

Assessment of Balance in Elderly with Risk of Fall

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Abstract: Background: Falls belong to the most common events threatening the independence of older people and are considered one of the “Geriatric Giants”. It occur around 30–40% of community-dwelling adults older than 65 years worldwide each year. Approximately 1 in 10 falls results in a serious injury, such as hip fracture, other fracture, and subdural hematoma, other serious soft tissue injury, or head injury. Falls account for approximately 10 percent of visits to the emergency department. Numerous risk factors for falls are found in elderly, such as dialysis, polypharmacy, diabetes mellitus and cardiovascular disease, peripheral neuropathy, autonomic dysfunction, orthostatic hypotension, functional decline and cognitive impairment. Posturography test may provide good prediction of all the different classes of falls. There is increase in elderly population all over the world and there is trend towards improving quality of health care services for them. So the medical assessment of fall risks and provision of appropriate intervention are challenging. **Aims:** This study was undertaken to identify specific risk factors that place elderly individuals at increased risk of falling, to predict values of posturography in estimating the risk and cause of falls in elderly and to detect percentage of peripheral or central vestibular disorders in elderly with repeated falls. **Material & Methods:** during the period from January 2016 to February 2018. 60 subjects as a study group. It was a systematic sample, all done tympanogram, PTA, office tests, FGA, VNG & CDP. **Results:** The peripheral vestibular lesions was (68.33%), episodic vestibular syndrome (EVS) was the commonest with (75%) **Conclusion:** No single symptom can predict specifically the underlying causes of falling in elderly and determining the cause remains a challenging problem. Intensive early proper multi-disciplinary management (diagnosis and treatment) remains the primary approach to reduce the risk of fall. Vestibular, postural control & gait dysfunction are common in elderly.

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1. Introduction and Rationale

Balance is fundamental to our daily activities. It is a mechanism that facilitates our orientation in the three dimensional space, thereby preventing falling down by regulating postural control. As maintenance of balance depends on interaction of multiple sensory, motor and integrative systems, if any one of them is affected, patient is at a risk of fall (**Sherrington et al., 2001**). There is a rise in the proportion of people aged 65 years and older. Successful independent living in older people can be compromised by a number of key health conditions including heart disease, stroke, diabetes and falls (**Gschwind et al., 2014**). This makes enabling healthy human aging to be one of the most challenging tasks for health care systems around the world (**Heckenbach et al., 2014**).

Falls belong to the most common events threatening the independence of older people and are considered one of the “Geriatric Giants”. It occur around 30–40% of community-dwelling adults older than 65 years worldwide each year [**Pan et al., (2014)** and **Rezaei et al., (2015)**]. More than one third of

people 65 years of age or older fall each year and in half of such cases the falls are recurrent. Approximately 1 in 10 falls results in a serious injury, such as hip fracture, subdural hematoma, other serious soft tissue injury or head injury. Falls account for approximately 10 percent of visits to the emergency department and 6 percent of urgent hospitalizations among elderly persons. Independently of other health conditions, falls are associated with restricted mobility; a decline in the ability to carry out activities such as dressing, bathing, shopping or housekeeping; and an increased risk of placement in a nursing home (**Tinetti, 2003**).

Numerous risk factors for falls are found in elderly, such as dialysis, polypharmacy, diabetes mellitus, cardiovascular disease, peripheral neuropathy, autonomic dysfunction, orthostatic hypotension, functional decline and cognitive impairment (**Polinder-Bos et al., 2014**). Another condition that is considered risk factor for falls in elderly is sarcopenia (Loss of muscle mass and strength) (**Paddon-Jones and Rasmussen 2009**).

Vertigo and dizziness are common complaints in elderly subjects with repeated falls. Vertigo (illusion of movement) most likely indicates a dysfunction within the vestibular system. On the other side, sensation of rotatory movement suggests a lesion involving the semicircular canals, an illusion of linear movement indicates a disturbance of otolith organs (Fetter, 2000).

Among older adults, falls are the leading cause of both fatal and nonfatal injuries. The consequences of fall-related injuries among over 65-year-olds include: long-lasting disability, loss of autonomy, lower quality of life, and problems with organizing professional and non-professional care for this group of patients. Falls are the main cause of injury-related disability, morbidity and mortality in geriatric people (Scherder et al., 2007 and Tinetti, Kumar 2010).

There is a constant concern among health professionals to prevent the consequences of fall in geriatric health. Thus, several instrument models have been developed for the early detection of those with the greatest risk of falls. An extensive range of tests has been developed for use in the clinical setting (Rezaei et al., 2015).

Posturography test may provide good prediction of all the different classes of falls as the dynamic postural responses to destabilizing events are significantly altered to fallers compared to non-fallers (Lois et al., 2003).

One of the clinical tests which evaluates peripheral and central vestibular system and can be used as a tool to predict risk of fall in the elderly is the VNG test. The VNG has become the “gold-standard” assessment of the integrity of semicircular canal function (Rezaei et al., 2015).

So it is crucial to conduct a research aimed at dealing with health challenges of an ageing population such as fall prevention. The prevention of falls and its serious consequences (e.g., hip fracture) may enable older people to live independently, maintain their quality of life and reduce health care costs (Gschwind et al., 2014).

Also, there is increase in elderly population all over the world and there is trend towards improving quality of health care services for them. So the medical assessment of fall risks and provision of appropriate intervention are challenging. Accordingly, this study was designed to explore the complex nature of falls and to provide the optimal approaches in assessment and guide for intervention.

Also, to determine which measurements and test conditions on posturography are most useful for identifying balance problems in older peoples.

Aims of the work:

- To identify specific risk factors that place elderly individuals at increased risk of falling.

- To predict values of posturography in estimating the risk and cause of falls in elderly.
- To detect percentage of peripheral or central vestibular disorders in elderly with repeated falls.

2. Materials and Method

This study was carried out in Audiology unit, ENT department EL Hussein hospital. The duration of the study was from January 2016 to February 2018.

Research Ethic Committee of Al- Azhar University approved the study.

Materials:

Subjects

The present study was included 60 patients. The participants were selected from the Audiovestibular clinic of EL Hussein hospital with the following criteria.

Equipment:

- Two channel audiometer Interacoustics, model AC40.
- Sound treated room locally made.
- Immittance meter Interacoustics, Model AZ26.
- Computerized infra-red 4 channel video nystagmography (VNG), model Micromedical spectrum8.
- Computerized Dynamic Posturography system (Equitest), Neurocom Smart.

All subjects were submitted to the following:

- All subjects submitted to the following:

1. Full history taking.
2. Otoloscopic examination.
3. Basic audiological evaluation:
 - a. Pure tone and speech audiometry.
 - b. Acoustic immittance testing.

Assessment of risk of fall by:

- Arabic Dizziness handicap inventory (DHI) (EL Gohary et al., 2000).
- Representative Falls Case History Form (Tibbits, 1996).
- Functional gait assessment test (FGA) (Wrisley et al., 2004).
- Office tests
- Laboratory Vestibular Tests:
 - Videonystagmography (VNG).
 - Computerized Dynamic Posturography (SOT).

3. Results

The present study included 60 subjects as a study group. It was a systematic sample, came to audio vestibular clinic at Al Hussin University Hospital, most of cases done in 2 sessions one for audiological evaluation and the other for vestibular evaluation, it was difficult to do all the tests at same session because

of their age. Norms for VNG & CDP tests were obtained from the standardized normal values of the software used. The standard of FGA was used the

values of Arabic version of FGA (Tawfik et al., 2010).

Table 1: Mean, SD and range of age & gender distribution for the study groups:

		Mean + SD	Minimum - Maximum
Age		68.9 + 2.9	65.0 - 75.0
		N	%
Gender	female	36	60.0%
	male	24	40.0%

Table 2: Distribution of study groups:

Study groups	No.	Percent
Group I	7	11.66%
*Group II	49	81.66%
Group III	4	6.66%

*The largest % is group II

Group I: subjects complaining of dizziness with non-fall.

Group II: subjects with risk factors for falling with or without dizziness.

Group III: Subjects with multiple falls without dizziness or risk factors.

Table 3: Distribution of associated Comorbidities among studied population:

Risk factors	Abnormality number	%
Smoking	20	33.3%
Dizziness	51	85%
Obesity	11	18.3%
DM	20	33.3%
Hypertension	37	61.7%
Cardiovascular	7	11.6%
Neurological	11	18.3%
Impaired gait due to anyother diseases	10	16.7%
History of fracture	5	8.3%
Urinary incontinence	3	5%
Hyperlipidemia	21	35%
Impaired vision	22	36.6%
Arthritis	16	26.6%

Extrinsic risk factors for falling in our study shows that 51 patients c/o dizziness, most of patients had more than one risk factors for fall.

Table 4: History of previous falls in the studied groups (%):

		N	%
No of Falls	0	37	61.7%
	1	4	6.7%
	2	10	16.6%
	3	8	13.3%
	4	1	1.7%

Most of study group patients (61.7%) had no history of previous falls.

Table 5: Different types of vestibular lesions:

	N	%
Peripheral	41	68.33%

Central	15	25%
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The peripheral vestibular lesions was (68.33%).

Table 6: Correlations between different tests

Correlations		Age	DHI score	CDP C4	CDP C5	CDP C6	CDP SOT	FGA
Age	Pearson Correlation	1						
	P							
DHI score	Pearson Correlation	.274*	1					
	P	.034						
CDP C4	Pearson Correlation	.147	-.576**	1				
	P	.262	.000					
CDP C5	Pearson Correlation	.148	-.611**	.874**	1			
	P	.260	.000	.000				
CDP C6	Pearson Correlation	.061	-.591**	.815**	.945**	1		
	P	.644	.000	.000	.000			
CDP SOT	Pearson Correlation	.144	-.627**	.865**	.922**	.931**	1	
	P	.271	.000	.000	.000	.000		
FGA	Pearson Correlation	-.107	-.834**	.651**	.675**	.664**	.706**	1
	P	.415	.000	.000	.000	.000	.000	
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

There was a strong negative correlation between means of DHI & FGA scores, as patients reported more disabilities had worse total score in FGA test and There was either a strong negative correlation between means of DHI & SOT scores (C4, C5, C6 and composite). The table above indicates significant positive correlation between the total of FGA and SOT scores (C4, C5, C6 and composite).

4. Discussion

Falls are a main cause of morbidity and disability in the elderly. More than one-third of persons 65 years of age or older fall each year, and in half of such cases the falls are recurrent (Tinetti and Kumar, 2010). The risk doubles or triples in the presence of cognitive impairment or history of previous falls (Tinetti, 1988). In Canada, falls are the most common cause (85%) of injury-related hospital admissions among those aged 65 years or older (Canadian Institute for Health Information, 2003).

In the present study 60 subjects had an age range of 65-75 years with mean age 68.9 years, all independence in their activities of daily living. It consisted of 40% males & 60% females (table 1) this results agree with Jonsson et al. (2004) and Timothy, 2018 found that the overall prevalence of balance problems at age 70 was (36%) females and (29%) males, i.e balance symptoms were more common among women than men and increased with increasing age. They divided into 3 groups according to their

complaints, group II was the largest (main) one it consisted of 49 subjects (subjects with risk factors for falling with or without dizziness) (table 2). Dizziness was the most frequent complaint (85%) in the studied groups (table 4) which reflected vestibular and balance dysfunction, considered to be one of the major risks for falls (Tinetti, 2003). Similar results were obtained by Murray et al., (2005) who conducted a study on the elderly discharged home from the Emergency Department following a fall and found that 75% of them suffered from vestibular and balance dysfunction also, Taha et al., (2012) found 40% of their patients had vestibular and balance dysfunction. Dizziness and vertigo may result from a myriad of other underlying factors, including medications, cardiovascular conditions, anxiety, depression (Rubenstein, 2006), or age-related deterioration of the vestibular system (Matheson et al., 1999). Orthostatic, or postural, hypotension is usually defined as a drop in systolic blood pressure ≥ 20 mmHg upon standing from lying down (Rubenstein, 2006). Approximately 10-30% of healthy, community-dwelling, elderly people have postural hypotension. Orthostatic hypotension may be a side effect of some medications and can also be caused by prolonged periods of lying down (Rubenstein, 2006).

Falls are usually multifactorial in origin, so multidisciplinary assessments and interventions are needed to prevent falls. As regard risk factors for falling, they include the following: previous falls,

balance impairment, decreased muscle strength, visual impairment, polypharmacy (more than 4 medications increased risk of recurrent falls) or psychoactive drugs (was excluded in our study), gait impairment and walking difficulty, depression, functional limitations, female sex, incontinence, cognitive impairment (decline typically affects aspects of memory, processing speed, and reasoning – all of which are necessary to carry out everyday tasks), arthritis and diabetes (**Takakusaki et al., 2008**). The risk of falling increases with the number of risk factors: 1-year risk of falling doubles with each additional factor, starting from 8% with none, and reaching 78% with 4 risk factors (as mentioned in the review). So a valid and reliable measure of fall risk could also be used as an outcome measure for interventions designed to reduce an individual's risk for falls. In this study, the possible predictors of fall risk, on the basis of a review of the study (vestibular battery test (DHI, office tests and VNG), CDP, vision, arthritis (history of visual acuity and arthritis) and FGA (**Harwood et al., 2005 and Barak et al., 2006**) was shown in (**table 3**) most of patients had more than one risk factors for fall.

Prevention strategies for falls in the elderly population have yet to be properly studied. It is therefore important to identify those people most at risk of falling to maximize the effectiveness of any proposed intervention. Published studies have identified specific risk factors for falls and related injuries. The presence of multiple chronic conditions or comorbidities is significantly associated with falls (**Byers et al., 2008 and Deandrea et al., 2010**).

In this study **table (3)** shows the risk factors (intrinsic and extrinsic factors) that found in the patients, through objective and subjective assessments we tried to assess these risk factors. We believe that a valid and reliable measure of fall risk could also be used as an outcome measure for interventions designed to reduce an individual's risk for falls. **Table (8)** shows another risk factor for falling (38.3%) had a history of previous falls, these results agree with **John et al., 2010**, they reported that falls in the elderly are often of multifactorial origin.

As revealed by audiological evaluation, (5%) had normal peripheral hearing while sensorineural hearing loss was detected in (81.66%) (**table 6-7**). It is may be due to presbycusis, which is the auditory dysfunction associated with the aging process, it is a generic term used to include several forms of hearing degeneration. The World Health Organization (WHO) estimates that in 2025 there will be 1.2 billion people over 60 years of age worldwide, with more than 500 million individuals who will suffer significant impairment from presbycusis (**Sprinzl and Riechelmann, 2010**). Sensory presbycusis stems from degenerating organ of Corti, which elicits hearing loss in the high-frequency

range. Neural presbycusis shows a moderate downward slope of pure tone threshold toward high-frequency and a severe decrease in speech discrimination compared to pure tone threshold (**Merchant and Nadol, 2010**). Strial or metabolic presbycusis shows hearing loss across all frequency range in audiogram. Cochlear conductive presbycusis is manifested by a low-frequency hearing loss (**Lee, 2013**).

Most of the patients had moderate degree of handicap (86.7%) in Dizziness Handicap inventory (DHI) scoring (**table 9**) which assess the impact of dizziness on quality of life. **Vereek et al., (2007)** reported that DHI explains a large component of handicap in dizzy and unsteady patients (physical, emotional and functional).

Age related deficits appear to be larger on semicircular canals function, followed by saccular function, while the utriculus remains less affected [**Agrawal et al., (2013), Davalos-Bichara and Agrawal, (2014) and Li et al., 2015**]]. A steady asymmetrical decrease in the ability of sensing angular rotation with age has been reported, as assessed by video head impulse testing (vHIT) of the vestibulo-ocular reflex (VOR) [**Ekvall and Magnusson, (2013) and Li et al., (2015)**]].

As regard office tests (**table 10**) to assess Vestibulospinal Reflex (VSR) we applied: Fukuda test which was positive in 12 patients (20%), mCTSIB test was positive in 38 patients (63.3%) and Romberg's test which was positive in 9 patients. The role of VSR to generates compensatory body movement to maintain head and postural stability, thereby preventing falls. Poor VSR results reflecting in diminished confidence in balance, decreased gait speed and increased risk for falling.

Bedside HIT remains a useful clinical sign to assess patients with acute spontaneous vertigo because it helps to distinguish between acute VN, where the test is positive, and a central vestibular lesion, where the test is usually negative. However, between 9% and 39% of positive clinical HIT results have been reported in patients with acute cerebellar or brainstem strokes (**Cnyrim et al., 2008) and Newman-Toker et al., (2008)**). It was positive in 16 patients in this study.

HST assesses function of horizontal SCC at middle frequency while caloric test assess at low frequency range and it was positive in 9 patients.

In the present study, the vestibular test battery (**Tables 11-14**) revealed that most patients suffered from peripheral vestibular dysfunction (68.33%). The most frequent VNG abnormality was benign paroxysmal positional vertigo (BPPV) which diagnosed in 18 patients (30%) and this agree with **Imbaud Genieys, 2007** performed vestibular function tests in the elderly and reported that the commonest

cause for fall was BPPV (68%), neurologic problems (9%), Meniere's disease (5%) and lastly a psychiatric (8%) and vascular disorders (8%). Also, in a studies conducted by [Katsarkas, (1994), Davis, (1994) and Iwasaki and Yamasoba, (2015)] benign paroxysmal positional vertigo (BPPV) was the most frequent form of peripheral vestibular dysfunction, followed by Meniere's disease and vestibular neuritis which was explained by dislodged otoconia by aging and participated in SCC, in older women may have osteopenia or osteoporosis due to estrogen deficiency.

Concerning VNG test findings, Oculomotor test results for all the groups were within normal range; except one patient had abnormal oculomotor test and diagnosed as central vestibular lesion, spontaneous nystagmus was detected in (11.7%) and Positional nystagmus was found in (28.3%) (table 11).

Most patients suffered from peripheral vestibular lesions (68.33%) while central vestibular lesions were presented in (25%). These 15 patients were referred for further radiological and neurological evaluation, whereas diagnosed as TIA, vestibular migraine, subacute cerebellar hemorrhage and old brainstem infarction (table 15-16); this agree with most studies regarding dizziness in the elderly, peripheral vestibular dysfunction is the first or the second most frequent cause of dizziness (Lawson et al., (1999) and Neuhauser et al., (2001)).

Regarding FGA total scores, (100%) of patients had abnormal scoring with mean + S.D (22.0 + 3.1) reflecting decrease gait stability; similar findings were demonstrated in a study conducted by Walker et al. (2007) they assessed (33, 63 & 44) subjects in (5th, 6th & 7th decades) respectively, with vestibular disorders who had age mean 58.7years. They reported a systematic decrease with increased age & an increase in SD of total scores with each decade, demonstrating increased variability of performance of FGA with age another study agree with these results (Tewfik et al., 2010).

CDP is an important tool that can complement conventional tests as it shows evidence of changes in body balance in the majority of cases and provides information to establish an otoneurological clinical picture as it is an objective and quantitative measure of balance and postural instability. CDP was efficient in the present study in the evaluation of the elderly population because imbalance and falls in this population result from the cumulative effects of diseases and degenerative phenomena that are typical of aging (tables 17-18) and make an appropriate differential diagnosis in patients presenting with falls or balance impairment. It was also used to reliably identify participants who are at risk of falling.

This study found that in the SOT test condition 4 showed that elderly population (33.4%) table (17) was

affected with respect to falls's table, this agreed with Whitney et al. (2006) reported that (33%) patients fell on at least 1 trial of condition 4. which probably indicated a difficulty in stabilizing the image on the retina in patients with vestibular disorders when facing an unstable supporting surface and which may explain the body oscillation in the condition mentioned. Similarly, body oscillation can be explained by other hypotheses, such as neurological impairment as a result of conflicting afferent stimuli (Mirallas et al., 2011); dependence on proprioceptive afferents that are associated with the inability to compensate with visual support (Bankoff and Bekedorf, 2007); dependence of vision on postural control, especially when facing a rough surface [Hay et al., (1996) and Lord and Menz, (2000)] inadequate motor response when proprioception is modified (Teixeira et al., 2011); alteration in vestibular-visual integration, which is hampered by age (Ricci et al., 2009); or all of the above.

The most frequent abnormalities were SOT conditions C5 and C6 reflecting a vestibular pattern of dysfunction in this study, Whitney et al. (2007) found that the elderly prone to falls have lower SOT scores than those who are not prone to falls. As abnormalities in C5 & C6 were proven to be of vestibular origin, in the present study all abnormalities in SOT test were in these conditions and also in the composite score. All subjects had normal conditions 1, 2 & 3. While there were twenty patients with abnormal scores in condition 4 (table17).

Conditions 5 and 6, (70% and 78.3%) respectively (table 17) which are more difficult to implement due to the decrease in the proprioceptive sensory afferents of the ankles, together with the absence of visual support, as was shown in the results of this study, Teixeira et al. (2011) explained similar results that vestibular system require higher efficiency in the maintenance of balance.

Condition 6 was the situation that best evaluated the vestibular system because the patient was free on the platform and did not have any visual information (Bittar et al., (2004) and Pang et al., (2011)). Mean + S.D was the lowest 59.4 + 8.6 (table 18) which lied in fall risk.

The functional impact of peripheral and/or central vestibular abnormalities on patients' body balance can be categorized as the inability to use vestibular information, which was shown as abnormal results in conditions C5 and C6 or only C5. The inability to cancel the influence of inaccurate visual information, which was shown as abnormal results in condition C6 and the combinations of that described above, elicited abnormal results in conditions C5 and C6. Patients with peripheral vestibular disorders showed abnormal balance, especially in conditions C5

and C6, which require normal vestibular function for the maintenance of body stability, and this completed the analysis of the findings and agreed with the information collected from the patients in the SOT (Asai et al., 1993). Similar results was found by EL-Zarea et al., (2015) that the elderly exhibited lower equilibrium composite scores compared to control group in all SOT conditions and about 12.5% of elderly subjects have abnormal SOT results especially in (conditions 4,5 and 6). they suggested that visual and somatosensory afferences were effective compensatory systems to maintain equilibrium in the fixed platform and stable visual field conditions attributed to the compromised sensory inputs (vision, vestibular and proprioception) of balance in elderly.

The patients in this study had reduced SOT composite scores with a mean of (62.2) due to vestibular deficit. The total mean score of FGA was (22.0) (table 18). Which means that FGA can truly measure functional impairment in these patients.

Wrisley and Kumar, (2010) found that A cutoff score of 22/30 on the FGA provides optimum validity for classifying fall risk in older adults at risk for falling and in predicting unexplained falls in community-dwelling older adults. The FGA appears to predict falls in community-dwelling older adults better than other clinical tools.

As regard graph (1) 90% of patients in our study with gait problems have falling tendency in CDP. While the patients without gait problems (50 persons), 32% were within normal range of composite score.

The correlation between tests:

1. There was a significant positive correlation between SOT composite score and FGA total score (table 25). This reveals that risk of fall due to SOT abnormalities could be detected during performance of the FGA test. This reflects that FGA test can predict functional deficit efficiently as the high tech SOT. Tewfik et al., 2010 reported similar results in peripheral vestibular disease. Whitney et al. (2006) reported that using the SOT composite score can help confirm the clinician's other examination findings about the patient's postural stability. They found a relationship between the composite score of the SOT and reported falls in persons with vestibular disorders.

2. Dizziness handicap inventory (DHI) showed a highly statistically significant negative correlation in comparison with the total score of FGA test (table 25). This means that higher degrees of handicap reflected functionally by lower total score in FGA test. This indicates that subjective sense of handicap reflects functional deficits present during FGA test performance with increased risk of fall. This results agreed with Tewfik et al., 2010.

3. There was a strong negative correlation between means of DHI & SOT scores (C4, C5, C6 and

composite). This means that higher degrees of handicap reflected functionally by lower SOT total score.

4. In this study there was highly positive correlation between mCTSIB & SOT composite score and benefit in clinics we can use mCTSIB as easy & inexpensive way can predict functional deficit efficiently as the high tech SOT and risk of falling.

The present study revealed that FGA test could be used in detecting functional deficits in elderly as it matches the composite score of SOT. Also, to predict risk of fall in elderly, this can help in application of a short form of test battery to assess elderly and save time.

Age related balance deterioration seems to be extremely variable from patient to patient. Reaching a complete management in elderly dizzy patients remain an important challenge for the audiovestibular clinicians.

Conclusions

- No single symptom can predict specifically the underlying causes of falling in elderly and determining the cause remains a challenging problem.
- It is important that audiologists are aware of the increased risk of falls among their patients and address this issue especially in elderly patients.
- Intensive early proper multi-disciplinary management (diagnosis and treatment) remains the primary approach to reduce the risk of fall.
- Vestibular (otolith & semicircular canal), postural control & gait dysfunction are common in elderly.
- Office tests are simple, useful for screening, fast, low cost and easy to interpret VOR and VSR.
- The impairments of each of 3 SCC can be examined by VHIT and assessment of utricle and saccular function by VEMP.
- Overall equilibrium performance can be evaluated by using Dynamic Posturography.

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