RISK OF FALLS IN THE ELDERLY AND ITS RELATION WITH VESTIBULAR AND COGNITIVE FUNCTION

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ABSTRACT:

Background: *Falls are defined as unintentional incidents in which a person loses equilibrium and either fails to attempt to regain it or makes no attempt at all.*

Aim and Objectives: *To investigate relationship between risk of falls in elderly with or without vestibular disorders and cognitive function.*

Patients and Methods: *This cross-sectional study was conducted on 30 elderly patients aged ≥ 60 in vestibular clinic at El-Demerdash hospital by random sampling.*

Results: *The study group was divided into two groups normal / abnormal cognitive function regarding mini mental state examination. All patients had normal peripheral hearing. Three patients had positive Spontaneous nystagmus in VNG test. Two patients had positive Post head shake nystagmus in Video-Nystagmography (VNG) test and only one patient had positive Positional nystagmus. There was a highly statistically significant difference between the two groups in Arabic fall Efficacy scale- international (FES-I) levels and mini-mental state examination (MMSE) score normality and risk of falls.*

Conclusion: *Dizziness, vertigo, and falls are common in older adults. Cognitive decline is a primary factor in determining the risk of falls and has affect in vestibular functions proof that we are increasing effectiveness of vestibular rehabilitation by adding cognitive tasks to improve effect of rehabilitation and assess cognitive function improvement during vestibular rehabilitation. A fall risk prediction tool for the elderly could gauge vestibular multimodal processing decline, which would be useful for both prevention and determining rehabilitation goals.*

Keywords: *Vestibular and Cognitive function, MMSE score, Fall-related injuries.*

INTRODUCTION:

Falls are defined as unintentional incidents in which a person loses equilibrium and either fails to attempt to regain it or makes no attempt at all [(1)].

The most frequent cause of injuries among the elderly is thought to be falls. Falls are the cause of 40% of hospitalizations related to traumatic injuries [(2)].

It has been demonstrated that fall-related injuries account for over 1,800 deaths annually among US older adults. Nonetheless, among older persons who survive falls, a decline in quality of life and persistent impairment predominates. It has

also been demonstrated that fear of falls is caused by other aberrant lifestyle characteristics, such as social isolation, a sense of helplessness, loss of function, and depression among the elderly. More money was spent in the US on treating injuries caused by falls among the elderly. It has been demonstrated that gait and balance disorders are the most frequent causes of falls in the elderly, and that these falls typically result in harm, impairment, and a reduced quality of life [(3)].

Health care has traditionally placed a high premium on a safe atmosphere. Uneven surfaces, items on rugs or surfaces, damp surfaces or slick shoes, storage issues, a lack of safety features in the restroom, and transfer issues were among the environmental factors that contributed to falls. At two and four months after the intervention, there is a significant decrease in the scores of all environmental risks and safety measures when there is an increase in awareness of these topics [(4)].

Vertigo affects 41% of patients with unexplained falls, while vestibular system involvement symptoms affect 80% of patients. Even while multisystem impairment is a common cause of falls in the elderly, vestibular system impairment can also play a significant role. This patient population has vestibular issues, and it is crucial to identify them because vestibular rehabilitation exercises help with symptoms and balance. This could aid in preventing additional falls [(5)].

AIM OF THE WORK:

The aim of the work was to investigate relation of risk of falls in elderly with cognitive and vestibular function.

PATIENTS AND METHODS:

This cross-sectional study was conducted on 30 elderly patients aged 60 year and older in vestibular clinic at El-Demerdash Hospital by random sampling.

Inclusion Criteria: Both males and females, subject older than 60 years old, patients have history of fall in the last 6 months and no restriction of associated common disease (DM, hypertension)

Exclusion Criteria: Severe cognitive disabilities, mental retardation, neuropsychiatric disorders receive medication and any subject unable to participate in the study because of blindness or musculo-skeletal abnormalities.

Equipment:

Questionnaire: Arabic fall Efficacy scale- international (FES-I (Ar) [(6)], computerized video –nystgmography 2channels (Micromedical Technologies, mobile eyes, spectrum 8.10) and stopwatch_ medium density foam.

Study Procedures:

Full history taking: Personal history including (age, gender, educational level and occupation), Ear problems or previous ENT operations, loss of consciousness, fainting or falling attacks, Systemic disease (Diabetes mellitus, Hypertension) and medication used and ototoxic drug intake.

Cognitive assessment: Using the Arabic version of mini-mental state examination (MMSE). It comprises 30 questions assessing orientation to time and place, attention, calculation and language skill. Ten items devoted to orientation (five regarding time and five regarding place). Three items requiring registration of new information (repeating three words). Five questions addressing attention and calculation. Mental control questions requiring patient to make five serial subtractions of 7 from 100 (or spell word backward). Three recall items (remembering the three registration items). Eight items assessing language skills (two naming items, repeating phrase, following a written command, and writing a sentence).

One construction question (copying a figure consisting of two overlapping pentagons) [7].

Risk of fall assessment: (physical and mental) including: Questionnaire: The Arabic fall Efficacy scale- international (FES-I(Ar) is a 16-item questionnaire that translated from the original English version of the scale (FES-I) [6,8], physical examination: detailed clinical examination including.

Vestibular assessment: including Vestibular office tests, Fukuda stepping test, modified clinical test of sensory integration for balance (mCTSIB), Head thrust test, Tandem gait test (Assessment was by 2 examiners to protect patients and close to walls. Stop the test with any sway) and Video-Nystagmography Test (VNG). The video and data of the patient were stored in a privacy file with password in the computer of the clinic. No one had right to read the patient medical information except the main researcher.

Ethical consideration:

Informed written consent was taken from the patients involved in this study and the study protocol has been approved by the Ain-Shams Institute's Ethical Committee of Human Research. Committee number is (MS564/2021).
Written consent will be obtained from all patients before testing and after explaining the aim of the study and the procedure to be done.

RESULTS:

This cross-sectional study was carried on 30 patients 60 years old and older. The study group was selected from vestibular clinic at El-Demerdash hospital.

Table 1: Demographic data among the study population

Study population (n = 30)	
Age in years	
Mean ± SD.	70 ± 4.71
Range (Min-Max)	20 (60 - 80)
Gender	
Male	16 (53.33%)
Female	14 (46.67%)

Number of male patients in the study population was more than female patients.

Table 2: FES_I Questionnaire among the study population

	Study population (n = 30)
FES-I total score	
Mean ± SD.	27.77 ± 12.98
FES-I levels	
• Low concern about falling	9 (30%)
• Moderate concern about falling	6 (20%)
• High concern about falling	15 (50%)

Nine patients in the study population had low concern about falling, six patients had moderate concern about falling and the remaining half of the study population had high concern about falling.

Table 3: VNG test results among the study population

Spontaneous	3 (10%)
Post head shake	2 (6.67%)
Positional	1 (3.33%)
Oculomotor test	
Positive Gaze	0 (0%)
Positive Saccade	0 (0%)
Positive Smooth pursuit	0 (0%)
Positive OPK	0 (0%)
Caloric test	
Asymmetry	
Mean ± SD.	6.97 ± 3.03
Range (Min-Max)	13 (3 - 16)
Fixation Index	
Mean ± SD.	0.18 ± 0.08
Range (Min-Max)	0.27 (0.03 - 0.3)

Three patients had positive Spontaneous nystagmus in VNG test. Two patients had positive Post head shake nystagmus in VNG test and only one patient had positive Positional nystagmus.

Table 4: Association between MCTSIB test abnormality on FES_I and MMSE questionnaires abnormality

	Negative MCTSIB	Positive MCTSIB	Test of Sig.	p
FES-I levels			X2 = 17.733	<0.001
Low concern about falling	9 (60%)	0 (0%)		
Moderate concern about falling	4 (26.67%)	2 (13.33%)		
High concern about falling	2 (13.33%)	13 (86.67%)		
MMSE abnormality			X2 = 9.13	0.003
Normal	15 (100%)	8 (53.33%)		
Abnormal	0 (0%)	7 (46.67%)		

There was a highly statistically significant difference between the two groups regarding FES-I levels and regarding MMSE score normality, there was a significant difference.

Table 5: Comparison between normal vs abnormal cognitive people regarding Risk of falls

	Normal cognitive people (n = 23)	Abnormal cognitive people (n = 7)	Test of Sig.	p
Risk of falls (FES-I) total score			t = -7.263	<0.001
Mean ± SD.	23.13 ± 11.03	43 ± 3.92		
Range (Min-Max)	42 (6 - 48)	11 (37 - 48)		
Risk of falls (FES-I) levels			X2 = 9.13	0.01
• Low concern about falling	9 (39.13%)	0 (0%)		
• Moderate concern about falling	6 (26.09%)	0 (0%)		
• High concern about falling	8 (34.78%)	7 (100%)		

χ2: Chi- Square test, **SD:** standard deviation , **IQR:** interquartile range
t: Independent T test, **p**: p value for comparing between the studied groups.
P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.001: Highly significant

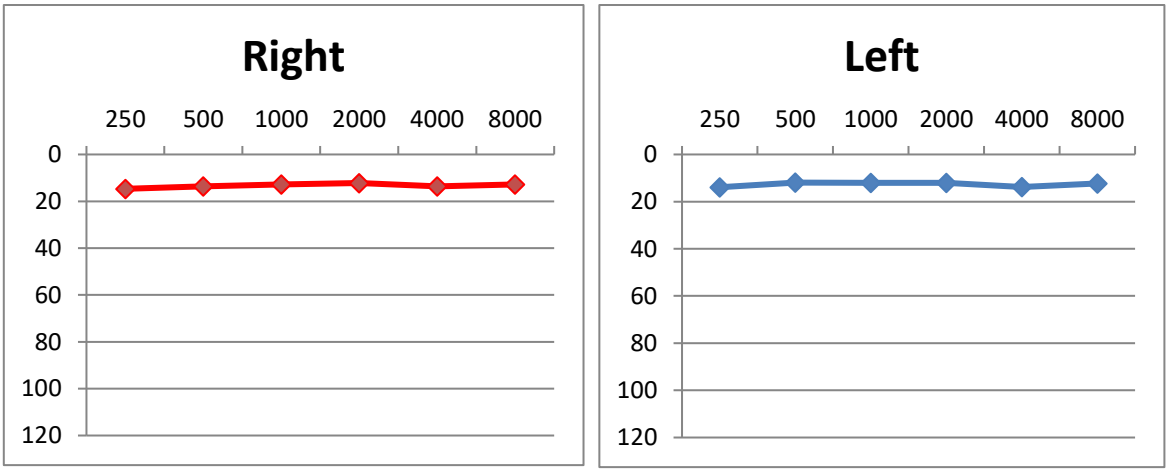
Regarding risk of falls, there was a statistically significant difference between the two studied groups.

Table 6: Comparison between levels of risk of fall regarding cognitive functions:

	Low concern (n = 9)	Moderate concern (n = 6)	High concern (n = 15)	Test of Sig.	p
MMSE total score				F = 45.11	<0.001
Mean ± SD.	29.56 ± 1.59	26.83 ± 1.6	23 ± 1.73		
Range (Min-Max)	4 (27 - 31)	4 (24 - 28)	6 (20 - 26)		
	P1 = 0.008, P2 = 0.001, P3 = <0.001				
MMSE score normality				X2 = 6.564	0.01
• Normal	9 (100%)	6 (100%)	8 (53.33%)		
• Abnormal	0 (0%)	0 (0%)	7 (46.67%)		
	P1 = <0.001, P2 = 0.04, P3 = 0.015				

χ2: Chi- Square test, SD: standard deviation, IQR: interquartile range, F: ANOVA test, p: p value for comparing between the studied groups, P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.001: Highly significant, P_1: Group 1 vs Group 2, P_2: Group 2 vs Group 3, P_3: Group 1 vs Group 3

Regarding cognitive function, there was a statistically significant difference between the three studied groups.



Line chart showing study population data regarding Right and left ear pure tone audiometry.

Figure (1) showed that all patients had normal right and left ear pure tone audiometry results in all frequencies.

DISCUSSION:

In the current study demographic characteristics of the studied patients showed that, mean age was 70 ± 4.71 years and number of male patients in the study population 16 (53.33%) was higher than the number of female patients 14 (46.67%) Table(1).

These data agreed with a recent study by *Politi et al.* [9] They used the results of vestibular testing to determine the fall risk in an elderly patient population that had a history of falls. With a mean age of 79.16 ±1.32 years, there were 17 (54.84%) men and 14 (45.16%) females among the 31 cases under study.

According to our findings, every patient exhibited pure tone audiometry readings in both the right and left ears that were normal across the board Figure (1).

In the same line *Harun et al.* [10] demonstrated that, at 125Hz, 250Hz, 500Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz, pure tone audiometry for air conduction was carried out for both the right and left ear. (100%) out of the sixty patients in total Participants with normal ear pure tone audiometry results were selected between December 2014 and November 2015 from the Johns Hopkins Memory and Alzheimer's Treatment Center, an interdisciplinary memory disorder.

In the current study, nine patients (30%) in the study population had low concern about falling, six patients (20%) had moderate concern about falling and the remaining half of the study population had high concern about falling. Table (2)

These findings disagreed with a previous study by *Caixeta et al.* [11] reported that 59 patients (77.6%) scored from 47 to 54 points a lower risk for falls, and 17 patients (22.4%) scored 0 to 46 points a higher risk for falls .

In the current study, three patients (10%) had positive Fukuda stepping test and positive VNG in the study population. Two patients (6.67%) had positive Post head shake VNG test in the study population. One patient (3.33%) had positive Positional VNG test in the study population Table (3).

Rogers [12]. reported similar findings to our results (14%) had positive Spontaneous VNG test in the study cases, and (9%) had positive Post head shake VNG test in the study patients.

Also, in another study titled "Study of Relationship between Results of Videonystagmography (VNG) Test with Number of Falls in Elderly" *Janghorban et al.* [13]. noted that, among all studied patients there were (4.6%) had positive Positional VNG test and (13%) had positive Spontaneous VNG test.

Regarding FES-I levels and MMSE score normally, there was a substantial difference between the two groups that was highly statistically significant. Table (4).

Noble et al. [14] revealed that no discernible difference had been observed between the normalized MMSE score and the FES_I total score. The study's objectives were to create and assess a 12-item version of the Speech, Spatial, and Qualities of Hearing Scale for use in clinical research and rehabilitation settings with older adults.

Our results showed that, there was a statistically significant difference between normal and abnormal cognitive people as regards risk of falls Table (5). Also, there was a statistically significant difference between the three studied groups (Low, Moderate and High concern) regarding cognitive function Table (6).

In agreement with our study a systematic review and meta-analysis performed by *Loughrey et al.* [15]. discovered a substantial correlation between age-related hearing loss and a decline in performance across all areas of cognitive function, as well as a significant difference between Low, Moderate, and High anxiety about falling. Moreover, they claim that hearing loss is associated with dementia and cognitive impairment, and that this link may also be influenced by vascular dysfunction and poor verbal communication.

In the light of the present study results, it can be concluded that, dizziness, vertigo, and falls are common in older adults. Cognitive decline had no effect on vestibular and balance function tests. On the other hand it can be considered as a complication of the high levels of risk of falls.

Moreover, High concerns in FES-I can be used as a predictive tool for high possibility of associated cognitive decline in elderly. So,it could be used to estimate vestibular multimodal processing decline and can be used in evaluation of outcome of rehabilitation programme in elderly .

Conclusion:

It can be inferred from the results of the current study that dizziness, vertigo, and falls are frequent in the elderly. One of the main factors influencing fall risk is cognitive deterioration. A fall risk prediction tool for the elderly may be able to quantify the decline in vestibular multimodal processing, which would be useful for both prevention and setting goals for rehabilitation. To get fresh findings on the association between senior people's cognitive and vestibular function and their fall risk, however, a large sample size and additional multicentric research in the future would be required.

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Conflicts of interest:

No conflicts of interest

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خطر السقوط لدى كبار السن وعلاقته بالوظيفه الأدراكيه والاتزان

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المقدمه: أنتشرعجز المشى والتوازن بشكل كبير بين كبار السن وترتبط بالعديد من العوامل الصحية ، يعتبر السقوط السبب الأكثر شيوعا للأصابات بين كبار السن. 40% من حالات الاصابات ذات صلة بالمستشفيات بسبب السقوط.

الهدف: من هذه الدراسة هو التحقيق فى تأثير مخاطر السقوط لدى كبار السن على الوظيفة الإدراكيه والإتزان.

المرضي وطريقة البحث: اجريت هذه الدراسة المستعرضة على 30 من كبار السن الذين عانو اخر 6 شهور من نوبات السقوط نتيجة لعدم الاتزان بقسم المسنين مستشفي الدمرداش.

النتايج: قمنا بتقسيم مجموعة الدراسة إلى مجموعتين: الوظيفة الإدراكية (الطبيعية / غير الطبيعية). جميع المرضى لديهم سمع محيطي طبيعي. لدى ثلاثة مرضى رأرأة عفوية إيجابية. لدى مريضين رأرأة إيجابية بعد هز الرأس في اختبار تصوير الرأرأة بالفيديو وكان مريض واحد فقط لديه رأرأة موضعية إيجابية. هناك فرق ذو دلالة إحصائية عالية بين المجموعتين في مقياس فعالية السقوط العربي - المستويات الدولية وفحص الحالة العقلية المصغرة الذي يسجل الحالة الطبيعية وخطر السقوط.

الخلاصه: الدوخة والدوار والسقوط شائعة لدى كبار السن. يعد التدهور المعرفي عاملاً أساسيًا في تحديد خطر السقوط وله تأثير على الوظائف الدهليزية، مما يدل على أننا نعمل على زيادة فعالية إعادة التأهيل الدهليزي عن طريق إضافة مهام معرفية لتحسين تأثير إعادة التأهيل وتقييم تحسن الوظيفة الإدراكية أثناء إعادة التأهيل الدهليزي. يمكن للأداة التنبؤية لخطر السقوط لدى كبار السن تقدير انخفاض المعالجة الدهليزية المتعددة الوسائط وبالتالي تلعب دورًا مهمًا في الوقاية وفي تقييم أهداف إعادة التأهيل.