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Ultrasonographic Evaluation of Painless Shoulder in Patients with Post-Stroke Hemiplegia

İnme Sonrası Hemipleji Hastalarında Ağrısız Omuzun Ultrasonografik Değerlendirilmesi

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This study was presented oral at the 29th National Physical Medicine and Rehabilitation Congress with International Participation, 2-6 March, 2022, Antalya, Türkiye.

ABSTRACT Objective: This study was performed to evaluate the shoulder ultrasound (US) findings of the hemiplegic patients without shoulder pain and to evaluate the relationship between the sonographic findings and the motor stage, activities of daily living (ADL), and functional status. **Material and Methods:** This cross-sectional study included a total of 22 hemiplegic patients and 18 healthy controls. The demographic data of all participants, and, Brunnstrom recovery scale (BRS), functional ambulation scale (FAC) scores, Barthel index, and muscle tone, were analyzed. Shoulder cartilage, deep joint space of the acromioclavicular joint (ACJ), and ultrasound shoulder pathology rating scale (USPRS) scores of healthy controls and hemiplegic patients were evaluated by the US. **Results:** The demographic data of the patient and healthy control groups were comparable. The total USPRS score and the scores of each component were significantly higher in the hemiplegic shoulder compared to healthy controls ($p<0.01$). The mean score of cartilage thickness and the width of the ACJ on the hemiplegic side were statistically significantly different from the measurements of the healthy controls ($p<0.017$). There was a significant and moderate negative correlation between the USPRS scores and Barthel index, BRS, and FAC ($p=0.009$, rho=-0.546; $p=0.023$, rho=-0.482; $p=0.016$, rho=-0.516 respectively). **Conclusion:** The US was a simple, non-invasive, and accessible method by which to evaluate soft tissue changes in the shoulder girdle. Its findings were correlated with ADL, functional status, and motor recovery stage in hemiplegic patients with painless shoulders

Keywords: US; hemiplegia; painless shoulder; activities of daily living; motor stage

ÖZET Amaç: Bu çalışma, omuz ağrısı olmayan hemiplejik hastaların omuz ultrason (US) bulgularını değerlendirmek ve bunların motor evre, günlük yaşam aktiviteleri (GYA) ve fonksiyonel durum ile ilişkisini değerlendirmek amacıyla yapıldı. **Gereç ve Yöntemler:** Bu kesitsel çalışmaya, toplam 22 hemiplejik hasta ve 18 sağlıklı kontrol dâhil edildi. Tüm katılımcıların demografik verileri ile hemiplejik hastaların Brunnstrom motor evrelemesi [Brunnstrom recovery scale (BRS)], fonksiyonal ambulasyon skalası (FAS), Barthel indeksi ve kas tonusu analiz edildi. Sağlıklı kontroller ile hemiplejik hastaların omuz kıkırdak kalınlığı, akromiyoklaviküler eklem (AKE) derinliği ve omuz patolojisi derecelendirme ölçeği [ultrasound shoulder pathology rating scale (USPRS)] US ile değerlendirildi. **Bulgular:** Hasta ve sağlıklı kontrol gruplarının demografik verileri benzerdi. Hemiplejik omuzda total USPRS skoru ile ölçeğin her bir bileşenin skorları sağlıklı kontrollere göre anlamlı derecede yüksekti ($p<0,01$). Hemiplejik taraftaki kıkırdak kalınlığı ile AKE derinliğinin ortalama değeri, sağlıklı kontrollerin ölçümlerinden istatistiksel olarak farklıydı ($p<0,017$). USPRS skorları ile Barthel indeksi, BRS ve FAS arasında anlamlı ve orta düzeyde negatif bir korelasyon vardı (sırasıyla $p=0,009$, rho=-0,546; $p=0,023$, rho=-0,482; $p=0,016$, rho=-0,516). **Sonuç:** US, omuz kuşağındaki yumuşak doku değişikliklerini değerlendirmek için basit, noninvaziv ve erişilebilir bir yöntemdir. Ağrısız omuzu olan hemiplejik hastalarda US bulguları GYA, fonksiyonel durum ve motor iyileşme evreleri ile korele idi.

Anahtar Kelimeler: US; hemipleji; ağrısız omuz; günlük yaşam aktiviteleri; motor evreleme

Stroke is a clinical syndrome that presents with the sudden onset of a focal neurological deficit secondary to a vascular lesion.[1] Upper or lower limb paralysis is the main clinical feature of stroke. It is an important cause of mortality in the adult population in developed countries. On the other hand, it is the 2nd or

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3rd most common cause of mortality in the vast majority of countries. Most patients who survive a stroke experience neurological sequelae and stroke-related complications. Pain caused by shoulder complications is one of the conditions that impair the quality of life and participation in rehabilitation. The most common causes of these pathologies include loss of motor control, the severity of paralysis, development of an abnormal movement pattern, glenohumeral subluxation, changes in muscle tone, and secondary changes that occur in the surrounding soft tissue, respectively.[2]

The standard imaging modalities for evaluating soft tissue lesions of the shoulder region are arthrography and magnetic resonance imaging (MRI).[3] However, both types of examinations take a long time and cost a large amount of money. In addition, neither of these 2 imaging modalities is indicated for stroke patients due to limited and intolerable positioning. So the use of ultrasound (US) has recently increased in recent years since it is broad availability, cost-effectiveness, real-time imaging, direct multiplanar assessment, immediate side-to-side comparison, short examination time, and lack of ionizing radiation. Furthermore, it closely rivals shoulder MRI in accurately diagnosing full-thickness rotator cuff tears and is preferred to MRI by patients with shoulder pain.[4] However, the requirement for experience and being an operator-dependent modality is also an important disadvantage.

There are some studies in the literature evaluating the shoulder by the US in hemiplegic patients. Lin et al. stated that the mechanism through which soft tissue lesions cause hemiplegic shoulder pain may be independent of the mechanisms through which changes in muscle tone and nervous activity cause shoulder pain.[5] Lee et al. reported that there was no correlation between the stages of motor recovery and the grades of US findings.[6] But, the aforementioned studies have evaluated only the painful shoulder. However, most of the hemiplegic patients with the post-stroke painless shoulder but impaired arm motor function and/or low general status developed shoulder pain within 1 year and their quality of life was affected.[7] However, to our knowledge, there are no studies, which evaluated asymptomatic subjects with hemiplegia. So, it could be of interest to investigate whether hemiplegia has an additive effect on age-related tendon degeneration and whether US evaluation of the shoulder in the pre-symptomatic stage could be a useful tool for discovering subjects at risk.

This study aimed to screen the US findings of hemiplegic patients without shoulder pain and compare the shoulder US findings of the hemiplegic side and the non-hemiplegic side with each other as well as with the shoulder US findings of healthy controls and to determine whether these findings are correlated with motor recovery stage, quality of life, and functional status.

MATERIAL AND METHODS

PARTICIPANTS

Between May 2021 and August 2021, 26 consecutive patients with hemiplegic shoulders caused by a cerebrovascular accident and 18 healthy controls were evaluated in this study. All the subjects were aged between 19 and 56 years. Patients were recruited from the physical medicine and rehabilitation clinics of the university, while healthy controls were university staff or their family members. Patients with a stroke for the first time, resulting in unilateral hemiplegia, and who had not experienced pain on both shoulders in 6 months before stroke onset, and the patients following rehabilitation in the hospital were included. The exclusion criteria were a previous shoulder trauma or surgery, evident or previously diagnosed major pathologies, and the presence of other musculoskeletal, neurological, or psychiatric impairments. Furthermore, subjects who performed repetitive movements of the upper arm or carried heavy loads for professional reasons were also excluded. Participants were asked if they had had any musculoskeletal disorders in the last 12 months that had prevented normal activity and if they had had shoulder pain at least once a month in the past year or during at least 7 consecutive days in the past year, or if they felt continuous pain. A negative response was considered as an "asymptomatic shoulder"; otherwise, a positive response was considered as "symptomatic shoulder."

CLINICAL EVALUATION

The clinical evaluation included age, gender, body mass index (BMI), duration of hemiplegia, length of

hospital and intensive care stay, occupational status, medical treatment, type of cerebrovascular disease, motor recovery stage, ambulation, activities of daily living (ADL), and muscle tone of hemiplegic patients. The Brunnstrom recovery scale (BRS) was used for evaluating motor recovery stages, the functional ambulation scale (FAC) for evaluating ambulation, the Barthel index for evaluating ADL, and the Ashworth scale for evaluating spasticity.[8]

ULTRASONOGRAPHIC EVALUATION

In this study, the shoulder US was performed through the posterior side following a protocol to ensure the orientation of the operator. The probe was held at its base by placing either the edge of the hand or the little finger on the patient to reduce stress and allow adequate motor control. A MyLab60 Xvision (Esaote Biomedica, Genova, Italy) equipped with a linear transducer with a frequency of 6-18 MHz was used for the evaluations. The selection of the probe frequency was based on the patient's body structure. While lower frequencies were preferred for obese patients, higher frequencies were preferred for slim patients. Furthermore, it was ensured that the BMI, age and gender distributions were matched between the groups. We examined only the dominant shoulder in 18 healthy controls and bilateral sides in 26 patients with hemiplegia. The paresis of the stroke patients was on the dominant side.

To obtain the most accurate assessment of pathology, evaluating a combination of US abnormalities has been recommended as opposed to relying on a single sentinel sign. So 3 US parameters (USPRS, the width of acromioclavicular-joint, and cartilage thickness) were chosen. To evaluate inter- and intraobserver variability, measurements were initially made always by the same first examiner (KS, 5 years experience in the US in musculoskeletal, with national certification). Next, another examiner (SS, 3 years experience in the US in muskoloskeletal, with national certification), previously informed about the nature of the study, took the same measurements from another image obtained with no knowledge of the previous results. Finally, the same first examiner repeated the measurements according to the criteria established above. All measurements were independently recorded and photographed.

USPRS

The ultrasound shoulder pathology rating scale (USPRS) was used for periarticular soft tissue assessment. USPRS is a quantitative scale that allows for an objective evaluation of the shoulder components involved in shoulder pathology considering 3 static and 2 dynamics, a total of 5 US findings. The static findings include greater tuberosity cortical surface irregularity, supraspinatus tendinopathy, and bicipital tendinopathy, while the dynamic findings include supraspinatus impingement and subscapularis/biceps/coracoid impingement.[9] Commonly used pathological US findings determine the type and severity of pathology. Each US finding was rated using a numerical scale depending on the extent of the current pathology. The total USPRS score was calculated as the sum of all the scores for the relevant shoulder. The maximum possible score for a shoulder was 20, and the minimum was 0.

THE WIDTH OF THE ACROMIOCLAVICULAR JOINT

The acromioclavicular joint (ACJ) was evaluated by placing the high-frequency linear probe coronally to the joint level to make it possible to evaluate 2 articular extremities of the scapula acromion and the clavicle. The superior acromioclavicular ligament was visualized as a band arch-like echoic structure across the bones.[10] There are 6 measurements to assess the biometrics of the ACJ.[11] But the maximum distance between the joint capsule and the deep joint space through the superior plane is a reproducible measurement with the best confidence interval among these measurements. So, the width of ACJ was considered (Figure 1).

SHOULDER CARTILAGE THICKNESS

The thickness of the shoulder cartilage was evaluated in the crass position on the coronal view. The patient was asked to place the arm in retroversion/adduction. The cartilage thickness was measured after the deltoid, supraspinatus, cartilage, and humeral head were identified.[12]

ETHICS

This study was approved by Pamukkale University Non-Invasive Clinical Research Ethics Committee

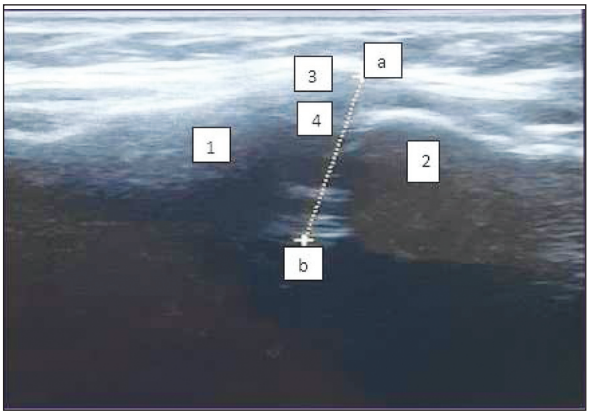

FIGURE 1: Ultrasonographic image of the width of the ACJ in the longitudinal plane in a healthy control. 1. Acromion; 2. Clavicle; 3. Joint capsule of the ACJ and superior acromioclavicular ligament; 4. Articular disc; a-b, the maximum distance between the joint capsule and deep joint space.
ACJ: Acromioclavicular joint.

(date: December 28, 2021, no: E-60116787-020-151346). All participants were informed about the purpose of the study before participation. Their written informed consent was obtained. The study was conducted by the principles of the Helsinki Declaration.

STATISTICAL ANALYSES

G*Power version 3.1 (Heinrich-Heine-Unıversity, Germany) software was used to compute the minimum sample size based on 85% power and a 2-sided significance level of 0.05.[13] We targeted a sample size based on discerning differences in the width of the ACJ space among groups.[14] The sample size capable of detecting a change in the difference between the groups was estimated using the mean and expected standard deviation of change in the width of the joint space data obtained from a previous study (The width of the ACJ space for Group 1: 4.1 +/- 0.9 mm vs. Group 2: 4.1 +/- 0.9 mm). The required sample size was estimated to be 18 patients per group.

IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA) was used for statistical analyses of the study data. Demographic characteristics were presented using descriptive statistics. The Kolmogorov-Smirnov test was used to test whether the set of data comes from a normal distribution. Non-parametric tests were used for statistical analyses of non-normally distributed data. The significance of the differences for continuous variables was analyzed using the Kruskal-Wallis variance analysis, while the chi-square test was used to analyze categorical variables at baseline. Spearman's correlation analysis was used to evaluate the correlation between non-parametric variables. A correlation coefficient (rho) of 0.8 was interpreted as excellent agreement. Inter- and intra-observer variability and agreement were evaluated by the one-sample t-test for dependent samples and the intra-class correlation coefficient. Intra-class correlation coefficient (ICC) values less than 0.5 were considered indicative of poor reliability, values between 0.5 and 0.75 moderate reliability, values between 0.75 and 0.9 good reliability, and values greater than 0.90 excellent reliability.[15] The post-hoc Bonferroni correction (Mann-Whitney U test) and the Kruskal-Wallis variance analysis were used for intergroup comparisons. A p-value less than 0.0167 was considered statistically significant in the post-hoc Bonferroni correction analyses, while a p-value less than 0.05 was considered statistically significant in all other analyses.

RESULTS

A total of 26 patients with hemiplegia were evaluated for eligibility. Of these patients, 4 patients were excluded from the study. Of them, 1 had rheumatoid arthritis, 1 had thalamic pain, and 2 had complex regional pain syndrome. The demographic data of the remaining 22 hemiplegic patients and 18 healthy controls were comparable. The mean disease duration of the patients was 15 months, with a mean length of hospital stay of 3.9 weeks (Table 1). The inter-operator agreement was moderate to excellent for the mean scoring of USPRS and the measurement of cartilage thickness and the width of the ACJ (ICC: 0.821, 0.999, and 0.622 respectively); however, the intra-operator agreement was low to moderate (ICC: 0.432, 0.521, and 0.673 respectively).

None of the hemiplegic shoulders was sonographically normal, while 13 (59.1%), and 14 (77.7%) unaffected/contralateral shoulders and control shoulders had normal sonographic images, respectively. The most frequent pathologies in the hemiplegic shoulders were the following: tendi-

TABLE 1: Demographic, clinical characteristics and medical treatments of hemiplegic patients and healthy controls.

	Patients with hemiplegia n=22	Healthy controls n=18	p value
Characteristics Mean±SD or n (%)			
Gender			
-Male	11 (50)	12 (67)	0.358
-Female	11 (50)	6 (33)	
Age (year)	56.4±14.3	48.7 (11.2)	0.074
BMI (kg/m^2)	26.4±3.9	26.4 (3.7)	0.919
Disease duration (months)	15±15	-	
Walking aids	18 (82)	-	
Length of intensive care stay (weeks)	3.9±3.9	-	
Occupational status			
-Student or unemployed	9 (41)	3 (16)	0.063
-Employed, full- or part-time	4 (18)	9 (50)	
-Retired	9 (41)	6 (34)	
Medical treatment			
-SSRI	1 (4.5)	-	
-Anticonvulsant	6 (27)	-	
-Anti-spasticity agents	6 (27)	-	
-Anticoagulant	20 (91)	-	
Form of CVD			
-Ischemic	21 (95.5)	-	
-Hemorrhagic	1 (4.5)	-	
Tonus			
-Spasticity	14 (63)	-	
-Flaccid	8 (37)	-	
Barthel index	57.9±27.9	-	
FAC			
-0	2 (4.8)	-	
-1	4 (9.5)	-	
-2	1 (2.4)	-	
-3	7 (16.7)	-	
-4	4 (9.5)	-	
-5	4 (9.5)	-	

Chi-square and the Mann-Whitney U tests were used; *p<0.05: Statistically significant; CVD: Cerebrovascular disease; SSRI: Selective serotonin re-uptake inhibitors; FAC: Functional ambulation scale; SD: Standard deviation; ; BMI: Body mass index.

nosis/tendinopathy of supraspinatus (1.86±0.45), greater tuberosity cortical surface of the humeral head (1.5±0.50), and tendinosis/tendinopathy of biceps (1.30±0.7). The mean thickness of cartilage and the mean width of ACE were 0.05±0.03 and 1.01±0.27, respectively. The total USPRS score and the scores of each component and the width of ACJ were significantly higher on the hemiplegic side compared to the non-hemiplegic side and healthy controls (p<0.01). Only greater tuberosity cortical surface mean subscore of the USPRS was significantly higher on the non-hemiplegic side compared to healthy controls (p<0.017). The mean score of cartilage thickness of the hemiplegic side and the non-hemiplegic side was statistically significantly different from the measurements of the healthy controls (p<0.017). The width of ACJ was significantly higher in the hemiplegic side shoulder compared to healthy controls (p<0.01) (Table 2).

There was a significant and moderate negative correlation between the USPRS scores and Barthel index, BRS, and FAC (p=0.009, rho=-0.546;

TABLE 2: Comparison of shoulder US findings of the hemiplegic and non-hemiplegic side and shoulder US findings of healthy controls.

US findings mean±SD	Group 1 (n=22) Hemiplegic side	Group 2 (n=22) Non-hemiplegic side	Group 3 (n=18) Healthy control	p value	Mann-Whitney U test with Bonferroni correction
-Biceps tendinosis/tendinopathy	1.3±0.7	0.27±0.45	0.17±0.39	<0.001*	Group 1>Group 2, p<0.001 Group 2=Group 3, p=0.863 Group 1>Group 3, p<0.001
-Supraspinatus endinosis/tendinopathy	1.86±0.45	0.83±0.50	0.17±0.39	<0.001*	Group 1>Group 2, p<0.001 Group 2=Group 3, p=0.175 Group 1>Group 3, p<0.001
-Greater tuberosity cortical surface	1.5±0.5	0.67±0.59	0.58±0.24	<0.001*	Group 1>Group 2, p<0.001 Group 2>Group 3, p=0.011 Group 1>Group 3, p<0.001
-Dynamic supraspinatus impingement	0.95±0.90	0.78±0.29	0	<0.001*	Group 1>Group 2, p<0.001 Group 2=Group 3, p=0.412 Group 1>Group 3, p<0.001
-Dynamic subscapularis/biceps/ coracoid impingement	0.81±0	0.73±0	0.058±0.024	<0.001*	Group 1>Group 2, p<0.001 Group 2=Group 3, p=0.712 Group 1>Group 3, p<0.001
Total USPRS score	5.8±3.3	2.2±2.1	0.64±1.2	<0.001*	Group 1>Group 2, p<0.001 Group 2=Group 3, p=0.019 Group 1>Group 3, p<0.001
Cartilage thickness, mm	0.05±0.03	0.08±0.1	0.39±0.37	<0.001*	Group 1=Group 2, p=0.634 Group 2<Group 3, p=0.012 Group 1<Group 3, p=0.006
ACJ width, mm	1.01±0.27	0.89±0.27	0.79±0.24	0.045*	Group 1=Group 2, p=0.383 Group 2=Group 3, p=0.090 Group 1>Group 3, p=0.0038

*p<0.05: Statistically significant; ACJ: Acromioclavicular joint; USPRS: Ultrasound shoulder pathology rating scale; mm: Milimeter; SD: Standard deviation.

p=0.023, rho=-0.482; p=0.016, rho=-0.516 respectively). Moreover, there was a moderate positive correlation between the Barthel index and cartilage thickness (p=0.019, rho=0.497) (Table 3).

DISCUSSION

Shoulder pain is one of the 4 most common medical complications following stroke, with a reported incidence of between 30 and 65% depending upon the population studied.[16] In the literature, shoulder pathologies which are risk factors for shoulder pain in hemiplegic patients, have been reported to negatively affect functional capacity and rehabilitation potential.[17] However, there are a limited number of studies in the literature reviewing the US findings of shoulder pathologies and their relationship with ADL in hemiplegic patients without shoulder pain. The results of our study showed that the total USPRS score, the mean thickness of cartilage, and the width of ACJ were significantly different from that of healthy controls. But only cartilage thickness of the non-hemiplegic side was different from that of healthy controls among US findings.

There are a limited number of studies evaluating different imaging modalities for the painless shoulder in hemiplegic patients. In a published study, arthrography was performed for the painful and painless shoulders in hemiplegic patients. The results of this study showed a rotator cuff lesion in the painless shoulder.[18] Another study evaluated the painless shoulder in hemiplegic patients using MRI. This study most frequently found ACJ degeneration, increased intra-articular fluid, and impingement of the supraspinatus muscle.[18] Similarly, the present study showed that periarticular soft tissues, the width of ACJ, and the cartilage thickness were significantly

TABLE 3: Correlation of clinical characteristics and quality of life with US findings in hemiplegic patients.

	Total USPRS		Cartilage thickness		ACJ width	
	r	p value	r	p value	r	p value
-Disease duration	-0.033	0.830	0.084	0.711	0.213	0.293
-BRS	-0.482	0.023*	0.218	0.330	0.081	0.720
-Barthel index	-0.546	0.009*	0.497	0.019*	-0.113	0.617
-Length of hospital stay	0.381	0.080	0.05	0.982	0.196	0.382
-FAC	-0.516	0.016*	0.392	0.066	-0.10	0.966

*p<0.05: Statistically significant; USPRS: Ultrasound shoulder pathology rating scale; BRS: Brunnstrom recovery scale; ACJ: Acromioclavicular joint; FAC: Functional ambulation scale.

different in hemiplegic sides than that in healthy controls. Therefore, shoulder pathologies can be observed in hemiplegic patients even if they do not have shoulder pain. However, the relationship between these pathologies and shoulder pain is uncertain. A study found no relationship between shoulder pain and subluxation and impingement in patients with hemiplegia.[19] Another study found a similar incidence of subluxation for painful and painless shoulders in hemiplegic patients.[20] However, in a study in which the imaging modality was not used, it was observed that the majority of hemiplegic patients with poor functional status and impaired arm function developed shoulder pain after 1 year of follow-up, although they did not initially have shoulder pain.[7] So even if patients with hemiplegia have no shoulder pain, shoulder imaging, evaluating ADL and functional status was critical since they allow for making awareness for following up on hemiplegic shoulder pain.

Risk factors for shoulder pain in hemiplegic patients have been described in the literature. Especially, mechanical factors of the joint itself (rotator cuff lesions) and neurological disorders (lack of sensation, initial flaccid paralysis, hemispatial neglect, and spasticity) are among the most well-known risk factors.[21] Pong et al. found more soft tissue disorders in the US in those with a low BRS recovery stage than in those with a high BRS recovery stage.[22] Lee et al. did not find a relationship between US findings and motor recovery.[6] Huang et al. reported that hemiplegia patients with good poor function had fewer US findings and less length of stay in hospital when compared to hemiplegia patients with bad poor function.[23] Another study showed that the likelihood of experiencing shoulder pain increased as the duration of hemiplegia increased.[22] The results of our study showed a negative correlation between the total USPRS score and Barthel index, motor recovery stage, and FAC. But no association was found between this measurement and disease duration and length of hospital stay. Moreover, cartilage thickness has a moderate positive correlation with the Barthel index. There may be 2 possible reasons for our different results from the literature. First, other studies have included patients with shoulder pain. Second, the US is an operator-dependent modality with high sensitivity and low specificity. Therefore, there is a need for many studies to verify this relationship.

In the literature, there are limited number of studies that evaluated the thickness of the cartilage and ACJ with the US in patients with hemiplegia. Tunç et al. reported that the cartilage thickness on the nonparetic side was thicker when compared to the paretic side due to mobilization. They also stated that it correlated with duration and functional status.[24] Yalçın et al. concluded that metacarpal cartilage was thinner on the paretic side when compared with the non-paretic side. But they did not find a correlation between cartilage thickness and functional status and disease duration.[25] Similarly, cartilage thickness was thinner on the hemiplegic side compared to the healthy control in our study. In addition, shoulder cartilage thickness was not associated with clinical features (disease duration, length of stay, motor recovery, FAC) except for the Barthel index. The discrepancies between the results of studies might be attributed to the differences between the usage and

weight-bearing features of different extremities. There were also different results obtained in studies on findings of the US of ACJ in hemiplegia patients. For instance, synovial hypertrophy and degenerative changes in the ACJ were reported in 67% and 64.3% rates by MRI, it was detected in 79.8% by MRI and 26.5% by the US in a different study.[2,26] Moreover, synovial hypertrophy was recorded in 35.7% of hemiplegic asymptomatic shoulders with a mean age of 64 and reported no significant difference in hemiplegic painful shoulders.[27] A published study reported that ACJ degeneration was found to be the most common pathologic finding (70.3%) but it was not directly related to hemiplegic shoulder pain in patients with hemiplegia.[27] Similarly, the width of ACJ was affected compared to the healthy control in the present study. However, it was not associated or correlated with clinical features. Therefore, there is a need for many studies compiling the relationship between shoulder cartilage thickness and ACJ depth with clinical characteristic.

There were four potantial limitations in our study. First, historical self-report information may be affected by recall bias when elicited from respondents. However, we excluded in our analysis the subjects who presented at least one symptomatic shoulder because impairment on one shoulder could be a risk factor for the contralateral side. Second, the original work was an observational cross-sectional study; therefore, the sample was assessed at one time point, so no surgical confirmation or clinical follow-up for the abnormalities was found. We could not determine whether the shoulders we examined will remain asymptomatic and how long the abnormality was present. Third, the sample size of the study was relatively small.

CONCLUSION

The US was a simple, non-invasive, and accessible method by which to evaluate soft tissue changes in the shoulder girdle. Its findings were correlated with ADL, functional status, and motor recovery stage in hemiplegic patients with painless shoulders. Therefore, imaging of the shoulder on the hemiplegic side following stroke is critical since the physicians can begin early treatment, educate the caregiver on appropriately transferring or positioning, and modify the rehabilitation program to prevent further shoulder injury that may impede the upper extremity neurological and functional recovery during the optimum period.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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