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ORIGINAL REPORT

PHYSICAL FINDINGS AND SONOGRAPHY OF HEMIPLEGIC SHOULDER IN PATIENTS AFTER ACUTE STROKE DURING REHABILITATION

Yu-Chi Huang, MD, Pei-Jung Liang, MS, PT, Ya-Ping Pong, MD, Chau-Peng Leong, MD and Cheng-Hao Tseng, MD

From the Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital–Kaohsiung Medical Center, Chang Gung University College of Medicine, Kaohsiung, Taiwan

Objective: **Physical and sonographic evaluation of hemiplegic shoulder in patients after acute stroke and correlation between the physical/sonographic findings and early-onset hemiplegic shoulder pain.**

Design: **Cross-sectional study.**

Subjects: **Fifty-seven patients after stroke with hemiplegic shoulder.**

Methods: **Subjects were assigned to poor motor function and good motor function groups according to the Brunnström motor recovery stages of hemiplegic shoulder. Physical findings and sonography of hemiplegic shoulder at admission and before discharge were compared, and the relationship between the physical/sonographic findings of hemiplegic shoulder and hemiplegic shoulder pain was analysed.**

Results: **The 2 groups differed significantly in proprioception, spasticity, subluxation, and shoulder rotation ($p<0.05$). Frequency of abnormal sonographic findings and shoulder pain and visual analogue scale score of hemiplegic shoulder pain before discharge were significantly higher in the poor motor function group ($p<0.05$) than in the good motor function group. Brunnström motor recovery stages, shoulder motion, subluxation, and abnormal sonographic findings of hemiplegic shoulder were moderately correlated with visual analogue scale scores of hemiplegic shoulder pain ($\gamma=0.34$–0.65; $p<0.01$).**

Conclusion: **The frequency of shoulder soft tissue injuries (85%) and hemiplegic shoulder pain (67%) was higher in patients with hemiplegic shoulder with impaired sensation, spasticity, subluxation, and restricted rotation. Brunnström motor recovery stages, limited rotation, subluxation, and abnormal sonographic findings of hemiplegic shoulder were associated with hemiplegic shoulder pain severity in patients after acute stroke.**

Key words: hemiplegia; shoulder pain; stroke; sonography.

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Correspondence address: Chau-Peng Leong, Department of Physical Medicine of Rehabilitation, Chang Gung Memorial Hospital–Kaohsiung Medical Center, Chang Gung University College of Medicine, No. 123, Ta-Pei Rd., Niao Sung Hsiang, Kaohsiung County, Taiwan, ROC. E-mail: cpleong@adm.cgmh.org.tw

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INTRODUCTION

Hemiplegic shoulder pain (HSP) is the most common complication after a stroke (1–3). Its frequency has been reported as 5–84% (3–7). It can occur within the first few weeks after a stroke (8). Early-onset HSP hinders the motor recovery of the upper extremity and may hamper daily activities (7, 9, 10). Some researchers believe that HSP is an important predictor of the number of days of hospitalization for patients after stroke (9). The pathogenesis of HSP is not well established and most investigators believe that multiple factors contribute to HSP. The associated factors of HSP include poor upper extremity function, shoulder motion limitation, shoulder subluxation, increased muscle tone on the shoulder, reflex sympathetic dystrophy, and rotator cuff injuries (3, 5, 6, 11–14).

In patients with flaccid shoulders, inappropriate stretching during rehabilitation or transferring in daily life, poor protection of the paralytic shoulder girdle, or extended pulling due to gravity while standing or walking may lead to soft tissue injuries after stroke (3). Several physical manoeuvres, including the painful arc, drop-arm, supraspinatus strength, and infraspinatus strength tests, and the Neer and Hawkins-Kennedy impingement signs are useful for rotator cuff lesions in the general population (15, 16). However, patients after stroke with flaccid shoulders not only have insufficient muscle strength to participate in the tests but also have impaired sensory functions when reporting any pain during testing.

In addition to physical examination, several imaging techniques are used to evaluate structural changes in hemiplegic shoulder. The standard imaging modalities for assessing rotator cuff injuries are arthrography and shoulder magnetic resonance imaging (MRI) (17, 18), but these methods are time-consuming and expensive. Shoulder sonography is a convenient and inexpensive imaging tool for evaluating rotator cuff injuries among hemiplegic stroke patients. Shoulder sonography has also been used to identify soft-tissue injuries in patients after stroke (19–21); a high prevalence of periarticular soft-tissue injuries was reported in stroke patients, based on shoulder sonography (19, 20). Thus far, no longitudinal sonographic research has been conducted for hemiplegic shoulder in patients with acute stroke. In this study, a follow-up on the soft tissue injuries in hemiplegic shoulder was conducted during in-patient rehabilitation using sonography.

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The aim of this study was to determine the clinical characteristics and the frequency of the soft tissue injuries in hemiplegic shoulder in patients after acute stroke who had different arm motor functions and were undergoing rehabilitation. We also investigated the correlation between the physical/sonographic findings of hemiplegic shoulder and HSP.

METHODS

Participants

A total of 57 patients post-stroke (34 men, 23 women) who had previously been admitted to a rehabilitation unit after acute stroke were enrolled in the study. The patients' strokes were diagnosed by neurologists on the basis of brain damage symptoms caused by the interruption of cerebral blood supply that lasted longer than 24 h and the findings of brain computed tomography (CT) or an MRI. The inclusion criteria were: (*i*) first stroke resulting in unilateral hemiplegia; and (*ii*) no history of shoulder pain in the 6 months prior to the stroke. The exclusion criteria were: history of rotator cuff injuries; frozen shoulder; shoulder surgery; cognitive impairment that impeded communication; and neuromuscular disorders resulting in a weakened shoulder.

The study was reviewed by the medical ethics committee of a medical centre and informed consent was obtained from all participants. All patients participated in an in-patient rehabilitation programme, including active and passive range of motion (ROM) exercises, stretching and strengthening exercises, hand function training, transferring training, balance training, and ambulation training. The programme for each patient included physical therapy and occupational therapy, each conducted for 1 h daily for 5 days per week during hospitalization.

Procedures

The clinical characteristics of each patient, including age, gender, body height and weight, stroke type, hemiplegic side, time since stroke onset, duration of 2 sonographic examinations, and length of hospital stay were recorded. The Brunnström motor recovery (BMR) stages, sensation for proprioception, pin-prick and light touch, glenohumeral subluxation, spasticity of the affected limb, passive ROM of the hemiplegic shoulder, and visual analogue scale (VAS) for hemiplegic shoulder pain were also evaluated for all patients by the same therapist at admission and before discharge.

Each patient was assigned to one of 2 groups according to his or her BMR stage of hemiplegic upper extremity at admission. The definition of BMR stages in the upper extremity are as follows: stage I, flaccid limbs without any voluntary movement; stage II, spasticity with weak flexor synergy; stage III, voluntary movement of the limbs, but the action is still within a flexor synergy pattern; stage IV, selective activation of muscles outside the flexor synergy; stage V, decrease in muscle spasticity and selective muscle activation, which is mostly selective and independent of limb flexor synergy; and stage VI, well-coordinated movements (22). Patients with BMR stages I, II, or III of the upper extremity were placed in the poor motor function (PMF) group, and those with BMR stages IV, V, or VI were put in the good motor function (GMF) group. Impaired sensation was defined as inability to correctly respond to instructions during testing. Spasticity was measured using the following 5-point Ashworth scale: 0 = no increase in muscle tone; 1 = slight increase in muscle tone, manifested by a catch at the end ROM; 2 = marked increase in muscle tone through most ROM such that the affected limb is easily movable; 3 = considerable increase in muscle tone but difficult passive movement of the affected limb; and 4 = rigid affected limb (23, 24). Spasticity was identified if the Ashworth scale was greater than or equal to a score of 1. Glenohumeral subluxation was clinically measured by one therapist during physical examination and diagnosed if the distance between the acromion and the humeral head was equal to or more than one finger width. The flexion, extension, abduction, and internal and external rotation of a pain-free shoulder motion were assessed by goniometry at admission and before discharge. A 10-cm VAS was used to evaluate the hemiplegic shoulder pain while resting or performing passive ROM exercises of the shoulder. The VAS score 0 was defined as no pain and a score of 10 as severe pain.

Sonographic examination

Shoulder sonography was performed using a 5–12 MHz linear-array transducer (t3000 terason, Burlington, VT, USA), both within 5 days after admission and before discharge. The hemiplegic shoulders were evaluated using sonography by one physician certificated by the Taiwan Society of Ultrasound in Medicine and blinded to all clinical data of the participants. The investigated tendons of the shoulder were scanned in both longitudinal and transverse planes according to the techniques described by Mack et al. (25) and Middleton (26). The accessed soft tissues for hemiplegic shoulder included the long head of the biceps brachii tendon, subscapularis tendon, supraspinatus tendon, infraspinatus tendon, and subacromial-subdeltoid (SA-SD) bursa complex. Effusion in the biceps tendon sheath appears as an anechoic area partially or completely surrounding the long head of the biceps tendon in the transverse or longitudinal plane (26). Bicipital tenosynovitis was interpreted by the thickened hypoechoic or anechoic change around the biceps tendon using increasing power Doppler flow on the sonography. Biceps tendinitis was defined as thickening of and a decreased echogenicity in the tendon (26). We diagnosed a full-thickness tear of the tendon if the following sonographic findings were found: absence of the rotator cuff, naked tuberosity, focal non-visualization of the cuff, discontinuity or a hypoechoic cleft in the cuff, herniation of the deltoid muscle or subacromial-subdeltoid bursa in the cuff, or compression of the tendon (27). Two sonographic criteria for a partial-thickness tear of the tendon were mixed hypo- and hyperechoic changes in the critical zone of the tendon or a hypoechoic lesion within the tendon with either bursal or articular extension in both imaging planes (28). Tendinitis of the rotator cuff was indentified when a hypoechoic change and a thicker tendon (> 2 mm) was observed compared with the contralateral side (27). SA-SD bursitis was diagnosed when effusion accumulated in the bursa with more than 2 mm thickness and increased power Doppler imaging in the bursa were also found.

Data analysis

SPSS software (SPSS v12.0, Chicago, IL, USA) was used to analyse all collected data. The *t*-test was applied to compare differences in age, height, weight, time since stroke onset, duration of 2 sonographic examinations, ROM of hemiplegic shoulders at admission, and VAS score of hemiplegic shoulder pain between the PMF and GMF groups at admission and before discharge. The differences in gender, stroke type, hemiplegic side, sensation (light touch, pinprick, and proprioception), shoulder subluxation and spasticity, the presence of shoulder pain, and sonographic findings between the PMF and GMF groups were calculated with a χ^2 test. The correlation between the VAS score of HSP and shoulder motion was analysed by the Pearson correlation coefficient test. Point-biserial correlation coefficient test was used to analyse the correlation between VAS scores and BMR stages, spasticity, and subluxation, and sonographic findings of hemiplegic shoulders. The statistical significance was defined as $p < 0.05$.

RESULTS

The clinical characteristics of patients after stroke in the PMF and GMF groups are listed in Table I. The PMF group comprised 34 patients (15 women, 19 men; mean age 60.2 years; mean height 163.2 cm; mean weight 66.3 kg) and the GMF group comprised 23 patients (8 women, 15 men; mean age 64.7 years; mean height 163.2 cm; mean weight 67.3 kg). No significant differences were found in age, gender, height, and weight between these 2 groups. In the PMF group, 24 patients had ischaemic

Table I. *Group comparison of clinical characteristics in patients after stroke*

	PMF group ($n=34$)	GMF group ($n=23$)	p
Age, years, mean (SD)	60.2 (13.3)	64.7 (13.3)	0.21
Gender, female/male, n	15/19	8/15	0.48
Height, cm, mean (SD)	163.2 (7.7)	163.2 (7)	0.97
Weight, kg, mean (SD)	66.3 (11.9)	67.3 (14.4)	0.78
Stroke type, n (%)			0.52
Infarction	24 (70.6)	18 (78.3)	
Haemorrhage	10 (29.4)	5 (21.7)	
Hemiplegic side, n (%)			0.55
Left	21 (61.8)	16 (69.6)	
Right	13 (38.2)	7 (30.4)	
Duration from stroke onset, days, mean (SD)	20.6 (11.5)	18.4 (11.8)	0.5
Duration of 2 sonographic exam, days, mean (SD)	23 (5.8)	20.1 (6.6)	0.1
LOS, days, mean (SD)	32.9 (7.3)	27.1 (7.8)	<0.01*

*$p<0.05$.
χ^2 test for gender, stroke type, hemiplegic side; t-test for age, height, weight, duration from stroke onset and duration of 2 sonographic examinations.
SD: standard deviation; PMF: poor motor function; GMF: good motor function; exam: examination; LOS: length of stay.

Table II. *Physical findings in the poor and good motor function groups*

	PMF group ($n=34$)	GMF group ($n=23$)	p
Sensation, n (%)			
Light touch	14 (41.2)	4 (17.7)	0.06
Pin-prink	13 (38.2)	4 (17.4)	0.09
Proprioception	16 (47.1)	2 (8.7)	<0.01*
Shoulder spasticity, n (%)	17 (51.5)	4 (17.4)	0.01*
Glenohumeral subluxation, n (%)	9 (26.5)	1 (4.2)	0.01*
Shoulder motion, mean (SD)			
Flexion	158.8 (22.7)	166.3 (23.1)	0.23
Extension	49.9 (13.1)	54.6 (9.6)	0.12
Abduction	164.4 (28.6)	169.6 (18.9)	0.56
External rotation	71.6 (21.6)	85.9 (7)	<0.01*
Internal rotation	76.6 (18.1)	84.6 (10.4)	0.04*

*$p<0.05$.
χ^2 test for sensation, shoulder spasticity, glenohumeral subluxation; t-test for shoulder motion.
SD: standard deviation; PMF: poor motor function; GMF: good motor function.

stroke and 10 had haemorrhagic stroke. In the GMF group, 18 patients had ischaemic stroke and 5 had haemorrhagic stroke. No significant difference was found in stroke type between the 2 groups ($p=0.52$). The ratio of left hemiplegia to right hemiplegia in the PMF and GMF groups were 21/13 and 16/7, respectively. No significant difference was found in hemiplegic side between the 2 groups ($p=0.55$). Mean duration from stroke onset was 20.6 days in the PMF group and 18.4 days in the GMF group. There was no significant difference in mean duration from stroke onset between these 2 groups ($p=0.5$). The mean duration of the 2 sonographic examinations was 23 days in the PMF group and 20.1 days in the GMF group. There was no significant difference in the mean duration of the 2 sonographic examinations between the 2 groups ($p=0.1$). The mean length of hospital stay was 32.9 days in the PMF group and 27.1 days in the GMF groups. We found a significant difference in length of hospital stay between the 2 groups ($p<0.01$).

Table II shows the physical findings in the PMF and GMF groups. In the PMF group, 14 patients had impaired light touch and 13 had impaired pin-prick sensation. In the GMF group, 4 patients had both impaired light-touch and pin-prick sensation. There was no significant difference in light touch and pin-prick sensation between the 2 groups ($p=0.06$ and $p=0.09$). Sixteen patients in the PMF group and 2 patients in GMF group had a deficit in proprioception. A significant difference was found in the proprioception between these 2 groups ($p<0.01$). Spasticity was observed on admission in 17 hemiplegic shoulders of the PMF group and in 4 hemiplegic shoulders of the GMF group; the incidence of spasticity differed significantly between the 2 groups ($p=0.01$). At admission, glenohumeral subluxation was noted in 9 patients of the PMF group and one patient of the GMF group. There was a significant difference in glenohumeral subluxation between the 2 groups ($p=0.01$). The mean ROM of shoulder flexion, extension, abduction, external rotation, and internal rotation were 159°, 50°, 164°, 72°, and 77°, respectively, in the PMF group, and 166°, 55°, 170°, 86°, and 85°, respectively, in the GMF group. Significant differences were noted in both shoulder external and internal rotation ($p<0.05$) between the 2 groups.

The abnormal findings of shoulder sonography at admission and before discharge are shown in Table III. Effusion, tenosynovitis, or tendinitis at the long head of the biceps tendon, tendinitis of the supraspinatus tendon, and effusion or bursitis of SA-SD bursa on shoulder sonographic images were the most common findings at admission and before discharge in

Table III. *Group analysis for abnormal sonographic findings of hemiplegic shoulders at admission and before discharge*

	At admission			Before discharge		
The abnormal findings of shoulder sonography	PMF group ($n=34$)	GMF group ($n=23$)	p	PMF group ($n=34$)	GMF group ($n=23$)	p
Biceps tendon (effusion, Tenosynovitis, tendinitis, tear), n (%)	11 (32.4)	5 (21.7)	0.38	17 (50)	7 (30.4)	0.14
Supraspinatus tendon (tendinitis, tear), n (%)	12 (35.3)	4 (17.4)	0.14	16 (47.1)	4 (17.4)	0.02*
Subscapularis tendon (tendinitis, tear), n (%)	1 (2.9)	1 (4.3)	0.65	5 (14.7)	2 (8.7)	0.40
Subacromial-subdeltoid bursa (effusion or bursitis), n (%)	8 (23.5)	2 (8.7)	0.14	15 (44.1)	5 (21.7)	0.08
Total, n (%)	19 (55.9)	9 (39.1)	0.22	29 (85.3)	11 (47.8)	<0.01*

*$p<0.05$ by χ^2 test.
PMF: poor motor function; GMF: good motor function.

both groups. Effusion, tenosynovitis or tendinitis at the long head of the biceps tendon was found at admission in 32% of patients in the PMF group and 22% in the GMF group, and before discharge in 50% of the PMF group and 30% of the GMF group. In a supraspinatus tendon, tendinitis or a tear was noted in 35% of patients in the PMF group and 17% in the GMF group at admission and in 47% of the PMF group and 17% of the GMF group before discharge. In the SA-SD bursa, effusion or bursitis was found in 24% of the PMF group and in 9% of the GMF group at admission, but it was identified in 44% of the PMF group and in 22% of the GMF group before discharge. At admission, the frequencies of the abnormal findings of SA-SD bursa, biceps, supraspinatus, and subscapularis tendons for the shoulder sonographies were not significantly different between the 2 groups. However, there was a significant difference in the frequency of the supraspinatus tendinitis or tears between the PMF and GMF groups before discharge ($p=0.02$). Before discharge, a significant difference was also noted in the frequency of total abnormal sonographic findings between these 2 groups ($p<0.01$).

Table IV compares the structural abnormalities via shoulder sonography, and the presence and severity (VAS) of HSP at admission and before discharge between the PMF and GMF groups. At admission, there were 19 patients with HPS in the PMF group and 10 with HSP in the GMF group. Before discharge, there were 23 patients with HSP in the PMF group and 8 with HSP in the GMF group. We found a significant difference in the presence of HSP before discharge between the 2 groups ($p=0.02$). Mean VAS scores of the PMF group at admission as well as before discharge were significantly higher than those of the GMF group ($p<0.05$ and $p<0.01$). At admission, shoulder sonography revealed abnormal findings in 19 patients in the PMF group and 9 in the GMF group. On the other hand, before discharge, shoulder sonography revealed abnormal findings in 29 patients in the PMF group and 11 in the GMF group. Hence, the sonographic findings did not differ significantly at admission, but the findings before discharge did differ between the 2 groups ($p<0.01$). Table V shows a moderate correlation ($\gamma=0.34\sim0.65$) between the VAS scores of HSP and BMR stages, shoulder motion, subluxation, and abnormal sonographic findings of hemiplegic shoulder before discharge ($p<0.01$).

Table IV. *The shoulder pain and structural abnormalities of shoulder sonography at admission and before discharge in PMF and GMF groups*

	PMF group ($n=34$)	GMF group ($n=23$)	p
Presence of shoulder pain, n (%)			
At admission	19 (55.9)	10 (43.5)	0.36
Before discharge	23 (67.6)	8 (34.8)	0.02*
VAS score, mean (SD)			
At admission	2.47 (2.80)	1.26 (1.74)	<0.05*
Before discharge	3.62 (3.18)	1.39 (2.37)	<0.01*
Abnormal findings of shoulder sonography, n (%)			
At admission	19 (55.9)	9 (39.1)	0.22
Before discharge	29 (85.3)	11 (47.8)	<0.01*

*$p<0.05$.

χ^2 test for presence of shoulder pain, abnormal findings of shoulder sonography; *t*-test for visual analogue scale (VAS).

SD: standard deviation; PMF: poor motor function; GMF: good motor function.

Table V. *Correlations between the physical/sonographic findings and the visual analogue scale (VAS) score of hemiplegic shoulders before discharge*

	VAS score (γ)	p
BMR stage	–0.34	0.01*
Shoulder motion	–0.44	<0.01**
Flexion	–0.49	<0.01**
Extension	–0.65	<0.01**
Abduction	–0.51	<0.01**
External rotation	–0.40	<0.01**
Internal rotation		
Shoulder spasticity	0.25	0.06
Glenohumeral subluxation	0.36	<0.01**
Abnormal findings of shoulder sonography	0.41	<0.01**

*$p<0.05$; **$p<0.01$.

Point-biserial correlation test for BMR stage, shoulder spasticity, glenohumeral subluxation, abnormal findings of shoulder sonography; Pearson correlation test for shoulder motion.

BMR stage: Brunnström Motor Recovery stage.

DISCUSSION

Shoulder pain is one of the 4 most common complications during in-patient stroke rehabilitation (29). However, the functional recovery of the affected upper extremity is most effective within the first 12 weeks of stroke onset (30). Early-onset HSP impedes the motor recovery of the affected upper limb and curtails the performance of daily activities (2, 9). We enrolled 57 patients after acute stroke who were undergoing rehabilitation, in order to investigate clinical, physical, and sonographic findings of hemiplegic shoulders with different motor functions. The main findings of our study showed that the stroke patients in the PMF group had significantly decreased proprioception, restricted shoulder rotation, increased spasticity, shoulder subluxation, increased HSP, higher VAS score, and increased abnormal sonographic findings (85%) of hemiplegic shoulders after an acute stroke. BMR stages, restricted shoulder motion, shoulder subluxation, and abnormal sonographic findings of acute hemiplegic shoulders were all related to the severity of HSP in acute stroke patients before discharge.

Many authors have proposed that HSP is related to severe paralysis, sensory impairment, shoulder subluxation, limitation of shoulder motion, and spasticity (1–3, 5, 6, 8, 9, 11, 31). In our study, acute stroke patients with paralytic shoulders had a significantly higher frequency of impaired proprioception, increased shoulder muscle tone and subluxation, and limited motion in external and internal rotation of the shoulder, which were associated with HSP. Moreover, BMR stages, motion restriction, and subluxation of hemiplegic shoulder were all significantly correlated with VAS scores of early-onset HPS. No correlation was established between early-onset HSP and spasticity of the affected limb in this study. Roy et al. (9) and

Cheng et al. (32) did not find a relationship between HSP and shoulder spasticity in recent-stroke patients. However, Van Ouwenaller et al. (6) reported an association between HSP and spasticity. Their study of 219 patients who were followed up for one year revealed that HSP occurred in 85% of the patients with spasticity, but in only 18% of the patients with flaccidity (6). The different results among these studies may be attributable to different methods of assessment for spasticity and the difference in durations from stroke onset.

Musculoskeletal sonography is a common tool for evaluating a rotator cuff injury. Several researchers have reported that the sensitivity and specificity of sonography for rotator cuff injury ranges from 57% to 100% and from 76% to 94%, respectively (28, 33–35). Several studies used sonography to evaluate hemiplegic shoulders. Aras et al. (19) found a higher prevalence of HSP in 48 of 64 patients (75%) at a low BMR stage compared with that in 6 of 19 patients (31.6%) at a high BMR stage. Their mean duration from stroke onset was 70.2 days and the main abnormalities of shoulder sonography were found on the long head of the biceps tendon (64.8%) and supraspinatus tendon (64.8%). Lee et al. (20) reported on 84 patients (median age, 61 years) and the interval from their stroke onset to sonographic evaluation was 14 days to 7 years. Abnormal sonographic findings were observed in 62.2% of hemiplegic shoulders and 20.7% of non-hemiplegic shoulders. The main abnormalities in hemiplegic shoulders were effusion (39%) of the biceps tendon and tendinopathy (17.3%) of the supraspinatus and the biceps tendons, which were significantly more than in non-hemiplegic shoulders. Lee et al. (20) did not describe and analyse the motor functional status of hemiplegic shoulders in that study. Those 2 studies found similar results and both revealed a high prevalence of effusion or tendinopathy in biceps and supraspinatus tendons of hemiplegic shoulders. In the current study, we assessed hemiplegic shoulders with a short mean duration from stroke onset (21.8 days), in order to observe the sonographic structural changes during the optimum period of neurological recovery, while receiving rehabilitation. Similar results on shoulder sonography as noted were as follows: a higher frequency of structural abnormalities of the long head of the biceps tendon (24/57; 42%), supraspinatus tendon (20/57; 35%), and SA-SD bursa (20/57; 35%) before discharge. We also found a higher prevalence of HSP in the PMF group before discharge, which was similar to the result in the study by Aras et al. (19). Moreover, we observed that the prevalence of supraspinatus tendinopathy in the PMF group was significantly higher than that in the GMF group before discharge. Therefore, it is important that rehabilitation teams carefully schedule exercises/activities that involve the supraspinatus muscle in patients after acute stroke with flaccid shoulders.

Moderate correlation was observed not only between HSP and abnormal sonographic findings but also between the VAS scores of the HSP and BMR stages in acute hemiplegic shoulders. We therefore believe that soft-tissue injuries of the shoulder play an important role in early-onset HSP, especially in flaccid shoulders. The number of soft-tissue injuries of the shoulder may have been increased in the PMF group because the patients in this group received more exercises on excessive stretching, manipulation, and passive ROM for flaccid shoulders during rehabilitation than did the patients in the other group. The caregivers encountered during hospitalization may not be adequately educated about handling the patients while transferring or positioning, which also causes soft-tissue injuries of the shoulder on flaccid shoulders.

The main limitations of our study were the small sample size, and the lack of representation of population-based patients after stroke, since all patients belonged to one rehabilitation unit. Early-onset HSP was investigated in these stroke patients for only a short period. Additionally, we did not record and compare the differences in the rehabilitation programmes among patients with poor and good arm motor functions. In subsequent research, more subjects should be included from multiple stroke centres and they should be studied for a longer period in order to observe the functional recovery of hemiplegic shoulders among patients after stroke with and without soft-tissue injuries according to shoulder sonography. The detailed daily exercises and rehabilitation programmes can be recorded and analysed to establish a relationship between the quantities and types of activities/exercises and shoulder soft tissue injuries in acute stroke patients.

In conclusion, patients after acute stroke with poor arm motor function that was combined with impaired sensation, shoulder spasticity and subluxation, and restricted shoulder rotation at admission, demonstrated a higher prevalence of shoulder soft-tissue injuries (85%) and HSP (67%) before discharge. Additionally, we identified several factors, including BMR stages, limited rotation, subluxation, and abnormal sonographic findings of the affected shoulder, associated with the severity of early-onset HSP. Shoulder sonography can detect soft tissue injuries associated with HSP at an early stage and clarify the injured tendons during hospitalization. On the basis of the sonographic findings, the physicians can begin early treatment of the HSP, educate the caregiver for appropriately transferring or positioning, and modify the rehabilitation programme to prevent further shoulder injury that may impede the upper extremity neurological and functional recovery during the optimum period.

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