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RESEARCH

EFFECT OF CHRONIC NECK PAIN ON BALANCE, CERVICAL PROPRIOCEPTION, HEAD POSTURE, AND DEEP NECK FLEXOR MUSCLE ENDURANCE IN THE ELDERLY

ABSTRACT

Introduction: The purpose of this study was to investigate the effect of chronic nonspecific neck pain on balance, cervical proprioception, head posture, and deep neck flexor muscle endurance in the elderly.

Materials and Method: Elderly participants aged ≥ 65 years with chronic neck pain ($n=16$; 9 females) and without neck pain [$n=16$; 8 females (control group)] were included in this study. Balance function of the participants was assessed using the SportKAT 550 kinesthetic balance device, one-leg standing test, and timed up and go test. The joint position error test was used to evaluate cervical proprioception. Head posture was assessed by craniovertebral angle measurement, and muscle endurance was evaluated by the deep neck flexor endurance test.

Results: All balance tests results, joint position error value, and deep neck flexor muscle endurance were better in the control group than in the neck pain group ($p<0.05$). No difference was observed between the neck pain and control groups with respect to the craniovertebral angle value ($p>0.05$).

Conclusion: Our results indicate that chronic neck pain negatively affects the balance, cervical proprioception, and muscle endurance in the elderly. Our study results will guide health professionals to plan appropriate treatment strategies for the elderly with neck pain.

Keywords: Aged; Neck pain; Postural balance; Proprioception; Posture.

ARAŞTIRMA

YAŞLILARDA KRONİK BOYUN AĞRISININ DENGE, SERVİKAL PROPRİOSEPSİYON, BAŞ POSTÜRÜ VE DERİN BOYUN FLEKSÖR KAS ENDURANSI ÜZERİNE ETKİSİ

Öz

Giriş: Bu çalışmanın amacı, yaşlı popülasyonda kronik nonspesifik boyun ağrısının denge, servikal proprioepsiyon, baş postürü ve derin boyun fleksör kas enduransı üzerine etkisini incelemektir.

Gereç ve Yöntem: Çalışmaya 65 yaş ve üzeri kronik boyun ağrılı ($n=16$; 9 kadın) ve boyun ağrısı olmayan [$n=16$; 8 kadın (kontrol grubu)] yaşlı bireyler dahil edildi. Katılımcıların denge fonksiyonu SportKAT 550 kinestetik denge cihazı, tek ayak üzerinde durma testi ve zamanlı kalk yürü testi kullanılarak değerlendirildi. Servikal proprioepsiyonu değerlendirmek için "eklem pozisyon hata testi" kullanıldı. Baş postürü kraniovertebral açı ölçümü ve kas enduransı "derin boyun fleksör endurans testi" ile değerlendirildi.

Bulgular: Kontrol grubunda tüm denge test sonuçları, eklem pozisyon hata değeri ve derin fleksör kas enduransı boyun ağrılı gruba göre daha iyiydi ($p<0.05$). Kraniovertebral açı değeri açısından iki grup arasında anlamlı bir fark yoktu ($p>0.05$).

Sonuç: Çalışma sonuçları kronik boyun ağrısının yaşlılarda denge, servikal proprioepsiyon ve kas enduransını olumsuz yönde etkilediğini işaret etmektedir. Sonuçlar; boyun ağrılı yaşlılarda uygun tedavi stratejilerini belirlemek için sağlık profesyonellerine yol gösterici olacaktır.

Anahtar sözcükler: Yaşlı; Boyun ağrısı; Postüral denge; Proprioepsiyon; Postür

INTRODUCTION

Neck pain is a common health problem that negatively affects the quality of life of individuals of different age groups, and most people experience this problem at some point in their lives. Neck pain significantly affects the family, community, healthcare costs, and business life and has become an increasingly widespread health problem (1). In a study conducted by Hoy et al., it is reported that the prevalence of neck pain in the general population varies from 0.4% to 86.8% and the 12-month prevalence ranges from 12.1% to 71.5% (2). It is a common problem in the elderly and in the general population. The point prevalence of neck pain in the elderly was reported to be 38.7% (3).

Receptors in the cervical region are connected to the visual and vestibular system as well as the central nervous system. Afferent input from these receptors may be impaired owing to trauma, dysfunction of the receptors, muscle tissue sensitivity, and pain, which may result in impaired balance (postural instability), decrease in proprioception, and impaired head and eye movements. It is important to understand the contribution of neck pain to sensorimotor functions in the elderly because postural instability increases the risk of falls (4).

Increasing age is accompanied by changes in vestibular, visual, and neuromuscular functions, which are considered normal. It has been shown that cervical proprioception and postural stability are impaired in healthy elderly individuals but not in healthy adults (5). Neck pain in young adults has been associated with increased cervical joint position error (JPE), poor eye movement control, and balance disorders (6). Examination of the disorders documented in young population for the elderly with neck pain and investigation of its effect on sensorimotor functions may be useful.

In a study conducted by Szeto et al. on female office staff, it was reported that there was an increase in cervical postural errors in patients with neck pain compared with asymptomatic patients

(7). No previously published studies have found a relationship between chronic neck pain and anterior head posture in the elderly.

Pain causes errors in the activation of the muscles by providing abnormal afferent input. Furthermore, it causes delay in cortical responses (8), resulting in protective spasm in the muscles and decreased circulation in the muscles after the spasm. The muscle with decreased blood flow commences anaerobic metabolism, leading to decreased muscle endurance (9). The relationship between neck pain and flexor muscle endurance in young and middle-aged groups has been investigated (10,11). Studies examining the effect of neck pain on deep neck flexor (DNF) endurance in the elderly will contribute to the literature.

This study aimed to investigate the effect of chronic nonspecific neck pain on the balance, cervical proprioception, head posture, and DNF endurance in the elderly.

MATERIALS AND METHOD

Participants

The study included 32 elderly volunteers aged ≥ 65 years, including those with complaints of ongoing nonspecific neck pain for at least 3 months (neck pain group, $n=16$) and those with no complaints (control group, $n=16$).

The inclusion criteria for the neck pain group were as follows:

- having a pain intensity of ≥ 3.5 cm according to the Visual Analogue Scale (VAS)
- having a score at least 5 out of 50 on the Neck Disability Index (NDI)
- no cognitive problems according to the Hodkinson Abbreviated Mental Test (HAMT)
- not having musculoskeletal pain except neck pain

The control group included individuals without cognitive problems and complaints of neck pain in



the last year. Participants with no musculoskeletal pain in any part of the body during the evaluation were included in the control group.

To eliminate other factors that may affect the results, participants who satisfied the following criteria were excluded in both groups: taking more than four medications or medication which could affect balance, a history of spinal surgery, orthopedic surgery in the last year, neurological or vestibular pathology, malignant conditions, psychological disorders, and visual disturbances despite glasses.

The neck pain group selected from patients who applied to physical therapy and rehabilitation outpatient clinic. The control group was selected from the subjects accompanying with patients who applied to physical therapy and rehabilitation outpatient clinic with other problems. All participants were included in the study after being evaluated according to inclusion criteria by a psychiatrist.

A very large effect size was found in the reference study used in power analysis ($d=1.7$) (12). Assuming we can achieve a lower effect size level ($d=1.1$), a power analysis was performed before the study. On the basis of the results of power analysis, it was calculated that 90% power would be obtained with 95% confidence when 32 elderly participants (16 patients and 16 controls) were included in the study. For total balance results of SportKAT 550 kinesthetic balance device, we had a very large effect size ($d=1.14$) and with this result we reached 93.5% power with 95% confidence. Moreover, for JPE results, we had a very large effect size ($d=1.34$) and with this result we reached 98% power with 95% confidence.

The study was approved by Pamukkale University Medical Ethics Committee with the number 60116787-020/49874 on 03/08/2017. The study was conducted in accordance with the Declaration of Helsinki. All individuals included in the study signed the informed consent form.

Questionnaires

The questionnaire was used to determine demographic data, pain intensity, neck disability level, cognitive status, and musculoskeletal pain localization. On the basis of the VAS scores, Boonstra et al. classified the pain experienced by patients with chronic musculoskeletal pain as mild (≤ 3.4 cm), moderate (3.5–7.4 cm), and severe (≥ 7.5 cm) (13). Participants with moderate and severe pain intensity were included in this study.

Balance assessment

Static (one-leg standing test and SportKAT 550 kinesthetic balance device) and dynamic balance (timed up and go test) assessments was performed.

The one-leg standing test (OLST) is appropriate and valid for the assessment of the elderly. Participants were allowed to practice before the test and were asked to decide which leg to lift during the test period. Participants were asked to lift the leg they had chosen while standing up to their arms in a drooping position. The test was terminated when the support leg was repositioned, the raised leg contacted the floor, the support of the observer was obtained, or the maximum test time of 30 seconds was completed. Three trials were performed in the eyes open and closed position, and the best results in these positions were recorded (14).

The SportKAT 550 kinesthetic balance device provides objective data for balance assessment. The device comprises the following two parts: an electronic tilt sensor and a movable platform. The electronic sensor evaluates the movement of the platform throughout the test period and transmits the data to the connected computer. The cross on the monitor screen represents the center of the platform; during the test period, the participant is asked to keep this mark in the center. The difficulty of test is adjusted by changing the pressure of the movable platform. Increasing the pressure increases the stability of the platform and makes the test easier. The evaluations were performed at 10 PSI stability value. At the end of the 30 second

test period, the device calculates a balance score between 0 and 6000. Low scores obtained from the test indicate that the balance performance is good (15).

The timed up and go test (TUGT) was used to evaluate the dynamic balance. This is a reliable and valid test recommended for evaluation of dynamic balance in geriatric population. The participant was asked to stand up from the chair without any support, walk to the target at a distance of 3 meters, return around the target without touching any place, and sit on the chair again; the evaluator noted the time of completion of the test. Three trials were performed, and the best result was recorded (16).

Cervical proprioception assessment

The JPE test defined by Revel et al. was used to evaluate cervical proprioception (17). In this test, a small laser pointer mounted in a light helmet and a panel of circles drawn 1 cm apart were used as target. The participants were seated in a back-supported chair, 90 cm from the wall-mounted panel. Participants were asked to memorize the first neutral position and try to find the same point after an active head movement. Active head movements included flexion, extension, and right and left rotations. Each movement was repeated 10 times. Later, horizontal, vertical, and global distances to the starting point of the each returned point after movement were recorded. The mean value of all errors (distances) in centimeter was used for analysis.

Forward head posture assessment

Anterior head posture was evaluated using the craniovertebral angle (CVA) value. CVA was determined by measuring the angle between the horizontal line and the line connecting the tragus of the ear to the C7 spinous process. A digital camera was placed at a distance of 1.5 meters on a fixed base, and the height of the camera was adjusted to the shoulder level. To provide the correct posture, individuals were asked to stand in

a comfortable posture and look at a point straight in front of them, and a marker was stucked on the C7 spinous process. Using the computer program, CVA values were obtained from the photograph taken. Reduction of the CVA value indicates increased forward head posture (18).

Deep neck flexor endurance assessment

The DNF endurance test described by Olson et al. was used (19). The test was performed in a supine, hook-lying position. The participants' hands were placed on the abdomen. The subjects were asked to pull their chin in maximally tucked and lift their head off the bed (approximately 2.5 cm from the resting position). They were requested to maintain this position for as long as possible without distortion, and the time for which the position was maintained was recorded in seconds. The test was terminated when the chin-tuck position disappeared, sudden and severe pain occurred, and the subjects did not want to continue the test. For appropriate application, the test was applied to the subjects in a practical way before evaluation. The trial period was kept as short as possible to avoid pain and fatigue.

Statistical analysis

SPSS package program was used for data entry and analysis process. Conformity of data to normal distribution was examined with Shapiro-Wilk test. Descriptive statistics were given as mean±standard deviation and median (minimum–maximum) and the categorical variables as number and percentage. In the comparisons between study groups, when the parametric test assumptions were provided, independent samples t-test was used for independent variables and Mann-Whitney U test was used when parametric test assumptions were not provided. Chi-square analysis was used when categorical variables were compared between groups. The statistical significance level was determined as 0.05.



RESULTS

The descriptive data of groups are presented in Table 1. Participants in both groups had similar descriptive data. In addition, the results of VAS, HAMT, and NDI used to determine the adequacy to inclusion criteria are presented in Table 1.

Table 2 presents the results of the static and dynamic balance tests. The neck pain group exhibited significantly worse balance results in the anterior ($p=0.029$) and total balance ($p=0.003$) scores of SportKAT 550 kinesthetic balance device. Right, left, and posterior balance scores of SportKAT 550 kinesthetic balance device were higher in the neck pain group; however, this difference was not statistically significant. The results of the eyes open ($p=0.049$) and eyes closed ($p=0.001$) in OLST were

statistically worse in the neck pain group. The neck pain group took significantly longer to complete TUGT than the control group ($p=0.005$).

JPE, CVA, and DNF endurance values of the groups are presented in Table 3. When the JPE values indicative of cervical proprioception were examined, it was found that all the error values in the neck pain group were higher and the vertical ($p=0.002$) and global ($p=0.001$) error values were statistically higher than in the control group. CVA values in the neck pain group were lower than in the control group, but the difference was not statistically significant ($p=0.061$). DNF endurance values were found to be statistically lower in the neck pain group than in the control group ($p=0.004$).

Table 1. Characteristics of the neck pain and control groups.

Variable	Neck Pain Group (n=16) mean±sd	Control Group (n=16) mean±sd	p
Age (yrs)	68.8±4.3	68.7±3.7	0.985
Height (cm)	163.1±8.9	162.8±7.9	0.956
Weight (kg)	73.6±12.2	76.9±9.4	0.396
BMI (kg/m ²)	27.7±4.3	29.1±3.8	0.321
Education (yrs)	8.3±4.3	7.8±3.7	0.669
VAS (0–10 cm)	5.1±1.8	-	
HAMT (0–10 score)	9.4±0.7	9.4±0.7	
NDI (0–50 score)	12.8±3.5	-	
Gender (female) n(%)	9 (56.2)	8 (50)	0.723
Daily medication			
No medication n(%)	4 (25.0)	1 (6.3)	0.664
1	2 (12.5)	2 (12.5)	
2	3 (18.8)	5 (31.3)	
3	5 (31.3)	6 (37.5)	
4	2 (12.5)	2 (12.5)	

Table 2. The comparison of the results of balance tests of neck pain and control groups.

Variable	Neck Pain Group (n=16) mean±sd median (min-max)	Control Group (n=16) mean±sd median (min-max)	p
SportKAT 550			
Right balance score	387.3±263.8 291.5 (142-1099)	273.3±153.9 243.5 (84-765)	0.171 ^a
Left balance score	349.8±191.6 368.5 (7-759)	227.6±162.9 191.5 (10-572)	0.06 ^b
Anterior balance score	388.2±320.2 345.5 (3-1065)	190.6±92.3 185.0 (52-353)	0.029^b
Posterior balance score	348.9±313.1 215 (17-965)	310.1±218.3 227.0 (62-720)	0.956 ^a
Total balance score	737.1±242.9 738.5 (319-1193)	500.9±161.8 456.0 (291-775)	0.003^b
OLST (sec.)			
Eyes open	14.5±8.8 11.8 (5.1-30)	20.6±8.0 22.4 (6.9-30)	0.049^a
Eyes closed	2.9±2.3 2.5 (0.9-8.7)	7.1±5.5 5.2 (1.7-24.7)	0.001^a
TUGT (sec.)			
	11.6±2.1 11.4 (8.5-16.1)	9.9±0.9 9.7 (9.0-12.3)	0.005^a

^aMann-Whitney U test; ^b independent samples t-test; statistically significant results are given in bold

DISCUSSION

Neck pain is a common problem that negatively affects the quality of life, functionality, and well-being of a person (2). This study aimed to determine the effect of chronic neck pain on balance, cervical proprioception, head posture, and DNF muscle endurance in the elderly population. The results of the study indicated that elderly with chronic neck pain showed greater deficits in balance, cervical proprioception, and deep neck flexor muscle endurance than those in the control group.

Previously, balance performance has been shown to be worse in people with neck pain compared with healthy individuals (4,6,12,20).

However, these studies were conducted with patients of different age groups (6,20) and those with neck pain with other comorbidities (12). In line with our findings, Poole et al. reported that the dynamic and static balance performances of the patients with nonspecific neck pain were worse compared with those of participants in the control group. Additionally, the researchers found that the anteroposterior balance was negatively affected in the neck pain group compared with the control group (4). In another study, it was stated that the anteroposterior balance disorders are mostly of somatosensorial origin and mediolateral balance disorders are more of the vestibular problem origin (6). Similarly, our results showed that the

**Table 3.** The comparison of JPE, CVA, and DNF endurance values of neck pain and control groups.

Variable	Neck Pain Group (n=16) mean±sd median (min–max)	Control Group (n=16) mean±sd median (min–max)	p
JPE (cm)			
Horizontal error	5.3±2.8 5.1 (1.8–10.1)	4.2±1.6 4.2 (1.7–7.4)	0.197 ^b
Vertical error	6.9±3.1 5.7 (3.0–14.7)	3.74±1.73 4.06 (1.25–6.38)	0.002^b
Global error	9.6±3.2 9.0 (5.1–16.8)	6.32±1.32 6.63 (3.88–8.40)	0.001^b
CVA (°)	43.8±5.3 42.7 (35.5–51.9)	46.7±2.5 46.5 (42.2–52.9)	0.061 ^b
DNF endurance (sec.)	25.2±6.8 27.3 (9.5–34.2)	33.5±7.7 33.6 (22.7–52.6)	0.004^a

^aMann–Whitney U test; ^b independent samples t-test; statistically significant results are given in bold

anterior balance was worse in the neck pain group compared with that in the control group. In the literature review, the effects of neck pain on balance in individuals of different age groups are examined. However, the number of studies conducted on elderly patients with chronic neck pain is less than those conducted on patients of other age groups (12). This study will contribute to the literature in this respect. Additionally, this study suggests that balance problems should be considered more in the elderly with chronic nonspecific neck pain.

As with the central nervous system, receptors in the cervical region have important connections with the vestibular and visual system. The pain-related disturbances in these receptors can cause afferent changes that would disrupt sensorimotor control. In our study, the JPE values used to evaluate proprioception were significantly higher in the neck pain group than in the control group. Even though studies conducted on individuals of different age groups showed that JPE values were significantly higher in patients with neck pain,

some studies reported that this difference was not statistically significant (17,21,22). We have reached only one study investigated the effect of chronic neck pain on cervical proprioception in the elderly population. In this study, although the cervical joint error values in the neck pain group were higher than those in the control group, the difference was not significant (12). The literature has not reached sufficient saturation. Further studies are needed on the subject.

Data from our study showed that elderly with chronic neck pain exhibited more forward head posture than those in the control group. However, this difference was not significant. On the contrary, Yip et al. reported a significantly increased forward head posture in patients with neck pain (23). Studies investigating the relationship between neck pain and forward head posture indicated a moderate correlation (18,24). However, no study selected the elderly as the study population. We did not examine other factors that may affect the head posture, such as body types, previous work, and

occupations of participants. There are few studies examining the relationship between neck pain and anterior head posture, and different results of these studies. Further studies are warranted to examine the effect of neck pain on head posture.

Pain leads to incorrect afferent information, delayed cortical responses, muscle spasm, and decreased blood flow. Muscles with decreased blood flow commence anaerobic metabolism, resulting in decreased muscle endurance. Numerous studies show decreased endurance of the flexor muscle in patients with neck pain, but no studies have been conducted on the elderly population (10,25). Results of our study show that the DNF muscle endurance in the neck pain group decreased significantly compared with that in the control group.

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Conflict of interest

None.



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