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Original Article

Evaluation of glenohumeral subluxation and related factors in patients with post-stroke shoulder pain

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Abstract

Aim: Glenohumeral subluxation (GHS) is a frequent complication of post-stroke patients which can be considered as a major predisposing factor for other disorders. We aimed to assess the frequency of GHS in patients with post-stroke shoulder pain and to determine the relationships of GHS with motor recovery, pain, functional status and depression.

Material and Methods: This study has a descriptive design. A total of 73 stroke patients with shoulder pain were enrolled in this study. Patients' demographic characteristics, disease duration, Brunnstrom motor recovery levels for upper extremities, functional ambulation scales (FAS), spasticity stages, pain levels, Barthel Index (BI) and depression scores were recorded. The presence of GHS was evaluated clinically and radiologically. Considering patients with and without GHS, clinical variables were compared.

Results: Of the 73 patients, 21 (28.7%) of them had GHS. The ratio of patients in Brunnstrom Category I (Brunstrom 1-3) and non-functional ambulation level were significantly higher in patients with GHS ($p < 0.05$). Shoulder flexion, abduction, internal rotation and external rotation ROMs were found to be significantly lower in patients with GHS ($p < 0.05$). No significant difference was found in terms of spasticity and shoulder extension ($p > 0.05$). Pain levels and BDI scores were significantly higher, BI scores were significantly lower in patients with GHS, though ($p < 0.05$).

Conclusion: GHS is a frequent problem in stroke patients which is closely related to the motor recovery and ambulation level. Patients with GHS have a more restricted shoulder ROM, higher pain and depression scores and poor level functional independence.

Keywords: Glenohumeral subluxation; hemiplegic shoulder pain; stroke

INTRODUCTION

Post-stroke shoulder pain is one the most frequent and disturbing complications in patients with stroke. Incidence rates up to 84% were reported in the literature (1). The potential effects of post-stroke shoulder pain have been evaluated in various studies and reported to be associated with poor functional recovery and quality of life, prolonged rehabilitation processes and higher depression scores (2). A variety of disorders including soft tissue damages, rotator cuff injuries, tendinitis, adhesive capsulitis and complex regional pain syndrome may play a role in the etiopathogenesis of post-stroke shoulder pain (3).

Post-stroke glenohumeral subluxation (GHS) is described as disruption of the connection between the humerus and the scapula in all plans without trauma after stroke (4). The glenohumeral joint has wide joint range of motion, but this negatively affects the stabilization of the joint and causes a tendency to subluxation (2). Stabilization of the glenohumeral joint can be achieved by the active contraction of a group of muscles including rotator cuff muscles, deltoid and biceps (5). However, the function of this muscle group is impaired after stroke and glenohumeral joint stabilization is adversely affected. There are conflicting results regarding the role of GHS in the development of post-stroke shoulder pain. Although some studies found a clear relationship between GHS and post - stroke shoulder pain, there are also studies that did not find a clear causality (6, 7, 8, 9). Additionally, the relationship between GHS and motor function is unclear (10). GHS may arise in the flaccid phase of stroke when muscle strength is decreased and gravity deteriorates the stabilization of shoulder joint. Additionally, GHS may occur after the development of spasticity which places the upper limb to inversion and pronation (11).

The first aim of this study was to evaluate the frequency of GHS in patients with post-stroke shoulder pain. Secondary aim was to assess the relationships of GHS with motor

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recovery, shoulder range of motions (ROM), neuropathic pain and depression.

MATERIAL and METHODS

For this cross-sectional study, patients admitted to physical medicine and rehabilitation clinic of Kahramanmaraş Sütçü İmam University with the diagnosis of hemiplegia after stroke between July 2019 and October 2019 were evaluated. Patients with post-stroke shoulder pain were included in the study. Outpatients and inpatients were evaluated for the study. Patients with recurrent stroke attacks, bilateral motor deficit, pre-stroke shoulder pain, fracture or surgical history of shoulder, aphasia, cognitive dysfunction and rheumatologic or endocrinologic disorders that may cause shoulder ROM restriction / GHS were excluded from the study. After the inclusion and exclusion criteria, 73 patients with post-stroke shoulder pain were enrolled in this study.

Data Collection

Data including age, sex, body mass index (BMI), educational status, marital status, working status, etiology of stroke (ischemic / hemorrhagic), plegic side, and duration after stroke were recorded for each participant.

A 10 cm visual analogue scale (VAS) was used to evaluate the pain level. 'No pain' is described as 0 point and 'highest pain' is described as 10 points. Leeds Assessment of Neuropathic Symptoms and Signs Scale (LANSS) were used to assess the neuropathic pain in stroke patients. LANSS includes 2 sections. The patients who complete the first section by responding the questions are involved in the physical examination, which is in the second part of data collection. Patients can be evaluated with a maximum of 24 points. 12 points or more are interpreted in favor of neuropathic pain (12).

All patients uncovered their affected arm to facilitate the shoulder ROMs and to expose bone reference points. Passive shoulder flexion, extension, abduction, internal rotation and external rotation ROM of the plegic shoulder was evaluated by the same physical medicine and rehabilitation research assistant. Measurements were performed in the sitting position. The ROM was performed to the point where the patients felt significant pain. Goniometer was used to measure the ROM.

The Brunnstrom scale was used to evaluate the motor function of the stroke patients. This scale includes the stages from 1 to 6. Stage 1 indicates that patient is in the flaccid phase and cannot voluntarily move extremity. Stage 6 indicates that patient performs the isolated joint movements (13). The Brunnstrom motor recovery stages for the upper extremity were divided into two categories by considering the synergy pattern (Category I: Brunnstrom 1-3 and Category II: Brunnstrom 4-6). As of Brunnstrom stage 4, patients can gradually perform isolated movements outside the synergy pattern. Spasticity begins to decrease. Patients can perform independent movements and start regaining their control on their extremities. Therefore, the above mentioned categorization was performed in this study.

The modified Ashworth Scale ranging from 0 to 4 was used to evaluate the upper extremity spasticity (14). Score of 0 indicates no increase in muscle tone. Score of 1 indicates slight increase in muscle tone and minimal resistance at the end of the ROM. Score of 1+ indicates slight increase in muscle tone and resistance throughout less than half of the ROM. Score of 2 indicates more marked increase in muscle tone through most of the ROM, but affected part easily moved. Score of 3 indicates considerable increase in muscle tone, and passive movement is difficult. Score of 4 indicates affected part is rigid in flexion or extension. Patients with Ashworth scores of 0-2 were classified as Category I and patients with 3-4 were classified as Category II.

Ambulation levels of the patients were evaluated with functional ambulation scale (FAS), which includes the stages from 0 to 5. 0 indicates bed level, 5 shows a complete independence in ambulation (15). Patients with FAS 0-2 were considered as 'non-functional ambulation' and those between 3 and 5 were considered as 'functional ambulation'.

Functional status of the patients was evaluated with Barthel Index (BI). The index consists of 10 items related to daily living activities and mobility. A scoring is performed as to whether patients have received support during the activities assessed. The highest total score is 100, which indicates the individual is completely independent in physical functions (16,17).

Beck depression inventory (BDI) was used to evaluate the depression scores of the patients. BDI involves 21 questions and each question is scored 0 to 3 points. Thus, the maximum score of BDI is 63 points. Higher scores indicate higher levels of depression (18, 19).

Assessment of Glenohumeral Subluxation

Patients with post-stroke shoulder pain were evaluated clinically and radiographically to detect GHS. In the clinical evaluation, patients were placed in a sitting position and the gap between the lower part of the acromion and the upper part of humerus was evaluated by comparing the finger-breadth. The presence of at least one finger-breadth was evaluated in favor of subluxation (20). In the radiographic evaluation, anterior–posterior radiographs of the glenohumeral joint were obtained in an unsupported position. GHS was evaluated by using the grading system recommended by Van Langenberghe et al. (21). In this grading system, grade 0 indicates a normal joint, grade 1 indicates a V-shaped widening, grade 2 indicates a moderate subluxation, grade 3 indicates an advanced subluxation and grade 4 indicates a dislocation. The patients whose radiographs were evaluated as grade 1-4 were considered in favor of subluxation. It was accepted that GHS was present in the patients evaluated in favor of subluxation in both clinical and radiographic examinations.

The participation in this study was based on voluntarism, and the approval of local ethics committee was obtained before the study (approval date: 03.07.2019; approval number: 10).

Statistical Analysis

The Statistical Package for the Social Sciences version 20.0 package program (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. Expression of the data was displayed as median (minimum – maximum), numbers, and percentages. The normality of data distribution was evaluated by using a Shapiro–Wilk test. Comparisons between patients GHS and without GHS were performed by using a Chi-Square test and a Mann-Whitney U test by considering whether the data were categorical or continuous. If a p value was less than 0.05, it was considered as statistically significant.

RESULTS

Of the 73 patients with post-stroke shoulder pain, 21 patients (28.7%) were found to have GHS. The median age of patients with and without GHS was 65 (minimum: 27; maximum: 81) and 58 (minimum: 19; maximum: 89) years, respectively. In the GHS group, 17 patients had ischemic

Table 1. Distribution of demographic and clinical features of patients with and without glenohumeral subluxation

	Patients with GHS	Patients without GHS	p
Age* (year)	65 (27-81)	58 (19-89)	0.132
Sex+			
Female (n)	10	19	0.381
Male (n)	11	33	
BMI*	26.9 (22.2-36)	26.75 (18.6-38.4)	0.922
Symptom duration* (day)	90 (10-720)	90 (10-1460)	0.252
Employment status+			
Worker (n)	2	16	
Non-worker (n)	12	26	0.125
Retired (n)	7	10	
Educational status+			
Illıterate (n)	3	11	
Literate (n)	6	3	
Primary school (n)	7	14	0.106
Secondary school (n)	2	9	
High school (n)	3	13	
University or higher (n)	0	2	
Marital status+			
Married (n)	14	39	0.470
Single/divorced (n)	7	13	
Stroke etiology+			
Ischemic (n)	17	37	0.388
Haemorrhagic (n)	4	15	
Plegic side+			
Right (n)	14	30	0.478
Left (n)	7	22	

n: number, BMI: Body mass index, GHS: Glenohumeral subluxation.
* Data are expressed as median (minimum – maximum) and Mann-Whitney U test was performed for the analyses.
+ Chi-Square test was performed for the analyses

stroke and 4 patients had hemorrhagic stroke. In the group without GHS, 37 patients had ischemic stroke and 15 patients had hemorrhagic stroke. The data including demographic and clinical features of the patients with GHS and without GHS is presented in Table 1. No statistically significant difference was found between the groups in terms of the related data (p > 0.05).

Two categories were formed for the Brunnstrom, Ashworth and FAS scales. In patients with GHS, the ratio of patients in Brunnstrom Category I (Brunstrom 1-3) was significantly higher as compared to the patients without GHS (p < 0.001). Additionally, the ratio of patients with non-functional ambulation level was significantly higher in patients with GHS (p = 0.009). On the other hand, no significant difference was detected in terms of spasticity (p = 0.563). Shoulder flexion, abduction, internal rotation and external rotation ROMs were found to be significantly lower in patients with GHS (p < 0.05). No significant difference was found in terms of shoulder extension (p = 0.080). VAS and BDI scores were found to be significantly higher in the GHS groups (p < 0.001). BI score was significantly lower in patients with GHS (p < 0.001). Additionally, the frequency of neuropathic pain was significantly higher in patients with GHS (p = 0.009) (Table 2).

DISCUSSION

Table 2. Comparison of clinic variables between patients with and without glenohumeral subluxation

	Patients with GHS	Patients without GHS	p
Brunnstrom⁺			
Category I (n)	19	9	<0.001
Category II (n)	2	43	
Spasticity⁺			
Category I (n)	18	47	0.563
Category II (n)	3	5	
FAS⁺			
non-functional (n)	12	13	0.009
functional (n)	9	39	
Shoulder ROM*			
Flexion	110 (50-160)	170 (50-180)	<0.001
Extension	40 (20-45)	40 (15-45)	0.080
Abduction	100 (45-160)	160 (40-180)	<0.001
Internal Rotation	50 (15-80)	70 (5-90)	0.001
External Rotation	45 (15-80)	70 (10-90)	0.001
VAS*	6 (1-9)	2 (1-10)	<0.001
Neuropathic Pain⁺			
Yes (n)	8	6	
No (n)	13	46	0.009
BI*	45 (5-75)	85 (30-100)	<0.001
BDI*	14 (0-32)	5.5 (0-25)	<0.001

n: Number, GHS: Glenohumeral subluxation, FAS: Functional ambulation scale, ROM: Range of motion,
VAS: Visual analogue scale, BI: Barthel index, BDI: Beck depression inventory
* Data are expressed as median (minimum – maximum) and Mann-Whitney U test was performed for the analyses.
⁺ Chi-Square test was performed for the analyses

Patients with post-stroke shoulder pain were evaluated in this study and the following results have been reached:

- GHS was detected clinically and radiologically in 28.7% of the patients.
- Patients with GHS had lower Brunnstrom and FAS stages.
- Shoulder ROMs except extension were found to be restricted in patients with GHS.
- Higher pain and depression scores as well as impaired functional status were detected in patients with GHS.

Variable frequency rates have been reported in studies by evaluating GHS in stroke patients. There are studies reporting the frequency of GHS from 17% to 81% (22). GHS was detected in 28.7% of the patients in our study. Various reasons may cause the different rates of GHS presented in the literature. Different methods including clinical evaluation, examination of shoulder x-rays or ultrasonography assessments were used in the diagnosis of GHS. The sample sizes were variable and patients at different stages of stroke (acute, subacute or chronic) were included in the studies. The relatively low rate in our study may have been due to the inclusion of patients who clinically and radiologically met the diagnosis of GHS. Additionally, previous rehabilitation programmes may also have affected the results.

One of the factors considered to be related to GHS is the level of motor recovery. Brunnstrom was evaluated for upper extremity motor recovery and FAS for lower extremity motor recovery and ambulation. The frequency of patients with Brunnstrom Category I (early stages of functional recovery) was found to be significantly higher in patients with GHS. Additionally, there was a significant increase in the rates of non-ambulatory patients in the GHS group. Consistent with our results, Huang et al. (23) and Pop et al. (11) reported significantly higher subluxation rates in patients with poor motor function. Decreased levels of muscle activity and loss of tone during the early phases of motor recovery, particularly in the deltoid and supraspinatus muscles, cause a significant weakness in inferior part of the capsule, which creates a tendency to GHS (24).

The traction effect caused by the gravity contributes to the GHS during the flaccid period of stroke where spasticity is not evident. On the other hand, with the development of spasticity in the later phases, normal biomechanics of the shoulder joint is impaired with the forcing of glenohumeral joint to adduction and internal rotation (11, 25). Therefore, GHS can occur both in the flaccid and spastic periods. Consistent with this view, there was no significant difference in spasticity between the groups with and without GHS.

Pain scores evaluated with VAS and the frequency of neuropathic pain were significantly higher in patients with GHS. Central pain in stroke patients is characterized as continuous or intermittent pain occurring in body parts due to central nervous system lesions. Central pain after stroke may cause complaints of burning, tingling, freezing and needling and increase the overall pain levels (26). Stretching in the joint capsule formed by the effect of gravity and the weight of the plegic upper extremity can damage the supporting structures of the shoulder joint and induce pain. GHS changes shoulder biomechanics and creates a tendency to different painful disorders. Huang et al. (23) reported that the most common pathologies are effusion, bicipital and supraspinatus tendinitis which may explain the higher pain scores in patients with GHS. The frequency of complex regional pain syndrome is significantly higher in patients with GHS, and painful rotator cuff injuries are found to be strongly associated with GHS (2). It has been reported that spasticity may induce pain by accelerating the development of adhesive capsulitis (27). Botulinum toxin injection in the subscapularis muscle was found to decrease pain levels by supporting the role of spasticity in shoulder pain (28).

Patients with GHS had restricted shoulder ROMs except extension. High levels of pain and poor motor function in patients with GHS may lead to these results. Weakness of the muscles that move the shoulder joint is more pronounced in patients with GHS and this may negatively affect ROMs. On the shoulder where the GHS occurs, a stable base cannot be provided to increase ROMs. In addition, spasticity particularly in the subscapularis muscle may lead to limitations in shoulder external rotation, abduction and flexion (29).

Higher depression and lower BI scores were detected in patients with GHS. Impaired motor recovery and ambulation levels may be the cause of low scores in BI parameters assessing functional independence in the areas of personal care and mobility. Additionally, higher pain levels, poor stages of Brunnstrom and FAS may lead to increase the scores of depression in patients with GHS.

This study has several limitations. Our sample size is relatively small. Therefore, the number of patients with GHS is low. The study was planned as a cross-sectional and the patients were not followed up for a specific period. Healthy controls were not evaluated in the study. We did not compare acute, subacute and chronic cases due to the relatively small sample size The potential effects of the rehabilitation programs on GHS were not evaluated. On the other hand, ultrasonography examination could not be performed. We did not investigate corresponding pathologies with MRI scans. Therefore, prospective studies with higher sample sizes and quantitative methods are needed

CONCLUSION

GHS is more frequent in the early stages of motor recovery. Patients with GHS have higher pain and depression scores, impaired daily living activities and ambulation levels. Stroke patients should be closely followed for GHS development and GHS should be diagnosed using detailed physical examination and radiological methods.

Competing interests: The authors declare that they have no competing interest.
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