

Comparison of Shoulder Abduction Range of Motion in Glenohumeral Joint in Individuals with and without Myofascial Trigger Points in the Upper Trapezius

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Background Myofascial trigger points in upper trapezius are common in people with shoulder pain. However, there are few studies that have observed the shoulder abduction range of motion in glenohumeral joint in individuals who have upper trapezius pain with myofascial trigger points.

Purpose The purpose of this study was to compare the glenohumeral joint abduction range of motion between individuals with and without upper trapezius pain.

Study design Cross-sectional study

Methods Twenty-four subjects who had upper trapezius pain with myofascial trigger points and 24 sex-, age-, and weight- matched subjects who had no upper trapezius pain and myofascial trigger points participated. The shoulder abduction range of motion was measured with and without restricted scapular motion in both groups. Smart KEMA strength measurement system was used to restrict scapular motion.

Results The glenohumeral joint abduction range of motion measured with restricted scapular motion was significantly decreased in the upper trapezius pain group compared to the control group ($p < 0.05$). However, the general shoulder abduction range of motion had no significant difference between groups ($p > 0.05$).

Conclusions It was investigated that individuals with upper trapezius pain accompanied by myofascial trigger points had decreased shoulder abduction range of motion in the glenohumeral joint. This finding suggests that abduction range of motion in the glenohumeral joint with restricted scapular motion should be considered in evaluating and treating people with upper trapezius pain.

Key words Biomechanics; Glenohumeral joint abduction RoM; Myofascial trigger point; Shoulder abduction RoM; Upper trapezius pain

J Musculoskelet
Sci Technol

2023; 7(1): 34-49

Published Online

Jun 30, 2023

pISSN 2635-8573

eISSN 2635-8581



Article History

Received 5 May 2023

Revised 12 May 2023

(1st)

Revised 22 May 2023

(2nd)

Accepted 23 May 2023

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INTRODUCTION

Upper trapezius (UT) pain accompanied by myofascial trigger points (MTrPs) is a common type of musculoskeletal pain.¹ Previous studies said the etiology of MTrPs in UT can be associated with multiple factors such as a restricted range of motion (RoM), muscle weakness, and disturbed muscle activity pattern.¹⁻³ Several studies suggested interaction

between MTrPs in UT and cervical joint hypomobility.^{4,5} However, there are few studies which investigated the interaction between MTrPs in UT and GH joint flexibility.

The association of scapular kinematics and glenohumeral (GH) joint pathologies was reviewed by Ludewig and Reynolds.⁶ Altered biomechanics of the shoulder can affect scapular musculature. Kim et al. (2017) investigated that shoulder abductor strength in the group with UT pain was

significantly lower than in the control group when scapular movement was restricted. It proposed to consider the association between muscles function in the GH joint and UT pain. However, this study has not investigated the association between flexibility in the GH joint and UT pain.

Limited RoM in the shoulder can alter the kinematics of the shoulder joint and may affect not only the scapular kinematic, but also the scapular muscles.⁷⁻¹³ It is important to evaluate the RoM of shoulder abduction to determine the specific cause of shoulder joint deficit in people who have UT pain with MTrPs. Although shoulder abduction RoM includes movements in the GH joint, the scapulothoracic joint, and shoulder girdle,^{8,14} there is no study that has selectively observed the GH joint RoM in individuals with UT pain.

The aim of this study is to compare the shoulder abduction RoM in the GH joint by restricting scapular motion between individuals with and without UT pain accompanied by MTrPs. We hypothesized that the shoulder abduction RoM in the GH joint would be significantly decreased when

scapular movement is restricted in individuals with UT pain.

METHODS

Subjects

Twenty-four subjects who had UT pain with MTrPs (male: 14, female: 10) were included in the UT pain group.¹⁵ Twenty-four sex-, age-, and weight- matched subjects who had no UT pain with MTrPs (male: 14, female: 10) were included in the control group. Anthropometric and demographic data on the UT pain and the control groups are presented in Table 1. The inclusion and exclusion criteria for the UT pain group and the control group were shown in Table 2.^{16,17} Before the experiment, all subjects were told about the procedures of this study and offered informed consent form. This study was approved by the Yonsei University Wonju Institutional Review Board (1041849-201807-BM-068-02).

Procedure

The general shoulder abduction RoM and the GH joint

Table 1. Inclusion and exclusion criteria

	UT pain group	Control group
Inclusion	<ul style="list-style-type: none"> - Sustained and repeated pain in the UT over 3 months - Tightness and palpable tender spots in the UT - VAS rating of the UT of > 3 cm - PPT < 2.9 kg/cm² in males < 2.0 kg/cm² in females 	<ul style="list-style-type: none"> - No pain in the UT for at least 3 months - No tightness or palpable tender spots in the UT - Pain VAS rating of the UT = 0 cm - PPT ≥ 2.9 kg/cm² in males ≥ 2.0 kg/cm² in females.
Exclusion	<ul style="list-style-type: none"> - A previous life-threatening disease - Whiplash - Trauma - Arthritis in the neck or shoulder - Diagnosis of shoulder impingement syndrome 	

UT pain, upper trapezius pain; VAS, visual analog scale; PPT, pressure pain threshold.

Table 2. Anthropometric and demographic data on the UT pain group and the control group

Characteristics	UT pain group (n=24)	Control group (n=24)	<i>p</i>
Sex (male/female)	14/10	14/10	N/A
Age (years)	24.4(2.7)	24 (3.2)	0.63
Height (cm)	169.6 (7.4)	169.5(7.6)	0.96
Weight (kg)	65.5 (11.1)	64.2 (15.3)	0.74
PPT (kg/cm ²)	1.6 (0.4)	3.8 (0.8)	0.000*
VAS (cm)	4.7 (1.6)	N/A	N/A
Pain duration (month)	26.7 (30.2)	N/A	N/A

Mean (standard deviation); UT pain, upper trapezius pain; PPT, pressure pain threshold; VAS, visual analog scale; * *p*<0.05 significant difference; N/A, not applicable.

abduction RoM were actively and passively measured in supine position. A previous study investigated that shoulder abduction in a supine position has a high intra-rater reliability [intraclass correlation coefficients (ICCs) active RoM (ARoM): 0.9880, passive RoM (PRoM): 0.9795].¹⁸ To measure the general shoulder abduction ARoM, subjects lie on the table with palm facing the ceiling. Subjects were asked to abduct their arm toward their ear with their elbow extended as much as possible actively until the end range. To measure the general shoulder abduction PRoM, subjects passively performed shoulder abduction by an examiner until the end feel (Figure 1).

To measure the GH joint abduction RoM, the Smart KEMA motion strength measurement system (Smart KEMA Measurement System, Factorial Holdings Co., Ltd., Seoul, Korea) was used to provide the real-time monitoring on the screen of a tablet and to restrict scapular motion.¹⁹ The sensor was connected with a strap and an orthopedic belt. A strap was placed on acromion of the tested shoulder and an

orthopedic belt was placed on the same side foot. Subjects were asked to push the orthopedic belt inferiorly with his/her foot until tension was established at 5 kgf. The examiner had the subject maintain the foot position while abducting the subject's shoulders until the end feel (Figure 2). All conditions of RoM measurement were performed twice.

Axis of goniometer was placed at the head of the humerus. Stationary arm was placed along the mid axillary line of the trunk. Moving arm was placed along the lateral mid-line of the humerus in line with lateral epicondyle.

Statistical analysis

The Kolmogorov-Smirnov Z-test was used to confirm normal distribution. Independent *t*-tests were used to compare the general shoulder abduction RoM and the GH joint abduction RoM between the UT pain group and control group. A significance level of .05 was used for all tests. Statistical analysis was performed using SPSS statistical 22 software.

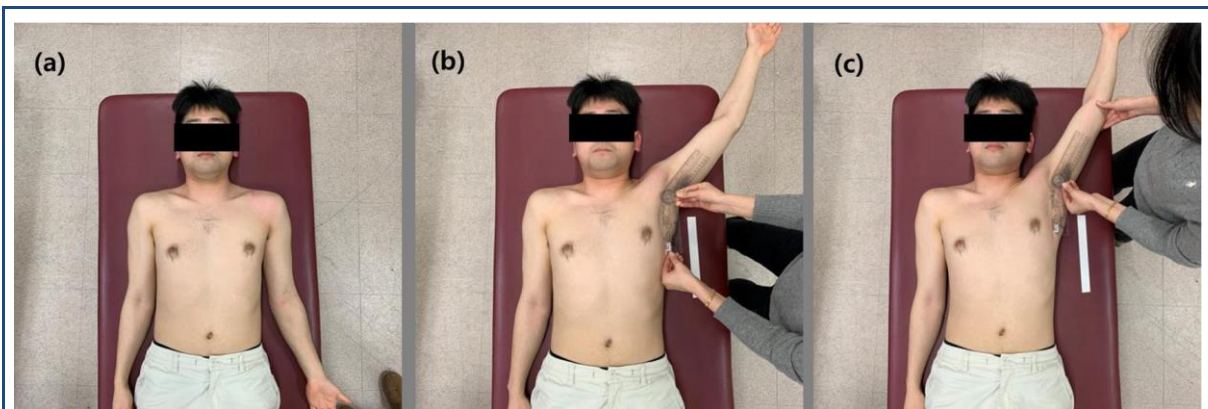


Figure 1. General shoulder abduction RoM. (a) resting position, (b) active range of motion, (c) passive range of motion.

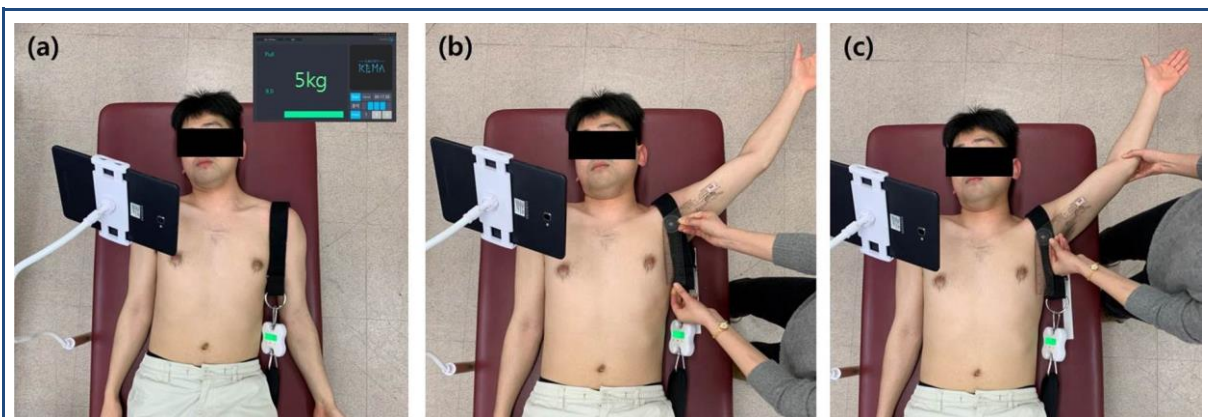


Figure 2. Glenohumeral joint abduction RoM with restricted scapular motion. (a) resting position, (b) active range of motion, (c) passive range of motion.

RESULTS

The means (standard deviations) for the RoM measurements are shown in Table 3. The results showed that the GH joint abduction RoM were significantly decreased both ARoM and PRoM in the UT pain group compared to the control group ($p<0.05$). However, there was no significant difference in the general shoulder abduction ARoM and PRoM between groups ($p>0.05$) (Table 3).

DISCUSSION

Normal shoulder abduction full RoM is 180°, consisting of 120° in the GH joint and 60° in the scapulothoracic joint by scapulohumeral rhythm.²⁰ In this study, we could measure the GH joint abduction RoM selectively by using the method to restrict the scapulothoracic movement such as the scapular upward rotation and elevation. The main finding of this study is that the GH joint abduction RoM was significantly decreased in the UT pain group (ARoM: 110.40°, PRoM: 104.06°) than in the control group (ARoM: 134.69°, PRoM: 132.15°) ($p<0.05$). On the other hand, there was no significant difference in the general shoulder abduction ARoM (UT pain: 176.69°, Control: 180.73°) and PRoM (UT pain: 174.06°, Control: 175.81°) between groups ($p>0.05$). This finding shows that flexibility in the GH joint is relatively reduced in the UT pain group. In other words, reduced flexibility in the GH joint seems to lead to the increased mobility in the scapulothoracic joint in the UT pain group. This result can support a previous study which investigated that females with fibromyalgia had greater scapular upward rotation during arm elevation compared to control group.²¹

Sahrrman 2002 said that an arthrokinematics impairment, one of biomechanical elements is an important contributing factor to develop pain syndrome. It leads to a directional

susceptibility to movement such as compensatory movement and a stress applied in a specific direction. The area of the compensatory movement can be the site of the pain.²² The arthrokinematics dysfunction in the GH joint can change scapulohumeral rhythm that may influence scapular kinematics and musculature.¹¹ In a recent study, the UT pain group was found to have increased EMG Serratus anterior muscle/UT ratio and decreased middle deltoid activation at 25% load of the maximum of 60 degree shoulder abduction strength.²³ Changes in motor control of scapular upward rotators and shoulder abductors during shoulder abduction in the UT pain group may be related to reduced RoM of the GH joint. When the RoM in the GH joint was limited, it can lead to the compensatory movement of scapulothoracic joint. And muscle performance and motion in scapula might be altered. It could be the factor contributing to the UT pain.

Kim et al. (2017) investigated that shoulder abductor strength in the group with UT pain was significantly lower than in the control group when scapular elevation was restricted.¹⁹ The present study also investigated that the GH joint abduction RoM in the UT pain group was significantly lower than in the control group. Therefore, this study supports that UT pain has the relationship with not only the force in the GH joint but also flexibility in the GH joint. Therefore, in a further study, it is necessary to restore the function of the GH joint in the UT pain group to investigate the cause-and-effect relationship between the GH joint and UT pain.

Theoretically, the PROM value is usually greater than the AROM. However, AROM values were greater than the PROM in this study (Table 3). Shoulder abduction ROM was measured in the supine position, and this position might lead to a reduction of the influence of gravity and inertia.¹⁸ Therefore, when the subject performs an AROM movement, the action of the antagonist might be diminished and the inferior gliding of the head of the humerus by the rotator

Table 3. A comparison of the general shoulder abduction and the GH joint abduction RoM between the UT pain and the control groups

RoM	UT pain group (n=24)	Control group (n=24)	<i>t</i>	<i>p</i>
The general shoulder abduction				
Active RoM (°)	176.69 (16.50)	180.73(14.41)	-0.90	0.37
Passive RoM (°)	174.06 (20.04)	175.81(19.17)	-0.31	0.76
The GH joint abduction				
Active RoM (°)	110.40 (27.99)	134.69 (17.83)	-3.59	0.000*
Passive RoM (°)	104.06 (19.46)	132.15 (19.34)	-5.01	<0.001*

Mean (standard deviation). UT pain, upper trapezius pain; RoM, range of motion; GH, glenohumeral; * $p<0.05$ significant difference.

cuff contraction may contribute to an increased shoulder abduction ROM. The scapula has three axes which induce upward-downward rotation, internal-external rotation, and anterior-posterior tilt. However, the scapula was only fixed inferiorly toward the inferior direction which can restrict upward rotation and the shoulder girdle elevation in this study. Therefore, during the AROM test, scapular adduction and posterior tilt movement might occur via the scapular muscles, and the AROM can be relatively greater compared to the PROM.

There were some limitations. First, the scapula was only fixed by 5 kgf toward the inferior direction which can restrict scapular upward rotation and the shoulder girdle elevation in this study. It was not able to restrict scapular abduction/adduction and scapular anterior/posterior tilt movements. Therefore, scapular adduction and posterior tilt movement might occur via the scapular muscles, so the ARoM can be relatively greater compared to the PRoM. Second, contributed muscle activities were not investigated. Compensatory mechanism of shoulder muscles should be demonstrated by EMG study in further study.

CONCLUSION

In conclusion, we investigated that there was no significant difference in the general shoulder abduction RoM in both groups. However, the GH joint abduction RoM measured with restricted scapular motion were significantly smaller in the UT pain group than in the control group. Therefore, we postulated that the UT pain group has compensatory movement in scapulothoracic joint. Limited GH joint abduction RoM may be one of the biomechanical factors which can lead to or cause UT pain. Clinicians should consider the GH joint flexibility for the diagnosis and intervention of people with UT pain.

Key Points

Question Is there a difference in the GH joint abduction ROM with limited scapular movement between individuals with and without upper trapezius pain?

Findings There was a difference in shoulder abduction RoM when scapular movement was restricted, but there was no significant difference in shoulder abduction RoM when it was not restricted.

Meaning This result indicates that upper trapezius pain is related to the flexibility of the GH joint, and it is assumed that this may influence scapular compensation.

Article information

Conflict of Interest Disclosures: None.

Funding/Support: None.

Acknowledgment: None.

Ethic Approval: The study was approved by the Ethics and Research Committee of Yonsei University Wonju Institutional Review Board (1041849-201807-BM-068-02).

Author contributions

Conceptualization: OY Kwon, HA Kim.

Data acquisition: HA Kim.

Design of the work: HA Kim, OY Kwon.

Data analysis: HA Kim.

Project administration: HA Kim.

Interpretation of data: HA Kim, OY Kwon.

Writing – original draft: HA Kim.

Writing–review&editing: HA Kim, OY Kwon.

Additional contributions: CH Yi, HS Jeon, WJ Choi, JH Weon.

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