Neurotological Findings at a Health Unit for Adults with Cervicalgia

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Abstract

Introduction The cervical spine is a flexible link between the sensory platform of the skull and torso. The fundamental principle of its operation is due to the balance between muscle strength and flexibility, and any dysfunction of this balance causes neck pain, known as cervicalgia.

Objective The objective of this study is to analyze the most prevalent neurotological findings in adults with neck pain.

Method A cross-sectional study in which 33 adults from 50 to 83 years of age with neck pain were evaluated and underwent the following procedures: anamnesis, as well as ENT, audiological, and vestibular exams.

Results The most evident neurotological symptoms were dizziness (75.7%), tinnitus, neck cracking, tingling in the extremities, and auditory problems (36.3% for each). The most frequently reported clinical symptoms were related to cardiovascular (69.7%), endocrine-metabolic (48.5%), and rheumatic (30.3%) systems. In the audiological assessment, 30 subjects (91.0%) presented hearing impairment in at least one ear, with sensorineural impairment being the most prevalent (88.0%). In the vestibular assessment, there were alterations in 13 subjects (39.0%) found in the caloric test. There was a prevalence of alterations in the peripheral vestibular system with a predominance of irritative peripheral vestibular dysfunction.

Conclusion Neurotological complaints were frequent in this population, verifying the importance of these tests in the dysfunctions of the cervical region or the craniocervical junction.

Keywords
- neck pain
- postural balance
- vestibular function tests
- dizziness
- tinnitus

Introduction

It is believed that the cervical spine is one of the most complete joint systems in the human body, allowing the neck to move over 600 times per hour or once every six seconds.[1]

The cervical spine is a flexible link between the sensory platform of the skull and the torso. The fundamental principle of its operation is due to the balance between muscle strength and flexibility, and any impairment of this balance causes neck pain known as cervicalgia.[2]

Cervicalgia has an impact on arthritic and degenerative processes of the cervical segment. It has a higher prevalence in women (68–70%) and mostly affects people between 42 and 58 years of age.[3]

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International data show that 1.4% of visits to doctors in the United States are related to neck pain. In Brazil, it is suggested that up to 55% of the population will have cervicalgia at some point in their life.[3,4]

Postural balance is maintained from visual, vestibular, and proprioceptive sensory information. Thus, musculoskeletal disorders in the neck can cause changes in the functioning of proprioceptors and a consequent postural disturbance in control called cervical vertigo.[5]

For the authors,[6,7] aside from the cause shown above that explains cervical vertigo through the change in proprioceptive signs, there are two other possible causes of cervical vertigo. The first is vertebrobasilar insufficiency, which occurs via compression of the vertebral arteries due to osteoarthritic osteophytes or atlantoaxial instability. The second cause can be posterior cervical sympathetic (Barre-Lieou) syndrome, which is caused by an irritation of the labyrinthine artery, which consequently causes a hypoperfusion of the peripheral vestibular system leading to vertigo.

Manifestations of dizziness associated with cervical changes were first described in 1955 by Ryan and Cope, who used the term "cervical vertigo" to refer to a combination of cervical column problems and dizziness.[8] Cervical vertigo or dizziness has been a controversial topic since then, however, there is much evidence of its existence. Studies in patients with chronic pain and cervicobrachialgia showed cervical vertigo in 50% of participants.[8]

Postural balance is maintained both by the viscoelastic properties of muscles and by postural adjustments triggered from sensory information. Thus, musculoskeletal disorders in the neck can cause changes in the functioning of proprioceptors causing a disturbance in posture control.[5,9]

Therefore, the aim of this study was to analyze the most prevalent otoneurological findings in adults with cervicalgia.

Method

This is a cross-sectional study of 33 individuals diagnosed with neck pain: six men (18%) and 27 women (82%), aged 50–83 years (mean 67 years old, standard deviation of 5.95 years) referred by a Health Unit.

In terms of lifestyle, five individuals (15.0%) maintained bad habits, with one being an alcoholic, two being smokers, and two having excessive coffee intake that exceeded 600mg of caffeine per day, corresponding to ~700 mL of coffee.

The study included individuals diagnosed with cervicalgia independent of gender. Excluded from the study were subjects who had some type of disorder that prevented important examinations, such as psychological and musculoskeletal impairments and individuals with otological abnormalities such as the presence of earwax, otorrhea, and tympanic membrane perforation.

The study received approval from the Institutional Ethics Committee, protocol number 00047/2008 and individuals underwent evaluation after signing a consent form.

The following procedures were performed:

- Anamnesis – subject received a questionnaire focusing on otoneurological signs and symptoms (Attachment 1).
- ENT evaluation – Conducted to rule out any alterations that could affect the testing.
- Audiological assessment - Conventional tonal audiometry was performed with a Madsen-GN Otometrics brand, Itera model audiometer (São Paulo, Brazil), with TDH-39 headphones, and thresholds in dB HL. The equipment was calibrated according to ISO 8253 standards. Next, the speech recognition threshold (SRT) was measured as well as the speech recognition index (SRI). Criteria were applied to characterize the degree and type of hearing loss.[10,11] Vestibular evaluation – Initially, we checked vertigo and verified spontaneous and semi-spontaneous positional nystagmus. Then, for vector-electronystagmography (VENG), we used a three-channel thermosensitive Berger VN316 model device (São Paulo, Brazil) along with a Ferrante swivel chair, a Neurograff model EV VEC visual stimulator, and a Neurograff ear calorimeter model NGR 05 measuring air temperature. Next were eye and labyrinth VNG tests, according to criteria proposed by the authors.[12]
- Eye movement calibration – Verified spontaneous and semi-spontaneous nystagmus using pendular tracking, checking for pre- and post-rotatory plus pre- and post-caloric optokinetic nystagmus. The caloric stimulation time in each ear with air at 42°C and 18°C lasted 80 seconds for each temperature and responses were recorded with eyes closed and then with eyes open to observe the inhibitory effect of eye fixation (IEEF). The criteria used in the air caloric test were: Absolute value: between 2 and 24 degrees/ sec (< 2 degrees/sec (hyporeflexia), > 24 degrees/ sec (hyperreflexia); Relative values: Labyrinth preponderance (LP) $< 41\%$ and Nystagmus directional preponderance (NDP) $< 36\%$.[13]

Statistical Analysis

For statistical analysis, we used descriptive statistics methods (frequency distributions) along with Fisher and difference of proportions tests with a significance level of 0.05 (5%).

Results

Otoneurological symptoms most evident in the interview were: dizziness (75.7%), tinnitus, neck cracking, tingling in the extremities and hearing problems (36.3% for each). The various clinical symptoms that were most evident were: cardiovascular disorders (69.7%), endocrine-metabolic (48.5%), and rheumatic (30.3%), as shown in ►**Tables 1** and **2** respectively.

The correlation of harmful lifestyle habits (alcohol, cigarettes, and coffee) with complaints of dizziness ($p = 0.6503$), tinnitus ($p = 0.2418$), and the results of audiologic ($p = 0.6004$) and vestibular ($p = 0.4910$) evaluations showed no significance upon application of Fisher's test.

The interrelationship between the complaints of dizziness, tinnitus, and hearing are noted in ►**Table 3**.

Table 1 Distribution of frequency for otoneurological complaints in subjects with cervicalgia

Otoneurological symptoms	Absolute frequency	Relative frequency
Dizziness	25	75.7
Tinnitus	12	36.3
Neck cracking	12	36.3
Tingling of extremities	12	36.3
Hearing loss	12	36.3
Headache	10	30.3
Difficulty or pain when moving the neck	10	30.3
Radiating pain to shoulders and / or arms	9	27.2
Fatigue	5	15.1
Agitation during sleep	5	15.1
Dysphagia	4	12.1
Blurred vision	3	9.0
Dysphonia	2	6.0
Double vision	1	3.0
Tremors	1	3.0
Tingling of the face	1	3.0
Dysarthria	1	3.0
Change in sense of taste	1	3.0

Table 2 Other clinical findings related to diverse systems in subjects with cervicalgia

Diverse clinical symptoms	Absolute frequency	Relative frequency
Cardiovascular disorders (high or low pressure)	23	69.7
Endocrine and metabolic disorders (dyslipidemia, diabetes, thyroid gland)	16	48.5
Rheumatic disorders (arthritis, osteoporosis)	10	30.3
Head trauma	4	12.1
Kidney disease	1	3.0
Respiratory failure	1	3.0

The application of the difference of proportions test showed significance for dizziness in individuals with hearing complaints ($p = 0.0245$) and tinnitus ($p = 0.0133$).

In the audiological evaluation, 30 individuals (91.0%) had some kind of hearing impairment in at least one ear, with sensorineural loss being the most prevalent (88.0%) and three patients (9.0%) had hearing thresholds within the normal range, as denoted in ►**Table 4**. The results of the SRT and the SRI were compatible with the tonal threshold.

For the application of the difference of proportions test among individuals with sensorineural hearing loss and those with hearing thresholds within the normal range, the difference was significant to both ears ($p = 0.0000$).

The relationship between dizziness and the vestibular examination showed eight cases of dizziness in patients with abnormal vestibular test results and 17 cases of dizziness with normal vestibular examination results. Fisher's test did not show statistical significance ($p = 0.1317$), although a large number of individuals had complained of symptoms, even those with normal test results.

The research of positional nystagmus, eye movement calibration, research of semi-spontaneous and spontaneous nystagmus with open and closed eyes, optokinetic and pendular tracking, as well as for and pre- and post-rotatory nystagmus showed no alterations.

Table 3 Correlation among complaints of dizziness, tinnitus, and hearing loss in subjects with cervicalgia

Subjects with dizziness			
Complaint	Present		P
	Yes	No	
Hearing loss	12	13	0.8025
Tinnitus	15	10	0.2077
Subjects with hearing loss			
Complaint	Present		P
	Yes	No	
Dizziness	12	4	0.0245
Tinnitus	8	8	1.0000
Subjects with tinnitus			
Complaint	Present		P
	Yes	No	
Dizziness	10	2	0.0133
Hearing loss	8	4	0.2068

The application of a difference of proportions test showed significance in the correlation among dizziness complaints with hearing loss ($p = 0.0245$) and tinnitus ($p = 0.0133$).

Table 4 Findings from audiological evaluation in subjects with cervicalgia

Audiological exam result	Absolute frequency	Relative frequency
Sensorineural hearing loss in RE	29	43.94
Sensorineural hearing loss in LE	27	40.91
Hearing thresholds normal in LE	5	7.58
Hearing thresholds normal in RE	4	6.06
Mixed hearing loss in LE	1	1.52

Abbreviations: LE, left ear; RE, right ear.
The application of a difference of proportions test among subjects with sensorineural hearing loss and subjects with hearing thresholds with normal parameters showed significance in both ears ($p = 0.0000$).

In the caloric test, 20 subjects (61.0%) had normal reflexes, six individuals (18.0%) presented unilateral labyrinthine hyperreflexia, four individuals (12.0%) had bilateral labyrinthine hyperreflexia, two individuals (6.0%) presented bilateral labyrinthine hyporeflexia, and one individual (3.0%) had asymmetrical labyrinthine preponderance (LP).

There were 13 patients (39.0%), with peripheral vestibular dysfunction, 10 cases (30.3%) of peripheral vestibular irritant dysfunction, and three cases (9.1%) of peripheral vestibular deficit dysfunction. The vestibular exam was normal in 20 patients (61.0%), as described in ►**Table 5**.

The application of the difference of proportions test showed no significant difference between the proportions of individuals with normal test results and altered vestibular exams ($p = 0.0786$). Although there was no significance, the results showed a high incidence of altered cases for the labyrinthine examination.

Discussion

In the medical history analysis, we found multiple otoneurological complaints with a higher prevalence of dizziness, then tinnitus, followed by neck cracking, tingling in the extremities, and hearing loss. These symptoms have also been highlighted in several studies[9,14,15] describing dizziness, tinnitus, and hearing loss as being the most frequent otoneurological complaints in cervical alterations.

In one study,[16] the authors evaluated 76 patients 20–83 years old with cervical alterations and the main complaints reported in the medical history were dizziness (96.0%), tinnitus (81.6%), and hearing loss (64.5%). To maintain balance, the cervical somatosensory (proprioceptive), vestibular, and visual systems receive information regarding posture, position, and movements of the head and eyes. For proper integration of these systems, the proper functioning of the head-neck-eye complex is essential as these structures are related to information from the receptors located on the capsule of the zygapophyseal joints and intrinsic muscles of the neck. The stimuli pass through spinal vestibular pathways to lower vestibular nuclei and the central region of the cerebellum, along with the ocular afferent tracts.[17] Cervical proprioception is extremely important in postural control and cervical disorders are often associated with complaints of dizziness and vertigo.[17]

Table 5 Result of vestibular exam in subjects with cervicalgia

Result of vestibular exam	Absolute frequency	Relative frequency
Normoreflexia	20	61.0
UIPVD	6	18.0
BIPVD	4	12.0
BDPVD	2	6.0
UDPVD	1	3.0

Abbreviations: BDPVD, bilateral deficit peripheral vestibular dysfunction; BIPVD, Bilateral irritative peripheral vestibular dysfunction; UDPVD, unilateral deficit peripheral vestibular dysfunction; UIPVD, Unilateral irritative peripheral vestibular dysfunction.
The application of a difference of proportions test showed no significance among the proportions of subjects with normal and altered vestibular exams ($p = 0.0786$). Despite not having significance, the result showed a high incidence of altered cases in the labyrinthine exam.

For authors in another study,[18] the emergence of tinnitus is due to the dynamic interaction of various centers of the nervous and limbic systems and alterations or lesions in the cochlea precede this process. This leads to imbalance in the lower pathways of the auditory system, resulting in abnormal neural activity perceived and interpreted by the central nervous system as tinnitus. The authors also refer to the possibility of afferents from the cervical structures with projections for the cochlear nucleus, indicating an influence of reflection of the cervical spine. Another study[19] refers to other autonomic disorders as concomitant symptoms of cervicalgia.

With regard to the various clinical findings, we highlight a higher occurrence of systemic diseases such as endocrine-metabolic cardiovascular and rheumatic disorders. In one study, the authors[20] analyzed 70 medical records to evaluate the most common chronic diseases that affected adults, and found a higher prevalence of cardiovascular diseases, followed by rheumatic, allergic, and endocrine-metabolic diseases. It is noteworthy that the majority of participants in this study consisted of individuals who are prone to the occurrence of these diseases.

In the present study, regardless of not having observed significance in the relationship between excessive consumption of coffee, alcohol, or tobacco with complaints of dizziness, tinnitus, nor in the results of auditory and vestibular tests, it is known that these are potentially harmful habits that are toxic to the inner ear and should be eliminated because they may lead to increased cochleovestibular symptoms.[21]

In the interrelation between otoneurological complaints, there was a higher prevalence of dizziness in individuals with hearing complaints and tinnitus. For the authors,[9] dizziness, tinnitus and hearing loss can also be clinical manifestations of postural system impairment. The origin of tinnitus is a contentious issue and, among the various existing theories, it is caused by increased spontaneous neuronal activity along the auditory pathways, often associated with lesions of the inner ear and the vestibulocochlear nerve.[22–25] Furthermore, there may be a dynamic interaction between various regions of the central nervous system, between cochlear nuclei and the pontine region, important for the control of eye movements, along with the areas involved neural interaction of the pons, cerebellum, and vestibular nuclei.[22–24] For authors in one study,[26] tinnitus can be the first manifestation of a labyrinthine disease process, before the onset of vestibular dysfunction.

The audiological evaluation showed higher prevalence of sensorineural alteration. One study[16] evaluated 76 patients with cervical spine alterations and observed a high frequency (61.8%) of sensorineural hearing loss.

The relationship between dizziness and the vestibular examination predominated normal exams in subjects with dizziness. With the low diagnostic sensitivity of VNG, some individuals with labyrinthine alterations may qualify within normal standards.[27]

In the present study, we observed changes in the peripheral vestibular system, located in the caloric test, with a predominance of irritative vestibular dysfunction. These findings were also highlighted by another study[28] that evaluated 10 patients with cervical vertigo and mentioned peripheral vestibular alteration of the irritant type in 80% of patients evaluated. Other studies[9,29] showed that the muscles located in the sub-occipital space provide adequate cervical proprioception for having large numbers of neuromuscular receptors. The cervical tonic muscles work with afferent information from cervical-cochlear and cervical-ocular reflexes, also influenced by information from the vestibular and visual system, allowing adjustments to the position of the head, eyes and to posture. The cervical-cochlear reflex activates the muscles of the neck in response to stretching, to maintain the position of the head; the cervical-ocular reflex works with the vestibular-ocular and optokinetic structures, acting on the extraocular muscles to allow proper vision during movement, and cervical tonic reflex is integrated into the vestibule-spinal to control posture. When a cervical change, and consequently a proprioceptive commitment, occurs, there is an increase in latency of the vestibular-ocular and cervical-ocular reflex. This is manifested by the change in fine-control eye movement that may cause important labyrinthine commitment. A study[30] applied static and dynamic balance tests on 92 patients with neck pain and observed imbalance and dizziness in 65% of patients.

Conclusion

The most common otoneurological symptoms found in our study were dizziness, tinnitus, neck cracking, tingling in the extremities, and hearing loss. The various clinical symptoms most frequently reported were cardiovascular, endocrine-metabolic, and rheumatic.

There was significance for dizziness in individuals with hearing complaints and with tinnitus.

In the audiological evaluation, there was a prevalence of sensorineural alteration (88.0%) in at least one ear.

The alteration in the vestibular examination occurred in 39.4% of subjects, evidenced in the caloric test, with a predominance of an irritative dysfunction of the peripheral vestibular system.

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