivotal evidence points to a vestibular-related brain network in humans that is widely distributed in nature. By using resting state source localized electroencephalography in non-vertiginous state, electrophysiological changes in activity and functional connectivity of 23 patients with balance complaints where chronic symptoms of vertigo and dizziness are among the most common reported complaints are analyzed and compared to healthy subjects. The analyses showed increased alpha2 activity within the posterior cingulate cortex and the precuneus/cuneus and reduced beta3 and gamma activity within the pregenual and subgenual anterior cingulate cortex for the subjects with balance complaints. These electrophysiological variations were correlated with reported chronic symptoms of vertigo intensity. A region of interest analysis found reduced functional connectivity for gamma activity within the vestibular cortex, precuneus, frontal eye field, intra-parietal sulcus, orbitofrontal cortex, and the dorsal anterior cingulate cortex. In addition, there was a positive correlation between chronic symptoms of vertigo intensity and increased alpha-gamma nesting in the left frontal eye field. When compared to healthy subjects, there is evidence of electrophysiological changes in the brain of patients with balance complaints even outside chronic symptoms of vertigo episodes. This suggests that these patients have a neural signature or trait that makes them prone to developing chronic balance problems.

PMID: 27089185

Link to free article:

<https://europepmc.org/articles/PMC4835222?sessionid=D94C0ABCFF5B4C116CB82865EEE75934>



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## September Topic: Back to Basics

### September 26, 2019

Özdilek A, Yalınay Dikmen P, Acar E, Ayanoğlu Aksoy E, Özdilek A. **Determination of Anxiety, Health Anxiety and Somatosensory Amplification Levels in Individuals with Benign Paroxysmal Positional Vertigo.** J Int Adv Otol. 2019 Jul 26. doi: 10.5152/iao.2019.6874. [Epub ahead of print]

**OBJECTIVES:** Psychiatric comorbidities may intensify peripheral vertigo and increase the number of repositioning maneuvers required. This study was designed to examine the relationship between benign paroxysmal positional vertigo (BPPV) and anxiety and assess its association with somatic amplification and health anxiety.

**MATERIALS AND METHODS:** Sixty patients with BPPV (43 women, 17 men; age range: 24-81 years, mean age 40.4±13.3), and 60 healthy participants (29 women, 31 men; age range: 18-71, mean age 38.2±11.43) were prospectively enrolled. The participants completed the Beck Anxiety Inventory (BAI), Short Health Anxiety Inventory (SHAI), and Somatosensory Amplification Scale (SSAS) questionnaires.

**RESULTS:** The BAI scores of the patients with BPPV were higher than those of the control group participants and were as follows: (16.4 vs. 12.7; p=0.01). The SHAI (p=0.44) and SSAS (p=0.60) scores were not significantly different between the two groups. The BAI scores were positively correlated with the SHAI (rho: 0.273, p=0.035) and SSAS (rho: 0.357, p=0.005) scores. Neither the number of BPPV attacks nor the number of Epley maneuvers required showed any correlation with the BAI [(rho: 0.208, p=0.11); (rho: -0.007, p=0.96)], SHAI [(rho: 0.068, p=0.06); (rho: 0.021, p=0.87)], and SSAS [(rho: -0.081, p=0.53); (rho: -0.012, p=0.92)] scores.

**CONCLUSION:** Our findings indicate that patients with BPPV had higher anxiety scores than healthy participants. Although our findings indicated normal health anxiety and somatic amplification levels in patients with BPPV, regular evaluation of psychological status would be a good strategy to prevent chronic dizziness.

PMID: 3134750

### September 18, 2019

Rodrigues DL, Ledesma ALL, Pires de Oliveira CA, Bahmad F Jr. **Effect of Vestibular Exercises Associated With Repositioning Maneuvers in Patients With Benign Paroxysmal Positional Vertigo: A Randomized Controlled Clinical Trial.** Otol Neurotol. 2019 Sep;40(8):e824-e829. doi: 10.1097/MAO.0000000000002324.

In addition to positional vertigo, it is quite common for patients with benign paroxysmal positional vertigo (BPPV) to present complaints associated with balance problems and a feeling of dizziness even after repositioning maneuvers.



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**OBJECTIVE:** It was to evaluate the additional effects of vestibular rehabilitation exercises as a therapeutic resource in the treatment of BPPV, to improve symptoms and reduce recurrence.

**STUDY DESIGN:** This was an experimental, prospective, randomized, controlled study.

**SETTING:** Instituto Brasiliense de Otorrinolaringologia (IBORL) from August 2016 to September 2017.

**PATIENTS:** Thirty-two individuals, both men and women, over 18 years of age with BPPV.

**INTERVENTION:** They were randomly assigned to two groups: the control group (n=15) performing only the maneuver technique as treatment and the experimental group (n=17) performing the maneuvers and vestibular rehabilitation exercises. Patients underwent treatment and responded to the dizziness handicap inventory (DHI) and visual analog scale (VAS) questionnaires for comparison between groups. Participants were followed up for 6 months to observe recurrence of symptoms.

**MAIN OUTCOME MEASURES:** To investigate the additional effects of vestibular exercises in the treatment of BPPV.

**RESULTS:** The experimental group had a lower level of dizziness in the posttreatment period ( $p < 0.05$ ) and a lower incidence of recurrences ( $p = 0.038$ ) than the control group.

**CONCLUSIONS:** Vestibular exercises performed after repositioning treatments for BPPV increased the overall efficacy of treatment by improving symptoms with a lower rate of recurrence.

PMID: 31356483

**September 11, 2019**

Appiah-Kubi KO, Wright WG. **Vestibular training promotes adaptation of multisensory integration in postural control.** *Gait Posture.* 2019 Sep;73:215-220. doi: 10.1016/j.gaitpost.2019.07.197. Epub 2019 Jul 16.

**BACKGROUND:** Postural stability depends on the integration of the multisensory system to produce motor outputs. When visual and somatosensory input is reliable, this reduces reliance on the vestibular system. Despite this, vestibular loss can still cause severe postural dysfunction. Training one or more of the three sensory systems through vestibular habituation and adaptation can alter sensory weighting and change postural behavior.

**AIM:** The purpose of this study was to assess sensory reweighting of postural control processing after combined vestibular activation with voluntary weight shift training in healthy adults.

**METHODS:** Thirty-three healthy individuals (18-35 y.o.) were randomly assigned to one of three groups: No training (control), visual feedback weight shift training (WST) coupled with an active horizontal headshake (HS) activity to elicit a vestibular perturbation, or the same WST without HS (NoHS). Training was performed 2x/day, every other day (M, W, F), totaling six sessions. Pre- and post- assessments on the Sensory Organization Test (SOT) were performed. Separate between- and within- repeated measures ANOVAs were used to analyze the six SOT equilibrium scores, composite scores, sensory ratios and center of pressure (COP) variables by comparing baseline to post-training. Alpha level was set at  $p < .05$ .



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**RESULTS:** There was a significant group x session x condition change ( $p=.102$ ) in the COP multiscale entropy (MSE) velocity sway in the HS group during SOT conditions 5 and 6. Similarly, COP medio-lateral standard deviation sway (ML Std) showed group x session x visual condition ( $p=.028$ ), due to HS in condition 6 relative to other two groups.

**CONCLUSION:** Postural training can alter sensory organization after a visual feedback-vestibular activation training protocol, suggesting a possible sensory reweighting through vestibular adaptation and/or habituation.

**SIGNIFICANCE:** Translating these findings into a vestibular-impaired population can stimulate the design of a rehabilitation balance protocol.

PMID: 31376748

**September 5, 2019**

Verdecchia DH, Monzón AM, Urbina Jaimes V, Oliveira FR, Paiva L da S, Carvalho TD de. **Patient-Reported and Performance Outcomes Significantly Improved in Elderly Patients with Vestibular Impairment following Rehabilitation: A Retrospective Study.** Journal of Aging Research. August 2018:1-8. doi:10.1155/2018/5093501.

**OBJECTIVE:** To describe the results of a vestibular rehabilitation (VR) program in the timed up and go (TUG), gait speed (GS), and dizziness handicap inventory (DHI) scores for elderly vestibular patients in a developing country.

**METHODS:** Descriptive study with retrospective data collected from the clinical records of vestibular patients. The following information was recorded: sex, age, type of vestibular disorder, DHI score, and performance in TUG and GS, before and after participation in a VR program taking place from January 1 to August 30, 2017. The VR program consisted of 10 twice weekly sessions in the clinic and daily exercises at the patient's home. We used Student's t-test for paired and Wilcoxon's test according to the data distribution. The level of significance was 5%.

**RESULTS:** Data from 57 patients (49 females;  $78 \pm 5.8$  years old) were used. There were statistically significant differences in TUG (12.52 versus 11.56), GS (0.81 versus 0.90 m/s), DHI total handicap (46 versus 24), physical (14 versus 8), emotional (14 versus 6), and functional (18 versus 12) domains.

**CONCLUSION:** The functional outcome measures reported, including TUG, gait speed, and DHI, reflect statistically significant improvements in elderly patients after vestibular rehabilitation; the DHI improvements are clinically relevant.

PMID: 30225142

## August Topic: Motion Sensitivity

**August 28, 2019**



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Clément G, Deguine O, Bourg M, Pavy-LeTraon A. **Effects of vestibular training on motion sickness, nystagmus, and subjective vertical.** J Vestib Res. 2007.

Pitch head-and-trunk movements during constant velocity rotation are a provocative vestibular stimulus that produces vertigo and nausea. When exposed to this stimulus repeatedly, motion sickness symptoms diminish as the subjects habituate. Acetylleucine is a drug that is used to treat acute vestibular vertigo. In this study, we wanted to ascertain whether this drug (a) lessened motion sickness or delayed habituation; (b) accelerated the recovery following habituation; and (c) whether changes in the subjective vertical accompanied habituation. Twenty subjects were administered acetylleucine or placebo in a double-blind study during a five-day vestibular training. Horizontal vestibulo-ocular reflex, optokinetic nystagmus, smooth pursuit, and subjective visual vertical were evaluated before, during, and up to two months after the vestibular training. Based on Graybiel's diagnostic criteria, motion sickness decreased steadily in each vestibular training session, and there was no difference between the scores in the acetylleucine and placebo groups. Post-rotatory nystagmus peak velocity and time constant also declined in both groups at the same rate. Thus, acetylleucine neither reduced the nausea associated with this provocative stimulus, nor hastened the acquisition or retention of vestibular habituation of motion sickness and nystagmus. There was no difference in optokinetic nystagmus and smooth pursuit between the acetylleucine and placebo groups. However, subjects showed larger error in the subjective visual vertical after habituation, which indicates that spatial orientation is also affected by vestibular training.

PMID: 18626134

**August 21, 2019**

Chu H1, Li MH, Juan SH, Chiou WY. **Effects of transcutaneous electrical nerve stimulation on motion sickness induced by rotary chair: a crossover study.** J Altern Complement Med. 2012 May;18(5):494-500. doi: 10.1089/acm.2011.0366. Epub 2012 Apr 26.

**OBJECTIVES:** Motion sickness (MS) is evoked by the conflict among somatosensory, visual, and vestibular input. Some of the MS symptoms and signs are mediated by activation of the autonomic nervous system (ANS). Transcutaneous electrical nerve stimulation (TENS), a maneuver used for pain control, was found to influence cardiovascular responses through ANS reflex, and to enhance motor function, visuospatial abilities, postural control, and cognitive function. The purpose of the present study is to investigate the effects of TENS on MS.

**SUBJECTS AND DESIGN:** Fifteen (15) healthy young men participated in a within-subjects crossover study. Each completed four test sessions (control, rotation, TENS, TENS+rotation) in randomized order. Rotary chair (120°/s) combined with pitch movement of the subject's head was used as a model to provoke MS. Whole rotation protocol consisted of 5 1-minute rotations, each separated by a 1-minute rest period. TENS protocol involved simultaneous electrical stimulation of posterior neck and Zusanli acupoint.



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**OUTCOME MEASURES:** Motion sickness susceptibility was rated on a standardized questionnaire (Motion Sickness Susceptibility Questionnaire). Motion sickness symptoms, blood pressure (BP), skin temperature, heart rate (HR), and heart rate variability (HRV) were measured. Saliva samples were collected to analyze the level of stress markers. Cognitive function was evaluated with d2 test prior to and after MS provocation.

**RESULTS:** Spinning by itself significantly decreased task response speed and contraction. MS symptom scores, BP, as well as the sympathetic parameter of HRV increased progressively with MS provocation ( $p < 0.05$ ), but skin temperature decreased ( $p = 0.023$ ). Severity of MS symptoms significantly decreased with TENS intervention ( $p < 0.05$ ). After TENS treatment, subjects were able to concentrate better and showed fewer errors in a cognitive test. Salivary cortisol concentration significantly decreased after TENS treatment.

**CONCLUSIONS:** Sympathetic activity increased but parasympathetic activity decreased during MS. TENS was effective in reducing MS symptoms as well as alleviating cognitive impairment.

PMID: 22537562

**August 16, 2019**

Takeuchi N, Mori T, Suzukamo Y, Izumi SI. **Modulation of Excitability in the Temporoparietal Junction Relieves Virtual Reality Sickness.** *Cyberpsychol Behav Soc Netw.* 2018.

Virtual reality (VR) immersion often provokes subjective discomfort and postural instability, so called VR sickness. The neural mechanism of VR sickness is speculated to be related to visual-vestibular information mismatch and/or postural instability. However, the approaches proposed to relieve VR sickness through modulation of brain activity are poorly understood. Using transcranial direct current stimulation (tDCS), we aimed to investigate whether VR sickness could be relieved by the modulation of cortical excitability in the temporoparietal junction (TPJ), which is known to be involved in processing of both vestibular and visual information. Twenty healthy subjects received tDCS over right TPJ before VR immersion. The order of the three types of tDCS (anodal, cathodal, and sham) was counterbalanced across subjects. We evaluated the subjective symptoms, heart rate, and center of pressure at baseline, after tDCS, and after VR immersion. VR immersion using head-mounted displays provoked subjective discomfort and postural instability. However, anodal tDCS over right TPJ ameliorated subjective disorientation symptoms and postural instability induced by VR immersion compared with sham condition. The amelioration of VR sickness by anodal tDCS over the right TPJ might result from relief of the sensory conflict and/or facilitation of vestibular function. Our result not only has potential clinical implications for the neuromodulation approach of VR sickness but also implies a causal role of the TPJ in VR sickness.

PMID: 29792509

**August 8, 2019**



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Wang L, Cao Y, Tan C, Zhao Q, He S, Niu D, Tang G, Zou P, Xing L. **Uncoupling VOR and vestibuloautonomic retention to Coriolis acceleration training in student pilots and control subjects.** J Vestib Res. 2017.

**PURPOSE:** Explore the different vestibular physiologic response retention patterns after Coriolis acceleration training in student pilots and extend the results for use with Chinese astronauts in the future.

**METHODS:** Twelve healthy control male subjects were screened from males familiar with vestibular training and who physically resembled the astronauts. Fourteen student pilots were selected from 23 participants by rotational vestibular function tests. All subjects were exposed to five-day continuous or intermittent Coriolis acceleration training. Subjective motion sickness (MS) symptom scores, electrocardiography, electrogastrography (EGG), post-rotatory nystagmus and renin-angiotensin system responses were measured before, during and after rotational vestibular function tests at different times after vestibular training.

**RESULTS:** Subjects could tolerate 10 min or 15 min of vestibular with mild MS symptoms. Retention of vestibular autonomic responses (retention of MS symptom scores, heart rate variability, power density of EGG, variations in levels of arginine vasopressin) were approximately 1 week for control subjects and approximately 5 weeks for student pilots. Decreases in slow-phase velocity of post-rotatory nystagmus were maintained for 14 weeks for control subjects and 9 weeks for student pilots.

**CONCLUSIONS:** Retention of the vestibulo-autonomic reaction after vestibular training was different for control subjects and student pilots. All parameters related to autonomic responses could be maintained at low levels after vestibular training for approximately 1 week for control subjects and approximately 5 weeks for student pilots. Uncoupling patterns between post-rotatory nystagmus and the vestibulo-autonomic reaction may be helpful in the design of clinical rehabilitation plans for balance-disorder patients and for exploration of artificial gravity in future space missions.

PMID: 29064824

## July Topic: Vestibulotoxicity

### No 481: July 31, 2019

Prayuenyong P, Taylor JA, Pearson SE, Gomez R, Patel PM, Hall DA, Kasbekar AV, Baguley DM.

**Vestibulotoxicity Associated With Platinum-Based Chemotherapy in Survivors of Cancer: A Scoping Review.** Front Oncol. 2018 Sep 25;8:363. doi: 10.3389/fonc.2018.00363. eCollection 2018.

**Background:** Cochleotoxicity following the treatment with platinum-based chemotherapy is well documented. The potential for vestibulotoxicity is still unclear. This scoping review examined the extent of current research literature, summarized research findings and identified research gaps regarding vestibular-related adverse effects associated with platinum-based chemotherapy in survivors of cancer.



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**Methods:** Inclusion criteria followed the PICO principles: Participants, adult, and pediatric cancer patients of any cancer type; Intervention, platinum-based chemotherapy (such as cisplatin, carboplatin, and oxaliplatin); Control, none or any; Outcomes, vestibular-related adverse effects. English language articles published since 1978 were retrieved. Seventy-five eligible studies were identified from a systematic literature search, and relevant data were charted, collated, and summarized. **Results:** Testing for vestibulotoxicity predominately featured functional evaluation of the horizontal semicircular canal using the caloric and rotational tests. The rate of abnormal vestibular function test results after chemotherapy administration varied from 0 to 50%. The results of objective testing did not always correspond to patient symptoms. There is tentative support for patients with pre-existing loss of vestibular function to be more likely to experience vestibular toxicity after dosing with cisplatin. **Conclusions:** A number of studies reported significant evidence of vestibular toxicities associated with platinum-based chemotherapy, especially cisplatin. This scoping review emphasizes that vestibular toxicity needs more attention and comprehensive evaluation. Specifically, studies that analyse cumulative dose of platinum-based chemotherapy, affected sites of lesion in vestibular end organs, and the correlation and temporal patterns of cochlear and vestibular toxicity are needed.

PMID: 30319960

Link to free article: <https://www.frontiersin.org/articles/10.3389/fonc.2018.00363/full>

**No 480: July 26, 2019**

Handelsman JA. **Vestibulotoxicity: strategies for clinical diagnosis and rehabilitation.** Int J Audiol. 2018 Sep;57(sup4):S99-S107. doi: 10.1080/14992027.2018.1468092. Epub 2018 May 9.

**OBJECTIVE:** The purpose of this article is to discuss the most commonly prescribed vestibulotoxic medications and their impact on the vestibular system, to describe the clinical features of vestibular ototoxicity including symptoms reported by patients, and to describe assessment tools that may be used in a monitoring programme, including the functional impact of vestibular loss. Recently published data from a cohort of patients exposed to systemic aminoglycosides (AGS) are summarised, which highlight the importance of monitoring. The role and importance of vestibular rehabilitation in treating affected individuals is discussed.

**DESIGN:** This is a descriptive article.

**STUDY SAMPLE:** Recently published data from 71 patients with cystic fibrosis with AGS exposure are summarised.

**RESULTS:** Recently published data from a cohort of patients exposed to systemic AGS reveal a high prevalence of vestibular system involvement.

**CONCLUSIONS:** Evidence suggests that including assessment of vestibular function in a programme to monitor for ototoxic damage is essential. While suggestions about possible components of a monitoring programme are made, the need for further study in order to determine an ideal protocol for assessing vestibular system function during and following exposure to toxic agents is stressed.

PMID: 29741128



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**No 479: July 17, 2019**

Van Hecke R, Van Rompaey V, Wuyts FL, Leyssens L, Maes L. **Systemic Aminoglycosides-Induced Vestibulotoxicity in Humans.** *Ear Hear.* 2017 Nov/Dec;38(6):653-662. doi: 10.1097/AUD.0000000000000458.

**OBJECTIVES:** This systematic review aimed to investigate the prevalence and characteristics of vestibular adverse effects of aminoglycoside (AG) therapy in humans and to analyze objective vestibular tests for the detection of AG-induced vestibulotoxicity.

**DESIGN:** PubMed, Cochrane Database, Web of Science, and reference lists of all included studies were screened by two independent researchers. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were followed. Studies were included according to preset inclusion criteria and reported outcomes of studies evaluating vestibular function using one or more objective vestibular function tests in adults and children after systemic AG administration. The methodological quality of each study was assessed using the quality assessment tool for quantitative studies. Interrater reliability was established using Cohen's Kappa.

**RESULTS:** Twenty-seven studies were included, with the vast majority showing AG-induced vestibulotoxic side effects, ranging from 0 to 60%. Most studies reported AG-induced abnormalities by caloric and rotatory testing, whereas only a few studies reported using video Head Impulse test and vestibular evoked myogenic potential testing.

**CONCLUSIONS:** Because type I hair cells (particularly of the semicircular canals) are more susceptible to ototoxicity, video Head Impulse test and vestibular evoked myogenic potential testing seem more promising for the early detection of vestibulotoxicity than caloric and rotatory testing. Prospective studies using an extensive vestibular test battery are needed to further characterize the impact of AGs on the different vestibular end organs and to identify the most sensitive vestibular technique for the early detection of vestibulotoxicity.

PMID: 28650850

**No 478: July 10, 2019**

Rutka J. **Aminoglycoside Vestibulotoxicity.** *Adv Otorhinolaryngol.* 2019;82:101-110. doi: 10.1159/000490277. Epub 2019 Jan 15.

Many pharmaceuticals have ototoxicity (both cochlear and/or vestibular) as part of their adverse medication profile. The aminoglycoside class of antimicrobials has been especially well studied in this regard. Many questions remain unanswered as to how to best monitor and prevent this complication. A bilateral vestibular loss profoundly affects an individual's quality of life, physical activities, and overall independence. Paradoxically, the effects of gentamicin ototoxicity have provided further insight into the workings of the vestibular system, especially the vestibulo-ocular reflex. The microbiological activity,



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therapeutic use, toxicities, and genetics predisposing a person to aminoglycoside ototoxicity are presented. The clinical importance of recognizing ataxia, disequilibrium, and oscillopsia as presenting symptoms for vestibulotoxicity rather than hearing loss or vertigo is stressed. Documented risk factors and new observations regarding the spectrum of vestibular dysfunction and differences in vestibulotoxicity from multiple daily dosing vs. single daily dosing schedules are presented for the first time. While most vestibulotoxicity arises from systemic aminoglycoside administration, intratympanic application has been used therapeutically for intractable Ménière's disease. Commercially available ototopical aminoglycoside preparations for the treatment of external/middle ear disease in the presence of a tympanic membrane defect have also been documented to cause unintentional ototoxicity.

PMID: 30947191

June Topic: Visual Dependence

No 477: June 26, 2019

Roberts RE, Da Silva Melo M, Siddiqui AA, Arshad Q, Patel M. Vestibular and oculomotor influences on visual dependency. *J Neurophysiol.* 2016 Sep 1;116(3):1480-7. doi: 10.1152/jn.00895.2015. Epub 2016 Jun 29.

Abstract

The degree to which a person relies on visual stimuli for spatial orientation is termed visual dependency (VD). VD is considered a perceptual trait or cognitive style influenced by psychological factors and mediated by central reweighting of the sensory inputs involved in spatial orientation. VD is often measured with the rod-and-disk test, in which participants align a central rod to the subjective visual vertical (SVV) in the presence of a background that is either stationary or rotating around the line of sight-dynamic SVV. Although this task has been employed to assess VD in health and vestibular disease, what effect torsional nystagmic eye movements may have on individual performance is unknown. Using caloric ear irrigation, 3D video-oculography, and the rod-and-disk test, we show that caloric torsional nystagmus modulates measures of VD and demonstrate that increases in tilt after irrigation are positively correlated with changes in ocular torsional eye movements. When the direction of the slow phase of the torsional eye movement induced by the caloric is congruent with that induced by the rotating visual stimulus, there is a significant increase in tilt. When these two torsional components are in opposition, there is a decrease. These findings show that measures of VD can be influenced by oculomotor responses induced by caloric stimulation. The findings are of significance for clinical studies, as they indicate that VD, which often increases in vestibular disorders, is modulated not only by changes in cognitive style but also by eye movements, in particular nystagmus.

PMID: 27358321

Link to free article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5040385/>

No 476: June 19, 2019

Maire R, Mallinson A, Ceyte H, Caudron S, Van Nechel C, Bisdorff A, Magnusson M, Petersen H, Kingma H, Perrin P. Discussion about Visual Dependence in Balance Control: European Society for Clinical Evaluation of Balance Disorders. *J Int Adv Otol.* 2017 Dec;13(3):404-406. doi: 10.5152/iao.2017.4344.



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**Abstract**

The executive committee of the European Society for the clinical evaluation of balance disorders meets annually to address equilibrium problems that are not well understood. This is a review paper on discussions in the latest meeting we held.

**MATERIALS AND METHODS:** Seeing patients with vestibular disorders who end up depending on visual information as part of their compensation process is a common clinical occurrence. However, this "visual dependence" can generate symptoms, which include nausea, sensations of imbalance, and anxiety. It is unclear how this develops, as symptoms can be widely variable from patient to patient. There are several triggering factors to this symptom set, and quantifying it in a given patient is extremely difficult. **Results:** The committee agreed that the presence of this symptom set can be suggestive of vestibular pathology, but the pathology does not have to be present. As a result, there is no correlation between symptom severity and test results.

**CONCLUSION:** Visual dependence can often be present in a patient, although little, if any, measurable pathology is present. It is important to emphasize that although we cannot accurately measure this with either standardized testing or pertinent questionnaires, "hypersensitive" patients have a genuine disease and their symptoms are not of psychiatric origin.

PMID: 29360093

No 475: June 12, 2019

Bronstein AM, Dieterich M. Long-term clinical outcome in vestibular neuritis. *Curr Opin Neurol.* 2019 Feb;32(1):174-180. doi: 10.1097/WCO.0000000000000652.

**Abstract**

**PURPOSE OF REVIEW:** To review recent work on clinical and imaging aspects of vestibular neuritis (or acute vestibular syndrome), in particular with a view to identifying factors predicting long-term clinical outcome.

**RECENT FINDINGS:** Evidence for a role of inflammation in the vestibular nerve, and the presence of Gadolinium enhancement acutely in vestibular neuritis, is accruing. Visual dependence, anxiety and somatization traits predict the development of chronic dizziness after acute vestibular neuritis. Adaptation to asymmetric rotation is impaired in vestibular neuritis and this may indicate insufficient central compensation in chronic dizzy patients. Corticosteroids appear ineffective at improving long-term clinical outcome. Functional imaging changes during the central compensation period lead to structural brain changes; both processes correlate with clinical recovery.

**SUMMARY:** Vestibular neuritis appears to be the result of postviral neuroinflammation of the vestibular nerve. However, long-term prognosis is not dependent on the magnitude of the peripheral residual damage (as measured with caloric and video head-impulse test). Instead, a combination of visuovestibular psychophysical factors (visual dependence), psychological traits and dysfunctional vestibular perception are relevant. Several functional and structural neuroimaging changes develop after vestibular neuritis, which reflect and underlie the aforementioned psychophysiological and psychological features.

PMID: 30566414

No 474: June 7, 2019



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Smyth N, Flynn M, Rajcani J, F Hucklebridge M, Thorn L, Wood C, Golding J, Evans P, Clow A. Attenuated cortisol reactivity to psychosocial stress is associated with greater visual dependency in postural control. *Psychoneuroendocrinology*. 2019 Jun;104:185-190. doi: 10.1016/j.psyneuen.2019.02.028. Epub 2019 Mar 2.

**Abstract**

Despite known anatomical links between the hypothalamic-pituitary-adrenal (HPA) axis and the vestibular system, there are no studies on the relationship between postural control and HPA axis function. Visual dependence in postural control, often measured by increased postural sway on exposure to visual motion, is an indication of altered visual-vestibular integration with greater weighting towards visual cues for balance. Visual dependence is more common in older age and a range of vestibular and non-vestibular health conditions. The relationship between visual dependence in postural control was investigated in relation to cortisol reactivity to psychosocial stress (using the Trier Social Stress Test for groups: TSST-G), as an index of HPA axis function, in healthy young females. In those who exhibited a cortisol response ( $>2$  nmol/l), a negative relationship between stress-induced cortisol reactivity and visual dependence in postural control was observed, since those with the largest cortisol response showed less visual motion induced postural sway (measured by force platform). This finding in healthy females indicates that subtle non-clinical differences in vestibular function are associated with dysregulated HPA axis activity as indicated by lower cortisol reactivity to psychosocial stress. It adds to the growing body of evidence linking blunted cortisol reactivity to stress to poor homeostatic regulation and potential negative health and behavioural outcomes.

PMID: 30856424

May Topic: Vestibular Schwannoma

No 473: May 29, 2019

Berkowitz O, Han YY, Talbott EO, Iyer AK, Kano H, Kondziolka D, Brown MA, Lunsford LD. Gamma Knife Radiosurgery for Vestibular Schwannomas and Quality of Life Evaluation. *Stereotact Funct Neurosurg*. 2017;95(3):166-173. doi: 10.1159/000472156. Epub 2017 May 23.

**Abstract**

**BACKGROUND:** Further investigation is needed to look at the impact of vestibular schwannoma (VS) on the health-related quality of life (QOL) of participants who undergo Gamma Knife® radiosurgery (GKRS).

**OBJECTIVES:** Investigators compared the QOL for VS participants to reported US population norms in order to evaluate disease burden and long-term QOL several years after GKRS.

**METHODS:** This cross-sectional study surveyed participants to assess hearing status, tinnitus, imbalance, vertigo, as well as the Short-Form 36-item Health Questionnaire (SF-36). The data were normalized, age adjusted, and functional status was correlated to determine clinically significant differences.

**RESULTS:** A total of 353 participants who underwent GKRS between 1997 and 2007 were included in this study with a median postoperative period of 5 years. SF-36 scores were very similar to population norms, and age-adjusted scores for participants followed the US population curve. Frequent vertigo and balance problems had the largest statistically and clinically significant effect on physical and mental component summary scores followed by nonuseful hearing in the tumor ear.



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**CONCLUSIONS:** Participants reported a good long-term QOL that was very similar to the QOL of US population norms. Of the common VS symptoms, vertigo had the greatest impact on QOL followed by imbalance and then hearing loss.

PMID: 28531896

No 472: May 23, 2019

Batuecas-Caletrio A, Rey-Martinez J, Trinidad-Ruiz G, Matíño-Soler E, Cruz-Ruiz SS, Muñoz-Herrera A, Perez-Fernandez N. Vestibulo-Ocular Reflex Stabilization after Vestibular Schwannoma Surgery: A Story Told by Saccades. *Front Neurol.* 2017 Jan 25;8:15. doi: 10.3389/fneur.2017.00015. eCollection 2017  
Abstract

**OBJECTIVE:** To evaluate vestibular compensation via measurement of the vestibulo-ocular reflex (VOR) following vestibular schwannoma surgery and its relationship with changes in saccades strategy after surgery.

**PATIENTS:** Thirty-six consecutive patients with vestibular schwannomas, without brainstem compression, underwent surgical resection. Patients were recruited from University Hospital of Salamanca, Spain.

**METHODS:** We assessed the age, sex, tumor size, degree of canalicular weakness, and preoperative video head impulse test (gain and saccade organization measured with PR score). Gain and saccade organization were compared with postoperative values at discharge and also at 1,3, and 6 months. PR scores are a measure of the scatter of refixation saccades.

**RESULTS:** Patients with normal preoperative caloric function had higher PR scores (saccades were scattered) following surgery compared to patients with significant preoperative canal paresis ( $p < 0.05$ ).

VOR gain and the presence of covert/overt saccades preoperatively did not influence the PR score ( $p > 0.05$ ), but a group of patients with very low VOR gain ( $< 0.45$ ) and covert/overt saccades before surgery had lower PR scores after surgery. The differences after 6 months were not significant.

**CONCLUSION:** Patients with more severe vestibular dysfunction before vestibular schwannoma surgery show significantly faster vestibular compensation following surgery, manifested by changes in VOR gain and PR score. The scatter of compensatory saccades (as measured by the PR score) may be a surrogate early marker of clinical recovery, given its relationship to the Dizziness Handicap Inventory.

PMID: 28179894

No 471: May 16, 2019

Constanzo F, Teixeira BCA, Sens P, Ramina R. Video Head Impulse Test in Vestibular Schwannoma: Relevance of Size and Cystic Component on Vestibular Impairment. *Otol Neurotol.* 2019 Apr;40(4):511-516. doi: 10.1097/MAO.0000000000002158.

Abstract

**OBJECTIVES:** Tumor factors that influence vestibular function in vestibular schwannoma (VS) have not been properly described. We evaluated whether cystic VSs have different vestibular function than solid VS. Tumor size on vestibular function was also evaluated.

**STUDY DESIGN:** Cross-sectional study.

**SETTING:** Tertiary referral center.

**PATIENTS:** Forty-one cases of sporadic, untreated VS.



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**INTERVENTION:** Evaluation with video head impulse test and MRI.

**MAIN OUTCOME MEASURES:** Tumors were classified as solid, heterogeneous, or cystic and by size using the Hannover classification. Vestibulo-ocular reflex (VOR) gain was correlated to tumor size and cystic status.

**RESULTS:** Large VS had worse VOR gain than small lesions ( $p < 0.001$ ). Cystic lesions had lower VOR gain than all other tumors ( $p = 0.001$ ), Hannover T3 and T4 ( $p = 0.014$ ), Hannover T4 ( $p = 0.015$ ), solid tumors ( $p < 0.001$ ), solid Hannover T3 and T4 ( $p = 0.003$ ), and solid Hannover T4 ( $p = 0.008$ ). Heterogeneous VSs had lower VOR gain compared to solid tumors ( $p = 0.02$ ), solid Hannover T3 and T4 ( $p = 0.08$ ), and solid Hannover T4 ( $p = 0.14$ ). Heterogeneous and cystic VSs had lower VOR gain than solid tumors ( $p < 0.001$ ), solid Hannover T3 and T4 ( $p = 0.004$ ), and solid Hannover T4 ( $p = 0.02$ ). VOR gain of solid T4 lesions was not significantly lower than solid Hannover T1-T3 ( $p = 0.33$ ).

**CONCLUSION:** Cystic status is directly associated with a worse vestibular dysfunction. Size did not significantly impact vestibular function in solid VS.

PMID: 30870368

No 470: May 8, 2019

Tranter-Entwistle I, Dawes P, Darlington CL, Smith PF, Cutfield N. Video head impulse in comparison to caloric testing in unilateral vestibular schwannoma. *Acta Otolaryngol.* 2016 Nov;136(11):1110-1114.

Epub 2016 May 25.

Abstract

**CONCLUSIONS:** Although there was a statistically significant relationship between the results of the vHIT and the caloric test, the limited strength of this relationship suggests that, for unilateral vestibular schwannoma (UVS), caloric testing and vHIT may provide complementary information on vestibular function.

**OBJECTIVE:** There is limited information that can be used to determine which of the video head impulse test (vHIT) and caloric test might be better used in the diagnosis and management of UVS. In this study, a group of participants with un-operated UVS was studied using both methods.

**METHODS:** The subjects' vestibular function was assessed using the vHIT and caloric testing. Tumour size was quantified using MRI and their balance disturbance assessed using the Jacobsen Dizziness Handicap Inventory (DHI).

**RESULTS:** Twenty of 30 subjects had an abnormal canal paresis according to the Jongkees' criterion ( $> 0.25$ ); however, only 10/30 had an ipsilesional vHIT gain of  $< 0.79$ . Canal paresis could be predicted from the ipsilesional and contralesional vHIT gains. Tumour size could also be predicted from the ipsilesional vHIT gain and canal paresis. However, DHI scores could not be predicted from the degree of canal paresis, vHIT gain, or the MRI measures.

PMID: 27224664

No 469: May 1, 2019

Low Choy NL, Lucey MM, Lewandowski SL, Panizza BJ. Impacts of small vestibular schwannoma on community ambulation, postural, and ocular control. *Laryngoscope.* 2017 May;127(5):1147-1152. doi:

10.1002/lary.26105. Epub 2016 Aug 13.

Abstract



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**OBJECTIVES/HYPOTHESIS:** To investigate balance, community mobility, gaze instability, and dizziness handicap and assess falls risk in people who are conservatively managed with small vestibular schwannoma (VS).

**STUDY DESIGN:** Cross-sectional study with controls.

**METHODS:** The study involved 18 people (mean age  $58.7 \pm 12.2$  years) diagnosed with VS ( $<12$  mm) and 22 age-matched controls (mean age  $56.9 \pm 8.0$  years). Measures included standing on firm and foam surfaces with feet apart, then together with eyes open and closed, Timed Up and Go (TUG) test and dual TUG test, Dynamic Gait Index, 6-Minute Walk Test, Halmagyi Impulse Test, Dynamic Visual Acuity Test, and the Dizziness Handicap Inventory.

**RESULTS:** The clinical group failed more trials standing feet together on foam with eyes closed ( $P < .05$ ); had inferior mobility and walked more slowly with divided attention ( $P < .05$ ); had more difficulty walking with head movement, negotiating obstacles, and using stairs ( $P < .01$ ); and walked shorter distances ( $P < .001$ ) than controls. Reduced gaze stability ( $P < .01$ ) and higher total ( $P = .007$ ) and subcategory dizziness handicap scores ( $P < .05$ ) were revealed compared to age-matched controls.

**CONCLUSIONS:** Although outcomes for the clinical group are inferior to the control group across all measures and the dizziness impact is higher, the results fall in the low-risk category for falls. Preliminary data (level 4 evidence) support using a suite of clinical measures to monitor people with VS during conservative management.

PMID: 27519610

Summary of April 2019 Topic: Biobehavioral Aspects of Vestibular Rehab

No 468: April 17, 2019

Hsu CL, Tsai SJ, Shen CC, Lu T, Hung YM, Hu LY. Risk of benign paroxysmal positional vertigo in patients with depressive disorders: a nationwide population-based cohort study. *BMJ Open*. 2019 Mar 30;9(3):e026936. doi: 10.1136/bmjopen-2018-026936.

**OBJECTIVE:** The association between depression and benign paroxysmal positional vertigo (BPPV) remains debated. This study aimed to investigate the risk of BPPV in patients with depressive disorders.

**DESIGN:** Longitudinal nationwide cohort study.

**SETTING:** National health insurance research database in Taiwan.

**PARTICIPANTS:** We enrolled 10,297 patients diagnosed with depressive disorders between 2000 and 2009 and compared them to 41,188 selected control patients who had never been diagnosed with depressive disorders (at a 1:4 ratio matched by age, sex and index date) in relation to the risk of developing BPPV.

**METHODS:** The follow-up period was defined as the time from the initial diagnosis of depressive disorders to the date of BPPV, censoring or 31 December 2009. Cox proportional hazard regression analysis was used to investigate the risk of BPPV by sex, age and comorbidities, with HRs and 95% CIs.

**RESULTS:** During the 9-year follow-up period, 44 (0.59 per 1000 person-years) patients with depressive disorders and 99 (0.33 per 1000 person-years) control patients were diagnosed with BPPV. The incidence rate ratio of BPPV among both cohorts calculating from events of BPPV per 1000 person-years of observation time was 1.79 (95% CI 1.23 to 2.58,  $p=0.002$ ). Following adjustments for age, sex and comorbidities, patients with depressive disorders were 1.55 times more likely to develop BPPV (95% CI



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1.08 to 2.23,  $p=0.019$ ) as compared with control patients. In addition, hyperthyroidism (HR=3.75, 95% CI 1.67-8.42,  $p0.001$ ) and systemic lupus erythematosus (SLE) (HR=3.47, 95% CI 1.07 to 11.22,  $p=0.038$ ) were potential risk factors for developing BPPV in patients with depressive disorders.

CONCLUSIONS: Patients with depressive disorders may have an increased risk of developing BPPV, especially those who have hyperthyroidism and SLE.

PMID: 30928959

**No 467: April 11, 2019**

Sullivan KA, Kaye SA, Blaine H, Edmed SL, Meares S, Rossa K, Haden C. Psychological approaches for the management of persistent postconcussion symptoms after mild traumatic brain injury: a systematic review. *Disabil Rehabil.* 2019 Feb 11:1-9. doi: 10.1080/09638288.2018.1558292.

BACKGROUND: To evaluate the evidence for psychological treatments for persistent postconcussion symptoms following mild traumatic brain injury. There is scant evidence from limited clinical trials to direct the psychological management of persistent symptoms.

METHOD: Databases were searched for studies that: (1) included adults ( $\geq$  aged 16 years) following injury (from any cause); (2) tested interventions for postconcussion symptoms after the acute injury period (e.g., after hospital discharge), but prior to established chronicity (e.g., not more than 12 months post-injury), and; (3) applied one of five broadly-defined psychological interventions (cognitive behavioural therapy, counselling, psychoeducation, education/reassurance, or mindfulness). All controlled trials were eligible for inclusion.

RESULTS: Of the 20,945 articles identified, 10 underwent risk-of-bias analysis by two independent reviewers. Nine were retained for data extraction. They used: cognitive behaviour therapy ( $n=2$ ), counselling ( $n=2$ ), psychoeducation ( $n=2$ ), education/reassurance ( $n=2$ ), or compared cognitive behaviour therapy to counselling ( $n=1$ ).

CONCLUSION: Counselling or cognitive behaviour therapy have the most support but the evidence remains limited. We encourage further randomized controlled trials of early interventions in samples at risk for persistent symptoms, including closer study of psychological risk-factors and the 'active' ingredient. To advance the field, future trials must include additional methodological controls and improved reporting. Implications for rehabilitation Persistent symptoms following mild traumatic brain injury can be disabling and psychological management for rehabilitation may be proposed. However, Controlled trials show that while some psychological approaches hold promise for this purpose, there are significant gaps in the underpinning evidence. The best results are seen when postconcussion programs use counselling or cognitive behaviour therapy and are targetted for people with an increased risk of persistent symptoms.

PMID: 30741023



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No 466: April 3, 2019

Walker A, Kantaris X, Chambers M. Understanding therapeutic approaches to anxiety in vestibular rehabilitation: a qualitative study of specialist physiotherapists in the UK. *Disabil Rehabil.* 2018 Apr;40(7):829-835. doi: 10.1080/09638288.2016.1277393. Epub 2017 Jan 27.

**PURPOSE:** People with vestibular disorders are typically treated by physiotherapists in vestibular rehabilitation. Anxiety is strongly associated with vestibular disorders; however, there is a lack of understanding about how physiotherapists respond to people presenting with anxiety within vestibular rehabilitation. This study aimed to explore physiotherapists' current practice in assessing and treating patients with anxiety in vestibular rehabilitation.

**MATERIALS AND METHODS:** A qualitative study using semi-structured interviews with 10 specialist physiotherapists in vestibular rehabilitation in three university teaching hospitals in England. Data were analyzed using thematic analysis.

**RESULTS:** Four themes were identified: (i) The therapeutic relationship, (ii) Adapting assessment and treatment, (iii) Psychological intervention and support, and (iv) Physiotherapists' education and training. Physiotherapists reported using a range of behavioral and cognitive techniques and adapting their therapeutic approach by placing greater emphasis on education, building trust and pacing treatment. Physiotherapists highlighted the need for more specialist psychological support for patients during vestibular rehabilitation and tailored training and guidance on addressing anxiety within vestibular rehabilitation.

**CONCLUSIONS:** Physiotherapists working in vestibular rehabilitation consider managing aspects of anxiety within their scope of practice and describe taking a psychosocial therapeutic approach. There is limited access to expert psychological support for patients with anxiety within vestibular rehabilitation. Implications for rehabilitation Anxiety is strongly associated with vestibular disorders and it is common for these patients to be managed by physiotherapists in vestibular rehabilitation. Vestibular rehabilitation services could improve access to psychological expertise through dedicated psychological input, more effective signposting and referral pathways, and better access to inter-professional support from psychologists and/or CBT practitioners in managing more complex patients. Physiotherapists requested tailored training and guidance to enhance their ability to manage patients with anxiety more effectively in vestibular rehabilitation.

PMID: 28129508

Summary of March 2019 Topic: Vestibular Impairments with Thiamine Deficiency

No 465: March 27, 2019

Lee SH, Kim SH, Kim JM, Tarnutzer AA. Vestibular Dysfunction in Wernicke's Encephalopathy: Predominant Impairment of the Horizontal Semicircular Canals. *Front Neurol.* 2018 Mar 12;9:141. doi: 10.3389/fneur.2018.00141. eCollection 2018.



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**BACKGROUND:** Wernicke's encephalopathy (WE), a metabolic disorder due to thiamine deficiency, manifests with various neurological symptoms and signs. It has been known as a cause of vestibular dysfunction. Preliminary reports have proposed predominant involvement of the horizontal semicircular canals (HSCs).

**OBJECTIVE:** To better characterize the pattern of vestibular impairment in patients with WE using quantitative video head-impulse testing and to review the literature regarding this topic.

**METHOD:** From January 2014 to December 2016, we retrospectively enrolled five cases of WE that received quantitative video-head-impulse testing (vHIT). We retrieved the clinical features from the medical records and reviewed quantitative head-impulse testing (qHIT) and caloric irrigation. Based on the gain and the number of corrective saccades, the function (normal vs. impaired) of each semicircular canal was rated. In addition, we conducted a MEDLINE and EMBASE search to identify other published cases of WE that had received qHIT. Neuro-otologic and neuro-ophthalmologic findings and vestibular testing results were extracted.

**RESULTS:** A total of 17 patients (own series = 5; published cases = 12) aged  $54.6 \pm 11$  years were included. Key neurologic findings were ataxia of stance and gait (13/13, 100%), spontaneous nystagmus (7/14, 50%), gaze-evoked nystagmus (GEN) (17/17, 100%), positive bedside head-impulse testing for the horizontal canals (16/17, 94%), and memory impairment and mental changes (6/11, 54.5%). Regarding vestibular testing, qHIT (either video based or search-coil based) documented selective bilateral horizontal canal dysfunction with normal or minimal vertical canal impairment (14/14, 100%). On caloric irrigation, bilateral horizontal canal paresis was noted in most cases (10/11, 91%).

**CONCLUSION:** In WE, signs of both peripheral and central vestibular dysfunction (i.e., GEN, ataxia of stance and gait, abnormal head-impulse testing) were common. Selective or predominant impairment of the HSCs seems to be the most common finding of WE likely related to enhanced vulnerability of the medial vestibular nuclei neurons to thiamine deficiency. Quantitative vHIT of all six semicircular canals is therefore a useful tool for the diagnosis and should be applied in all patients with suspected WE.

PMID: 29593640

Link to free article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5857915/>

No 464: March 20, 2019

Kattah JC, Guede C, Hassanzadeh B. The medial vestibular nuclei, a vulnerable target in thiamine deficiency. *J Neurol*. 2018 Jan;265(1):213-215. doi: 10.1007/s00415-017-8670-1. Epub 2017 Nov 15.

**BACKGROUND:** Bilateral medial vestibular nuclei (MVN) is a common target in thiamine depletion and results in acute vestibular failure. Involvement of the MVN was present in 27 out of 38 brainstem sections reported in the largest thiamine deficiency autopsy cohort with Wernicke's encephalopathy.

**METHOD:** Serial clinical, imaging and vestibulo-ocular reflex gain measured with the video head impulse (vHIT) in one patient with acute thiamine deficiency.



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**RESULTS:** Low horizontal VOR gain correlated with an abnormal manual head impulse and with MRI evidence of MVN in an alcohol-dependent patient with low thiamine levels. The vertical VOR gain was either normal or mildly abnormal. Thiamine replacement and normal diet restored the VOR gain and MRI signal changes to normal.

**CONCLUSION:** This single case study provides clinical-imaging correlation for symmetric MVN compromise in thiamine deficiency, its effect on the VOR gain and the favorable response to thiamine and diet replacement when identified early.

PMID: 29143209

No 463: March 13, 2019

Kattah JC. The Spectrum of Vestibular and Ocular Motor Abnormalities in Thiamine Deficiency. *Curr Neurol Neurosci Rep.* 2017 May;17(5):40. doi: 10.1007/s11910-017-0747-9.

**PURPOSE:** The first aim of this review is to summarize recent ocular motor signs in pre-encephalopathy patients with nutritional deficiency at risk of thiamine deficiency. Timely recognition of thiamine depletion in these patients, who may have a normal brain MRI, could lead to appropriate management and prevention of Wernicke's encephalopathy (WE) with full recovery. The second aim is to incorporate recent diagnostic testing on the revised WE diagnostic criteria and the identification of patients who may show slow, partial, or no response to treatment.

**RECENT FINDINGS:** Selective vulnerability of periventricular gray neurons in thiamine deficiency is well known. Involvement of the vestibular and abducens nuclei may precede encephalopathy. Studies have shown mild ophthalmoparesis and bilateral symmetric vestibular loss in thiamine deficiency. Moreover, quantitative data has shown decreased horizontal vestibulo-ocular reflex (VOR) gain and nystagmus, with a favorable response to timely treatment. Ophthalmoparesis, horizontal nystagmus, and decreased gain of the horizontal VOR, sparing the vertical VOR, may be present in the early pre-encephalopathy stage of thiamine deficiency. Rapid response to a loading dose of parenteral thiamine might be seen in some cases and normalization, albeit slower in others. In contrast, analogous to the Korsakoff's syndrome, ocular motor and vestibular abnormalities may show only partial improvement. Future studies in larger populations at risk are needed to confirm the results of these preliminary observations.

PMID: 28365885

Summary of February 2019 Topic: Pediatric Concussion

No 462: February 27, 2019

Iaccarino MA, Fitzgerald M, Pulli A, Woodworth KY, Spencer TJ, Zafonte R, Biederman J. Sport concussion and attention deficit hyperactivity disorder in student athletes: A cohort study. *Neurol Clin Pract.* 2018 Oct;8(5):403-411.



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**BACKGROUND:** Attention deficit hyperactivity disorder (ADHD) is associated with impulsive behavior and inattention, making it a potential risk factor for sport-related concussion (SRC). The objectives of this study were to determine whether ADHD is an antecedent risk factor for SRC and whether ADHD complicates recovery from SRC in youth athletes.

**METHODS:** Student athletes with a history of SRC were evaluated for the presence of ADHD using diagnostic interview and to determine whether ADHD symptoms began before or after SRC. Concussion-specific measures of concussive symptoms and cognitive function were compared in SRC + ADHD and SRC + No ADHD groups to assess SRC recovery between groups.

**RESULTS:** ADHD was overrepresented in youth with SRC compared with population rates. ADHD was found to be an antecedent risk factor for SRC, with age at ADHD onset earlier than the date of SRC. Student athletes with SRC and ADHD reported more concussive symptoms compared with athletes without ADHD and were more likely to have a history of greater than one concussion.

**CONCLUSIONS:** The results of this study support our hypothesis that ADHD is an antecedent risk factor for SRC and may contribute to a more complicated course of recovery from SRC. Future research should focus on determining whether screening, diagnosis, and treating ADHD in youth athletes may prevent SRC. Providers that care for youth athletes with ADHD should be aware of the vulnerabilities of this population toward SRC and its complications.

PMID: 30564494

**No 461: February 20, 2019**

Morgan CD, Zuckerman SL, Lee YM, King L, Beaird S, Sills AK, Solomon GS. **Predictors of postconcussion syndrome after sports-related concussion in young athletes: a matched case-control study.** J Neurosurg Pediatr. 2015 Jun;15(6):589-98. doi: 10.3171/2014.10.PEDS14356. Epub 2015 Mar 6.

**OBJECT** Sport-related concussion (SRC) is a major public health problem. Approximately 90% of SRCs in high school athletes are transient; symptoms recover to baseline within 1 week. However, a small percentage of patients remain symptomatic several months after injury, with a condition known as postconcussion syndrome (PCS). The authors aimed to identify risk factors for PCS development in a cohort of exclusively young athletes (9-18 years of age) who sustained SRCs while playing a sport. **METHODS** The authors conducted a retrospective case-control study by using the Vanderbilt Sports Concussion Clinic database. They identified 40 patients with PCS and matched them by age at injury and sex to SRC control patients (1 PCS to 2 control). PCS patients were those experiencing persistent symptoms at 3 months after an SRC. Control patients were those with documented resolution of symptoms within 3 weeks of an SRC. Data were collected in 4 categories: 1) demographic variables; 2) key medical, psychiatric, and family history; 3) acute-phase postinjury symptoms (at 0-24 hours); and 4) subacute-phase postinjury features (at 0-3 weeks). The chi-square Fisher exact test was used to assess categorical variables, and the Mann-Whitney U-test was used to evaluate continuous variables. Forward



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stepwise regression models ( $P_{in} = 0.05$ ,  $P_{out} = 0.10$ ) were used to identify variables associated with PCS.

**RESULTS** PCS patients were more likely than control patients to have a concussion history ( $p = 0.010$ ), premorbid mood disorders ( $p = 0.002$ ), other psychiatric illness ( $p = 0.039$ ), or significant life stressors ( $p = 0.036$ ). Other factors that increased the likelihood of PCS development were a family history of mood disorders, other psychiatric illness, and migraine. Development of PCS was not predicted by race, insurance status, body mass index, sport, helmet use, medication use, and type of symptom endorsement. A final logistic regression analysis of candidate variables showed PCS to be predicted by a history of concussion (OR 1.8, 95% CI 1.1-2.8,  $p = 0.016$ ), preinjury mood disorders (OR 17.9, 95% CI 2.9-113.0,  $p = 0.002$ ), family history of mood disorders (OR 3.1, 95% CI 1.1-8.5,  $p = 0.026$ ), and delayed symptom onset (OR 20.7, 95% CI 3.2-132.0,  $p < 0.001$ ).

**CONCLUSIONS** In this age- and sex-matched case-control study of risk factors for PCS among youth with SRC, risk for development of PCS was higher in those with a personal and/or family history of mood disorders, other psychiatric illness, and migraine. These findings highlight the unique nature of SRC in youth. For this population, providers must recognize the value of establishing the baseline health and psychiatric status of children and their primary caregivers with regard to symptom reporting and recovery expectations. In addition, delayed symptom onset was an unexpected but strong risk factor for PCS in this cohort. Delayed symptoms could potentially result in late removal from play, rest, and care by qualified health care professionals. Taken together, these results may help practitioners identify young athletes with concussion who are at a greater danger for PCS and inform larger prospective studies for validation of risk factors from this cohort.

PMID: 25745949

**No 460: February 13, 2019**

Ellis MJ, Cordingley DM, Vis S, Reimer KM, Leiter J, Russell K. **Clinical predictors of vestibulo-ocular dysfunction in pediatric sports-related concussion.** *J Neurosurg Pediatr.* 2017 Jan;19(1):38-45. doi: 10.3171/2016.7.PEDS16310. Epub 2016 Sep 30.

**OBJECTIVE** There were 2 objectives of this study. The first objective was to identify clinical variables associated with vestibulo-ocular dysfunction (VOD) detected at initial consultation among pediatric patients with acute sports-related concussion (SRC) and postconcussion syndrome (PCS). The second objective was to reexamine the prevalence of VOD in this clinical cohort and evaluate the effect of VOD on length of recovery and the development of PCS.

**METHODS** A retrospective review was conducted for all patients with acute SRC and PCS who were evaluated at a pediatric multidisciplinary concussion program from September 2013 to May 2015. Acute SRC was defined as presenting < 30 days postinjury, and PCS was defined according to the International Classification of Diseases, 10th Revision criteria and included being symptomatic 30 days or longer postinjury. The initial assessment included clinical history and physical examination performed by 1 neurosurgeon. Patients were assessed for VOD, defined as the presence of more than 1 subjective



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vestibular and oculomotor complaint (dizziness, diplopia, blurred vision, etc.) and more than 1 objective physical examination finding (abnormal near point of convergence, smooth pursuits, saccades, or vestibulo-ocular reflex testing). Poisson regression analysis was used to identify factors that increased the risk of VOD at initial presentation and the development of PCS.

**RESULTS** Three hundred ninety-nine children, including 306 patients with acute SRC and 93 with PCS, were included. Of these patients, 30.1% of those with acute SRC (65.0% male, mean age 13.9 years) and 43.0% of those with PCS (41.9% male, mean age 15.4 years) met the criteria for VOD at initial consultation. Independent predictors of VOD at initial consultation included female sex, preinjury history of depression, posttraumatic amnesia, and presence of dizziness, blurred vision, or difficulty focusing at the time of injury. Independent predictors of PCS among patients with acute SRC included the presence of VOD at initial consultation, preinjury history of depression, and posttraumatic amnesia at the time of injury.

**CONCLUSIONS** This study identified important potential risk factors for the development of VOD following pediatric SRC. These results provide confirmatory evidence that VOD at initial consultation is associated with prolonged recovery and is an independent predictor for the development of PCS. Future studies examining clinical prediction rules in pediatric concussion should include VOD. Additional research is needed to elucidate the natural history of VOD following SRC and establish evidence-based indications for targeted vestibular rehabilitation.

PMID: 27689244

**No 459: February 6, 2019**

Storey EP, Wiebe DJ, D'Alonzo BA, Nixon-Cave K, Jackson-Coty J, Goodman AM, Grady MF, Master CL. **Vestibular Rehabilitation Is Associated With Visuovestibular Improvement in Pediatric Concussion.** *J Neurol Phys Ther.* 2018 Jul;42(3):134-141.

**BACKGROUND AND PURPOSE:** Vision and vestibular-related deficits are common after concussion and are associated with prolonged recovery times, substantially impacting the quality of life for children. The utility of targeted vestibular rehabilitation for these deficits in children after concussion is unknown. The purpose of this study was to determine whether active vestibular rehabilitation is associated with an improvement in visuovestibular signs and symptoms in children with concussion.

**METHODS:** A retrospective cohort study of children diagnosed with concussion and referred to vestibular rehabilitation between 2012 and 2014 was conducted. Patient-reported symptoms and visuovestibular performance measures were assessed in the medical practice and physical therapy settings.

**RESULTS:** One hundred nine children were included in the study with a mean age of 11.8 (3.4) years. Among this group, 59 (54%) were male and 48 (44%) had a sports-related concussion. Children presented to a pediatric sports medicine office and physical therapy a median of 24 (interquartile range [IQR], 14-42) and 55 (IQR, 39-94) days after injury, respectively. Concussion symptoms decreased from a median of 9 (IQR, 5-13) symptoms at initial evaluation to a median of 0 (IQR, 0-2) symptoms at final



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assessment. Performance on all visuovestibular tasks improved significantly over the course of therapy except for near point of convergence. For the 45 children who completed the Balance Error Scoring System at both initial and final therapy visits, there was a significant improvement in mean level of performance ( $P < 0.0001$ ). Characteristics between those who completed a full versus partial course of physical therapy were similar.

**DISCUSSION AND CONCLUSIONS:** Vestibular rehabilitation in children with concussion is associated with improvement in symptoms as well as visuovestibular performance. This active intervention may benefit children with persistent symptoms after concussion. Future prospective studies are needed to determine the efficacy and optimal postinjury timing of vestibular rehabilitation.

Video Abstract available for more insights from the authors (see Supplemental Digital Content 1, available at: <http://links.lww.com/JNPT/A208>).

PMID: 29912034

## Summary of January 2019 Topic: Complementary therapies for balance disorders and management of anxiety

### **No 458: January 30, 2019**

Bubela D, Sacharko L, Chan J, Brady M. **Balance and Functional Outcomes for Older Community-Dwelling Adults Who Practice Tai Chi and Those Who Do Not: A Comparative Study.** J Geriatr Phys Ther. 2017 Nov 9. doi: 10.1519/JPT.000000000000153.

**BACKGROUND AND PURPOSE:** A growing body of literature substantiates that Tai Chi is a form of exercise that may help older adults increase strength, improve balance, lower fall rates, and experience less fear of falling. Few studies, however, offer controlled experimental design and simultaneously investigate multiple factors known to contribute to fall risk. The purpose of this study was to compare performance on measures relating to fall risk (strength, balance, functional mobility, and fear of falling) in older community-dwelling adults who participated in a community-based Tai Chi program with a control group of their peers who had no Tai Chi training over the same time period.

**METHODS:** A quasi-experimental comparative pre- and posttest design was used to compare an experimental group of 16 community-dwelling older adults, mean (SD) age = 80.4 (6.8) years, participating in a 16-week Tai Chi training program with a group of 13 adults, mean (SD) age = 71.2 (6.1) years, who had no Tai Chi experience in the areas of knee extension strength (measured by handheld dynamometry), functional strength (by five-time sit to stand), mobility (by Timed Up and Go [TUG] test and Fifty-Foot Walk Test), balance (by Functional Reach and Berg Balance Scale), and fear of falling (by Activity-specific Balance Confidence scale). Within-group and between-groups comparisons were made using 2×2 mixed analysis of variance.

**RESULTS:** Tai Chi participants improved in nearly all measures, whereas controls did not. Tai Chi participants experienced significant improvement in the TUG test during the training period ( $P = .003$ ),



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with significant difference when compared with controls ( $P = .049$ ) and moderate effect size and observed power ( $\eta_p = 0.165$ ; observed power = 0.512). Significant knee extension strength improvement occurred ( $P = .042$ ) with moderate effect size and observed power ( $\eta_p = 0.183$ ; observed power = 0.543). While the total balance confidence scale score did not change significantly, responses on many individual items did reach a level of significant change for persons participating in the Tai Chi training.

**CONCLUSION:** Older adults' participation in a community-based Tai Chi program may lead to improvement in strength, mobility, and confidence in performing functional tasks. Incorporation of elements of Tai Chi into therapy programs for older adults at risk for fall and referral to community-based Tai Chi programs may be viable options in the continuum of health-related care for older adults.  
PMID: 29135600

**No 457: January 16, 2019**

Huang ZG, Feng YH, Li YH, Lv CS. **Systematic review and meta-analysis: Tai Chi for preventing falls in older adults.** *BMJ Open.* 2017 Feb 6;7(2):e013661. doi: 10.1136/bmjopen-2016-013661

**OBJECTIVE:** It remains unclear whether Tai Chi is effective for preventing falls in older adults. We undertook this systematic review to evaluate the preventive effect of Tai Chi by updating the latest trial evidence.

**DESIGN:** Systematic review and meta-analysis.

**METHODS:** The Cochrane Library, MEDLINE and EMBASE were searched up to February 2016 to identify randomised trials evaluating Tai Chi for preventing falls in older adults. We evaluated the risk of bias of included trials using the Cochrane Collaboration's tool. Results were combined using random effects meta-analysis.

**OUTCOME MEASURES:** Number of fallers and rate of falls.

**RESULTS:** 18 trials with 3824 participants were included. The Tai Chi group was associated with significantly lower chance of falling at least once (risk ratio (RR) 0.80, 95% CI 0.72 to 0.88) and rate of falls (incidence rate ratio (IRR) 0.69, 95% CI 0.60 to 0.80) than the control group. Subgroup analyses suggested that the preventive effect was likely to increase with exercise frequency (number of fallers:  $p=0.001$ ; rate of falls:  $p=0.007$ ) and Yang style Tai Chi was likely to be more effective than Sun style Tai Chi (number of fallers:  $p=0.01$ ; rate of falls:  $p=0.001$ ). The results might be influenced by publication bias as the funnel plots showed asymmetry. Sensitivity analyses by sample size, risk of bias and comorbidity showed no major influence on the primary results.

**CONCLUSIONS:** Tai Chi is effective for preventing falls in older adults. The preventive effect is likely to increase with exercise frequency and Yang style Tai Chi seems to be more effective than Sun style Tai Chi.

PMID: 28167744

Free PMC Article: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293999/>



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**No 456: January 9, 2019**

Pascoe MC, Thompson DR, Ski CF. **Yoga, mindfulness-based stress reduction and stress-related physiological measures: A meta-analysis.** Psychoneuroendocrinology. 2017 Dec;86:152-168. doi: 10.1016/j.psyneuen.2017.08.008. Epub 2017 Aug 30.

**BACKGROUND AND OBJECTIVES:** Practices that include yoga asanas and mindfulness-based stress reduction for the management of stress are increasingly popular; however, the neurobiological effects of these practices on stress reactivity are not well understood. Many studies investigating the effects of such practices fail to include an active control group. Given the frequency with which people are selecting such interventions as a form of self-management, it is important to determine their effectiveness. Thus, this review investigates the effects of practices that include yoga asanas, with and without mindfulness-based stress reduction, compared to an active control, on physiological markers of stress.

**MATERIALS AND METHODS:** A systematic review and meta-analysis of randomised controlled trials published in English compared practices that included yoga asanas, with and without mindfulness-based stress reduction, to an active control, on stress-related physiological measures. The review focused on studies that measured physiological parameters such as blood pressure, heart rate, cortisol and peripheral cytokine expression. MEDLINE, AMED, CINAHL, PsycINFO, SocINDEX, PubMed, and Scopus were searched in May 2016 and updated in December 2016. Randomised controlled trials were included if they assessed at least one of the following outcomes: heart rate, blood pressure, heart rate variability, mean arterial pressure, C-reactive protein, interleukins or cortisol. Risk of bias assessments included sequence generation, allocation concealment, blinding of assessors, incomplete outcome data, selective outcome reporting and other sources of bias. Meta-analysis was undertaken using Comprehensive Meta-Analysis Software Version 3. Sensitivity analyses were performed using 'one-study-removed' analysis. Subgroup analysis was conducted for different yoga and control group types, including mindfulness-based stress reduction versus non-mindfulness-based stress reduction based interventions, different populations, length of intervention, and method of data analysis. A random-effects model was used in all analyses.

**RESULTS:** Forty two studies were included in the meta-analysis. Interventions that included yoga asanas were associated with reduced evening cortisol, waking cortisol, ambulatory systolic blood pressure, resting heart rate, high frequency heart rate variability, fasting blood glucose, cholesterol and low density lipoprotein, compared to active control. However, the reported interventions were heterogeneous.

**CONCLUSIONS:** Practices that include yoga asanas appear to be associated with improved regulation of the sympathetic nervous system and hypothalamic-pituitary-adrenal system in various populations.

PMID:28963884

No 455: January 2, 2019

Nick N, Petramfar P, Ghodsbin F, Keshavarzi S, Jahanbin I. The Effect of Yoga on Balance and Fear of Falling in Older Adults. PM R. 2016 Feb;8(2):145-51. doi: 10.1016/j.pmrj.2015.06.442. Epub 2015 Jul 8.



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**OBJECTIVE:** To determine the effect of yoga on balance and fear of falling in older adults.

**DESIGN:** Randomized controlled trial.

**SETTING:** Jahandidegan Center in Shiraz, southern Iran.

**PARTICIPANTS:** Forty persons (17 men and 23 women) between the ages of 60-74 years with a Modified Falls Efficacy Scale (MFES) score <8 and a Berg Balance Scale (BBS) score <45. After completing the MFES questionnaire and BBS measurement, the participants were divided into intervention and control groups. BBS measurement and the MFES questionnaire were completed again immediately after the intervention.

**INTERVENTION:** The intervention group participated in 2 yoga practice sessions per week for 8 weeks. The control group received no intervention.

**MAIN OUTCOME MEASUREMENTS:** Fear of falling was measured with the MFES and balance was measured with the BBS.

**RESULTS:** We found significant changes in both variables ( $P < .0001$ ). Mean differences before and after the intervention for the BBS for yoga and control groups were 10.19 and -1.16, respectively. Mean differences before and after the intervention for the MFES for yoga and control groups were 1.62 and -0.21, respectively.

**CONCLUSION:** Yoga is a potential intervention to reduce fear of falling and improve balance in older adults.

PMID: 26164350