

THE EFFECT OF CERVICAL MANIPULATION TREATMENT IN BENIGN PAROXYSMAL POSITIONAL VERTIGO PATIENTS WITH NECK PAIN

Boyun Ağrılı Benign Paroksizmal Pozisyonel Vertigo Hastalarında Servikal Manipülasyon Tedavisinin Etkisi

Turgut KÜLTÜR¹, Gökçe ŞİMŞEK², Hatice AĞIR³

^{1,3} Kırıkkale Üniversitesi Tıp Fakültesi, FTR A.D., KIRIKKALE, TÜRKİYE

² Kırıkkale Üniversitesi Tıp Fakültesi, KBB A.D., KIRIKKALE, TÜRKİYE

ABSTRACT

ÖZET

Objective: Recurrence is common in the treatment of Benign Paroxysmal Positional Vertigo (BPPV) with an Epley maneuver. Methods such as manipulation are also effective in treatment. The study was aimed to determine the effect of cervical manipulation added to the Epley maneuver in treatment of patients with BPPV who has cervical lordosis and neck pain.

Material and Methods: Patients diagnosed with BPPV who has flattened cervical lordosis with at least level 6 neck pain in VAS and over 18 years of age were included in the study. Patients were stratified into two groups according to age and gender. In the first and control examination one month later, cervical manipulation was performed in addition to Epley maneuver to the first group (combined therapy), and only Epley maneuver to the second group. Patients were examined with video-head-impulse test (VHIT), the severity of neck pain determined with VAS and symptoms were questioned with the vertigo symptom scale (VSS) prior and after treatment.

Results: There was no difference between the groups in terms of VAS-pain, VSS and VHIT parameters before treatment ($p > 0.05$). While there was no difference in vestibulo-ocular reflex (VOR) gains between the study groups ($p > 0.05$), there was a significant difference in terms of VSS and VAS-pain ($p = 0.01$), after treatment. When compared by pathological VHIT findings, there was a significant difference in terms of improvement in favor of the combined treatment group after treatment ($p = 0.02$). At intragroup comparisons, VSS, VAS-pain, values were significantly decreased after treatment in both groups ($p = 0.01$). While intragroup pathologic VHIT findings were considered before and after treatment, there was no significant difference in improvement after treatment in the Epley group ($p > 0.05$). Contrarily difference was significant in the combined treatment group ($p = 0.01$).

Conclusion: Epley and manipulation therapy are more successful when applied together.

Keywords: Manual therapy, BPPV, Epley, VHIT

Amaç: Benign Paroksizmal Pozisyonel Vertigo (BPPV) tedavisinde Epley manevrası ile tedavide nüks sıklıkla görülmektedir. Manüel tedavi gibi yöntemler de tedavide etkilidir. Bu çalışmada servikal lordozda düzleşmenin yanısıra boyun ağrısı olan BPPV hastalarında Epley manevrasına eklenen servikal manüel tedavinin tedavi başarısına etkisini saptamak amaçlandı.

Gereç ve Yöntemler: Çalışmaya BPPV tanısı konulan, VAS'da en az 6 düzeyinde boyun ağrısı tarifleyen, servikal lordoz düzleşmesi saptanan 18 yaş üzeri hastalar alındı. Hastalar yaş ve cinsiyet açısından benzer iki gruba ayrıldı. İlk muayene ve bir ay sonraki kontrolde birinci gruba (kombine tedavi) Epley manevrasına ilaveten servikal manipülasyon, ikinci gruba ise sadece Epley manevrası uygulandı. Hastalara tedavi öncesinde ve sonrasında video-head-impulse test (VHIT) testi yapıldı, VAS ile boyun ağrısı şiddeti, vertigo semptom ölçeği (VSÖ) ile semptomlar sorgulandı.

Bulgular: Gruplar arasında tedavi öncesindeki VSÖ, VAS-ağrı, VHIT parametreleri açısından fark yoktu ($p > 0.05$). Tedavi sonrasında çalışma grupları arasında vestibulo-ocular reflex (VOR) kazançlarında fark bulunmazken ($p > 0.05$), VSÖ ve VAS-ağrı açısından anlamlı fark vardı ($p = 0.01$). Grupların patolojik VHIT bulguları açısından karşılaştırmasında tedavi sonrasında kombine tedavi grubu lehine iyileşme açısından anlamlı fark vardı ($p = 0.02$). Grup içi karşılaştırmalarda her iki grupta da VSÖ, VAS-ağrı, değerleri tedavi sonrasında anlamlı azalmış bulundu ($p = 0.01$). VOR kazançları açısından tedavi öncesi ve sonrası grup içi karşılaştırmalarında fark yoktu. Tedavi öncesi ve sonrasında patolojik VHIT bulguları grup içi karşılaştırmalarında Epley grubunda tedavi sonrasında anlamlı fark yoktu ($p > 0.05$). Aksine kombine tedavi grubunda ise tedavi sonrasında anlamlı fark saptandı ($p = 0.01$).

Sonuç: Epley ve manipülasyon tedavisi birlikte uygulandığında daha başarılı olmaktadır.

Anahtar Kelimeler: Manuel terapi, BPPV, Epley, VHIT



Correspondence / Yazışma Adresi:

Kırıkkale Üniversitesi Tıp Fakültesi, FTR A.D., Yahşihan KIRIKKALE, TÜRKİYE

Phone / Tel: +905054844016

Received / Geliş Tarihi: 31.01.2020

ORCID NO: ¹0000-0002-2420-5153, ²0000-0001-5281-0986

Dr. Turgut KÜLTÜR

Kırıkkale Üniversitesi Tıp Fakültesi, FTR A.D., Yahşihan KIRIKKALE, TÜRKİYE

E-mail / E-posta: kurgut@hotmail.com

Accepted / Kabul Tarihi: 25.03.2020

³0000-0003-1606-9224

INTRODUCTION

In the pathogenesis of benign paroxysmal positional vertigo (BPPV), which is the most commonly diagnosed form of vertigo, the current most accepted explanation is that the otoliths fall from the utricular macula into the semicircular canals (SSC) by creating an abnormal movement perception by fluctuating the endolymph (1).

In the pathogenesis of cervical vertigo, which is a disease different from BPPV, it is accepted that muscle, bone, joint pathologies in the neck region cause cervical sympathetic dysfunction and decreased vertebral artery blood flow causing dizziness and other symptoms (2).

The majority of BPPV patients have complaints of neck pain and signs of flattening in cervical lordosis have been reported (3,4). However, as far as we know in the literature, it has not been emphasized that cervical musculoskeletal diseases are among the etiological causes of BPPV. Although the channelite reposition maneuvers such as Epley are the most accepted treatment method in BPPV treatment, relapse is common (5). On the other hand, physical medicine methods for a musculoskeletal system such as manipulation in BPPV patients are also effective in treatment (6,7).

Video-head-impulse test (VHIT) which is a new method used for separating central and peripheral vertigo, is useful in detecting unilateral and bilateral vestibular balance problems. In this test, pushes are applied to the patient in various directions and six semicircular canals (SSC) are evaluated separately by measuring the eye-head movements by means of a video camera attached to a light glasses frame. It has been reported that VHIT can be used in BPVV (8-10). However, we did not find any article in the literature where BPPV patients treated manually were evaluated with VHIT.

In this study, we aimed to investigate the contribution of cervical manipulation application to the success of treatment in BPPV patients with cervical lordosis, accompanied by neck pain caused by musculoskeletal pathologies of the cervical region, and to determine the role of VHIT test in these patients in the short term.

MATERIALS AND METHODS

This study was carried out between January 2017–February 2018 at Kırıkkale University, Faculty of Medicine, Physical Medicine and Rehabilitation Department, after approval from the Clinical Research Ethics Committee of Kırıkkale University (Date: 3.1.2017, decision number: 1/15). Patients over 18 years of age who were diagnosed with BPPV by the ENT clinic, describing at least 6 levels of neck pain in VAS and who had flattened cervical lordosis were included in the study. The pain intensity of the patients was evaluated with the Visual Analogue Scale (VAS). VAS is created by marking the subjective perception level on a horizontal line as “0” where the patients have no complaint and “10” where the pain is the most severe (11). The lordosis flattening was considered to be less than 34 degrees between the lines drawn parallel to the posterior wall of the C2 and C7 vertebrae on the lateral radiograph (12).

Patients with malignancy, infection, trauma, inflammation, history of cervical surgery, myelopathy, severe osteoporosis, vertebrobasilar insufficiency, accompanying ear pressure or fullness sensation, hearing loss, tinnitus, facial paralysis, mental turbidity, syncope-like neurological deficit, continuous drug use or systemic disease, bleeding disorders and anticoagulation therapy that can cause vertigo, pregnancy, inability to communicate, psychiatric disorder, and those who were contraindicated for manipulation (acute arthritis, inflammation, effusion, infectious arthritis, osteomyelitis, malignancy, advanced cervical region degenerative changes,

inflammatory rheumatological diseases, spondylolisthesis, and instability) were not included in the study.

The study group was divided into two similar groups in terms of age, gender, vertigo severity, the severity of neck pain. Written informed consent was obtained after giving detailed information to the patients. In addition to the Epley maneuver to the first group (combined therapy group), cervical manipulation was performed by the physiatrist, and the Epley maneuver was applied only to the second group in the first examination and the control examination one month later. The combined therapy group included 50 patients, 37 women, and 13 men, aged 21-64 while the Epley group included 27 women, 18 female and 9 male aged 24-62. A total number of 77 patients were included in the study. Patients were evaluated before and after 1 month of treatment with VHIT, VAS for the neck pain and Vertigo Symptom Scale (VSS) for the vertigo.

VHIT is a test performed by mirroring the image of the patient's eye with a mirror to a high-speed infrared camera that measures two-dimensional eye movements (10). VHIT test was applied by using a lightweight pair of goggles frame and an accelerometer fixed on the patient's head (EyeSee at 250 Hz sampling rate, EyeSee Cam™ Interacoustics A/S Denmark™).

The VHIT parameters of the patient, regardless of the treatment group, were evaluated by an experienced ENT specialist for each of the semicircular canals for vestibulo-ocular reflex (VOR) gains and pathological saccades separately. The patient's VOR gain was calculated automatically by the device. The VOR gain of less than 0.8 or the presence of covert and/or overt saccades was accepted as the pathological VHIT response. Saccades that appeared during head pushing were considered "covert", and saccades that emerged after the head pushing movement were considered as "overt" saccade (10). VHIT parameters were evaluated for both VOR gains and the presence of pathological findings.

Vertigo Symptom Scale (VSS) is a questionnaire that questions the complaints caused by dizziness, the frequency of these complaints, the general mood of the patient, anxiety and the quality of life of the patient. In this study, a short form of VSS consisting of 15 questions was used and the patients answered the complaints described above by using numbers between 1 and 4 points according to the frequency they experienced. While scoring; 0: never, 1 point: very rare, 2 points: most of the time, 3 points: very often (every week), 4 points: always (every day). The Turkish validity and reliability study of this test was conducted before by Yankı et al (13).

The manual therapy was carried out in two stages. The therapist was placed on the unaffected side of the patient, as determined by the provocation test. The ulnar region of one hand of the therapist and the temporal region of the patient were fixed without touching the ear. The middle finger of the other hand was placed parallel to the transverse process of the segment with dysfunction. The patient's head was positioned on the contralateral side with 15-20° lateral flexion and fixed. A trial mobilization was performed after the pre-tension caring for not to exceed the pathological barrier. The patient, who did not describe any complaints, was applied in the direction of high-velocity low-amplitude impulse were applied within physiological limits in the direction of rotation to the patient who did not describe any compliant during the trial mobilization. Secondly, manipulation was applied to the cervicothoracic transition region under C2 while the patient was still sitting. The patient was asked to cross his hands over his T1 spinous neck. The physician, by positioning the patient on his back, passed his arms under the armpits and fixed his hands and applied a cranial thrust with his arms and chest (14).

With the Epley maneuver, it is aimed to turn the otoliths that have fallen into the canal into the vestibule. The patient is seated on the stretcher, the

head is turned 45° to the side of the lesion and suspended from the stretcher with 30° hyperextension. After the nystagmus is over, the patient is turned 90° to the opposite side, after about 1 minute it is turned 45° more to the same side. A total rotation of 135° is performed. After waiting again for 1 minute, the patient is placed in a sitting position and the head is bent forward 20°. The patient is recommended to avoid sudden movements (15).

Statistical Analysis: All analyses were carried out using SPSS 16.0 (IBM SPSS Statistics 16) software program package. Average \pm standard deviation, continuous variables, categorical variables, median, minimum and maximum values were expressed as numerical and percentage. Compliance of data with normal distribution was assessed by Shapiro-Wilk test. When the parametric test assumptions were provided, the t-test was used in the comparison of the independent group differences, and the Mann-Whitney U test was used to compare the independent group differences. When the parametric test assumptions were not provided for comparison, for dependent groups Wilcoxon test was used. Differences among categorical variables were evaluated by Chi-square test. In all analyses, $p < 0.05$ was considered statistically significant.

RESULTS

There was no difference between the combined treatment and Epley groups in terms of age, gender, pre-treatment VAS, VAS-pain, and VOR values ($p > 0.05$) (Table 1). In the qualitative evaluation of VHIT parameters according to the pathological or normality performed by the ENT specialist, there was no difference between the groups before the treatment

in terms of pathological VHIT findings ($p = 0.86$). Unilateral (13 right, 12 left) involvement was detected. Before treatment, in the Epley group, 6 normal (22.22%), 21 (77.77%) pathological VHIT parameters, 16 unilateral (8 left, 8 right) involvement and 5 bilateral involvement were detected (Table 1).

There was no significant difference between the right or left side in VOR gains in patients with unilateral involvement both before and after treatment ($p > 0.05$).

While there was no difference in VOR gains between the study groups after treatment ($p > 0.05$), there was a significant difference in terms of VSS, VAS pain ($p = 0.01$, $p = 0.01$, respectively). In the comparison of the groups in terms of pathological VHIT findings, a significant difference was found in terms of improvement in favor of the combined treatment group after treatment ($p = 0.02$).

After treatment, in the combined treatment group, there were a total of 16 (32%) pathological and 34 normal (68%) parameters of VHIT. Of the pathological ones, 10 were bilateral and 6 were unilateral (3 right, 3 left). After treatment, the Epley group had 11 normal (40.74%), 16 (59.25) pathological VHIT parameters. Pathological VHIT parameters showed 5 bilateral and 11 unilateral (6 right, 5 left) involvements (Table 2).

In intragroup comparisons, VSS and VAS-pain values were significantly decreased after treatment in both groups ($p = 0.01$ and $p = 0.01$). There was no difference in intra-group comparisons before and after treatment in terms of VOR gains. In the intragroup comparison of the pre-treatment and post-treatment pathological VHIT findings, there was no significant difference in the Epley group after treatment ($p = 0.06$), whereas in the combined treatment group, there was a significant difference after treatment ($p = 0.01$) (Table 3).

Table 1: Comparison of pretreatment study groups in terms of age, gender, VSS, VAS-pain, VOR gains, presence of pathological VHIT findings.

	Epley + manipulation	Epley	p
Age (mean ±std)	43.04±11.27	45.74±.04	0.20*
Gender Male-Female	13 (%26)-37(%74)	9 (%33.4)-18 (%66.6)	0.60**
VSS (median / min-max)	30 (17-60)	29 (9-50)	0.99***
VAS-pain(median/min-max)	7 (6-10)	7 (6-10)	0.27***
VHIT total	50	27	
normal/pathological [bilateral/unilateral (right/left)]	12/38 [13/25(13/12)]	6/21[5/16 (8/8)]	0.86**
%normal/pathological [bilateral/unilateral (right/left)]	%24/%76 [26/50(26/24)]	%22.22/%77.77[18.15 /59.25(29.63/29.63)]	
Left LB (Mean ±Std)	1.1064±0.20861	1.0744±0.19698	*0.51
Left AB (Mean ±Std)	0.72±0.23	0.74±0.20	0.49
Left PB (Mean ±Std)	0.6918±0.32556	0.6900±0.24389	*0.90
Right LB (median/min/max)	1.05/0.44/1.60	1.04/0.28/1.66	***0.50
Right PB (median/min/max)	0.70/0.06/1.41	0.72/0.35/1.11	***0.58
Right AB (median/min/max)	0.95/0.40/1.87	0.85/0.33/1.39	***0.07

*Independent t-test **Fischer exact test ***Man Whitney U test

[VSS: Vertigo Symptom scale, VAS: Visual analog scale, LB: lateral semicircular canal VOR gain-before treatment, PB: posterior semicircular canal VOR gain-before therapy, AB: anterior semicircular canal VOR gain-before therapy,]

Table 2: Comparison of posttreatment study groups in terms of age, gender, VSS, VAS-pain, VOR gains, presence of pathological VHIT findings.

	Epley + manipulation	Epley	p
VSS (median/min-max)	11(0-27)	23(7-45)	0.01***
VAS-pain(median/min-max)	2.5(0-80)	6 (2-9)	0.01***
VHIT total	50	27	
normal/pathological[bilateral/unilateral (right/left)]	34/16[10/6(3/3)]	11/16[5/11(6/5)]	0.02**
%normal/pathological[bilateral/unilateral (right/left)]	%68/%32[20/12(6/6)]	%40.74/%59.25[%18.51/40.74 (22.22/18.51)]	
Left LA (Mean ±Std)	1.1088±0.21682	1.0659±0.13843	*0.30
Right PA (Mean ±Std)	0.7542±0.22135	0.7374±0.20325	*0.70
Left AA (medyan/min/max)	0.74/0.41/1.42	0.73/0.32/1.35	***0.80
Left PA (medyan/min/max)	0.80/0.11/1.24	0.74/0.09/1.36	***0.40
Right LA (medyan/min/max)	1.12/0.69/1.68	1.03/0.53/1.38	***0.40
Right AA (medyan/min/max)	0.97/0.61/1.56	0.92/0.01/1.16	***0.12

*Independent t-test **Fischer exact test ***Man Whitney U test

[VSS: vertigo symptom scale, VAS: Visual analog scale, LA: lateral semicircular canal -VOR gain after treatment, PA: posterior semicircular canal -VOR gain after treatment, AA: anterior semicircular canal -VOR gain after treatment]

Table 3: Comparison of patients before and after treatment in terms of intra-group VSS, VAS-pain, VOR gains, presence of pathological VHIT findings.

	Manipulation +Epley Group p-value	Epley Group p-value
Left LA – Left LB	0.90**	0.82**
Left AA – Left AB	0.093*	0.718*
Left PA – Left PB	0.209*	0.885*
Right LA – Right LB	0.37*	0.540*
Right PA- Right PB	0.13**	0.81**
Right AA- Right AB	0.38*	0.61*
VHIT Pathological / normal	0.01***	0.063***
VSS After-Before	0.01*	0.01*
VAS After-Before	0.01*	0.01*

*Wilcoxon Signed Ranks Test **Paired samples T-test *** Mc Nemar test.

[VSS: Vertigo Symptom scale, VAS: Visual analog scale, LB: lateral semicircular canal VOR gain-before treatment, PB: posterior semicircular canal VOR gain-before treatment, AB: anterior semicircular canal VOR gain-before treatment, LA: lateral semicircular canal -VOR gain after treatment, PA: posterior semicircular canal -VOR gain after treatment, AA: anterior semicircular canal -VOR gain after treatment]

DISCUSSION

Neck pain and flattening in cervical lordosis are common in BPPV, which is the most common type of vertigo (1,3,4). In this study, we aimed to determine the contribution of cervical manipulation applied with Epley maneuver to the success of treatment in BPPV patients with neck pain and flattening of the cervical lordosis, as well as the role of the VHIT test in diagnosis and short-term follow-up.

According to the ingroup comparisons, we found a statistically significant difference after treatment in terms of VSS, VAS-pain, and parameters in both groups. This result was in line with the existing literature and indicating that both treatments were effective (6,7). However, some authors do not regard manipulation as an effective treatment in BPPV (16). In addition, in group comparisons, there was a significant improvement in the combined therapy group in the findings of pathological VHIT after treatment. Accordingly, pathological VHIT findings

may contribute to follow-up in BPPV patients who have received combined therapy. In the Epley group, despite the improvement in symptoms, no significant change was found in pathological VHIT findings. The reason for this situation may be related to the low number of cases, excessive bilateral involvement in our study group or short follow-up. In addition, since there was no intervention for cervical musculoskeletal disorders in our patient group, VHIT may be inadequate in a follow-up. Aslan et al. stated that VHIT is useful in BPPV (8). In the literature, we could not find any study other than our study, where Epley maneuver and manual therapy were applied together in BPPV and the results were evaluated with VHIT.

Comparing the VSS, VAS-pain, pathological VHIT parameters of the two groups after treatment, a significant difference was found in favor of the combined treatment group compared to the Epley group. Accordingly, the application of Epley maneuver, which is an effective method in the treatment of BPPV, by combining with manual therapy

gives more successful results compared to its application alone. This finding is supported by the improvement in pathological VHIT findings.

There was no difference in VOR gains between the study groups, both before and after treatment. Also, in intra-group comparisons, there was no difference in the VOR gains between pre-treatment and post-treatment values. As previously reported in the literature, in our results, it was found to be beneficial in both treatments in BPPV patients (6,7).

As far as we know, cervical musculoskeletal diseases are not among the etiological causes of BPPV. Our study group consisted of BPPV patients with lordosis flattening and neck pain. In a significant portion of BPPV patients, neck pain and flattening in cervical lordosis detected (3-7). In this context, it may be thought that at least in the pathogenesis or relapse of some BPPV cases, muscle, bone and joint disorders of the neck region may be among the factors. In our study, the fact that the effectiveness of manual therapy was demonstrated by the VHIT test and that the improvement in symptoms in the Epley group was not reflected in the VHIT test after the treatment supports this idea. This situation should be clarified with new studies.

These results also suggest that VHIT parameters should not only be evaluated in terms of VOR gain but should be evaluated by the experienced specialist in terms of pathology.

BPPV is mostly unilateral, and bilateral cases have been reported to be between 4% and 15%. It was reported that the incidence of BPPV was more frequent on the right side than on the left side (17). In our study group, there was no difference between the right and left sides, and our bilateral involvement rate was higher than those reported in the literature. We do not know whether cervical pathologies lead to the development of bilateral semicircular canal pathology to a greater extent. According to our findings, the neck pain caused

by musculoskeletal pathologies of the cervical region accompanied by cervical lordosis in BPPV patients contributed to the success of the cervical maneuver application, therefore the musculoskeletal system may have a place in the BPPV etiology, and VHIT test may be involved in the diagnosis and short-term follow-up in these patients. It may be regarded as useful, if not ideal. On the other hand, this study is important in terms of enlightening the effect of manipulation with the VHIT test. It is clear, however, that further work is needed on this issue.

The main limitations of our study were lack of healthy participants, the low number of patients and the short duration of follow-up.

As a result, the VHIT test may be beneficial in BPPV. However, only numerical analysis of VOR gains may not be sufficient. Therefore, VHIT parameters should be interpreted by an experienced specialist. Epley and manipulation therapy seem to be more successful when applied together. The reflection of the improvement reflected in the symptoms in the combination of manipulation therapy with Epley maneuver into the VHIT test can be evaluated as objective evidence of manual treatment effectiveness. The usefulness of manual therapy, which is a treatment for the locomotor system in BPPV, may suggest that musculoskeletal problems arising from the cervical region may contribute to the pathogenesis.

REFERENCES

1. Campbell B, Kimura K, Yawn R, Bennett M. Pathophysiology and Diagnosis of BPPV. In: Babu S, Schutt C A, Bojrab DI, eds. Diagnosis and Treatment of Vestibular Disorders. 1st ed. Cham: Springer, 2019:141-50.
2. Feng GK, Ma XJ, Chen YY, Wang L, Du Q, Shi RY et al. Effects of gegen dingxuan capsule on behavior, x-ray signs of the cervical spine, and humoral factor levels in a rat model of cervical

- vertigo. Evidence-Based Complementary and Alternative Medicine. 2019;1:18-21.
3. Iglebakk W, Tjell C, Borenstein P. Pain and other symptoms in patients with chronic benign paroxysmal positional vertigo (BPPV). Scandinavian Journal of Pain. 2013;4(4):233-40.
 4. Erdem D, Yıldırım G, Erdem EU. Benign paroksizmal pozisyonel vertigoda servikal lordozun değerlendirilmesi: pilot çalışma. KBB-Forum. 2013;12(3):70-4.
 5. Saberi A, Nematı S, Sabnan S, Mollahoseini F, Kazemnejad E. A safe-repositioning maneuver for the management of benign paroxysmal positional vertigo: Gans vs. Epley maneuver; a randomized comparative clinical trial. European Archives of Oto-Rhino-Laryngology. 2017;274(8):2973-9.
 6. Fraix M. Osteopathic manipulative treatment and vertigo: a pilot study. PM&R. 2010;2(7):612-8.
 7. Veloso CF, Silveira AFD, Garcia MV, Romero CAP. Osteopathic manipulation treatment on postural balance: a systematic review. Manual Therapy, Posturology & Rehabilitation Journal. 2016;14(352):1-4.
 8. Aslan H, Pınar E, Aladağ İ, İmre A, Songu M, Yazır M et al. Our Results of VHIT on BPPV. Eur J Rhinol Allergy. 2018;1(1):12-4.
 9. Albernaz PLM, Maia FZ, Carmona S, Cal RVR, Zalazar G. The Video Head Impulse Test (vHIT). In: Albernaz PLM, Maia FZ, Carmona S, Cal RVR, Zalazar G eds. The New Neurotology. 1st ed. Cham: Springer, 2019:79-87.
 10. Özdek A, Keseroğlu K, Er S, Ünsal S, Gündüz M. Periferik vestibüler hastalıklarda o-VEMP ve v-HIT test sonuçlarının kalorik test sonuçları ile karşılaştırılması. Journal of Academic Research in Medicine. 2017;7(1):26-31.
 11. Jones KR, Vojir CP, Hutt E, Fink R. Determining mild, moderate, and severe pain equivalency across pain-intensity tools in nursing home residents. J Rehabil Res Dev. 2007;44(2):305-14.
 12. Yoon SY, Moon HI, Lee SC, Eun NL, Kim YW. Association between cervical lordotic curvature and cervical muscle cross-sectional area in patients with loss of cervical lordosis. Clinical Anatomy. 2018;31(5):710-5.
 13. Yanık B, Külçü DG, Kurtais Y, Boynukalin S, Kurtarah H, Gökmen D. The reliability and validity of the Vertigo Symptom Scale and the Vertigo Dizziness Imbalance Questionnaires in a Turkish patient population with benign paroxysmal positional vertigo. Journal of Vestibular Research. 2008;18(3):159-70.
 14. Dirachan D. Manuel Tıp. In: Oğuz H, ed. Tıbbi Rehabilitasyon. 3. baskı. İstanbul. Nobel Tıp Kitapevi, 2015:227-58.
 15. Derin AT, Neslihan Y. Vertigolu Hastaya Yaklaşım. Türkiye Klinikleri J ENT-Special Topic. 2015;8(3):1-4.
 16. Chan TP. Is benign paroxysmal positional vertigo underdiagnosed in hospitalised patients? Hong Kong Medical Journal. 2008;14(3):198-202.
 17. Öztürk B, Güleç M, Devenci TN, Güler MT. Benign paroksizmal pozisyonel vertigo: patofizyoloji, değerlendirme ve tanılama. Türk Odyoloji ve İşitme Araştırmaları Dergisi. 2019;2(1):18-28.