Original Article

https://doi.org/10.1590/2317-6431R-2023-278en

Audiology Communication Research
ISSN 2317-6431

Effect of age on body balance and on the results of the video head impulse test in patients with heart failure

Efeito da idade no equilíbrio corporal e nos resultados do vídeo teste do impulso cefálico em pacientes com insuficiência cardíaca

Gizele Francisco Ferreira do Nascimento[1,2], *José Diniz Júnior*[3], *Rosiane Viana Zuza Diniz*[4], *Miguel Angelo Hyppolito*[5], *Erika Barioni Mantello*[1,2]

ABSTRACT

Purpose: to verify whether there is an association between the clinical assessment of balance and the gain in the vestibulo-ocular reflex with advancing age in patients with heart failure. **Methods:** analytical-descriptive, observational cross-sectional study, which included patients diagnosed with heart failure, divided into two groups by age (G1, under 60 years old and G2, 60 years old or older). The patients were evaluated through anamnesis, cardiac assessment, clinical assessment of body balance (cerebellar function screening and assessment of static and dynamic balance) and instrumental assessment of vestibular function (Video Head Impulse Test-vHIT). The findings were described and compared through inferential statistical analysis. **Results:** 34 patients with a mean age of 55 years and 9 months, mostly men (71.49%). There was no association between vestibulo-ocular reflex gain, symmetry of the semicircular canals and body balance with advancing age. Associations were observed between the results of the Unterberger-Fukuda test with the gain in the vestibulo-ocular reflex of the right lateral and left posterior semicircular canals and with the percentages of symmetry of the anterior semicircular canals for patients in Group 2. In Group 1, an association was observed between the results of the Unterberger-Fukuda test and the symmetry values of the anterior semicircular canals and the gain in the vestibulo-ocular reflex of the left anterior and right posterior semicircular canals. **Conclusion:** there was no association between the results of the clinical assessment of body balance and the vHIT findings with advancing age in patients with heart failure. However, there was a difference between the gain of the specific vestibulo-ocular reflex for some semicircular canals, with higher rates of alteration in the dynamic balance test, in both groups. The results of the applied tests allowed characterize the predominance of chronic vestibular hypofunction of peripheral origin in patients with heart failure, regardless of age group.

Keywords: Heart failure; Head pulse test; Vertigo; Vestibular tests; Cardiovascular diseases

RESUMO

Objetivo: verificar se existe associação entre a avaliação clínica do equilíbrio e o ganho do reflexo vestíbulo-ocular com o avanço da idade em pacientes com insuficiência cardíaca. **Métodos:** estudo transversal analítico-descritivo, de caráter observacional, que incluiu pacientes com diagnóstico de insuficiência cardíaca, divididos em dois grupos, por idade (G1,menos de 60 anos e G2, 60 anos ou mais). Os pacientes foram avaliados por meio de anamnese, avaliação cardiológica, avaliação clínica do equilíbrio corporal (triagem da função cerebelar e avaliação do equilíbrio estático e dinâmico) e instrumental da função vestibular (*Video Head Impulse Test-vHIT)*. Os achados obtidos foram descritos e comparados por meio de análise estatística inferencial. **Resultados:** foram avaliados 34 pacientes com média de idade de 55 anos e 9 meses, a maioria homens (71,49%). Não houve associação do ganho do reflexo vestíbulo-ocular, simetria dos canais semicirculares e avaliações do equilíbrio corporal com o avanço da idade. Observaram-se associações entre os resultados da prova de Unterberger-Fukuda com o ganho do reflexo vestíbulo-ocular do canal semicircular lateral direito e posterior esquerdo e com os percentuais de simetria dos canais semicirculares anteriores para os pacientes do Grupo 2. Para os indivíduos do Grupo 1, foi observada associação entre os resultados da prova de Unterberger-Fukuda com os valores de simetria dos canais semicirculares anteriores e do ganho de reflexo vestíbulo-ocular dos canais semicirculares anterior esquerdo e posterior direito. **Conclusão:** não houve associação entre os resultados da avaliação clínica do equilíbrio corporal e dos achados do vHIT com o avanço da idade, em pacientes com insuficiência cardíaca. Entretanto, observou-se diferença entre o ganho do reflexo vestíbulo-ocular específico para alguns canais semicirculares, com maiores índices de alteração na prova de equilíbrio dinâmico, em ambos os grupos. Os resultados dos testes aplicados permitiram caracterizar o predomínio da hipofunção vestibular crônica de origem periférica nos pacientes com insuficiência cardíaca, independentemente da faixa etária.

Palavras-chave: Insuficiência cardíaca; Teste do impulso cefálico; Vertigem; Testes vestibulares; Doenças cardiovasculares

Study carried out at Programa Associado de Pós-graduação em Fonoaudiologia – PPgFon, Universidade Federal do Rio Grande do Norte – UFRN – Natal (RN), Brasil.
[1]Programa Associado de Pós-graduação em Fonoaudiologia (Mestrado) – PpgFon, Universidade Federal do Rio Grande do Norte – UFRN – Natal (RN), Brasil.
[2]Departamento de Fonoaudiologia, Universidade Federal do Rio Grande do Norte – UFRN – Natal (RN), Brasil.
[3]Ambulatório de Otoneurologia, Departamento de Cirurgia, Universidade Federal do Rio Grande do Norte – UFRN – Natal (RN), Brasil.
[4]Ambulatório de Cardiologia, Departamento de Clínica Médica, Universidade Federal do Rio Grande do Norte – UFRN – Natal (RN), Brasil.
[5]Departamento de Oftalmologia, Otorrinolaringologia e Cirurgia de Cabeça de Pescoço, Faculdade de Medicina de Ribeirão Preto –FMRP, Universidade de São Paulo – USP – Ribeirão Preto (SP), Brasil.

Conflict of interests: No.
Authors' contribution: GFFN and EBM were responsible for the study design, analysis and interpretation of data and writing of the manuscript; JDJ and RVZD were responsible for patient referral and data selection; GFFN, MAH and EBM were responsible for critical review for intellectual and relevant content. All authors were responsible for the final approval of the version to be submitted for publication.
Funding: None.
Corresponding author: Gizele Francisco Ferreira do Nascimento. E-mail: gizele.nascimento.104@ufrn.edu.br
Received: February 21, 2023; **Accepted:** June 08, 2023

INTRODUCTION

Heart failure (HF) is a clinical syndrome characterized by a set of signs and symptoms caused by a structural or functional cardiac abnormality, resulting in decreased cardiac output or increased intracardiac pressures[1]. It is a highly prevalent disease, with implications on the patients' morbimortality and the health system's expenses[2]. It is the main cause of hospitalization in South America, and, in Brazil, 21% of hospital admissions due to respiratory system conditions are estimated to be caused by HF[3].

Some studies have investigated the correlation between the cardiovascular system and cochleovestibular systems[4-6]. Also, some drugs commonly used in clinical HF treatment, such as antiarrhythmics and diuretics, are potentially related to the onset of vestibular symptoms. Among these, vertigo can be considered an important biomarker of labyrinthic microcirculation changes and a relevant indicator of circulatory changes caused by cardiovascular diseases[4]. Damages caused by changes in inner ear circulation may lead to peripheral and central impairments in the cochleovestibular system, with mild, moderate, or severe symptoms, even in patients with cardiovascular compensation[5,6].

Vestibular assessment is indicated for all individuals with complaints of dizziness, regardless of its etiology. In the battery of tests that assess the vestibular function, the Video Head Impulse Test (vHIT) stands out as a gold standard test in the high-frequency domain thanks to its sensitivity and specificity, assessing the three pairs of semicircular canals (SCC) synergically, providing objective measures of gain, vestibulo-ocular reflex (VOR) asymmetry, and corrective saccades[7,8].

Dizziness complaints are a risk factor that may lead to falls and various complications. When associated with morbidity due to HF, the impact of these symptoms on the quality of life may be even more debilitating, as it impairs performance in occupational, social, and domestic activities[3,6].

Given the high prevalence of HF in the Brazilian and world population and the advantages and innovations brought about by vHIT for vestibular assessment, this study aimed to verify the association between results of clinical body balance assessment, vHIT, and advancing age in HF patients.

METHODS

This study was approved by the Research Ethics Committee of the Onofre Lopes University Hospital at the Federal University of Rio Grande do Norte - CEP/HUOL/UFRN, under evaluation report no. 2.809.558/2019. It is a cross-sectional, analytical, descriptive study. The sample comprised 34 patients, selected by convenience, with a medical cardiologic diagnosis of HF (functional class type I, based on criteria established by the New York Heart Association), followed up in a multiprofessional and interprofessional outpatient center, presenting vestibular and/or body balance complaints. Data were collected between August 2019 and January 2020.

The sample was divided into two selection groups: Group 1 (G1), with 21 adults, aged 30 to 59 years and 11 months; and Group 2 (G2), with 13 older adults aged 60 or more years. Concerning the type of HF, 21 patients were diagnosed with preserved ejection fraction (diastolic) and 13, with reduced ejection fraction (systolic).

Patients were informed about the study stages and procedures, and those who agreed to participate signed an informed consent form. Patients with chronic degenerative disease, tumors in the central nervous system, or any type of physical or cervical limitation that hindered them from doing the research procedures, especially vHIT, were excluded from the study.

Patients answered a previous protocol, developed by the authors to gather information on cochleovestibular symptoms, previous history, and cardiovascular disease. Cardiologic assessment information was obtained from the electronic medical record.

Body balance was clinically assessed to relate functional findings with vHIT parameters, using the following tests: diadochokinesia and finger-nose test, to rule out the possibility of central changes; Romberg and Sharpened Romberg tests, to assess static balance; and Unterberger-Fukuda Test (UFT), to assess dynamic balance[9,10].

In the Romberg test, the patient stands in an orthostatic position, arms by their body, heels together, and big toes 30º apart. The test is performed with eyes open and closed. In the Sharpened Romberg test, the patient stands in a semi-tandem stance, with eyes open and then closed. In both tests, they stand for 30 to 60 seconds in the position told by the evaluator, observing the difference in sway with and without eyesight. The test result is positive (+) when the patient has body sway, such as imbalance and tendency to fall, and negative (-) when they do not have imbalance and/or instability[9].

In UFT, the patient gaits without moving, raising their knees to about 45º, arms by their body, eyes open and then closed, for about 60 seconds. If the patient moves more than 1 meter and/or rotates the body more than 45º, the result is considered suggestive of vestibular dysfunction. It is important to highlight that, in asymmetric lesions, the body rotates to the side of the most poorly functioning labyrinth[10].

VHIT was performed (ICS-Impulse device, manufactured by Natus-Otometrics) according to the manufacturer's instructions and a previous study[11,12] concerning the patient's position and the placement and distance of the target on the wall, and calibration criteria. Lateral and vertical canal stimulation tests were performed with low-amplitude head impulses (10°–20°) at the speed of 150°–200°/seg, as instructed in the equipment's manual[7,11,12].

The following parameters were analyzed: VOR gain, the symmetry between SCCs, the presence and characterization of compensatory saccade parameters, the percentage of occurrence, amplitude, and latency, and the Perez and Rey Score (PR Score). Abnormality was indicated with a reduced VOR gain and/or the presence of compensatory saccades[13]. The vHIT analysis considered the reference values proposed in the literature[7,12], as follows: VOR gain between 0.8 and 1.20 for the lateral canals and between 0.7 and 1.20 for the vertical ones.

Vestibular system compensation was measured with the PR Score, whose goal is to measure the compensatory saccade grouping rate in relation to time. The PR Score ranged from 0 to 100 points – the higher the PR Score, the greater the saccade dispersion, indicating 'vestibular decompensation'. Lower scores indicate less dispersion (i.e., saccade grouping), which is characteristic of a better vestibular compensation than in dispersed saccades, directly contributing to a better VOR gain[14,15].

Latency was used to characterize the presence of covert and overt saccades. They were considered covert when they began before ending the head impulse (between 70 and 100 ms), and overt when they took longer than 100 ms (beginning after ending the impulse)[13].

Saccade amplitude was considered abnormal when higher than 100º/s regardless of the VOR gain, or when the interaural difference of contralateral canal amplitude was equal to or greater than 40º/s. The amplitude and latency parameters were used specifically to analyze the lateral canals[13].

Besides the descriptive statistical analysis, the following tests were used to reach the study objectives[16]:

- Fisher's exact test, to verify the statistical association of categorical variables in relation to the group.
- Student's t-test for independent samples, to compare two means of unpaired samples.
- Spearman correlation coefficient (rho), to quantify the association between two quantitative variables, ranging from -1 to 1, using the correlation values proposed in the literature, as follows: values between 0.2 and 0.4 are considered a weak correlation; between 0.41 and 0.7, moderate; and between 0.71 and 0.9, strong.
- Two-way ANOVA, to partition the total variance of a given response (dependent variable) into two: the first one due to the regression model (in this case, between groups), and the second one due to residues (errors) (within groups). The greater is the first in relation to the second, the greater is the evidence of the difference between the groups' means. This model assumes that its residues have a normal distribution, with a mean of 0 and constant variance.

In all analyses, the level of significance was set at 5%, and the adjustments were obtained in SAS software (version 9.2).

RESULTS

The sample had 27 men (79.41%) and seven women (20.59%), with a mean age of 55 years and 9 months. G1 corresponded to 61.76% of the study sample, with a mean age of 46 years and 6 months, while G2 was 38.32% of the sample, with a mean age of 68 years and 8 months. All patients had HF functional class type I, indicating their cardiovascular compensation.

Dizziness was the most self-reported cochleovestibular symptom (73.53%), followed by tinnitus in at least one ear (55.89%), vertigo (52.94%), presyncope (44.12%), and imbalance or instability (26.47%).

The cerebellar function screening and Romberg test did not find changes in the total sample. Abnormal results were found in the Sharpened Romberg and UFT tests (Table 1).

Abnormal vHIT parameters, considering decreased VOR gain and SCCs symmetry, were more frequent in the vertical SCCs in the total sample; this pattern was maintained in G1, whereas G2 had decreased gain in the left lateral SCC as well (Table 2).

It was found that 70.58% of patients had compensatory saccades in one or more SCCs. Lateral ones had more compensatory saccades, followed by the anterior and posterior canals. The characterization of saccadic parameters is described in Chart 1.

Student's t-test was used to compare the gain and symmetry of SCCs between G1 and G2 – however, it found no statistical difference. As for the correlation of ages with vHIT gain and the occurrence of saccades, the values indicated a weak correlation (left lateral SCC $r = 0.088$ and $p = 0.62$; right lateral SCC $r = 0.0509$ and $p = 0.02$; left anterior SCC $r = -0.285$ and $p = 0.10$; right anterior SCC $r = -0.292$ and $p = 0.09$; left posterior SCC $r = 0.066$ and $p = 0.71$ and right posterior SCC $r = 0.060$ and $p = 0.71$).

Since there were no abnormal results in the cerebellar function assessment with the Romberg test, the study did not perform an inferential analysis of these variables. Fisher's exact test was used to compare Sharpened Romberg test results, but it did not find any difference between G1 and G2's results ($p > 0.05$) – although the p-value was near the statistical difference ($p = 0.051$) in the Sharpened Romberg test.

The two-way ANOVA test was used to compare the results of the Sharpened Romberg and UFT tests with the other study variables (age, gain in the right and left anterior, lateral, and posterior SCCs, and asymmetry in the anterior, lateral, and posterior SCCs) between G1 and G2.

No association was found between the Sharpened Romberg test and the said variables between the age groups ($p > 0.05$).

As for UFT, there were statistical differences with specific vHIT parameters, such as VOR gain in G1, and other parameters in G2, such as the symmetry of SCCs and VOR gain (Table 3).

Table 1. Percentage distribution of the Sharpened Romberg and Unterberger-Fukuda Stepping test results per group

Test	Results	
Sharpened Romberg test	**Normal (%)**	**Abnormal (%)**
Group 1 (n=21)	42.86	57.14
Group 2 (n=13)	7.69	92.31
Unterberger-Fukuda Stepping test	Normal (%)	Abnormal (%)
Group 1 (n=21)	28.58	71.42
Group 2 (n=13)	23.07	76.07

Source: Research data (2019)
Subtitle: % = percentage; n = number of subjects

Table 2. Distribution of descriptive measures of vestibulo-ocular reflex gain and symmetry of each semicircular canal per group (n = 21 and n = 13) in the Video Head Impulse Test

SCC	Mean	SD	Median	Min	Max
Group 1 (n = 21)					
Gain in the canals					
Right Lateral	0.96	0.15	0.94	0.68+	1.38
Left Lateral	0.86	0.13	0.87	0.61+	1.24
Right Anterior	0.68+	0.22	0.75	0.63+	1.01
Left Anterior	0.61+	0.24	0.59+	0.10+	1.11
Right Posterior	0.62+	0.29	0.55+	0.18+	1.19
Left Posterior	0.67+	0.30	0.64+	0.34+	1.04
Symmetry (%)					
Lateral	10%	0.08	0.08	0.04	0.30
Anterior	26%+	0.19	0.19	0.01	0.90
Posterior	30%+	0.20	0.27	0.08	0.70
Group 2 (n=13)					
Gain in the canals					
Right Lateral	0.92	0.20	0.93	0.54+	1.30
Left Lateral	0.75+	0.23	0.77+	0.24+	1.03
Right Anterior	0.59+	0.24	0.52+	0.10+	1.01
Left Anterior	0.50+	0.21	0.52+	0.10+	0.78
Right Posterior	0.51+	0.17	0.54+	0.13+	0.84
Left Posterior	0.50+	0.36	0.32+	0.10+	1.24
Symmetry (%)					
Lateral	20%	0.22	0.08	0.02	0.71
Anterior	40%+	0.24	0.35	0.00	0.99
Posterior	39%+	0.32	0.53	0.00	0.99
Comparison between groups (G1-G2)					
	Gain in the canals – P-value				
Right Lateral	0.4761				
Left Lateral	0.0922				
Right Anterior	0.2334				
Left Anterior	0.2107				
Right Posterior	0.2620				
Left Posterior	0.0525				
Symmetry – P-value					
Lateral 0.0591					
Anterior 0.0777					
Posterior 0.4591					

Source: Research data (2019)
+ Abnormal value
Subtitle: SCC = semicircular canal; SD = standard deviation; Min = minimum value found; Max = maximum value found; n = number of subjects; % = percentage

Chart 1. Representation of descriptive measures of compensatory saccade parameters for the semicircular canals in which they were present

SCCs	Saccade classification	Occurrence (%)		PR Score (%)		Latency (ms)		Amplitude (º/s)	
		Mean		Mean		Mean		Mean	
		G1	G2	G1	G2	G1	G2	G1	G2
Right Lateral	**Covert**	36	10.66	26.37	60.25	130.33	88	82.33	83.55
	Overt	15.25	60.8			348.66	282.66	86.25	107.33
Left Lateral	**Covert**	15.57	34.5	20.87	62.5	94.57	101	104.25	144.5
	Overt	29.85	57			306.57	257.25	110.85	142.75
Right Anterior	**Covert**	5.76	12	13.44	19	99.50	109	59.77	36.5
	Overt	NA	NA			NA	NA	NA	NA
Left Anterior	**Covert**	43.30	NA	42.80	0	115.66	NA	60.33	NA
	Overt	28	NA			159	NA	79.66	NA
Right Posterior	**Covert**	30.2	19	36	15.5	98.8	108	63.4	57.5
	Overt	21.6	11			258	436	173.33	63
Left Posterior	**Covert**	NA	NA	0	0	NA	NA	NA	NA
	Overt	NA	NA			NA	NA	NA	NA

Source: Research data (2019)
Subtitle: % = percentage; ms = milliseconds; º/s = degrees per second; SCC = semicircular canal; G1 = group 1; G2 = group 2; PR Score = Perez and Rey Score; NA = not analyzed

Table 3. Distribution of results in the comparison of variables between age groups 1 and 2 in the Unterberger-Fukuda Stepping test, with the two-way ANOVA test

	Effect	Estimated difference	p-value	Confidence interval (95%)		Mean of Compared Variables	
Left anterior SCC gain	**UFT (G1- G2)**	0.13983333	0.1098	-0.03346792	0.31313459	**Abnormal UFT**	**Normal UFT**
	Group 1 (Abnormal - Normal)	-0.30133333	**0.0054***	-0.50638614	-0.09628052	0.52	0.82
	Group 2 (Abnormal - Normal)	-0.10766667	0.4375	-0.38710654	0.17177321	0.48	0.74
Right lateral SCC gain	**GROUP (G1- G2)**	-0.01716667	0.8014	-0.15529363	0.12096030	**Abnormal UFT**	**Normal UFT**
	Group 1 (Abnormal - Normal)	-0.00133333	0.9868	-0.16476736	0.16210069	0.96	0.96
	Group 2 (Abnormal - Normal)	-0.22700000	**0.0460***	-0.44972304	-0.00427696	0.86	1.06
Right posterior SCC gain	**GROUP (G1- G2)**	0.17583333	0.0667	-0.01290251	0.36456918	**Abnormal UFT**	**Normal UFT**
	Group 1 (Abnormal - Normal)	-0.34433333	**0.0037***	-0.56764860	-0.12101807	0.52	0.86
	Group 2 (Abnormal - Normal)	0.00066667	0.9965	-0.30366074	0.30499407	0.51	0.51
Left posterior SCC gain	**GROUP (G1- G2)**	0.13433333	0.2038	-0.07683394	0.34550060	**Abnormal UFT**	**Normal UFT**
	Group 1 (Abnormal - Normal)	-0.17033333	0.1741	-0.42018982	0.07952315	0.62	0.80
	Group 2 (Abnormal - Normal)	-0.34900000	**0.0449***	-0.68949699	-0.00850301	0.40	0.75
Symmetry between anterior SCCs	**GROUP (G1- G2)**	-0.08616667	0.3085	-0.25604419	0.08371086	**Abnormal UFT**	**Normal UFT**
	Group 1 (Abnormal - Normal)	0.07333333	0.4620	-0.12766847	0.27433513	28%	20%
	Group 2 (Abnormal - Normal)	0.28566667	**0.0415***	0.01174739	0.55958595	47%	18%

Source: Research data (2019)
*Statistically significant P-value
Subtitle: % = percentage; SCC = semicircular canal; UFT = Unterberger-Fukuda Stepping test; G1 = group 1; G2 = group 2

DISCUSSION

HF is a worldwide public health problem. Among cardiovascular diseases, it is diagnosed more often between the fifth and sixth decades of life, with a greater prevalence among males – which agrees with this study. The greater number of risk factors for the development of chronic diseases in men than in women is also cited in the literature[17,18].

Cochleovestibular symptoms may be common in the population with cardiovascular diseases, particularly classic dizziness, vertigo, and tinnitus. These symptoms are cited as common clinical manifestations in diseases that affect vascular functioning in the organism[4,19].

The cerebellar functioning screening had no abnormal results in the total sample, which is important to rule out possible central vestibulopathies[9,20]. Clinical changes were present in most of the study sample in the Sharpened Romberg and UFT tests, with findings characteristic of peripheral vestibular dysfunction. The patients assessed in the study had higher instability rates to the left side, showing that UFT helps identify the side of the lesion in cases of asymmetrical vestibular dysfunction – in which, this clinical test is even more sensitive than the Romberg test[9,10].

The vHIT results indicated a decreased mean gain for vertical SCCs in both groups, while G2 also had abnormal results for the left lateral SCC. The mean symmetry of vertical SCCs was also abnormal in both groups. So far, no study has been found relating these parameters in HF patients. However, these findings suggest that this population's peripheral vestibular dysfunctions may have occurred in the initial phase of cardiac decompensation and had not been fully recovered, as they were not treated at the appropriate time. Moreover, with advancing age and oscillations related to the cardiovascular condition, other peripheral vestibular sensors may have been impaired[21,22].

An association was found between vHIT and UFT results, confirming that the reduced VOR gain influences tasks that require body balance control[23]. G2 had worse UFT results than G1, with a statistical difference in some variables. This finding reinforces that aging influenced sensory receptors in the structures that originate VOR and vestibulospinal reflex (VSR) responses[24]. However, younger patients (G1) also had a statistical difference between VOR gain and UFT results, indicating that even younger patients diagnosed with HF may have impaired sensory structures involved with VOR and VSR.

A greater percentage of occurrence and higher amplitude values were found for lateral SCC saccades. Studies[25,26] show a possible tendency for greater occurrence of compensatory saccades in lateral SCCs due to the higher head impulse speed in these canals, leading to higher amplitude values than in the saccades of the vertical canals – which confirms the findings in this study.

Also, a small interaural difference was found in the saccade amplitude means for the lateral canals, which is characteristic of the predominance of bilateral and symmetric vestibular hypofunction[13]. Furthermore, there was a higher mean PR Score for lateral SCCs, bilaterally, in G2 than in G1 – i.e., a higher saccade dispersion rate, which suggests vestibular decompensation[14,15].

Due to the scarcity of research on high-frequency vestibular assessment in patients with HF or other cardiovascular diagnoses, some hypotheses were raised to justify these findings.

Cochleovestibular structures are more sensitive to systemic changes because their blood supply comes through a single artery. This makes the vestibular system more susceptible to vascular lesions, especially ischemic ones[27], possibly justifying episodes of vertigo and related symptoms, as a reflex of microvascular failure to provide blood to the labyrinthic structures[19].

The upper vestibular nerve branch innervates the utricle structures and lateral and anterior SCCs, while its lower branch innervates the posterior SCCs and saccule. Thus, it can be inferred that, besides the changes in the vascular supply to inner ear structures, the impairment caused by HF may affect the vestibular nerve, influencing the reduced VOR gain. In the study sample, all synergic SCC pairs were impaired, though with decreased mean VOR gain in the vertical canals in both groups.

The results of the procedures applied in this research allow for the suspected diagnosis of peripheral vestibular dysfunction in most cases. Though less frequently, there were also hearing impairment complaints, which agrees with data in the cited literature[4,5]. They suggest that vertigo complaints in patients with cardiovascular diseases could be a determining factor to request specialized vestibular assessments.

Test results associated with evidence in the literature[4,5] demonstrate a possible association between HF and vestibular hypofunction in this study. Even though the patients had cardiovascular compensation, they had vestibular complaints and abnormal body balance results in some clinical tests, which were confirmed with vHIT. Moreover, the various comorbidities associated with HF, along with the various drugs taken to control the disease, may have helped maintain the peripheral vestibular dysfunction.

There is a need for studies with larger samples and other procedures to assess various vestibular system structures, besides imaging tests, such as carotid ultrasound, angioresonance, or angiotomography, which would contribute to a differential diagnosis of cases associated with other diseases, such as HF.

CONCLUSION

No association was found between the results of clinical body balance assessment and vHIT findings (gain, asymmetry, and saccade occurrence) and advancing age in HF patients. However, there was a difference in VOR gain, specifically for some SCCs, with higher indices of abnormal results in the dynamic balance test in both groups.

The results of VOR gain, symmetry, and compensatory saccade parameters in vHIT, analyzed along with the other clinical balance tests, characterized the predominance of chronic peripheral vestibular hypofunction in HF patients, regardless of their age group.

ACKNOWLEDGMENTS

To the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) - Financing code 001.

REFERENCES

1. Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JG, Coats AJ, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC). Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016;37(27):2129-200. http://dx.doi.org/10.1093/eurheartj/ehw128. PMid:27206819.
2. Kurmani S, Squire I. Acute heart failure: definition, classification and epidemiology. Curr Heart Fail Rep. 2017;14(5):385-92. http://dx.doi.org/10.1007/s11897-017-0351-y. PMid:28785969.
3. Albuquerque DC, Souza Neto JD, Bacal F, Rohde LEP, Bernardez-Pereira S, Berwanger O, et al. I Registro Brasileiro de Insuficiência Cardíaca – Aspectos Clínicos, Qualidade Assistencial e Desfechos Hospitalares. Arq Bras Cardiol. 2015;104(6):433-42. http://dx.doi.org/10.5935/abc.20150031. PMid:26131698.
4. Neri G, Marcelli V, Califano L, Glicover Investigators. Assessment of the effect of mesoglycan in the treatment of audiovestibular disorders of vascular origin. Int J Immunopathol Pharmacol. 2018;32:2058738418773833. http://dx.doi.org/10.1177/2058738418773833. PMid:29734824.
5. Lee H. Isolated vascular vertigo. J Stroke. 2014;16(3):124-30. http://dx.doi.org/10.5853/jos.2014.16.3.124. PMid:25328871.
6. Marchiori LLM, Filho EAR. Vertigo complaint and blood hypertension. Rev CEFAC. 2007;9(1):116-21. http://dx.doi.org/10.1590/S1516-18462007000100015.
7. Macdougall HG, Mcgarvie LA, Halmagyi GM, Curthoys IS, Werber KP. The Video Head Impulse Test (vHIT) Detects Vertical Semicircular Canal Dysfunction. PLoS One. 2013;8(4):e61488. http://dx.doi.org/10.1371/journal.pone.0061488. PMid:23630593.
8. Roh KJ, Kim JU, Son EJ. Comparison of suppression head impulse and conventional head impulse test protocols. Res Vestib Sci. 2019;18(4):91-7. http://dx.doi.org/10.21790/rvs.2019.18.4.91.
9. Zuma e Maia FC, Carmona S, Costa SS. Avaliação clínica do paciente vertiginoso. In: Zuma e Maia FC, Albernaz PLM, Carmona S. Otoneurologia atual. Rio de Janeiro: Revinter; 2014. p. 25-51.
10. Fernandes ACG, Zamberlan-Amorim NE, Zanchetta S. Associação entre a prova de Unterberger-Fukuda e o exame de vectoeletronistagmografia. Rev CEFAC. 2018;20(2):145-53. http://dx.doi.org/10.1590/1982-0216201820213917.
11. Otometrics. ICS Impulse USB- Reference Manual [Internet]. Otometrics; 2015. [citado em 2023 Fev 21]. Disponível em: http://madsen.hu/pdf/utmutato/Impulse_3.0_Reference_Manual_7-50-2040-EN_01.pdf
12. Hougaard DD, Abrahamsen ER. Functional testing of all six semicircular canals with video head impulse test systems. J Vis Exp. 2019;18(4):1-14. http://dx.doi.org/10.3791/59012. PMid:31058885.
13. Yang CJ, Lee J, Kang BC, Lee HS, Yoo MH, Park H. Quantitative analysis of gains and catch-up saccades of video head impulse testing by age in normal subjects. Clin Otolaryngol. 2016;41(5):532-8. http://dx.doi.org/10.1111/coa.12558. PMid:26453356.
14. Rey-Martinez J, Atuecas-Caletrio A, Martiño E, Perez-Fernandez N. HITCal: a software tool for analysis of video head impulse test responses. Acta Otolaryngol. 2015;135(9):886-94. http://dx.doi.org/10.3109/00016489.2015.1035401. PMid:25857220.
15. Guajardo-Vergara C, Perez-Fernandez N. A New and Faster Method to Assess Vestibular Compensation: A cross-sectional study. Laryngoscope. 2020;130(12):E911-7. http://dx.doi.org/10.1002/lary.28505. PMid:32031691.
16. Pagano M, Gauvreau K. Princípios de bioestatística. São Paulo: Thomson; 2004.
17. Dourado MB, Oliveira FS, Gama GGG. Perfis clínico e epidemiológico de idosos com insuficiência cardíaca. Rev Enferm UFPE. 2019;13(1):408-15. http://dx.doi.org/10.5205/1981-8963-v13i02a236661p408-415-2019.
18. Tuppin P, Cuero A, Peretti C, Fagot-Campagna A, Danchin N, Juillière Y, et al. First hospitalization for heart failure in France in 2009: patient characteristics and 30-day follow-up. Arch Cardiovasc Dis. 2013;106(11):570-85. http://dx.doi.org/10.1016/j.acvd.2013.08.002. PMid:24140417.
19. Koo M, Chen JC, Hwang JH. Risk of peripheral artery occlusive disease in patients with vertigo, tinnitus, or sudden deafness: a secondary case-control analysis of a nationwide, population-based health claims database. PLoS One. 2016;11(9):1-10. http://dx.doi.org/10.1371/journal.pone.0162629. PMid:27631630.

20. Mangussi-Gomes J, Nogueira JB No, Kosugi EM. Manejo do Paciente com vertigem. In: Mangussi-Gomes J, Nogueira JB No, Kosugi EM. Manual do Residente da UNIFESP - Manual de Otorrinolaringologia. 2. ed. São Paulo: ROCA, 2015: 24-40.

21. Agrawal Y, Van de Berg R, Wuyts F, Walther L, Magnusson M, Oh E, et al. Presbyvestibulopathy: Diagnostic Criteria Consensus Document of the Classification Committee of the Bárány Society'. J Vestib Res. 2019;29(4):161-70. http://dx.doi.org/10.3233/VES-190672. PMid:31306146.

22. Ribeiro MBN, Morganti LOG, Mancini PC. Evaluation of the influence of aging on vestibular function by the video Head Impulse Test (v-HIT). Audiol Commun Res. 2019;24:e2209. http://dx.doi.org/10.1590/2317-6431-2019-2209.

23. Kammerlind AS, Ledin TE, Odkvist LM, Skargren EI. Influence of asymmetry of vestibular caloric response and age on balance and perceived symptoms after acute unilateral vestibular loss. Clin Rehabil. 2006 Fev;20(2):142-8. http://dx.doi.org/10.1191/0269215506cr886oa. PMid:16541934.

24. Chang TP, Schubert MC. Association of the Video Head Impulse Test With Improvement of Dynamic Balance and Fall Risk in Patients With Dizziness. JAMA Otolaryngol Head Neck Surg. 2018;144(8):696-703. http://dx.doi.org/10.1001/jamaoto.2018.0650. PMid:29955786.

25. Pogson JM, Taylor RL, Bradshaw AP, McGarvie LD, Souza M, Halmagyi GM, et al. The human vestibulo-ocular reflex and saccades: normal subjects and the effect of age. J Neurophysiol. 2019;122(1):336-49. http://dx.doi.org/10.1152/jn.00847.2018. PMid:31042447.

26. Anson ER, Bigelow RT, Carey JP, Xue QL, Studenski S, Schubert MC, et al. Aging increases compensatory saccade amplitude in the video head impulse test. Front Neurol. 2016;7:113. http://dx.doi.org/10.3389/fneur.2016.00113. PMid:27486430.

27. Kim JS, Lee H. Inner ear dysfunction due to vertebrobasilar ischemic stroke. Semin Neurol. 2009;29(5):534-40. http://dx.doi.org/10.1055/s-0029-1241037. PMid:19834865.