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Head and shoulder alignment among patients with unilateral vestibular hypofunction

Alinhamento de cabeça e ombros em pacientes com hipofunção vestibular unilateral

Adamar N. Coelho Júnior[1], Juliana M. Gazzola[1], Yeda P. L. Gabilan[2], Karen R. Mazzetti[2], Monica R. Perracini[3], Fernando F. Ganança[2]

Abstract

Objectives: To investigate head and shoulder alignment among patients with unilateral vestibular hypofunction (UVH), using computerized biophotogrammetry (CB) and to correlate these measurements with gender, age, duration of clinical evolution, self-perception of intensity of dizziness and occurrences of falls. **Methods:** This was a cross-sectional study. Thirty individuals with UVH and 30 with normal vestibular function and without complaints of dizziness underwent CB in the anterior, right and left and posterior views, in an upright standing position. Alcimage™ 2.0 was used to evaluate three angles in order to verify the anterior deviation and inclination of the head, and the alignment of the shoulders. The groups were paired according to age, gender and height. The statistical analysis consisted of the Mann-Whitney test, Kruskal-Wallis test followed by the Dunn test, and the Spearman Correlation Coefficient. **Results:** The patients with UVH had greater forward (55.44±16.33) and lateral (2.03±1.37) head deviation angles than did the normal individuals (34.34±4.60 and 1.34±1.05 respectively), with a statistically significant difference (p<0.001). The increment of forward and lateral deviation in the UVH group was 38.05% and 33.78% respectively. Forward head was associated with the duration of clinical symptoms of the vestibular disease (p=0.003), age (p=0.006), intensity of dizziness (p<0.001) and occurrence of falls (p=0.002). **Conclusions:** Patients with UVH had greater forward and lateral head deviations. Forward head deviation increased with age, duration of clinical symptoms and greater self-perception of the intensity of dizziness. Forward head deviation was also greater among patients who reported having had falls.

Key words: vestibular diseases; dizziness; posture; assessment; photogrammetry.

Resumo

Objetivos: Avaliar o alinhamento de cabeça e ombros de pacientes com hipofunção vestibular unilateral (HVU) por meio da biofotogrametria computadorizada e associar esses dados com gênero, idade, tempo de evolução clínica, autopercepção da intensidade de tontura e ocorrência de quedas. **Métodos:** Trata-se de estudo transversal em que 30 indivíduos com HVU e 30 indivíduos com função vestibular normal e sem queixa de tontura foram submetidos à biofotogrametria computadorizada. Foram registradas imagens em vistas anterior, posterior, laterais direita e esquerda em ortostatismo. O programa Alcimage® 2.0 foi usado para avaliar três ângulos que permitem verificar anteriorização e inclinação da cabeça e alinhamento dos ombros. Os grupos foram pareados por idade, gênero e estatura. Para a análise estatística, realizaram-se os testes de Mann-Whitney, Kruskal-Wallis, seguidos do teste de Dunn e Coeficiente de Correlação de Spearman. **Resultados:** Pacientes com HVU apresentam maiores valores para os ângulos de anteriorização (55,44±16,33) e de inclinação lateral da cabeça (2,03±1,37) quando comparados aos indivíduos normais (34,34±4,60 e 1,34±1,05, respectivamente), com diferença estatisticamente significante (p<0,001). O aumento da anteriorização e da inclinação lateral da cabeça do grupo de indivíduos com HVU foi de 38,05% e 33,78% respectivamente. A anteriorização da cabeça foi associada com o tempo de evolução clínica da doença vestibular (p=0,003) com a idade (p=0,006), com a intensidade da tontura (p<0,001) e com a ocorrência de quedas (p=0,002). **Conclusão:** Pacientes com HVU apresentam maior anteriorização e inclinação lateral da cabeça. A anteriorização da cabeça aumenta com a idade, com o tempo de evolução clínica, maior auto-percepção da intensidade da tontura e nos pacientes que relataram quedas.

Palavras-chave: doenças vestibulares; tontura; postura; avaliação; fotogrametria

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[1] Vestibular Rehabilitation and Social Inclusion Program, Universidade Bandeirante de São Paulo (UNIBAN), São Paulo (SP), Brazil

[2] Department of Otorhinolaryngology and Head and Neck Surgery, Universidade Federal de São Paulo (UNIFESP), São Paulo (SP), Brazil

[3] Master's Program in Physical Therapy, Universidade Cidade de São Paulo (UNICID), São Paulo (SP), Brazil

Correspondence to: Karen Renate Mazzetti, Rua Cantagalo, 980, apto 124, Tatuapé, CEP 03319-000, São Paulo (SP), Brazil, e-mail: karenmazzetti@globo.com

Introduction

Peripheral vestibular syndromes have relatively high prevalence from the fourth decade of life onwards, and may manifest through vertigo and other kinds of dizziness, nystagmus, postural instability, gait disturbances, falls and changes in body alignment[1]. In the United States, the general population have an incidence of dizziness of approximately 5.5%, which implies that more than 15 million people develop this symptom every year[2].

The sense of head position, and consequently the alignment expressed by body posture is influenced by proprioceptive sensory information from the receptors located in the neck and by the information provided by the vestibular system. There is a vast network of anatomical connections between the vestibular system and the proprioceptive information from the neck. If one piece of information from the vestibular system regarding the position and alignment of the head is imprecise, or if there is a fault in integrating this information with the central nervous system, an error in head position may occur, thus resulting in a distorted sense of the positional reference sense of the head and neck[3]. Humans with sudden unilateral loss of vestibular function have lateral deviation of the head towards the side of the injury during this acute phase[4].

Patients with uncompensated unilateral vestibular hypofunction (UVH) and those who are not going through a vertigo crisis may adopt a rigid head posture, tilting it and rotating it towards the injured labyrinth in an attempt to avoid the symptoms of the disease. Moreover, such postural abnormalities may negatively affect body alignment and the projection of the center of gravity within the support base, thereby resulting in complaints relating to balance[1,5].

Lateral deviation of the head may occur because of otolith dysfunction or simply through contraction of the sternocleidomastoid or trapezius muscles. In turn, backward deviation of the head may cause mechanical compression of the upper cervical spine, thus bringing about a reduction in mobility of the soft tissues and joints in this segment, and increasing the perception of dizziness[6].

In general, patients with peripheral vestibular dysfunction suffer from reduction in flexibility and in the capacity to relax. One study pointed out that about half of such patients demonstrate reductions in their range of motion in the neck, temporomandibular joints, shoulders and dorsal spine. Between 70 and 94% of such patients have contractions in the upper trapezius and sternocleidomastoid muscles when they receive muscle palpation[7].

Postural alignment assessments may be carried out in the conventional manner, as described by Kendall, McCreary and Provance[8], by observing the individual in an upright standing position in all four views (anterior, posterior, right and left lateral) and by using a plumb line. More recently, methods using digital equipment to acquire images, such as computerized biophotogrammetry (CB), have been used to assess body alignment. CB is a noninvasive, low-cost, high-precision method that also have good reproducibility of the results[9-13].

Investigation of possible abnormalities of body alignment in individuals with uncompensated UVH might imply a need to adopt specific therapeutic measures with the aims of correcting these abnormalities and probably improving body balance, as well as preventing and limiting postural abnormalities in occupational situations or among older individuals. No studies dealing with assessments on head and shoulder alignment among such patients using CB were found in the scientific literature.

The objectives of this study were to compare head and shoulder alignment measurements between patients with UVH and individuals without dizziness and normal otoneurological assessments, by means of CB, and to investigate associations between such measurements and sex, age, duration of clinical evolution of the vestibular dysfunction, self-perception of the intensity of dizziness and occurrences of falls during the preceding year.

Methods

This was a cross-sectional study approved by the Ethics Committees of Universidade Bandeirante de São Paulo (UNIBAN), in accordance with protocol number 30/2004.

The sample was made up of 60 individuals with ages ranging from 40 to 60. Thirty were in the UVH group (UVHG) and thirty were in the control group (CG), matched according to sex, age and height. The UVH patients were recruited from the otoneurology laboratory of a college hospital. They underwent anamnesis, physical tests, audiometry test, tympanometry, assessment of the stapes reflex thresholds and vestibular tests conducted using electronystagmography. The diagnosis of UVH was made whenever there was a reduction in or absence of the vestibular response to the caloric test, i.e. the main phase of electronystagmography. For the diagnosis to be positive, the maximum speed of the slow phase of the post-caloric nystagmus, during caloric irrigation with water at 30º C or 44º C, needs to be lower than three degrees per second on the affected side (with hypofunction), and the asymmetry between the responses of the two ears (both sides) must be greater than 25%, as measured using Jongkees' formula[14,15]. The UVHG reported suffering from chronic dizziness characterized by the presence of this symptom on at least three days a week over the preceding three months[16].

The CG individuals, who did not have any dizziness or other vestibular complaints, and had normal results from the otoneurological assessment, were recruited from the university community of students, professors and ancillary employees.

Individuals in either the UVHG or the CG who had orthopedic diseases in the cervical, dorsal and/or lumbar spine that might cause postural changes, abnormalities in the girdle or lesions in the brachial plexus were not included. Patients with central or mixed vestibular diseases, neurological diseases, physical deformities (both congenital and acquired) and obesity to the extent that it was impossible to locate the anatomical spots were also excluded from the study. Finally, patients with abnormalities in the knee axis (varus or valgus) or in the foot axis (planus or cavus) were also excluded, in order to avoid any interference in relation to the body alignment. All the patients signed a free and informed consent statement in order to participate in this study.

The individuals were assessed in relation to sociodemographic information (sex and age), as well as clinical data (time elapsed since the onset of the symptoms, self-perception of the intensity of dizziness and occurrences of falls during the preceding year). The time elapsed from the time when the symptoms were first noticed was classified as follows: 3 to 12 months; more than 12 months and up to 36 months; and more than 36 months. The self-perception of the intensity of dizziness was classified according to a visual analogue scale (VAS) that consisted of a line graded from 0 to 10, in which 0 corresponded to absence of dizziness, and 10 to the maximum degree of dizziness that could be experienced by patients.

For the postural assessment of head and shoulder alignment, the individuals wore swimsuits and were barefoot. If they did not have short hair, it was tied at the top of the head. No accessories (earrings, necklaces, headbands, etc) were worn during the assessment. The requirements followed the criteria suggested by Kendall, McCreary and Provance[8] and Magee[17].

Five anatomical spots were located and were marked using white styrofoam ball markers of 2cm in diameter, attached with double-sided scotch tape, in order to facilitate viewing: spots 1 and 2 (on the two temporomandibular joints); spots 3 and 4 (on both acromia); and spot 5 (on the C7 spinous process). In order to locate the anatomical spots, we followed the principles of palpatory anatomy[18]. The same appraiser marked all the individuals.

The support base adopted for all positions was the one recommended by Kendall, McCreary and Provance[8]. It consisted of positioning the ankles at about 7.5cm from each other and the anterior part of each foot turned out by 10º from the midline, thereby forming a 20º angle between the two first toes. The distance from the camera to the subject was always set at 3m; from the subject to the nearest wall, 30cm; and from the camera to the floor, 1.20m (measurement made from the camera lens to the floor). The individuals were instructed to remain in an upright standing position and to look at a spot marked on the wall in front of them, at eye level. They were allowed to wear glasses or lenses, when necessary. Four images were taken, with the same support base, in the anterior, right and left lateral and posterior views. Another researcher stood near to the individuals to hold them in case the subjects felt unsteady[10,13].

The camera used was a 2.0 megapixel digital Kodak Easy Share camera, model CX 4200, using optimum resolution and without using the zoom. The tripod used to fix the camera in position was a FanCier FT–363, which has a level indicator consisting of a liquid environment surrounded by acrylic, with an air bubble inside it. The camera lens was placed perpendicularly to the floor of the room, and in a parallel plane to the subject who was being photographed. All the images were shot with the camera in horizontal position[10,13].

The operational software ALCIMAGE® that was used in this study transforms image pixels into Cartesian axes, thus making it possible to calculate a selected angle through marking out three Cartesian axes, with accuracy to three decimal places[10,13]. This software was incorporated into the CB, thereby promoting greater reliability in assessing body posture.

In order to determine the extent of head protrusion, the C7 angle was formed between a straight line that was drawn to join the temporomandibular joint and the C7 spinous process and another vertical, ascending straight line, starting at the C7 spinous process (Figure 1). The bigger this angle was, the more the head was slanting backwards. Because this angle was measured twice (right and left profiles), the mean between them was used in interpreting the data[10,13].

To determine the head alignment, the temporomandibular interjoint angle (TMIJ) was used. This was obtained as the intersection of a line defined by the temporomandibular joints with a reference horizontal line, parallel to the floor, originating in one of the temporomandibular joints in the anterior view (Figure 1). The bigger this angle was, the bigger the head deviation was. To determine the shoulder alignment, the interacromial angle was measured. This was formed by the intersection of a straight line between the acromia, with a horizontal straight line as a reference, parallel to the floor, starting at one of the acromia in the anterior view (Figure 1). The bigger this angle was, the greater the asymmetry of the shoulders was[19]. The pictures were taken always by the same appraiser, who did not know which group the subjects belonged to. Backward inclination and deviation of the head were also calculated as percentages, as was shoulder asymmetry in the UVHG in relation to the CG.

The Mann-Whitney nonparametric test was used for comparative analysis of the ages (full years) between the UVHG and CG. The value of each angle in the UVHG and CG was compared in relation to sex by using the Mann-Whitney test. The associations between these angles and the groups were investigated using the Mann-Whitney test. In the inferential analyses between the angles studied and the clinical and demographic variables, only the angles showing a significant difference between the UVHG and CG were considered. Nonparametric tests were used because of the asymmetry and variability of the scoring of the variables analyzed, and because of the absence of normal distribution shown by the Kolmogorov-Smirnov test (n=60).

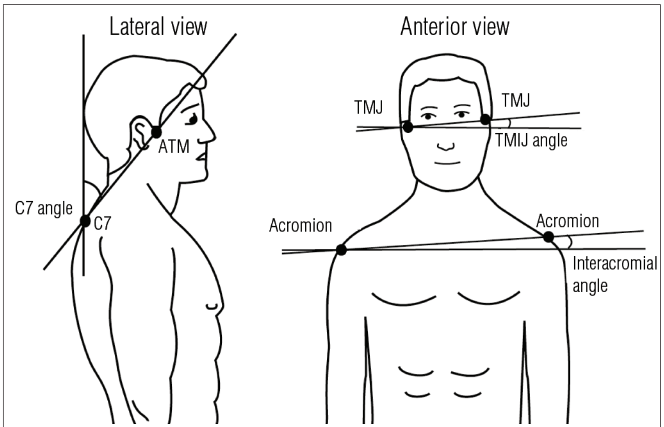
For the inferential analysis on the UVHG, the value of each angle assessed was compared between the variables studied through the Mann-Whitney and Kruskal-Wallis tests, followed by Dunn's test. In order to assess the correlations between the angles obtained in the UVHG and CG and the quantitative variables, Spearman correlation coefficients (ρ) were used. Nonparametric tests were used because of the asymmetry and variability of the scoring of the variables analyzed and because of the absence of normal distribution shown by the Shapiro-Wilk test (n=30). The significance level used for the statistical tests was set at 5% (α=0.05).

Results

The two groups were made up of 30 individuals each. Seven of them were male (23.33%) and 23 were female (76.67%). No significant differences were noticed between the median ages (full years) of the UVHG and CG (p=0.864): 55 years for the UVHG and 53 years for the CG. The mean age and standard deviation of the UVHG and CG were 52.63 and 6.97, and 52.13 and 7.25 years, respectively. Sixty years of age was the most prevalent age in both groups (26.7% in each group).

The time elapsed since the onset of the vestibular disease among the UVHG patients was 3 to 12 full months in the cases of 15 patients (50.0%); 12 to 36 full months for 13 (43.3%); and more than 36 months for two patients (6.7%). The etiologies of the vestibular dysfunction were as follows: 23 cases (38.3%) of benign paroxysmal positional vertigo; 22 cases (36.7%) of Ménière's disease; six cases (10.0%) of vascular vestibular disease; five cases (8.3%) of migraine or migraine equivalents; two cases (3.3%) of vestibular neuritis; and one case (1.7%) each of the etiologies of ototoxicity, metabolic vestibular disease, presbyvertigo / presbyataxia / presbytinnitus / presbycusis and vestibular schwannoma. Twenty-two patients in the UVHG (73.3%) had had falls during the preceding year. Seven patients (23.3%) of the CG reported suffering falls over this period.

Table 1 displays the mean values, standard deviations (SD), medians and minimum and maximum values of the



C7=seventh cervical vertebra; TMJ=temporomandibular joint; TMIJ=temporomandibular interjoint.

Figure 1. Profile (lateral view): Representation of the C7 angle formed by the intersection between a straight line joining the temporomandibular joint to the C7 spinous process and another ascending straight vertical line, for assessing the anterior deviation of the head. Anterior view: Representation of the temporomandibular interjoint angle formed by the intersection of a line joining the temporomandibular joints and a straight horizontal line taken as a reference, for assessing the head inclination. Representation of the interacromial angle, formed by the intersection of a straight line between the acromia and a straight horizontal line taken as a reference, for determining the shoulder alignment.

Table 1. Mean values, standard deviations, confidence intervals, medians, minimum and maximum values of the C7 angle, temporomandibular angle and interacromial interjoint angle, measured using computerized biophotogrammetry among patients with unilateral vestibular hypofunction (n=30) and among a control group (n=30).

Angles	Groups	Mean	Standard deviation	95% CI	Median	Minimum value	Maximum value	p-value
C7	UVH	55.445	16.339	49.34-61.54	64.533	28.560	74.094	<0.001[a]
	Control	34.345	4.604	32.63-36.07	32.985	27.711	45.165	
TMIJ	UVH	2.034	1.376	1.52-2.55	2.247	0.009	3.980	0.038[a]
	Control	1.347	1.055	0.95-1.74	1.145	<0.001	3.657	
Interacromial	UVH	1.986	1.286	1.50-2.46	2.388	<0.001	4.002	0.535
	Control	1.876	1.544	1.30-2.45	1.438	0.125	5.892	

[a] Mann-Whitney; C7=seventh cervical vertebra; UVH=unilateral vestibular hypofunction; TMIJ=temporomandibular interjoint; CI=confidence interval.

angles assessed in both groups. The C7 angle value was greater in the UVHG than in the CG, with a statistically significant difference (p<0.001). The TMIJ angle was also greater in the UVHG than in the CG, with a statistically significant difference (p=0.038). No significant difference in the interacromial angle was found between the groups. Regarding the side of the head deviation, 18 patients (60.0%) had an inclination that was ipsilateral to the vestibular lesion, and 12 patients (40%), counterlateral.

The backward deviation of the head, head inclination and shoulder asymmetry in the UVHG were respectively 38.05%, 33.78% and 5.54% greater than in the CG. No statistically significant differences in the median C7 angle (p=0.641) or TMIJ angle (p=0.677) in the UVHG were found in relation to sex. Likewise, no statistically significant differences in the median C7 angle (p=0.148) or TMIJ (p=0.239) in the CG were found in relation to sex.

Table 2 displays a descriptive and inferential analysis between the values of the C7 and TMIJ angles and the timespan of clinical evolution of the UVHG patients. There was a statistically significant difference (p=0.002) between the duration of clinical evolution and the medians of the C7 angle values. The longer the duration of clinical evolution was, the greater the abnormality of this angle. The main difference occurred between the categories "3 to 12 full months" and "more than 12 months and up to 36 full months". No statistically significant difference was found between the duration of clinical evolution and the medians of the TMIJ angle values. In this table, an association between the values of the C7 and TMIJ angles and occurrences of falls among the UVHG patients can be seen. There was a statistically significant association between the medians of the C7 angles and occurrences of falls, and the abnormalities in this angle were greater among patients who had suffered falls than among those who had not. No statistically significant difference in the median TMIJ angle values was found in relation to occurrences of falls.

The assessment of the intensity of dizziness among the patients in the UVHG showed a moderate positive statistical correlation with the C7 angle values. The bigger the VAS score was, the greater the change in this angle as assessed by the CB was (Table 3). The age of the UVH patients had a weakly positive statistically significant correlation with the C7 angle, but did not have any correlation with the TMIJ angle. The age of the individuals in the CG had a moderate positive correlation that was statistically significant in relation to the C7 and TMIJ angle values. As the age increased, so did the values of these angles (Table 3).

Table 2. Mean values, standard deviations and medians of the C7 angle and temporomandibular interjoint angle, measured using computerized biophotogrammetry, according to the duration of clinical symptoms and number of falls among patients with unilateral vestibular hypofunction (n=30).

Angles	Variables	Duration of clinical symptoms / Number of falls	Mean (SD)	Median	p-value	Differences between categories
C7	Duration of clinical symptoms	3 to 12 months (1)	44.09 (13.84)	38.80	0.003[a]	1 and 2 / 1 and 3
		More than 12 and up to 36 months (2)	66.65 (9.98)	68.09		
		More than 36 months (3)	67.71 (3.43)	67.71		
TMIJ	Duration of clinical symptoms	3 to 12 months (1)	1.66 (1.46)	1.74	0.342[a]	- -
		More than 12 and up to 36 months (2)	2.39 (1.31)	2.88		
		More than 36 months (3)	2.48 (0.37)	2.48		
C7	Number of falls	None	38.69 (6.87)	35.62	0.002[b]	
		1 or more falls	61.53 (14.39)	67.72		
TMIJ	Number of falls	None	1.56 (1.43)	1.21	0.260[b]	
		1 or more falls	2.20 (1.34)	2.51		

[a] Kruskal-Wallis; [b] Mann-Whitney; C7 = seventh cervical vertebra; TMIJ = temporomandibular interjoint.

Table 3. Correlation between self-perception of the intensity of dizziness (as verified using a visual analogue scale) and age, in relation to the C7 angle and temporomandibular interjoint angle, measured using computerized biophotogrammetry among the patients with unilateral vestibular hypofunction (n=30) and the individuals in the control group (n=30).

	Groups	Angles	p-value	Spearman correlation (ρ)	Direction and strength of correlation
Intensity of dizziness	UVH	C7	<0.001	+0.772	positive moderate
	UVH	TMIJ	0.057	+0.351	positive weak
Age	UVH	C7	0.006	+0.492	positive weak
	UVH	TMIJ	0.735	-0.065	absence of correlation
Age	Control	C7	<0.001	+0.787	positive moderate
	Control	TMIJ	<0.001	+0.760	positive moderate

C7=seventh cervical vertebra; UVH=unilateral vestibular hypofunction; TMIJ=temporomandibular interjoint.

Discussion

Abnormalities in head and shoulder alignment are common in individuals with peripheral vestibular syndrome (PVS)[7,20]. Under cervical spine conditions that are of inflammatory, degenerative and/or tensional nature, several structures in this region, such as the proprioceptors, sympathetic nervous chain and vertebral arteries may have characteristics related to otoneurological symptoms[21]. In addition, chronic alterations in the vestibulospinal reflex or, more specifically, in the vestibular-colic reflex, and/or adoption of a compensatory body posture to seek better balance might alter the body alignment of patients with PVS[20,22-25]. The increased muscle tension in the cervical region that patients with peripheral vestibular dysfunctions demonstrate, probably to reduce their head motion in an attempt to avoid the appearance or aggravation of otoneurological symptoms,[26] may also contribute towards the onset of such abnormalities in body posture.

The head may be kept in an inclined position to try to avoid stimulation of the proprioceptors of that region, because stimulation of these proprioceptors might cause or aggravate the feeling of dizziness through increased sensory conflict between the information riginating from the cervical proprioception and the damaged vestibular system[5]. Cesarani and Alpini[5] claimed that the typical postural pattern of patients with UVH consists of hyperactivity of the posterior cervical muscles and sternocleidomastoid muscle on the side of the auditory labyrinth, and of the trapezius muscle on the injured side. According to these authors, the muscles that apparently have the most important nervous connections with the vestibular centers are the greater posterior rectus, longus capitis, semispinalis capitis and splenius capitis.

The use of a control group in the present study, made up of individuals (matched according to sex, age and height) who were not experiencing dizziness and did not present any abnormalities in the otoneurological assessment, made it possible to investigate whether greater protrusion and inclination of the head existed among the patients with UVH. One of the most important tasks within human postural control is body balance on the small support base that is provided by the feet[20]. This position was used by the individuals during the CB assessment. Maintaining body balance involves central and peripheral structures that are responsible for motor execution. The control of such structures depends on integration of the information originating from the vestibular, visual and somatosensory systems, which is processed in the vestibular nuclei, under the surveillance of the cerebellum[24,25]. Vestibular stimulation triggers several reflexes, especially the vestibular-ocular, vestibular-colic and the vestibulospinal reflexes, which are responsible for increasing the tonus of the antigravity muscles of the neck, trunk and limbs[25,27]. Whenever a situation of sensory conflict occurs, balance strategies are activated in order to recover stability. The neck may be kept rigid in an attempt to stabilize the head in a certain position with the aim of avoiding vertigo[20]. This may be associated with postural fixations of the cervical region, thereby leading to muscle tensions, pain, limitations in joint motion and shortened muscles[17,28], in a feedback process between head motion and the vestibular system.

The sense of position of the neck and head, and consequently the alignment of these two structures, seems to suffer greater impact than does the position of the shoulders, as pointed out in this study, since the increase in anterior inclination of the head and deviation was about 30%, hereas the increase in shoulder asymmetry was approximately 5%. With increasing age in the UVHG and CG, the protrusion and head deviation also increased, thus showing that age brings about such alterations regardless of the presence or absence of vestibular dysfunction.

The association between greater protrusion of the head and longer periods of clinical symptoms of the disease might be related to longer periods of decompensation of vestibular function, which in turn may imply greater impairment of the vestibular-colic[25] and vestibulospinal reflexes. Similarly, head protrusion was associated with greater self-perception of the intensity of dizziness, probably because the bigger the vestibular decompensation was, the greater the chance of occurrences of vestibular episodes of greater intensity was. For instance, there may be complaints relating to dizziness, and also greater abnormality of the vestibular-colic[25] and vestibulospinal reflexes. Conversely, head protrusion might make it more difficult to compensate for the vestibular function, thus increasing the duration of the vestibular disease and the self-perception of the intensity of dizziness. Nevertheless, within the scope of this study, it was not possible to make such a claim. Moreover, no studies corroborating such a hypothesis were found in the scientific literature.

In the present investigation, it was observed that the patients who reported falls had greater head protrusion than did those who did not report any such events. The abnormalities in head alignment, probably triggered by dysfunction of the vestibular-colic[25] and vestibulospinal reflexes, might cause postural instability and a lack of balance during gait[1], thereby contributing towards greater incidence of falls among individuals with uncompensated vestibular disease.

The association of greater head protrusion with longer clinical evolution of the disease, greater self-perception of the intensity of dizziness and greater incidence of falls does not allow us to establish a cause and effect relationship. However, it allows us to suggest that these findings might be related to the same physiopathological condition, represented by uncompensated

UVH. Anterior deviation of the head increases the overload on the zygapophyseal joints, thus causing a tonic discharge that might be responsible for the augmented and more frequent complaints relating to dizziness[6].

The finding that patients with UVH, complaints about chronic dizziness and ages between 40 and 60 years have greater head protrusion may serve as a justification for treatment by means of a more comprehensive rehabilitation of body balance disturbances. Within this context, we suggest that the physical therapy treatment should emphasize maneuvers to increase the vestibulospinal reflex, along with body proprioceptive stimulation, kinesiological techniques and stretching of the posterior chain of the neck.

Patients with uncompensated UVH who underwent aquatic physical therapy for vestibular rehabilitation[29] and who were assessed through CB demonstrated changes to their body alignment after the treatment, such as reduction of the forward head inclination and head deviation, regardless of sex or age[21], which evinced a relationship between vestibular diseases and abnormalities in head alignment.

The results obtained in this study call for further investigations in this field in order to broaden the knowledge about the relationship between vestibular diseases and body posture abnormalities. Such studies could correlate the side of the postural deviation with the side of the vestibular injury, In addition, they could investigate individuals with other vestibular diseases, or investigate postural abnormalities using other assessment methods, such as electromyography of the muscle investigated in the present study or other parts of the body.

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