

Original Research Article

Evaluation of shoulder kinesthesia in patients with unilateral frozen shoulder

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ABSTRACT

Background: Intact sensory-motor system provides kinesthesia for maintaining joint stability. Joint proprioception or joint kinesthetic sensation is often used alternately to describe a deep sensation of joint motion and joint position sense. Mechanoreceptors located in superficial layer of joint capsule, muscle spindle, golgi tendon organ complex and ligaments around joint provides joint kinesthetic sensation. Frozen shoulder or adhesive capsulitis is one of the common musculoskeletal disorders encountered in Indian population with a prevalence of almost 50% older patients with diabetes and 2-10% in non-diabetic patients. This study assessed joint kinesthetic sensation during shoulder movements in people with frozen shoulder and healthy controls which may be affected due to presence of disease process or pain. Authors hypothesized that pain and alterations in non-contractile tissues (mainly capsule) around shoulder joint due to frozen shoulder may interfere with the joint kinesthetic sensation.

Methods: Case group consisted of 41 participants with frozen shoulder and 41 healthy participants without shoulder pathology. Joint kinesthesia was assessed in frozen shoulders and dominant shoulders using angle reproduction test by actively reproducing the target angle placed passively by the therapist during flexion, abduction, medial and lateral rotation movements. The angle reproduced was measured using universal goniometer by the same therapist and 3 readings were recorded.

Results: Results indicate significant differences between the mean difference of angle reproduction test during shoulder movements in cases of frozen shoulder and healthy group (p value <0.05).

Conclusions: Significant shoulder kinesthetic deficits were observed in patients with unilateral frozen shoulder. Therefore, clinicians should consider rehabilitation of kinesthesia in treatment of patients with frozen shoulder.

Keywords: Adhesive capsulitis, Angle reproduction test, Frozen shoulder, Joint kinesthesia, Joint proprioception, Shoulder function

INTRODUCTION

Intact sensory-motor system provides kinesthesia for maintaining joint stability. Joint proprioception or joint kinesthetic sensation is often used alternately to describe a deep sensation of joint motion and joint position sense. Mechanoreceptors located in superficial layer of joint capsule, muscle spindle, golgi tendon organ complex and

ligaments around joint provides joint kinesthetic sensation.¹

Joint kinesthetic sensation may be affected due to presence of disease process or the recent surgical process due to disruption of mechanoreceptors and presence of pain. Previously, Barrett et al reported impaired joint proprioception after ACL injury in patients with acute

and chronic anterior knee instability due to ruptured ligament at knee joint.² Joint proprioception and kinesthesia was assessed previously by number of researchers in patients with different shoulder pathologies. Patients with anterior gleno-humeral joint dislocation had impaired joint kinesthesia during medial and lateral rotation of shoulder joint may be due to injury to joint capsule.³ Also, a study done by Vincent AB et al, observed impairment in joint proprioception among patients with chronic rotator cuff pathology due to presence of painful shoulder movements.⁴ Similarly, we speculated that joint proprioception may be affected due to the presence of structural & functional impairments due to pain in patients with frozen shoulder. To best of our knowledge, patients with frozen shoulder were not evaluated for joint kinesthesia; therefore the present study was designed.

As frozen shoulder or adhesive capsulitis is one of the common musculoskeletal disorders encountered in Indian population with a prevalence of almost 50% older patients with diabetes and 2-10% in non-diabetic patients.⁵⁻⁶ Frozen shoulder is a condition characterized by functional restriction of both active and passive shoulder motion due to capsular tightness and contractures. Many studies confirmed the pathological changes in non-contractile structures around the shoulder in patients with frozen shoulder such as presence of capsular and gleno-humeral ligament thickening, dense adhesion, and capsular restriction etc.⁵ As mentioned earlier the non-contractile structures around the shoulder joint provide stability and kinesthesia which is important during carrying out functional tasks involving upper limb. Pain and alterations in non-contractile tissues (mainly capsule) around shoulder joint in patients with frozen shoulder may interfere with the stability and kinesthesia both. Therefore, authors intended to evaluate Joint kinesthesia in patients with frozen patients for physiological movements. Previous studies used various methods like active, passive repositioning test, electromagnetic tracking device, shoulder wheel apparatus, electro-goniometer, and isokinetic dynamometers etc. to measure joint kinesthesia at different joints in various conditions.¹⁻³ In a present study, a reliable method for measuring joint kinesthesia-angle reproduction test was used in which joint was placed at an angle for 30 seconds, after which subject was asked to actively take the extremity at the previous range.

The purpose of this study was to evaluate joint proprioception during flexion, medial, lateral rotation and abduction of shoulder in individuals with frozen shoulder using angle reproduction test.

METHODS

Instrumentation, subject position and procedure

Before implementing study, college ethical committee approval was obtained. Patients were explained about the

procedure, importance, benefits of the study. Verbal and written informed consent were signed by all the participants. Demographic data was collected including name, age, gender, occupation, dominant side, history of diabetes, duration of shoulder symptoms etc.

Subjects: A total of 82 subjects of both genders between the age group of 40 to 65 years were recruited and evaluated at Dr. Vikhe Patil Memorial Hospital Ahmednagar Maharashtra, India. All participants were allocated to two groups of 41 healthy shoulder (no history of any pathological condition related to shoulder joint) and 41 medically diagnosed patients with unilateral frozen shoulder (in freezing or frozen phase).⁵ Participants having type 2 diabetes mellitus participated in this study. Participants with shoulder pathologies such as impingement syndrome, shoulder dislocation etc. were excluded.

All participants were assessed using routine clinical examination protocol for shoulder joint including pain assessment, presence of capsular pattern, range of motion, and muscle strength as per the data collection sheet.

Outcome measures: Joint kinesthesia was assessed using the angle reproduction test on dominant side of healthy subject and on affected side of subject with frozen shoulder using half circle goniometer. Dominant side of healthy participant was confirmed by asking about the eating habits. The angle reproduction test was reliable and valid for evaluating joint kinesthesia.²

Angle reproduction test: This test was used to evaluate the subject's ability to reproduce the shoulder angle during flexion, abduction medial and lateral rotation. The procedure was done on dominant side of healthy individual and affected side of patient with unilateral frozen shoulder.

For assessing flexion movement, therapist passively flexed shoulder joint to be tested to 60 degree angle in supine position. This position was maintained for 30 seconds to appreciate the present position of shoulder with eyes closed. After 30 seconds the shoulder was taken to initial position. Then they were asked to actively flex the shoulder to the same range as previously demonstrated. Three readings of shoulder flexion which were reproduced by the patient actively were recorded and mean difference was considered for comparison.

Same procedure was followed for evaluation of proprioception during abduction, medial rotation and lateral rotation.

Data analysis: Statistical analysis was done using SPSS version 20 Descriptive statistic with mean and standard deviation and inferential statistic using student's unpaired "t" test to compare in between two groups. Two groups of shoulder tested were 1) healthy shoulder with no

pathology 2) shoulder medically diagnosed with frozen shoulder.

RESULTS

Physical characteristics-age, gender, side involved, duration of symptom, number of participants having type 2 diabetes mellitus and duration of diabetes were documented and presented in Table 1.

All the participants were marginally distributed in both the groups based on age. Gender wise distribution of participants among groups is presented in following Table 1.

It was also observed that the frozen shoulder occurred in non-dominant side of almost 75% of participants. In which only 5 participants were diabetic with frozen shoulder symptoms for 3.1±1.2 months with duration of diabetes was 7.2±1.8.

Table 1: Physical characteristic of participants.

	Group 1(n=41)mean ± SD	Group 2(n=41)mean ± SD
Age	54.0±2.0	56.4±2.2
Gender (M/F)	20/21	24/17
Side involved (dominant/non dominant)	41/0	10/31
Duration of shoulder symptoms (in months)		3.1±1.2
No of participants having type 2 diabetes mellitus		5
Duration of diabetes (years)		7.2±1.8

Table 2: Comparison of average range of motion values for angle reproduction test.

Movement(in degrees)	Group 1(n=41) Healthy subjects	Group 2(n=41) Affected subjects	p value
Flexion	60.0±3.5	62.9±7.4	0.000*
Abduction	43.7±3.0	51.5±5.6	0.000*
Medial rotation	29.5±1.9	29.0±1.1	0.036
Lateral rotation	29.5±1.6	22.4±4.7	0.000*

On comparing the means of the angle reproduction test values during flexion, abduction and lateral rotation in between healthy people and patients with frozen shoulder, a statistically significant difference was found except during medial rotation movement.

Comparison for amount of impaired proprioception results indicating mean angle reproduction deficit of approximately 2.9 degrees in flexion, 6.23 degree in abduction, 0.9 degrees in medial rotation and 7.5 degrees in lateral rotation was observed in patients with frozen shoulder presented in following table.

Table 3: Comparison of amount of impaired proprioception (mean difference between the desired rom values and actual rom values reproduced by participants) in both groups.

Movement (in degrees)	Group 1 (n=41)	Group 2 (n=4)
Flexion	0.06± 3.5	2.9±7.5
Abduction	-1.26± 3.01	6.23±5.6
Medial rotation	-0.5±1.95	-0.92±1.16
Lateral rotation	-0.4±1.66	-7.53±4.78

Authors found significant difference when we compared healthy subjects and frozen shoulder subjects (p<0.005). The observed values of angle reproduction test during flexion, abduction, medial and lateral rotation were 60.0±3.5, 43.7±3.0, 29.5±1.9 and 29.5±1.6 respectively in participants from Group 1. Whereas, the observed values of angle reproduction test during flexion, abduction, medial and lateral rotation were 62.9±7.4, 51.5±5.6, 29.0±1.1 and 22.4±4.7 respectively.

DISCUSSION

Joint kinesthesia was evaluated in patients with unilateral frozen shoulder which was expected to be impaired due to presence of shoulder pain and stiffness. Previous studies have demonstrated the validity of angle reproduction test to assess joint kinesthesia in patients with gleno-humeral joint dislocation.²

Results of this study revealed significant kinesthetic deficits in flexion, abduction; medial and lateral rotation movements were present among patients with unilateral frozen shoulder in comparison with the healthy age matched controls on dominant side. Mean angle reproduction deficit of approximately 2.9 degrees in flexion, 6.23 degree in abduction, 0.9 degrees in medial rotation and 7.5 degrees in lateral rotation was observed in patients with frozen shoulder.

MacDonald et al, study included eight participants with hamstring reconstruction and eight with patellar tendon

reconstruction and concluded persistent lack of proprioception in the mid- range position. Barrack et al, also found average Threshold to sensation and Angle reproduction test deficits to be approximately 3.8 and 3.6 degrees in normal knee joints.⁷ Grigg P et al, measured threshold to sensation in normal hip joint and found slight deficits of 0.13 to 1.32 degrees.⁸ Joint afferents and mechanoreceptors are responsible for maintaining the normal significant deficits in joint kinesthesia. And Newton RA and Rowinski MJ demonstrated impaired joint proprioception may be due to damage to joint mechanoreceptors and muscle spindle in anesthetized patients.^{9,10} Also anesthetization of joint capsule and pericapsular structures around the metatarsophalangeal joint of the great toe and the index finger resulted in severely impaired joint position and movement sensation in patients with peripheral nerve block.^{11,12}

Statistical analysis revealed the significant differences in the angle reproduction test deficits among the patients with frozen shoulder compared to healthy individuals ($p < 0.05$).

Many studies have revealed various structural changes such as inflammation of non-contractile structures may damage mechanoreceptors which can be a potential cause of impaired joint kinesthesia in such patients with unilateral frozen shoulder. As the mechanoreceptors may be affected in frozen shoulder patients along with pain joint proprioception is affected in patients with unilateral frozen shoulder.

In addition, a very marginal mean angle reproduction deficit of approximately 0.06 degrees in flexion, 1.26 degrees in abduction, and 0.5 degrees in medial rotation and 0.4 degrees in lateral rotation was observed in healthy individuals also. Similarly, previous study shoulder kinesthesia after anterior gleno-humeral joint dislocation has demonstrated an average kinesthetic deficit in the shoulder joint of the uninjured subject ranged from 0.91 to 1.5 degrees.²

Angle reproduction deficits are observed even in people with healthy and non-symptomatic shoulder. However, the significant difference in the angle reproduction deficits in affected joint compared to normal joint would confirm the impaired joint kinesthesia. Therefore, in our study we compared the angle reproduction deficits among the patients with frozen shoulder during various movements compared to healthy shoulder joint.

Present study has provided the evidence of impaired joint kinesthesia in patients with frozen shoulder. Kinesthetic sensation is critical for placement of hand in upper limb function. Example, shoulder position and joint sense are important while using upper extremity in sports activities (playing badminton), occupational work (labor), activities of daily living (grooming, bathing). Present results indicate significant kinesthetic deficit hence, clinicians and physiotherapists should consider treatment protocol

that includes kinesthetic rehabilitation. Example, physiotherapists could challenge a patient with frozen shoulder to match and rematch various positions in involved extremity. This will stimulate mechanoreceptors and re-educate them. Proprioceptive rehabilitation method should be considered for activation of joint and muscle afferents. The effect of this protocol requires further study.

Limitations of the study were the use of universal half circle goniometer lead to minor manual error as compared to electro-goniometer, isokinetic dynamometer, and computerized shoulder wheel apparatus due to unavailability. The presence of diabetes mellitus in patients with frozen shoulder was not addressed specifically in the present study.

CONCLUSION

Significant shoulder kinesthetic deficits were observed in patients with unilateral frozen shoulder. Clinicians or physiotherapy practitioners should consider addressing joint kinesthesia in the treatment of frozen shoulder.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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