ORIGINAL ARTICLE

ANALYSIS OF CERVICAL POSTURE IN PATIENTS WITH BENIGN PAROXYSMAL POSITIONAL VERTIGO

Benign Paroksismal Pozisyonel Vertigolu Hastalarda Servikal Postür Analizi

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ABSTRACT

Objective: Reduced cervical lordosis, frequently seen in benign paroxysmal positional vertigo (BPPV), has recently drawn attention to cervical posture disorder in the etiology. This study aimed to investigate the relationship between BPPV and cervical posture.

Material and Methods: Twenty-seven patients with BPPV (mean age 45.5±8.07 years) and 29 healthy volunteers without BPPV (mean age 36.0±9.11 years) were included in our study. Cervical spine range of motion (ROM) measurements, cervical lordosis angle (fleche cervicale) and posture evaluation were performed with DIERS Formetric 4D imaging device. The neck disability index (NDI) and neck pain Visual Analog Scale (VAS) of each patient was recorded.

Results: In cervical ROM assessment, all cervical ROMs were significantly lower in the case group ($p < 0.05$) except extension ($p > 0.05$). Neck pain VAS ($p = 0.004$) and NDI ($p < 0.01$) scores were significantly higher in the case group. There was no statistically significant difference between the groups in comparison of spinal sagittal angle parameters ($p > 0.05$). There was a significant positive correlation between fleche cervicale and thoracic kyphosis index ($r = 0.630$, $p < 0.01$).

Conclusion: No association was found between BPPV and cervical posture. Decreased cervical lordosis is a consequence of BPPV, not an etiologic cause. Painful cervical pathologies may accompany BPPV.

Keywords: *Benign Paroxysmal Positional Vertigo (BPPV), Cervical Lordosis, DIERS Formetric 4D Motion Imaging System*

ÖZET

Amaç: Benign paroksismal pozisyonel vertigoda (BPPV) sıklıkla görülen azalmış servikal lordoz, son zamanlarda etiyolojide servikal postür bozukluğuna dikkat çekmektedir. Bu çalışmada BPPV ile servikal postür arasındaki ilişkinin araştırılması amaçlanmıştır.

Gereç ve Yöntemler: Çalışmamıza BPPV'li 27 hasta (ortalama yaş 45,5 ± 8,07 yıl) ve BPPV'si olmayan 29 sağlıklı gönüllü (ortalama yaş 36,0 ± 9,11 yıl) dahil edildi. DIERS formetric 4D görüntüleme cihazı ile servikal omurga eklem hareket açıklığı (EHA) ölçümleri, servikal lordoz açısı (fleche servikale) ve postür değerlendirmesi yapıldı. Her hastanın boyun disabilite indeksi (NDI) ve boyun ağrısı Vizüel Analog Skala (VAS) kaydedildi.

Bulgular: Servikal EHA değerlendirmesinde, tüm servikal EHA'lar vaka grubunda ($p < 0,05$) ekstansiyon ($p > 0,05$) dışında anlamlı olarak düşüktü. Boyun ağrısı VAS ($p = 0,004$) ve NDI ($p < 0,01$) skorları vaka grubunda anlamlı olarak yüksekti. Spinal sagittal açı parametreleri karşılaştırıldığında gruplar arasında istatistiksel olarak anlamlı fark yoktu ($p > 0,05$). Fleche servikal ile torasik kifoz indeksi arasında anlamlı bir pozitif korelasyon vardı ($r = 0,630$, $p < 0,01$).

Sonuç: BPPV ile servikal postür arasında ilişki bulunamadı. Azalmış servikal lordoz BPPV'nin bir sonucudur, etiyolojik bir neden değildir. Ağrılı servikal patolojiler BPPV'ye eşlik edebilir.

Anahtar Kelimeler: *Benign Paroksismal Pozisyonel Vertigo (BPPV), Servikal Lordoz, DIERS Formetric 4D Hareket Görüntüleme Sistemi*

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INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is the most frequently occurring cause of vertigo. The lifetime prevalence rate is 2.4%. It is characterized by rotatory, short-lasting episodes of severe dizziness that occur with head movements (1, 2). BPPV occurs as a result of endolymph flow due to the free movement of otoliths separated from the utricular macula in the affected semicircular canals (3). Idiopathic BPPV occurs more frequently in women and elderly individuals. The female/male ratio is 2-3/1. The right ear is mainly affected and primarily develops in the posterior and horizontal semicircular canals (4).

The occurrence of BPPV is explained by two accepted theories: cupulolithiasis and canalolithiasis. In cupulolithiasis, the gravity of otoconia, which is higher than that of endolymph, adheres to the cupula of the semicircular canal, causing inappropriate cupula-endolymph movement with specific head movements, resulting in vertigo attacks. In canalolithiasis, it is said that the otoconia do not adhere to the cupula but circulate freely in the endolymph, and these particles settle in the endolymph because they are denser than the endolymph. It has been reported that vertigo attacks occur due to pushing and pulling the otoconia to the cupula with head movements (5). The causes of BPPV are examined in two groups primary (idiopathic) and secondary. Primary cases are idiopathic BPPV and constitute 50-70% of patients (6, 7).

Dix-Hallpike Maneuver is the gold standard for posterior canal BPPV. Other diagnostic tests include the Side Lying Test, Supine Head-Roll maneuver, Bow and Lean Test, and the Straight-Back Head Hanging Test, which is proposed as an alternative method (8). Dizziness is an umbrella term. It includes sensations such as vertigo, imbalance, dizziness, and presyncope. From this point of view, vertigo is only a part of dizziness. However, the International Society of Neurotology has declared that dizziness and vertigo are independent allelic symptoms. Dizziness and vertigo may coexist or occur one after the other. Dizziness (cervical vertigo) can also occur in cervical pathologies. Cervical degenerative disease is the most common cervical disease (9).

BPPV and cervicogenic dizziness are distinct diseases. Dizziness or vertigo is the result of vestibular or nonvestibular dysfunction. Cervicogenic vertigo belongs to the nonvestibular group, and its psychophysiology is still controversial. The central nervous system must integrate symmetrical inputs from the auditory, visual, and vestibular organs and proprioception inputs for balance and coordination. Any dysfunction that disrupts this integration results in dizziness and imbalance. Degeneration, inflammation, trauma, and mechanical dysfunction of the spine may be factors in the etiology of cervicogenic dizziness (10). Most researchers have analyzed the mechanism of cervicogenic dizziness in 3 categories: 1- Sympathetic plexus irritation, 2- Abnormal somatosensory input from the neck, and 3- Vertebrobasilar insufficiency. Among these, vertebrobasilar insufficiency is a mechanism accepted by most researchers (11). There are few studies in the literature on the relationship between abnormal head and neck posture and BPPV. Prolonged forward-facing work, increased thoracic kyphosis, and cervical degeneration results in forward head posture (FHP) (12). In particular, changes in the upper cervical spine are associated with dizziness more than in the lower cervical spine. Most cervical flexion, extension, and rotation movements occur between the atlantooccipital and atlantoaxial joints (13).

As a result of impaired upper cervical alignment and functional and structural changes in the suboccipital muscles, unnecessary stimuli persist due to instability in the facet joints and ligaments. Thus, proprioceptive inputs from the neck to the central nervous system become inconsistent with vestibular and visual inputs. As a result of the incompatibility of the information, integration is disrupted, and dizziness, and headache occur. Dizziness does not occur in every patient with abnormal head-neck posture (14).

There are different methods to measure FHP: Head tilt angle, Craniovertebral angle, Cobb angle, and cervical inclination angle measurement for cervical lordosis measurement (15). In FHP, stress increases in the posterior cervical spine, and muscle length changes. The increase in muscle length decreases joint position sensation (16).

This study aimed to investigate the relationship between BPPV and cervical posture, obtain clues to shed light on the unknown etiology and have an idea about the necessity of postural evaluation and interventions in diagnosis and treatment. For this purpose, DIERS

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Formetric 4D, Diers International GmbH Schlangenbad, Germany.

MATERIAL AND METHODS

In this research, which we conducted as a case-control study, the rules of the Declaration of Helsinki were followed. The patient and control groups were verbally informed about the course and purpose of the study. In addition, a written informed consent form was obtained from each patient. Ethical approval was obtained from Ankara City Hospital local ethics committee (E2-21-93). Patients who were admitted to Ankara City Hospital Neurology and Ear, Nose and Throat (ENT) departments between September 2021 and February 2022, who were diagnosed or followed up with BPPV as a result of routine examinations performed by Neurology and ENT departments, and healthy volunteers without BPPV diagnosis were enrolled in our study. The neurologic examination consisted of a systemic examination to detect nystagmus, a gait examination, cerebellar tests, and a brief neurologic examination. ENT examination consisted of bilateral otoscopic examination to check the tympanic membrane and middle ear and audiological examination for inner and middle ear pathologies.

According to the inclusion and exclusion criteria, 27 BPPV patients and 29 healthy volunteers without BPPV were enrolled. The age range of the participants was 18-60 years. Exclusion criteria; patients with vertigo of central origin, patients with problems in the tympanic membrane or middle ear as a result of the bilateral otoscopic examination in ENT examination, patients with neurological pathology as a result of nystagmus investigation, gait examination, cerebellar tests and brief neurological examination in the systemic examination, patients with hearing loss or pressure problems indicating inner ear or middle ear pathology as a result of the audiological examination, metabolic disorders that may mimic peripheral vertigo, patients with BPPV diagnosed as a secondary cause, patients with a history of psychosomatic disorders, heart disease, hypertension, orthostatic hypotension, cerebrovascular diseases, migraine, atherosclerosis, diabetes mellitus, cervical instability, inflammatory disease, tumoral and infectious diseases, and patients with anemia, hyperglycemia and high sedimentation rate in laboratory tests.

Gender, age, body mass index, weight, height, employment status, education, marital status, comorbidity, smoking, cell phone screen time, cervical spine range of motion (ROM) measurements (measured with a goniometer) were recorded in the patient and control groups. Cervical lordosis angle (fleche cervicale) and posture evaluation were performed with DIERS formetric 4D imaging device. The neck disability index (NDI) and neck pain Visual Analog Scale (VAS) of each patient was recorded.

Posture and cervical lordosis (fleche cervicale) were measured by the DIERS Formetric 4D motion imaging system in the Posture Analysis laboratory of Ankara City Hospital Physical Therapy and Rehabilitation Hospital in the presence of a physiotherapist. The DIERS formetric 4D system provides a 3-dimensional analysis of the spine surface for assessing posture with 4D technology, which pioneered functional clinical measurement technology. A precise measurement is made, and postural variants can be eliminated. Rasterstereography analyzes the surface topography of the spine without radiation, allowing the measurement of spinal deformity in 3D. It uses triangulation points for this. The DIERS formetric 4D System uses photogrammetric video recording of the spine surface. The measurement is performed in standing, static posture. For raster stereographic measurements, a white line of light is projected parallel to the surface of the spine. Anatomical landmarks are automatically fixed by adding convex and concave regions to this light curve pattern. The system can create a 3D human spine model and calculate relevant clinical parameters. Digital recording takes approximately 3 seconds, and 12 images are acquired. Data analysis is done with in-computer software.

In the DIERS formetric 4D System:

Kyphosis angle: Between vertebral prominence and estimated T12 position,

Lordosis angle Measured between T12 and the midpoint of the right and left dimples.

Fleche cervicale: The distance between the vertical plumb line and the cervical apex.

Fleche lombaire is the spatial distance between the vertical plumb line and the lumbar apex (17).

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A study of patients with idiopathic scoliosis found that measurements made with the Formetric 4D dynamic system were comparable to the current gold standard. The researchers reported that the DIERS 4D Formetric System has a high clinical value in assessing spinal curvatures. (18).

The Neck Disability Questionnaire assesses neck pain's effect on daily living activities. It consists of 10 questions about self-care, neck pain intensity, reading, headache, driving, lifting, sleep, concentration, and leisure activities. It has been reported that the Turkish version of the NDI is a reliable and valid measurement method for evaluating disability caused by problems in the neck region because patients easily understand it and have a short application time in the clinic (19).

Data were analyzed using Statistical Package for Social Sciences 23 (SPSS 23.0) (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) software. Variables were investigated using visual and analytical methods (Shapiro-Wilks test) to determine whether they were usually distributed. Descriptive statistics of normally distributed variables were presented as mean and standard deviation. In contrast, descriptive statistics of non-normally distributed and ordinal variables were presented as median, minimum-maximum values, and frequency tables. Physical and socio-demographic characteristics were compared using Mann-Whitney U tests or independent sample t-tests for numerical variables and the chi-square test for categorical variables. Fleche cervicale, thoracic kyphosis index, fleche lombaire and lumbar lordosis (LL) angle between groups were analyzed by independent sample t-test. Pearson correlation test was used to evaluate the relationship between LL angle, fleche lombaire, thoracic kyphosis index, and fleche cervicale.

RESULTS

The socio-demographic and physical characteristics of the participants are shown in Table 1. The mean age of the subjects were 45.5 ± 8.07 years, and 23 (85.2%) of the patients were female. Except for age and parity ($p < 0.05$), there was no significant difference between the groups in demographic data ($p > 0.05$).

In the cervical ROM evaluation, all cervical ROMs were significantly less in the case group except extension ($p < 0.05$). Neck pain (VAS) ($p= 0.004$) and NDI ($p < 0.01$) scores were significantly higher in the case group. There was no statistically significant difference between the groups in comparison of spinal sagittal angle values ($p > 0.05$) (Table 2).

In the correlation study between variables, there was a significant positive correlation between fleche cervicale and thoracic kyphosis index ($r = 0.630$, $p<0.01$; Figure 1). Also, LL angle was positively correlated with thoracic kyphosis index ($r = 0.437$, $p < 0.01$).

DISCUSSION

BPPV is the most expected diagnosis of vertigo. The most accepted explanation for its pathogenesis is that otoliths fall from the utricular macula into the semicircular canals. Thus, an abnormal movement sensation occurs due to a fluctuation in the endolymph (20). Since decreased cervical lordosis frequently accompanies BPPV. Recently, it has been suggested that cervical posture disorder may have a role in the etiology. Our study found no relation between BPPV and cervical lordosis angle. There was no significant difference between the two groups in fleche cervicale values.

Cervical vertigo is a different disease from BPPV. In its pathogenesis, confusion in proprioception caused by muscle, bone, and joint pathologies in the neck region, cervical sympathetic dysfunction, and decreased vertebral artery blood flow play a role (21). Traumatic or degenerative changes in the cervical spine and problems in the neck muscles, or sometimes just the pain itself, induce impaired sensation and lead to imbalanced symptoms. The cause of cervical dizziness is decreased vertebral artery blood flow caused by neck rotation in the degenerative cervical spine, compression of sympathetic nerve fibers, or proprioceptive receptor dysfunction in neck tissues (22).

Very few studies are on the relationship between BPPV and cervical lordosis. The fact that the etiology of BPPV cannot be found with a rate of 50-70% and postural disorders, including cervical axis straightening, are frequently observed in these patients has drawn attention to the possibility that the musculoskeletal system may be the etiologic factor. Erdem et al. investigated cervical lordosis in 40 patients with BPPV

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Table 1. Baseline demographic data of both groups.

Characteristics	Study group (n = 27)	Control group (n = 29)	p
Age (years, mean±SD)	43.5 ± 8.07	36.0 ± 9.11	**.002***
Weight (median (min-max))	70 (52 - 106)	59 (49 - 103)	.055
BMI (median (min-max))	26.1 (19.5 - 41.4)	23.2 (19.1 - 41.3)	.079
Gender (n, %)			
Female	23 (85.2)	22 7(5.9)	.380
Male	4 (14.8)	7 (24.1)	
Employment Status (n, %)			
Not working	13 (11.6)	11 (37.9)	.440
Working	14 (15.4)	18 (62.1)	
Marital status (n, %)			
Single	2 (7.4)	8 (27.69	.080
Married	25 (22.2)	21 (72.4)	
Child (n, %)			**.011***
No	3 (11.1)	12 (41.4)	
Yes	24 (88.9)	17 (58.69)	
Comorbidity status (n, %)			
No	14 (51.9)	20 (69.0)	.190
Yes	13 (48.1)	9 (31.0)	
Cigarette smoking (n, %)			
No	17 (63.0)	16 (55.2)	.554
Yes	10 (37.0)	13 (44.8)	
Screen time (n, %)			
Less than 1 hour	12 (44.4)	8 (27.6)	.418
1-4 hours	6 (22.2)	8 (27.6)	
More than 4 hours	9 (33.3)	13 (11.4)	

*p < 0.05, SD; standard deviation, BMI; body mass index.

and found that the angle was below average in 35 of 40 patients (87.5%). Based on this, the researchers reported that a decrease in the cervical axis may be an etiologic factor in BPPV (23).

However, there was no control group of healthy subjects in this study. Considering that decreased cervical lordosis is very common in the general population and is due to many different causes, we believe it is challenging to establish a definite link between BPPV and cervical lordosis without comparing it with healthy controls. In our study, we worked with a group of patients diagnosed with BPPV and a control group of healthy volunteers. In a study on the causes of cervical axis flattening, cervical lordosis was investigated by Cobb angle measurement. Patients with decreased cervical lordosis were diagnosed with tension-type headache, cervical spondylosis, cervical herniation, fibromyalgia, myofascial pain syndrome (MPS), and anxiety depression (24). Head position sense is influenced by proprioceptive input from the neck and vestibular system input. There is a wide anatomical connection between these two systems. If the information about the position of the head from the vestibular system is not precise or if there is an error in the integration of this information in the central nervous system, the head position may change (25).

Patients with peripheral vestibular dysfunction generally have decreased flexibility and relaxation capacity. One study pointed out that about half

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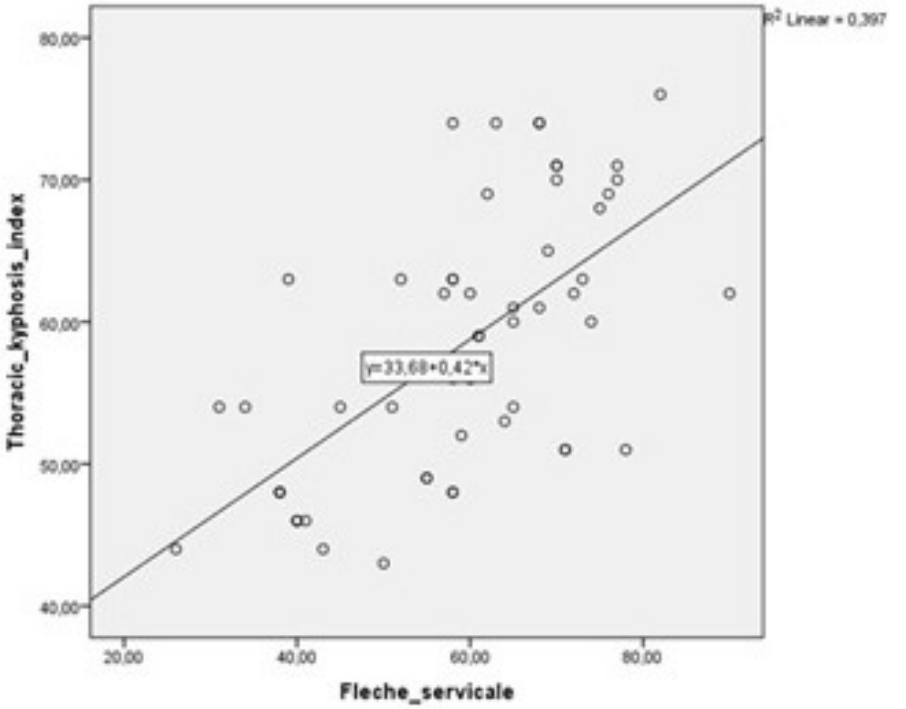
Table 2. Comparison of spinal sagittal values and ROM parameters between groups.

Characteristics features	**Study group (n = 27) X±SD**	**Control group (n = 29) X±SD**	**t values**	**p**
Fleche cervicale(mm)	60.6 ± 12.39	57.5 ± 15.79	-.816	.418
Thoracic kyphosis index	60.2 ± 9.8	56.5 ± 8.8	-1.500	.139
Fleche lombaire(mm)	48.48 ± 12.6	46.0 ± 11.5	-.768	.446
Lumbar lordosis angle (°)	51.18 ± 8.3	48.79 ± 8.01	-1.096	.278
Characteristic features	**Study group (n = 27) (Median (min-max))**	**Control group (n = 29) (Median (min-max))**	**z**	**p**
Neck disability index	1 (0-3)	0 (0-3)	-3.610	**.000***
Neck pain (VAS)	6 (0-9)	2 (0-9)	-2.869	**.004***
CROM_F (°)	40 (30-45)	45 (30-45)	-2.248	**.025***
CROM_E (°)	40 (30-45)	40 (30-45)	-.569	.569
CROM_LF-right (°)	40 (30-40)	40 (30-45)	-3.394	**.001***
CROM_LF-left (°)	40 (25-45)	40 (30-45)	-2.468	**.014***
CROM_R-right (°)	60 (50-60)	60 (50-70)	-2.396	**.017***
CROM_R_left (°)	60 (45-70)	60 (50-70)	-1.079	**.0281***

*p < 0.05, SD; standard deviation, VAS; visual analog scale, CROM_F-; cervical range of motion-flexion, CROM_E; cervical range of motion-extension, CROM_LF-right; cervical range of motion-right lateral flexion, CROM_LF-left; cervical range of motion-left lateral flexion, CROM_R-right; cervical range of motion-right rotation, CROM_R-left; cervical range of motion-left rotation.

Figure 1. Correlation between fleche cervicale and thoracic kyphosis index.



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of such patients showed reduced ROM in the neck, temporomandibular joints, shoulders, and dorsal spine. Muscle palpation revealed upper trapezius and sternocleidomastoid muscle contractions in 70 to 94% of patients (26). Patients with untreated vestibular hypofunction may adopt a rigid head posture to avoid symptoms. They may tilt their head forward, or the patient may turn them toward the labyrinth (27). Vestibuloocular, vestibulocollic, vestibulospinal, and many other reflexes that occur with vestibular stimulation increase the tone of the neck, trunk, and extremity muscles against gravity. Since stimuli from cervical proprioceptors in BPPV will increase the patient's current complaint of dizziness, the patient can keep his/her head tilted forward to reduce the stimulation of proprioceptors in that region (28).

Based on this literature information, BPPV, a peripheral vestibular dysfunction, is one of the causes of decreased cervical lordosis. There was no significant difference between our case group and the control group regarding cervical lordosis because decreased cervical lordosis, which is already very common in society, is not specific to any disease. It is seen that decreased cervical lordosis is not a condition specific to BPPV. It can also be seen in healthy asymptomatic individuals like our control group. Therefore, decreased cervical lordosis is not an etiologic factor in BPPV but rather a consequence of BPPV. However, in the association of cervicogenic dizziness and BPPV, symptoms originating from the neck may be added to the existing picture and increase the severity of the symptoms.

The relationship between cervical lordosis and other cervical symptoms, such as pain, is also controversial. In the literature, studies show a relationship between decreased cervical lordosis and neck pain, and studies report that decreased cervical lordosis is not associated with clinical symptoms. However, the relationship between differences in cervical lordosis angles and neck pain is vague in daily practice. In a study in which cervical lordosis was measured by Cobb, Tangent, and effective cervical lordosis methods in 44 patients with chronic neck pain and its relationship with neck pain was investigated, no significant relationship was found between neck pain and cervical lordosis (29). In a study conducted with 100 participants who were chronic laptop computer users and investigated the relationship between FHP and neck pain, no relationship was found between FHP and neck pain and cervical ROMs (30). A meta-analysis study reported that although FHP leads to decreased performance-based balance and cervical proprioception, the current evidence for the relationship between FHP and static balance and postural stability control and between FHP and vestibular deficits is controversial (28).

Kültür et al. reported that musculoskeletal system disorders may be the etiologic factor in BPPV. They suggested that most BPPV patients have decreased cervical lordosis, relapses are frequent despite Epley canalith repositioning treatment being the most accepted treatment, and musculoskeletal interventions such as manipulation are effective in BPPV. He divided 72 patients into two groups and performed only Epley maneuver in one group and cervical manipulation in the other group. He reported that the results were significantly better in the cervical manipulation group (31). However, there was no control group in this study. In addition, the improvement of vertigo with cervical traction and manipulative treatments suggests that it has a cervical origin rather than a vestibular focus (22). Since BPPV and cervicogenic dizziness can coexist and one worsens the other, improving the cervical pathology most likely reduced symptom severity and may have led to a better treatment outcome. Martelucci et al. reported that the success rate of the Epley maneuver decreased in cervical ROM limitation. Because in this maneuver, the patient's neck is forced to flexion, extension, and rotation. Since cervical ROM limitation is already expected in BPPV, they thought that manipulative approaches to the cervical spine would allow practical application of the Epley maneuver by improving ROM. For this purpose, they divided the patients into two groups and found that cervical flexion and extension limitations were significantly higher in those who needed multiple maneuvers (32). In conclusion, cervical manipulation positively affects the treatment results in BPPV by two mechanisms. The first mechanism of action is that it decreases the severity of the symptom by eliminating cervical dizziness in cases where BPPV and cervical dizziness are together, and the second mechanism of action is that it makes the Epley maneuver, which is the specific treatment of BPPV, effective.

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In this study, cervical ROM was significantly limited in the patient group compared to the control group. Cervical ROM limitation in BPPV is consistent with other reports in the literature. However, Martelucci stated that treatment failure is more strongly associated with the limitation of extension rather than the limitation of flexion. In contrast, in our study, the limitations of cervical flexion, rotation ($p < 0.05$), and lateral flexion ($p < 0.01$) were significantly different. No significant difference was found between the two groups in terms of extension. This result supports that there is no relationship between decreased cervical lordosis and BPPV.

Among cervical pathologies, cervical spondylosis is the pathology that has the most consensus about its relation with BPPV. Cervical degenerative disc disease is the most common disc pathology, and vertigo is observed in 50-60% of patients (33). Martinez et al. in their retrospective study of 493 patients, they analyzed the cervical radiographs of patients presenting with vertigo. They obtained radiographs in 281 of 493 patients. Degenerative changes were found in 74.1% of patients, osteophytes in 49.5%, and abnormal cervical lordosis in 37.1% (34). The posterior circulation is susceptible to ischemia due to the vertebral arteries' proximity to the cervical spine. This mechanism may be responsible for central and peripheral vestibular symptoms such as vertigo, dizziness, nystagmus, and imbalance. Olszewski et al. concluded that the vestibular labyrinth is selectively more sensitive to ischemia in the posterior circulation (35).

In a meta-analysis of 99 studies and 36646 patients, risk factors for recurrence in BPPV were evaluated. Although 30 risk factors were defined, 13 of them were found to be significant risk factors. The only cervical pathology among these 13 important risk factors was cervical spondylosis (36). The circulation of the inner ear is provided by the vertebrobasilar system, making the labyrinth susceptible to ischemia due to its localization in the inner ear, and labyrinth ischemia leads to the development of BPPV (37).

In the current study, NDI, and neck pain VAS scores were significantly higher in the case group compared to the control group ($p < 0.05$). Therefore, we can assume an association between BPPV and other painful cervical pathologies, but no association with decreased cervical lordosis was found. Considering that the mean age of our patient group was significantly higher than the control group ($p < 0.05$), we think that the only cervical pathology with an etiologic link to BPPV is cervical spondylosis causing vertebrobasilar insufficiency. Other cervical pathologies with vertigo are not associated with BPPV but with cervicogenic dizziness. BPPV and cervicogenic dizziness can be seen together. Therefore, other cervical pathologies, including decreased cervical lordosis, may not cause BPPV but may increase BPPV symptom severity. Musculoskeletal therapeutic approaches may be beneficial in BPPV. However, this is not directly affecting the pathophysiology of BPPV, but indirectly by relieving cervicogenic vertigo that is superimposed on BPPV or by facilitating canalith repositioning, the specific treatment for BPPV.

The limitation of this study is the small number of cases and the fact that cervical radiographs were not evaluated to detect other cervical pathologies in the participants.

CONCLUSION

There is no relationship between BPPV and decreased cervical lordosis. Decreased cervical lordosis is a consequence rather than a cause of BPPV. Decreased cervical lordosis is not an etiologic factor in BPPV, but it may lead to aggravation of the symptoms with the addition of cervicogenic dizziness to BPPV.

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