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Symptomatic Variations in Patients with Primary and Secondary Frozen Shoulder: A Cross-Sectional Study

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SUMMARY

Background. Frozen shoulder is one of the most prevalent shoulder diseases, which causes a painful restriction of the shoulder's active and passive range of motion (ROM). Additionally, there is evidence that subscapularis trigger points (TrPs) are strongly linked to frozen shoulder and contribute to shoulder morbidity and limited ROM.

Purpose. The purpose of this study is to compare the variations of subscapularis (TrPs), shoulder pain, shoulder abduction, and external rotation ROM between primary and secondary types of frozen shoulder.

Methods. Fifty patients were diagnosed with frozen shoulder and were allocated to two equal groups: group A, primary (idiopathic) frozen shoulder, and group B, secondary frozen shoulder, both aged 40 to 60 years. The study collected data regarding pressure pain threshold by pressure algometry, shoulder pain and function by shoulder pain and disability index (SPADI questionnaire), shoulder abduction, and external rotation ROM by digital inclinometer.

Results. Group A showed a significant increase in PPT compared to group B ($p = 0.001$). Group B revealed a significant increase in shoulder pain and functional disabil-ity, decreased shoulder abduction, and external ROM ($p = 0.001$) in comparison to group A.

Conclusions. Secondary frozen shoulder patients with subscapularis TrPs may experi-ence increased shoulder pain, limited shoulder abduction, and reduced external rota-tion compared to primary frozen shoulder patients.

KEY WORDS

Primary frozen shoulder; secondary frozen shoulder; shoulder pain and disability index; ROM; pressure pain threshold.

INTRODUCTION

Frozen shoulder is one of the most prevalent shoulder diseases that causes musculoskeletal disability of the shoul-der with painful restricted motion and function resulting from progressive fibrosis and contracture of the glenohu-meral joint capsule (1, 2). External range of motion (ROM) of the shoulder is the most restricted movement followed by abduction and internal rotation (3). Although the exact etiology is unknown, frozen shoulder may be idiopathic and related to various precipitating factors. Studies have shown older individuals, females, diabetes mellitus, or abnor-mal lipid profiles (4, 5) or thyroid dysfunction (6) have an increased risk of developing frozen shoulder. Furthermore, frozen shoulder could be the consensus for upper limb fracture, rotator cuff tear, rotator cuff/biceps tendinopa-thy, cerebral vascular accident, and myocardial infarction (7). The prevalence of frozen shoulder is about two percent in the general population; however, a meta-analysis of the prevalence of frozen shoulder revealed that diabetic frozen shoulder has a 5 times greater prevalence in non-diabetic

patients (8). Subscapularis (TrPs) could play a role in the pathophysiology of frozen shoulder, either in the development or severity of frozen shoulder (9). Trigger points are one of the frequent causes of pain in different musculoskeletal pathologies (10).

A significant association is found between subscapularis trigger point and frozen shoulder patients, which limits overhead elevation, shoulder abduction, and external rotation (11-13). Evidence suggests that frozen shoulder has a significant impact on the subscapularis muscle, specifically due to its anatomical location in the subscapular fossa and its function as a major stabilizer for the glenohumeral joint. Frozen shoulder also results in limited shoulder movement, particularly in external rotation, which is a critical function of the subscapularis. Additionally, the subscapularis muscle is closely connected to the capsuloligamentous complex, which may become fibrotic, thereby affecting its function (14). Trigger points (TrPs) are highly sensitive spots within a taut band of skeletal movement, which elicit pain during pressure and provoke referred pain (15). Sarcomeres and extrafusal motor end plates overactivity is a multifactorial phenomenon that manifests with TrPs development (16). The intracellular calcium in certain muscle fibers may be extremely released in response to trauma or abnormal stress. An abnormally elevated calcium level may cause uncontrolled shortening activity and increased metabolism, compromising local circulation and resulting in a loss of oxygen and nutrient supply to the region. This completes a vicious cycle, resulting in an energy crisis and the formation of TrPs (17). Consequently, pain and stiffness, which are typical signs of frozen shoulder, can be exacerbated by trigger points in the subscapularis muscle, which further restrict shoulder mobility (14). Unfortunately, there is no consensus on how to address this condition, which is likely due to a lack of high-level research. Few evidence to draw firm conclusions about the best way to manage patients with frozen shoulder and its treatment remains controversial. Treatment should be tailored to the stage of the disease and patients' characteristics (18). However, to the best of our knowledge, no study has compared the variation of subscapularis trigger points involvement, understanding the involvement of the subscapularis in both primary and secondary frozen shoulder can guide physical therapists for better treatment planning to alleviate symptoms. Besides, this can be a key factor in understanding its impact on shoulder pain, disability, and ROM in primary and secondary frozen shoulder. As a result, it can help with the diagnosis and treatment of idiopathic and secondary frozen shoulder.

MATERIALS AND METHODS

Study design

A cross-sectional design was conducted on fifty patients diagnosed and referred with frozen shoulder at the outpatient clinic of the Faculty of Physical Therapy. The study period extended from September 2023 to February 2024.

Study participants

Patients were enrolled and evaluated for their eligibility to participate in the study and were categorized into two equal groups: group A primary (idiopathic) frozen shoulder; and group B, secondary frozen shoulder. Their ages ranged from 40 to 60 years.

Ethical considerations

Written informed consent was obtained from all subjects before baseline evaluation. The research followed the ethical standards outlined in the 1964 Declaration of Helsinki (19), and was authorized by the faculty of physical therapy, Cairo University, Egypt's ethical committee (P.T.REC/012/004780 – date of approval: September 03, 2023).

Sample size calculation

The sample size was calculated using the statistical program G*POWER (version 3.0.10). Using a t-test, the difference between two independent means, from pilot study data, with a power of 0.80, a significance level of 0.05 (two-tailed), and an effect size of 0.82; a generated sample size of at least 50 participants, twenty-five patients in each group were included.

Inclusion criteria and exclusion criteria

Primary or secondary frozen shoulder patients with the presence of subscapularis TrPs and experiencing painful progressive stiffness of the shoulder for at least 3 months (stage 2), as well as a loss of both active and passive abduction shoulder and external rotation ROM were included.

Patients with a history of polyarthritis, a neurological condition, or cervical radiculopathy, and who underwent an intra-articular cortisone injection during the previous 6 months were excluded.

Procedures

The investigator collected the subsequent demographic data: age, gender, body weight, height, and BMI. Afterward, the screening procedure for the presence of subscapularis TrPs, shoulder pain, function, and shoulder ROM measurement was conducted.



Figure 1. Manual localization of trigger points.

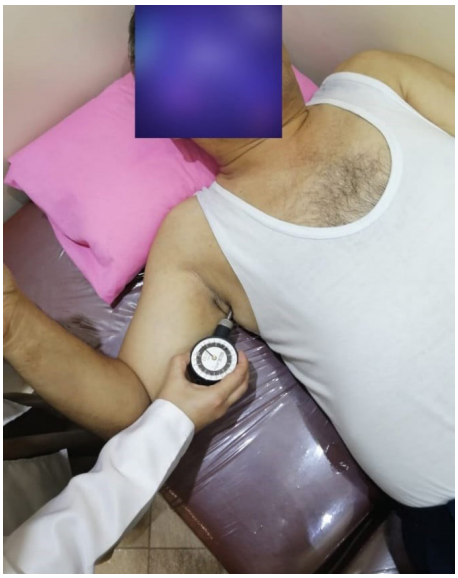


Figure 2. Pressure pain threshold measurement with pressure algometry.

Assessment of Subscapularis Trigger points (TrPs)

The pressure algometry (Wagner model) was employed to measure the pressure pain threshold on the identified subscapularis TrPs (**figure 1**). It consists of a 1-cm-diameter hard broad disk attached to a dial gauge calibrated in kg/cm^2. It has good to excellent inter-examiner reliability (ICC = 0.75-0.89) (20-22). The researcher began by palpating the subscapularis TrPs at the tenderest part of the posterior axillary wall while the patients were lying supine with their arm supported by the plinth. To gain access to the muscle, the shoulder was abducted and externally rotated, and the scapula was moved more laterally (23). If the patient had limited shoulder abduction and external rotation, the scapula was moved away from the body passively. At the same time, the arm was placed alongside it, and the trigger point was felt, which is frequently found around the most superomedial region of the scapula (13). Lastly, the algometry assessed steady and perpendicular pressure on the identified subscapularis TrPs, with patients expressing discomfort or pain. The average of three trials was taken with a 10-second rest period between them (24) (**figure 2**). Pressure thresholds of less than 3 kg are considered abnormally low (25).

Assessment of shoulder pain and function

The shoulder pain and disability index (SPADI**)** is employed to measure the existing shoulder pain and functional disability. It has been extensively employed as a shoulder outcome variable in patients with frozen shoulder (26-28). The SPADI has good construct validity (29), high levels of internal (30) consistency, and good test-retest reliability (31). It has 13 items that evaluate two domains: a 5-item subscale that measures pain and an 8-item subscale that assesses functional disability. Patients scored on a numerical rating scale from 0:10 on each item, with 0 indicating no pain or disability and 10 indicating the maximum pain or disability possible. The ratio of patient responses to relevant items is multiplied by 100. A higher score means higher pain and disability (25).

Assessment of shoulder range of motion

A Professional 9-inch digital inclinometer with a multi-function HUSKY digital level was utilized to assess shoulder abduction and external rotation ROM. This digital level has a 360° measurement range and is employed to measure the horizontal and vertical alignments of objects. The digital display's accuracy is ±0.1° for each level and ±0.2° for all angles (30).

Shoulder abduction ROM was assessed while seated, with the trunk erect. The patient was asked to abduct their arm while pointing their thumb upwards toward the ceiling and keeping their elbow extended. This motion was performed both actively and passively. Three trials were performed with rest intervals (32) (**figure 3A-C**).

Shoulder external rotation was assessed while the patient was supine with an adducted arm, elbow flexed to 90 degrees, and wrist in neutral position. The inclinometer



Figure 3. Shoulder abduction ROM measurement.
(**A**) starting position; (**B**) active; (**C**) passive.



Figure 4. External rotation ROM measurement.
(**A**) starting position; (**B**) active; (**C**) passive.

was aligned with the ulna's midline, and this measurement was then repeated actively and passively. Three trials were performed with rest intervals (32) (**figure 4A-C**).

Statistical analysis

The data was presented as mean ± SD. Demographic data (age and BMI) was analyzed using independent t-tests. The Chi-square test was used for gender analysis. For data normality, the Shapiro-Wilk and Kolmogorov-Smirnov tests were employed. A MANOVA was used to compare the mean values of PPT, SPADI, and shoulder ROM (abduction, and external rotation) between the two groups. The statistician was blind to group allocation until the analysis was completed.

RESULTS

In **table I**, the demographic characteristics are shown. Age, gender, and BMI did not differ significantly between the two groups. Shapiro-Wilk and Kolmogorov-Smirnov tests for normality revealed that all measured variables were normally distributed.

The PPT mean values in group A were significantly higher than those in group B ($p = 0.001$). The mean difference between group A and group B SPADI was statistically significant ($p = 0.001$). The study showed that Group B had a significant decrease in shoulder range of motion for active and passive shoulder abduction as well as shoulder external rotation when compared to Group A ($p = 0.001$) (**table II**).

DISCUSSION

The main objective of this trial was to assess the variation of subscapularis trigger point's tenderness, shoulder pain and function, and both active and passive shoulder abduction and external rotation ROM between primary *versus* secondary frozen shoulder. A total of fifty patients were assessed and the results revealed that a statistically significant difference was reported in PPT, shoulder pain and functional disability, and shoulder ROM (abduction, and external rotation) between primary and secondary frozen shoulder patients.

This study found a higher sensitivity of subscapularis TrPs

Table I. Demographic characteristics of patients.

	Group A (Primary frozen shoulder)	Group B (Secondary frozen shoulder)	T- value	P-value	Sig.
	Mean ± SD	Mean ± SD			
Age (years)	44.48 ± 4.93	45 ± 7.37	-0.29	0.77	NS
BMI (kg/m²)	24.71 ± 2.43	24.43 ± 2.34	0.41	0.68	NS
Females	18 (72%)	20 (80%)	$\chi^2 = 0.43$	0.5	NS
Males	7 (28%)	5 (20%)			

SD: Standard deviation; χ^2: Chi squared value; T-value: Unpaired t value; P-value: Probability value; NS: Non-significant.

Table II. Between-group comparison of measured variables.

Measured variables		Group A Mean ± SD	Group B Mean ± SD	MD	F-value	P-value
PPT (kg)		2.17 ± 0.83	1.28 ± 0.75	0.89	15.52	0.001
SPADI		65.32 ± 13.9	77.07 ± 10.07	-14.75	11.7	0.001
Shoulder abduction	Active	86.64 ± 8.55	69.28 ± 18.64	17.36	17.9	0.001
	Passive	96.12 ± 4.5	77.04 ± 20.43	19.08	20.78	0.001
Shoulder external rotation	Active	60.8 ± 8.25	48.16 ± 13.43	12.64	16.07	0.001
	Passive	68.16 ± 9.72	52.28 ± 15.3	15.88	19.17	0.001

SD: Standard deviation; MD: Mean difference; P-value: Probability value; F-value: Mixed MNOVA F value; PPT: Pressure pain threshold; SPADI: shoulder pain and disability index.

in secondary frozen shoulder than primary capsulitis, due to its causing factors like trauma, diabetes, immobilization, and rotator cuff injuries. Secondary frozen shoulder patients also reported increased shoulder pain, functional disability, and decreased ROM, like a previous study that linked subscapularis trigger points to shoulder pain, function, shoulder external rotation, and abduction in frozen shoulder patients (12).

Perez-Palomares *et al.* (33) conducted a descriptive investigation to determine the relationship between subacromial impingement syndrome, rotator cuff tendinitis, and the presence of active TrPs using magnetic resonance imaging (MRI) and ultrasonography (US). The results of this study were consistent with their findings. Furthermore, the development of TrPs has been associated with direct trauma (34).

The study findings revealed that patients with secondary frozen shoulder have a more sensitive trigger point and a more restricted shoulder ROM and function. The literature supports that secondary frozen shoulder management following anterior shoulder dislocation is more resistant to conservative treatment and more likely to require intervention due to a lower chance of spontaneous resolution, which could corroborate the study findings (35, 36). In addition, hyperglycemia can aggravate inflammation in the synovial membrane and generate an unfavorable microvascular environment around the shoulder joint (37, 38). Additionally, Sayed *et al.* (39) showed that combining supra-scapular nerve blocks with intra-articular injections, especially steroids, may help individuals with frozen shoulder to achieve better pain and functional results.

Factors that contribute to secondary frozen shoulder include the presence of immune cells in the affected shoulder, such as macrophages, mast cells, and T and B lymphocytes, as well as inflammatory mediators such as cytokines, interleukins (IL)-1β, IL-6, IL-8, and tumor necrosis factor-alpha (TNF-α) (40), as well as matrix metalloproteinases (MMPs) (41).

These pathogenic pathways excite fibroblasts and disrupt collagen generation, resulting in chronic pain and trigger point development (42).

The inflammatory process is triggered by transcription

factors such as nuclear factor Kappa B (NF-kB), hypoxia-inducible factor 1 (HIF-1), and the activation of several vascular and endothelial growth factors (VEGF) and MMP 1, 3, and 13 (43) that are implicated in inflammation, angiogenesis, and tissue damage (44). The persistent presence of these inflammatory mediators and other biochemicals may contribute to chronic pain disorders and the formation of trigger points in the viscous cycle (16).

Limitations

There are certain limitations in this study. All measurements were not blinded, and the sample size was relatively small, which may impact the study's generalizability. The study also utilized manual identification of subscapularis TrPs, which could introduce subjectivity and potential measurement errors. The subscapularis was the only muscle examined for the existence of trigger points.

Implications for research and practice

Future studies will be required to use objective methods such as ultrasound to determine the trigger points in the subscapularis and other shoulder girdle muscles to investigate the development of TrPs in primary and secondary frozen shoulder and guide clinical practice for an appropriate treatment plan. More research is needed to understand the association between causative pathologies and shoulder symptoms (pain, function, and range of motion) in secondary frozen shoulder.

CONCLUSIONS

This study concluded that patients with secondary frozen shoulder are more sensitive to subscapularis TrPs, causing increased shoulder pain perception, shoulder functional disability with reduced shoulder abduction, and external rotation than patients with primary frozen shoulder. From a future perspective, it's critical to develop precise tools to differentiate primary from secondary cases and tailor individual treatments based on the specific type and stage.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

HB: methodology, data curation, formal analysis, writing – review & editing. EF: conceptualization, writing – review & editing. MZ: formal analysis, data curation, writing – review & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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