H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

Original Research

Upper Extremity Function and Neuromuscular Parameters in Primary Headaches: A Cross-Sectional Study

Taskin Ozkan[1], Ulku Kezban Sahin[2], Sevim Acaroz[3], Zeynep Unluturk[4]

Submission Date: October 13rd, 2023 **Acceptance Date:** February 14th, 2024 **Pub.Date:** August 2nd, 2024
Online First Date: July 22nd, 2024

Abstract

Objectives: To investigate the upper extremity function, muscle strength, endurance, and proprioception in patients with primary headache compared to healthy controls.
Materials and Methods: The study was completed with 37 patients with primary headache (22 patients with tension-type headache and 15 patients with migraine) and 36 healthy controls with matched age and gender. Headache severity was evaluated with the Visual Analog Scale (VAS); upper extremity function with Nine-Hole Peg Test (9-HPT); upper extremity isometric muscle strength of shoulder flexor, extensor, and elbow flexor with a hand-held dynamometer; upper extremity endurance with 6-Minute Pegboard and Ring Test (6PBRT); and upper extremity proprioception with shoulder reposition tests using Dualer IQ^{TM} digital inclinometer. Intergroup differences were examined using the Mann-Whitney U Test, and the Spearman correlation analysis was used to ascertain the relationship between the variables in headache groups.
Results: There was a significant difference between the results for the 9-HPT, some upper extremity isometric muscle strength tests, 6PBRT, and shoulder reposition tests between patients with tension-type headache, migraine, and healthy controls ($p<0.05$). Except for the 9-HPT and 6PBRT (r between -0.518 and -0.645; $p<0.05$ for all), there was no significant relationship between the results for patients with tension type and migraine ($p>0.05$).
Conclusion: Upper extremity function, some upper extremity muscle strength parameters, endurance, and proprioception were decreased in patients with tension-type headache and migraine compared to healthy controls, and upper extremity function was found to be associated with upper extremity endurance in these patients.

Keywords: *Upper extremity, function, strength, endurance, proprioception*

[1]**Taskin Ozkan (Corresponding Author).** Giresun University, Vocational School of Health Services, Therapy and Rehabilitation, Giresun, Turkey, Tel: +904543101851, e-mail: fzttaskinozkan@hotmail.com, ORCID: 0000-0001-9448-0516
[2]**Ulku Kezban Sahin.** Giresun University, Vocational School of Health Services, Therapy and Rehabilitation, Giresun, Turkey, Tel: +904543101375, e-mail: ulkuertan@hotmail.com, ORCID: 0000-0001-8972-4774
[3]**Sevim Acaroz.** Ordu University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Ordu, Turkey, Tel: +904522265200, e-mail: fzt_acaroz@hotmail.com, ORCID: 0000-0002-2617-8865
[4]**Zeynep Unluturk.** University of Health Sciences, Kocaeli Derince Education and Research Hospital, Kocaeli, Turkey, Tel: +902623178000, e-mail: zeynepunluturk@gmail.com, ORCID: 0000-0003-3236-6712

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

Introduction

Primary headaches are defined as the presence of a headache regardless of known etiology, and 90% of all headaches are primary headaches (Robbins & Lipton, 2010; Silberstein et al., 2018). The two most prevalent primary headache disorders are tension-type headache and migraine (Robbins & Lipton, 2010). According to a national population-based study conducted in Turkey, the prevalence of definite migraine was estimated to be 16.4%, probable migraine to be 12.4%, pure tension-type headache to be 5.1%, and probable tension-type headache to be 9.5% based on International Classification of Headache Disorders (ICHD)-II criteria. In total, 43.4% of the general population experienced these two primary headache types (Ertas et al., 2012). The lives of the general population are significantly impacted by primary headaches, which have a considerable impact on work, leisure, and social activities. Patients with tension-type headaches and migraine experience pain above average; nearly half of these individuals are constantly exposed to pain, and pain significantly affects the activity level in daily life and quality of life (Madsen et al., 2018; Oksanen, 2008).

Tension-type headache is an important disease in which the shoulder and neck muscles may play an important etiological role (Jensen et al., 1998; Sohn et al., 2013). In studies examining the relationship between shoulder-neck muscle strength and headache severity in adults, shoulder-neck muscle strength was lower in patients with headache compared to healthy controls (Anttila et al., 2002a; Anttila et al., 2002b; Barton & Hayes, 1996; Watson & Trott, 1993). Adults with headaches had lower isometric muscle strength and endurance of the upper cervical flexor muscles than adults without headaches, according to Watson et al. (Watson & Trott, 1993). Barton et al. reported that M. sternocleidomastoideus was weak in adults with headache and unilateral neck pain (Barton & Hayes, 1996). According to a study by Antilla et al., self-reported neck-shoulder symptoms were correlated with both migraine and tension-type headache, and migraine increased the tenderness of the pericranial muscles in a group of 12-year-old schoolchildren (Anttila et al., 2002a; Anttila et al., 2002b). Girls with migraine and tension-type headaches had reduced bilateral upper extremity endurance, according to Oksanen et al. (Oksanen, 2008). In addition, the ability to control and maintain the activation of adequate muscle strength is highly dependent on the proprioceptive system, which may be impaired in patients with headache (Muceli et al., 2011). Examining training research revealed that active dynamic muscle training of the shoulder-neck muscles prevents headaches (Madsen et al., 2018; Varangot-Reille et al., 2022).

In the light of all these results, attention can be drawn to this region by showing a

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

decrease in upper extremity functions and neuromuscular parameters in patients with primary headache. Therefore, the primary aim of this study was to compare upper extremity function, muscle strength, endurance, and proprioception in patients with tension-type headache and migraine with healthy controls. The secondary aim was to examine the relationship between headache severity, upper extremity function and upper extremity muscle strength, endurance, and proprioception in patients with tension-type headache and migraine.

Materials and Methods

Study design

From July 2022 to September 2022, this study was carried out by the neurology department at Giresun State Hospital and was planned to be a cross-sectional study. The study was given ethical approval by the Ordu University's Clinical Research Ethics Committee with decision number 14 on 03.06.2022. All the procedures were carried out in line with the Helsinki Declaration. After informing the participants in this research about the procedure, written consent was obtained.

Participants

In the study, 40 patients diagnosed with primary headache by a neurologist and 40 healthy controls of similar age and body mass index were included in our research. The following were the requirements for inclusion of primary headache patients: (1) being diagnosed with a primary headache by a neurologist according to International Classification of Headache Disorders (ICHD)-II criteria (tension-type headaches ≥8 headache days/month and ≤3 migraine days/month) (Headache Classification Subcommittee of the International Headache Society, 2004), (2) being between the ages of 18-65 years, (3) having a score above 24 on the Mini-Mental State Examination (MMSE), and (4) agreeing to participate in the research after being given detailed information about the research. The exclusion criteria for patients with primary headache were (1) having drug overuse headache (ICHD-II) (Society, 2004), (2) whiplash or head trauma, and (3) cervical disc herniation disease, and (4) having any known neurological, rheumatological, orthopedic, or chronic diseases. For healthy controls, the inclusion criteria were (1) having a score above 24 on MMSE and (2) agreeing to participate in the research after being given detailed information about the research. The criteria for exclusion of healthy controls were (1) having had whiplash or head injury and (2) a significant headache history (greater than 12 headache days annually), and (3) having any known neurological, rheumatological, orthopedic, or chronic diseases.

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

The inclusion criteria were not met by 3 out of 40 patients with primary headache. Three patients with primary headache had MMSE scores below 24 points. Thirty-seven primary headache patients completed the study. Fifteen of 37 primary headache patients had migraine and 22 had tension-type headache. Out of the forty healthy controls that were assessed for the study, four did not fit the requirements for being included.

Procedure

The demographic information was recorded for the individuals. The same physiotherapist took outcome measurements in the same sequence, in a peaceful, well-lit setting room. All evaluations were performed at the time the patients were admitted to the hospital with headache (when the patients were in pain).

Outcome measures

Headache severity of patients was evaluated with the Visual Analog Scale (VAS). On a horizontal straight line with a length of 10 cm, 0 is marked at the starting point and 10 at the endpoint. The patient was asked to mark the pain they felt between 0 (no pain) and 10 (unbearable pain). The pain levels of the patients were recorded by measuring the marked point with a ruler (Christensen & Amin, 2023).

Upper extremity function was assessed using the Nine-Hole Peg Test (9-HPT). This is a reliable and valid method used to evaluate upper extremity function in many neurological diseases (Feys et al., 2017; Mendoza-Sánchez et al., 2022). The test was performed while the participant's feet were touching the floor, sitting in a chair with back support in front of a table. The 9-HPT test involves participants placing and then removing nine pegs from nine holes as quickly as possible. The time began when the participant touched the first peg, and the time was stopped as soon as the participant released the last peg. The first test was done as a trial test. The test was performed twice for both upper extremities, and the average of the test results was recorded for use in statistical analysis (Feys et al., 2017; Mendoza-Sánchez et al., 2022).

Using a hand-held dynamometer, upper extremity isometric muscle strength was evaluated bilaterally (Lafayette Instrument Company, Lafayette IN, USA). The isometric strength of three upper-extremity muscle groups (shoulder flexor-abductor and elbow flexor) was measured. When measuring isometric muscle strength, the subject's position and the location of the dynamometer were both standardized using the Bohannon Brake test procedure. For each measurement, subjects made a maximum of two attempts, and the mean was accepted as the test result. Results were recorded in Newtons (Bohannon, 1986; Van Harlinger et al., 2015).

Doi: 10.21020/husbfd.1375424

Upper extremity endurance was evaluated with the 6-Minute Pegboard and Ring Test (6PBRT). During the 6PBRT, a board with two lower and two upper pegs and 10 rings on each lower peg is placed in front of the participants. The higher pegs were positioned 20 cm above shoulder level, while the lower pegs were positioned at shoulder height. Within a 6-minute period, the patient was told to transfer as many rings as they could bilaterally from the lower pegs to the upper pegs. Prior to actual testing, patients were allowed to move the rings up and down in a cycle to become familiar with the testing procedure. If the patient wanted to rest during the test, they were allowed, but the stopwatch was not stopped. Encouraging standard expressions of encouragement were said to the patient at the end of each minute during the test. The total number of rings was calculated and recorded as a score (Lima et al., 2018).

Shoulder repositioning tests were used to assess upper extremity proprioception using the Dualer IQ^{TM} digital inclinometer. The tests were conducted at 30 degrees of flexion and abduction of the shoulder. The participants were told to sit up straight in a chair with their feet flat on the ground, their knees and hips bent 90 degrees, and their backs left unsupported. Participants were blindfolded to eliminate visual cues, and they did not use earbuds because dialogue with the evaluator was required. The participant's upper extremity was positioned with the arm in the sagittal plane for flexion and in the scapular plane for abduction. Both flexion and abduction were performed with the shoulder in a neutral rotation posture. The distal portion of the arm, approximately 5 cm above the lateral epicondyle, was where the digital inclinometer was attached. After being actively guided to the necessary angle, the participant was asked to hold it there for three seconds before bringing it back to its starting position. Once back at the beginning position, participants tried to replicate the previously learned angle. Participants held their positions and gave vocal acknowledgment when they thought they had reached the necessary angle. The tests were conducted three times on both extremities with a 30-second break in between each measurement. The absolute difference between the target angle and the observed angle was measured, and an average of three trials was used to determine the absolute error score. The analysis made use of each participant's absolute error scores (Dos Santos et al., 2015; Ünlüer et al., 2019).

Statistical analysis

G*Power version 3.0.10 software package was used to calculate the post hoc power analysis for the study (Faul et al., 2007). The effect size (d) of the study was calculated as 1.665 using the dominant-9HPT data in which the total number of samples was 58. With a 5% margin of error (a = 0.05), the study's power (1-β) was computed to be 0.99.

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

The Shapiro-Wilk test was used to test for data normality. Percentage and frequency are used to represent ordinal variables, while data without a normal distribution are represented by the median (IQR25–75), and data with a normal distribution are represented by the mean and standard deviation. Kruskal-Wallis Test was used to compare age and body mass index parameters between the groups. The chi-square test was used to assess the difference between the groups in terms of gender. Differences between upper extremity function, isometric muscle strength, endurance, and proprioception test results of patients with tension-type headache, migraine, and healthy controls were analyzed by the Mann-Whitney U test. The Spearman correlation analysis was used to ascertain the relationship between the upper extremity function with upper extremity isometric muscle strength, endurance, and proprioception in patients with tension-type headache and migraine. Statistical significance was set at $p<0.05$.

Results

Table 1 shows participant disease and demographic characteristics. There was no difference between the groups for demographic factors, including age, BMI, and gender ($p>0.05$, Table 1).

Table 1. Demographic and clinical characteristics of primary headache patients and healthy controls

Characteristics	Tension-type headache group (n=22)	Migraine group (n=15)	Healthy control group (n= 36)	p
Age, years (X±SD)	44.95±10.27	40.07±12.48	40.60±9.93	0.133
BMI, kg/m^2 (X±SD)	28.11±3.83	27.11±4.41	26.15±3.45	0.144
Gender (female/male), n (%)	12/3 (80/20)	18/4 (81.8/18.2)	28/9 (75.7/24.3)	0.814
Duration of illness, years (X±SD)	10.07±12.65	6.82±8.21	-	-
Headache severity, VAS (point) (X±SD)	6.40±1.50	5.91±1.57	-	-

p<0.05; BMI= Body Mass Index; X: Mean, SD: Standard deviation; VAS: Visual Analogue Scale

A significant difference was determined between the results of the 9-HPT, upper extremity isometric muscle strength tests except for the dominant shoulder flexor test, 6PBRT, and shoulder reposition tests in patients with tension-type headache and healthy controls ($p<0.05$, Table 2).

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

Table 2. Comparison of upper extremity function, isometric muscle strength, endurance, and proprioception test results of tension-type headache and healthy controls

			Tension-type headache group (n = 22) Median (IQR25/75)	Healthy control group (n = 36) Median (IQR25/75)	p
Upper extremity function	9-HPT (second)	Dominant	21.32 (19.02-22.37)	17 (16.46-17.37)	**<0.001**
		Nondominant	22.88 (20.73-24.11)	18.46 (17.50-19.14)	**<0.001**
Upper extremity muscle strength	Shoulder flexor	Dominant	178.21 (147.40-193.85)	182.90 (174.30-217.65)	0.081
		Nondominant	174.09 (148.10-212.90)	203.50 (173.00-238.75)	**0.004**
	Shoulder abduction	Dominant	172.60 (132.20-209.05)	183.70 (168.45-220.40)	**0.029**
		Nondominant	154.61 (126.90-180.80)	170.65 (143.75-211.15)	**0.045**
	Elbow flexor	Dominant	205.84 (169.50-231.35)	227.45 (208.10-253.50)	**0.033**
		Nondominant	197.24 (146.10-215)	212.50 (191-246.05)	**0.043**
Upper extremity endurance	6PBRT (number)		326.18 (300-346)	371 (355.50-390.50)	**<0.001**
Upper extremity proprioception	30 °shoulder abduction	Dominant	3.42 (2.90-4)	1.87 (1.48-2.48)	**<0.001**
		Nondominant	3.09 (2.13-3.70)	1.90 (1.46-2.20)	**<0.001**
	30° shoulder flexion	Dominant	3.44 (2.60-4)	2.00 (1.55-2.63)	**<0.001**
		Nondominant	3.38 (2.87-3.80)	2.00 (1.68-2.58)	**<0.001**

*p<0.05; IQR: Interquartile range; VAS: Visual Analogue Scale; 9-HPT: Nine-Hole Peg Test; 6PBRT; 6-Minute Pegboard and Ring Test; °: degree

A significant difference was determined between the results of the 9-HPT, 6PBRT, and upper extremity proprioception tests in patients with migraine and healthy controls (p<0.05, Table 3). However, no significant difference was found between upper extremity isometric muscle strength tests except for the nondominant shoulder flexor test in patients with migraine and healthy controls (p>0.05, Table 3).

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

Table 3. Comparison of upper extremity function, isometric muscle strength, endurance, and proprioception test results of patients with migraine and healthy controls

			Migraine group (n = 15) Median (IQR25/75)	**Healthy control group (n = 36) Median (IQR25/75)**	**p**
Upper extremity function	9-HPT (second)	Dominant	20.07 (19.90-22.59)	17 (16.46-17.37)	**<0.001**
		Nondominant	22.94 (20.43-23.90)	18.46 (17.50-19.14)	**<0.001**
Upper extremity muscle strength	Shoulder flexor	Dominant	176.70 (146.15-209)	182.90 (174.30-217.65)	0.166
		Nondominant	160.60 (131.40-201.60)	203.50 (173.00-238.75)	**0.004**
	Shoulder abduction	Dominant	164.10 (105.65-216.15)	183.70 (168.45-220.40)	0.137
		Nondominant	156.80 (118.40-181.35)	170.65 (143.75-211.15)	0.070
	Elbow flexor	Dominant	198.70 (149.95-250)	227.45 (208.10-253.50)	0.072
		Nondominant	188.35 (157.50-218.90)	212.50 (191-246.05)	0.124
Upper extremity endurance	6PBRT (number)		340 (300-360)	371 (355.50-390.50)	**0.013**
Upper extremity proprioception	30 °shoulder abduction	Dominant	3.40 (2.47-5.50)	1.87 (1.48-2.48)	**<0.001**
		Nondominant	3.17 (2.67-5.10)	1.90 (1.46-2.20)	**<0.001**
	30° shoulder flexion	Dominant	3.33 (2.20-4.03)	2.00 (1.55-2.63)	**<0.001**
		Nondominant	3.20 (2.47-5)	2.00 (1.68-2.58)	**<0.001**

*p<0.05; IQR: Interquartile range; VAS: Visual Analogue Scale; 9-HPT: Nine-Hole Peg Test; 6PBRT; 6-Minute Pegboard and Ring Test; °: degree

When examining the association between headache severity and upper extremity function and upper extremity muscle strength, endurance, and proprioception, except for the 9-HPT and 6PBRT, there was no significant relationship between the results for patients with tension-type headache (Table 4).

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

Table 4. The relationship between headache severity and upper extremity function and upper extremity muscle strength, endurance, and proprioception in patients with tension-type headache

			Headache severity		**Upper extremity function**			
			Visual Analogue Scale		Nine-Hole Peg Test			
					Dominant		Nondominant	
			r	p	r	p	r	p
Upper extremity muscle strength	Shoulder flexor	Dominant	0.123	0.586	0.077	0.732	-	-
		Nondominant	0.090	0.690	-	-	0.161	0.474
	Shoulder abduction	Dominant	0.131	0.562	-0.068	0.763	-	-
		Nondominant	0.089	0.692	-	-	0.049	0.828
	Elbow flexor	Dominant	-0.039	0.865	-0.118	0.601	-	-
		Nondominant	0.062	0.784	-	-	0.042	0.852
Upper extremity endurance	6-PBRT		-0.091	0.686	-0.645	**0.001**	-0.518	**0.014**
Upper extremity proprioception	30° shoulder abduction	Dominant	0.195	0.384	0.312	0.158	-	-
		Nondominant	-0.039	0.862	-	-	-0.153	0.498
	30°shoulder flexion	Dominant	-0.206	0.359	-0.141	0.533	-	-
		Nondominant	-0.161	0.473	-	-	0.385	0.077

*p<0.05; °: degree

When examining the association between headache severity and upper extremity function and upper extremity muscle strength, endurance, and proprioception, except for the dominant 9-HPT and 6PBRT, there was no significant relationship between the results for patients with migraine (Table 5).

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

Table 5. The relationship between headache severity and upper extremity function and upper extremity muscle strength, endurance, and proprioception in patients with migraine

			Headache severity		**Upper extremity function**			
			Visual Analogue Scale		Nine-Hole Peg Test			
					Dominant		Nondominant	
			r	p	r	p	r	p
Upper extremity muscle strength	Shoulder flexor	Dominant	0.216	0.440	-0.029	0.919	-	-
		Nondominant	0.129	0.647	-	-	-0.175	0.533
	Shoulder abduction	Dominant	-0.120	0.670	-0.284	0.305	-	-
		Nondominant	0.050	0.860	-	-	-0.093	0.742
	Elbow flexor	Dominant	-0.301	0.276	-0.456	0.088	-	-
		Nondominant	-0.127	0.651	-	-	-0.007	0.980
Upper extremity endurance	6-PBRT		-0.392	0.148	-0.540	**0.038***	-0.262	0.346
Upper extremity proprioception	30° shoulder abduction	Dominant	0.264	0.342	0.073	0.795	-	-
		Nondominant	0.433	0.107	-	-	0.461	0.084
	30°shoulder flexion	Dominant	0.353	0.197	0.135	0.631	-	-
		Nondominant	0.175	0.532	-	-	0.311	0.260

*p<0.05; °: degree

Discussion and Conclusion

In this study, it was shown that upper extremity function, all upper extremity isometric muscle strength tests except shoulder flexor isometric muscle strength, upper extremity endurance, and proprioception were affected in patients with tension-type headache compared to healthy controls and upper extremity function, nondominant shoulder flexor isometric muscle strength, upper extremity endurance, and proprioception were affected in patients with migraine compared to healthy controls. In addition, dominant and nondominant upper extremity function in patients with tension type headache and dominant upper extremity function in patients with migraine headache were found to be associated with upper extremity endurance.

Our findings are consistent with studies on patients with primary headache, which indicated that muscle strength and endurance are impacted. Ninety-three percent of migraine patients who were evaluated showed signs of at least three musculoskeletal disorders, according to Luedtke et al. (Luedtke et al., 2018); significant differences between healthy controls and patients with episodic or chronic migraine were found by post-hoc analyses. A noteworthy population-based study from Norway discovered a four-fold increase in the prevalence of chronic headache in individuals with musculoskeletal complaints compared to those without them (Hagen et al., 2002). According to Madsen et al., patients with tension-type headache tended to have considerably reduced shoulder abduction muscular strength compared to controls (Madsen et al., 2016). For this reason, training the weak trapezius muscle specifically may help neck and shoulder strength of patients with tension-type headache to return to normal and may even result in a decrease in tension-type headache. Neck-shoulder muscular soreness was reported by 35% of children with episodic tension-type headache, compared to 21% of children without this condition, in a population-based study of 12-year-old Finnish children (Anttila et al., 2002a). Fernandez-de-las-Penas et al.'s studies indicate that trigger points in the sternocleidomastoid, trapezius, and upper suboccipital muscles are related to patients with chronic tension-type headache (Fernández-de-Las-Peñas et al., 2007; Fernández‐de‐las‐Peñas et al., 2006a, 2006b). Low upper extremity endurance in females is significantly linked with tension-type headache and migraine, according to Oksanen et al. (Oksanen et al., 2006). In addition, for the management of adolescent headaches, particularly in girls, it was suggested that paying closer attention to the neck and shoulder region's healthy functioning may help prevent headaches. Compared to girls in the control group, girls with tension-type headache had lower upper extremity endurance on both the dominant and non-dominant sides and girls with migraine had lower non-dominant side upper extremity endurance than girls in the control group, according to Oksanen et al. (Oksaen et al., 2006). Girls with migraine and tension-type headache showed different neuromuscular functions in the shoulder and neck muscles, according to another study. Reduced electromyography/force ratio and lower shoulder flexion force were seen in girls with tension-type headache (Oksanen et al., 2008). They postulated that headaches could be caused by altered motor strategies and force imbalance in the shoulder-neck region with a decreased metabolism.

These results are remarkable in that they show that strength and endurance of the neck muscles, as well as the upper extremities connected to the neck area, are reduced in primary headaches. The bilateral decrease in abductor muscle strength in patients with tension-type headache may be due to trigger points in the trapezius muscle, as reported in previous studies.

H.Ü. Sağlık Bilimleri Fakültesi Dergisi
Cilt: 11, Sayı:2, 2024
Doi: 10.21020/husbfd.1375424

However, although there was no significant difference between the test results, it was observed that all test results decreased in patients with migraine compared to healthy controls. Although these results are not statistical, they are clinically important. In general, increased muscle tenderness, especially in the neck and shoulder complex, can also cause this condition. We think that strength and endurance of the shoulder area may be associated with headaches in two ways. Strength and endurance may decline due to the headache itself, or conversely, headache could be caused by a loss of strength and endurance. Additionally, no causal association can be shown in this investigation. Reduced muscle strength and endurance, on the other hand, can be a sign of imbalanced muscle activity, which can aggravate a primary headache and eventually cause a chronic headache.

Our results show that shoulder proprioception of primary headache patients was significantly lower bilaterally than healthy controls. This study is the first to show that shoulder proprioception is affected in patients with primary headache. The regulation and maintenance of appropriate muscular force are critical functions of the proprioceptive system (Muceli et al., 2011). For this reason, we think that loss of proprioception may be one of the reasons for the decrease in muscle endurance and strength in patients with primary headache. Recurrent headaches can also make it difficult to move the upper body effectively, which can result in excessive and long-lasting muscle tension and a decline in both joint mobility and muscle strength (Oksanen et al., 2006). There may be muscular tenderness in patients with primary headache (Anttila et al., 2002b; Fernández ‐ de ‐ las ‐ Peñas et al., 2006a). For all these reasons, the proprioceptive system may also be affected. However, training and longitudinal studies are needed to better understand the importance of the proprioceptive system.

In comparison to healthy subjects, the current study demonstrated a significant reduction in both dominant and non-dominant upper extremity function in patients with primary headache. Upper extremity function decreases due to both sensory and motor symptoms (Gillen & Nilsen, 2020). In patients with primary headache, both the decrease in muscular function and proprioceptive impairment may have affected the function of the upper extremity. However, our results show that upper extremity muscular endurance has a significant effect on the function of the upper extremity, especially in patients with primary headache. These results suggest the need to focus on improving muscular endurance in order to improve upper extremity function in patients with primary headache.

Additionally, our research revealed no association between headache severity and upper extremity function, muscle strength, endurance, and proprioception. There was no relationship

Doi: 10.21020/husbfd.1375424

between headache severity and neuromuscular parameters of the upper extremity in patients with primary headache. However, the fact that neuromuscular parameters are affected in these patients, even when the headache is mild, suggests that decreases in these parameters are factors that may trigger headaches.

A limitation of our study is that neck pain and neuromuscular parameters such as neck muscle strength, endurance, and proprioception, which may affect upper extremity function and neuromuscular parameters, were not evaluated.

In conclusion, in patients with primary headache, upper extremity function, some upper extremity muscle strength parameters, endurance, and proprioception sense were decreased compared to healthy controls, and decreased upper extremity function was especially found to be associated with upper extremity endurance. However, no causal association can be shown in this investigation. These results suggest that muscular function and the proprioceptive system, especially muscular endurance, are affected by headaches and that exercise training for these systems may have an effect on headaches. For this reason, training and longitudinal studies are needed to determine the importance and effect of experimental risk factors such as upper extremity muscle strength, endurance and proprioception sense on primary headache.

Acknowledgments

The authors thank everyone who took part in the study.

Funding

No funding was received for the support of this study.

Disclosure

No conflicts of interest were reported by the authors for this study.

Doi: 10.21020/husbfd.1375424

References

Anttila, P., Metsähonkala, L., Aromaa, M., Sourander, A., Salminen, J., Helenius, H., ... & Sillanpää, M. (2002). Determinants of tension-type headache in children. *Cephalalgia, 22*(5), 401-408. https://doi.org/10.1046/j.1468-2982.2002.00381

Anttila, P., Metsähonkala, L., Mikkelsson, M., Aromaa, M., Kautiainen, H., Salminen, J., ... & Sillanpää, M. (2002). Muscle tenderness in pericranial and neck-shoulder region in children with headache. A controlled study. *Cephalalgia, 22*(5), 340-344. https://doi.org/10.1046/j.1468-2982.2002.003

Barton PM, Hayes KC 1996 Neck flexor muscle strength, efficiency, and relaxation times in normal subjects and subjects with unilateral neck pain and headache. *Archives of physical medicine and rehabilitation, 77*(7): 680-687. https://doi.org/10.1016/S0003-9993(96)90008-8

Bohannon, R. W. (1986). Test-retest reliability of hand-held dynamometry during a single session of strength assessment. *Physical therapy, 66*(2), 206-209. https://doi.org/10.1093/ptj/66.2.206

Christensen, R. H., & Amin, F. M. (2023). Measuring Pain Intensity in Headache Trials. In Clinical Scales for Headache Disorders (pp. 73-79). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-25938-8_5

Dos Santos, G. L., Salazar, L. F. G., Lazarin, A. C., & De Russo, T. L. (2015). Joint position sense is bilaterally reduced for shoulder abduction and flexion in chronic hemiparetic individuals. *Topics in stroke rehabilitation, 22*(4), 271-280. https://doi.org/10.1179/1074935714Z.0000000014

Ertas, M., Baykan, B., Kocasoy Orhan, E., Zarifoglu, M., Karli, N., Saip, S., ... & Siva, A. (2012). One-year prevalence and the impact of migraine and tension-type headache in Turkey: a nationwide home-based study in adults. *The journal of headache and pain, 13*(2), 147-157. https://doi.org/10.1007/s10194-011-0414-5

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods, 39*(2), 175-191. https://doi.org/10.3758/BF03193146

Fernández-de-Las-Peñas, C., Ge, H. Y., Arendt-Nielsen, L., Cuadrado, M. L., & Pareja, J. A. (2007). Referred pain from trapezius muscle trigger points shares similar characteristics with chronic tension type headache. *European Journal of Pain, 11*(4), 475-482. https://doi.org/10.1016/j.ejpain.2006.07.005

Fernández-de-las-Peñas, C., Alonso-Blanco, C., Cuadrado, M. L., Gerwin, R. D., & Pareja, J. A. (2006). Myofascial trigger points and their relationship to headache clinical parameters in chronic tension-type headache. *Headache: The Journal of Head and Face Pain, 46*(8), 1264-1272. https://doi.org/10.1111/j.1526-4610.2006.00440.x

Fernández-de-las-Peñas, C., Alonso-Blanco, C., Cuadrado, M. L., Gerwin, R. D., & Pareja, J. A. (2006). Trigger points in the suboccipital muscles and forward head posture in tension-type headache. *Headache: The Journal of Head and Face Pain, 46*(3), 454-460. https://doi.org/10.1111/j.1526-4610.2006.00288.x

Feys, P., Lamers, I., Francis, G., Benedict, R., Phillips, G., LaRocca, N., ... & Multiple Sclerosis Outcome Assessments Consortium. (2017). The Nine-Hole Peg Test as a manual dexterity performance measure for multiple sclerosis. *Multiple Sclerosis Journal, 23*(5), 711-720. https://doi.org/10.1177/1352458517690824

Gillen, G., & Nilsen, D. M. (2020). *Stroke Rehabilitation E-Book: A Function-Based Approach* (5th Edition). Elsevier Health Sciences.

Hagen, K., Einarsen, C., Zwart, J. A., Svebak, S., & Bovim, G. (2002). The co-occurrence of headache and musculoskeletal symptoms amongst 51 050 adults in Norway. *European journal of Neurology, 9*(5), 527-533. https://doi.org/10.1046/j.1468-1331.2002.00451.x

Headache Classification Subcommittee of the International Headache Society. (2004) The international classification of headache disorders. 2nd ed. *Cephalalgia*, *24*(suppl 1), 1-159. https://doi.org/10.1111/j.1468-2982.2003.00824.x.

Jensen, R., Bendtsen, L., & Olesen, J. (1998). Muscular factors are of importance in tension-type headache. *Headache: The Journal of Head and Face Pain, 38*(1), 10-17. https://doi.org/10.1046/j.1526-4610.1998.3801010.x

Lima, V. P., Velloso, M., Almeida, F. D., Carmona, B., Ribeiro-Samora, G. A., & Janaudis-Ferreira, T. (2018). Test–retest reliability of the unsupported upper-limb exercise test (UULEX) and 6-min peg board ring test (6PBRT) in healthy adult individuals. *Physiotherapy Theory and Practice*, 34(10), 806-812. https://doi.org/10.1080/09593985.2018.1425786

Luedtke, K., Starke, W., & May, A. (2018). Musculoskeletal dysfunction in migraine patients. *Cephalalgia, 38*(5), 865-875. https://doi.org/10.1177/0333102417716

Madsen, B. K., Søgaard, K., Andersen, L. L., Skotte, J., Tornøe, B., & Jensen, R. H. (2018). Neck/shoulder function in tension-type headache patients and the effect of strength training. *Journal of Pain Research*, 445-454. https://doi.org/10.2147/JPR.S146050

Madsen, B. K., Søgaard, K., Andersen, L. L., Skotte, J. H., & Jensen, R. H. (2016). Neck and shoulder muscle strength in patients with tension-type headache: A case-control study. *Cephalalgia, 36*(1), 29-36. https://doi.org/10.1177/033310241557

Mendoza-Sánchez, S., Molina-Rueda, F., Florencio, L. L., Carratalá-Tejada, M., & Cuesta-Gómez, A. (2022). Reliability and agreement of the Nine Hole Peg Test in patients with unilateral spastic cerebral palsy. *European Journal of Pediatrics, 181*(6), 2283-2290. https://doi.org/10.1007/s00431-022-04423-w

Muceli, S., Farina, D., Kirkesola, G., Katch, F., & Falla, D. (2011). Reduced force steadiness in women with neck pain and the effect of short term vibration. *Journal of Electromyography and Kinesiology, 21*(2), 283-290. https://doi.org/10.1016/j.jelekin.2010.11.011

Oksanen, A. (2008). *Neck muscle function and adolescent headache*. Publications of the university of turku annales universitatis turkuensis.

Oksanen, A., Metsähonkala, L., Viander, S., Jäppilä, E., Aromaa, M., Anttila, P., ... & Sillanpää, M. (2006). Strength and mobility of the neck-shoulder region in adolescent headache. *Physiotherapy Theory and Practice, 22*(4), 163-174. https://doi.org/10.1080/09593980600822800

Oksanen, A., Pöyhönen, T., Ylinen, J. J., Metsähonkala, L., Anttila, P., Laimi, K., ... & Sillanpää, M. (2008). Force production and EMG activity of neck muscles in adolescent headache. *Disability and rehabilitation, 30*(3), 231-239. https://doi.org/10.1080/09638280701265430

Robbins, M. S., & Lipton, R. B. (2010). *The epidemiology of primary headache disorders*. Seminars in Neurology - Thieme E-Books & E-Journals*, 30*(2), 107-119. https://doi.org/10.1055/s-0030-1249220

Silberstein, S. D., Lipton R. B., Goadsby P. J. (2018). *Headache in clinical practice* (2. Edition). Routledge.

Sohn, J. H., Choi, H. C., & Jun, A. Y. (2013). Differential patterns of muscle modification in women with episodic and chronic tension-type headache revealed using surface electromyographic analysis. *Journal of Electromyography and Kinesiology, 23*(1), 110-117. https://doi.org/10.1016/j.jelekin.2012.08.001

Ünlüer, N. Ö., Ozkan, T., Yaşa, M. E., Ateş, Y., & Anlar, Ö. (2019). An investigation of upper extremity function in patients with multiple sclerosis, and its relation with shoulder position sense and disability level. *Somatosensory & motor research, 36*(3), 189-194. https://doi.org/10.1080/08990220.2019.1644998

Van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper limb strength: study providing normative data for a clinical handheld dynamometer. *PM&R, 7*(2), 135-140. https://doi.org/10.1016/j.pmrj.2014.09.007

Varangot-Reille, C., Suso-Martí, L., Romero-Palau, M., Suárez-Pastor, P., & Cuenca-Martínez, F. (2022). Effects of different therapeutic exercise modalities on migraine or tension-type headache: a systematic review and meta-analysis with a replicability analysis. *The Journal of Pain, 23*(7), 1099-1122. https://doi.org/10.1016/j.jpain.2021.12.003

Watson, D. H., & Trott, P. H. (1993). Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance. *Cephalalgia, 13*(4), 272-284. https://doi.org/10.1046/j.1468-2982.1993.13042