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Original Research Article

Assessment of Shoulder Proprioception in Shoulder Pain Patients

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ABSTRACT

Proprioception is an essential part of shoulder stability and neuromuscular control. The purpose of this study was to assess the shoulder proprioception in Shoulder pain patients and normal individuals. Hundred subjects (50 Shoulder pain Patients and 50 normal individuals) fulfilling the inclusion criteria were included in the study. Subjects were assessed on various target positions with active ipsilateral matching tasks. For each subject, active shoulder Range of Motion was measured for five movements. All target positions were tested thrice to assess the reliability of the measurement. Results revealed significant differences in Proprioception between the affected and un-affected shoulders of the patients *(P<0.05)*. No significant differences were observed in proprioception between the dominant and non-dominant shoulders of normal individuals.

Keywords: Proprioception, Joint Position Sense, Shoulder, Eyes Open, Eyes Closed.

INTRODUCTION

Shoulder Pain is a disabling symptom frequently encountered in primary care. The estimated prevalence of shoulder complaints is 7-34% [1] with about 1.47% new cases per year in clinics. Shoulder Impingement Syndrome (SIS) and Frozen Shoulder are most commonly reported Shoulder pain complaints.

The current study was aimed to assess Proprioception by Joint Position Sense in shoulders with and without shoulder pain in Patients and Normal Individuals.

Proprioception was originally defined by Sherrington in 1906. It is the afferent information, arising from peripheral areas of the body that contributes to joint stability, postural control, and motor control. [2] Proprioception has three sub-modalities - Joint Position Sense (JPS), Kinesthesia, and Sensation of Force. JPS is commonly tested using either active or passive reproduction of joint positioning, whereas kinesthesia uses passive motion. [3] Sensation is the fundamental ingredient that mediates the proprioceptive mechanism.

Mechanoreceptors are mechanically sensitive receptors that transduce mechanical tissue deformation as frequency modulated neural signals to the CNS through afferent sensory pathways. [4] Mechanoreceptors of the joints, muscles, tendons and skin provide information about muscle length, contractile speed, muscle tension and joint position. They form the basis for proprioception giving rise to the passive motion, active motion, and limb position senses, and the sense of heaviness. [5]

The disruption of muscle and joint mechanoreceptors from physical trauma results in partial deafferentation of the joint and surrounding musculature, thus resulting in diminished proprioception. Proprioception may play an important role in dynamic shoulder stability and modulation of muscle function. It is logical to assume that methods to improve proprioception in patients with shoulder disorders could improve shoulder function and decrease the risk of injury. [6]

MATERIALS AND METHODS

Materials used: Bubble Inclinometer (Base line), Marker, Plinth, Pen, Ruler, Calculator, Eye Mask (Blind Fold)

Eye Mask

Inclinomter

Method: 50 shoulder pain patients and 50 normal individuals were involved in the study. Pain analysis and difficulty in activity of patients was measured using Numeric Pain Rating Scale (NRS), Quick Dash scale and Patient-Specific-Functional-Scale (PSFS). Shoulder pain patients were compared for the affected and non-affected side while Control Group was compared for their dominant and non-dominant side.

Each patient's ROM was determined and measured in degrees for: i. Internal and External rotation with subject in Supine position and, ii. Flexion, Extension and Abduction with subject standing. This was at the beginning of the test session and was assessed with an active ipsilateral matching task. Supine position was maintained so that the scapula was stabilized by the table, thereby reducing scapular substitution. While the patient was in standing position, was instructed to maintain an upright posture and to avoid arching his/her back. If the subject moved the trunk during any of the Range of Motions or JPS measurements, the trial was repeated. The subjects were also instructed to keep the forearm in a single plane during all the Range of Motion and joint position sense testing. Immediately after these measurements were taken, the target angle was calculated. The target angle was calculated by subtracting 10% of the total Range of Motion (External Rotation + Internal Rotation OR Flexion + Extension) from the specific Range of Motion being tested. Example - To determine the target angle for external rotation we took 10 percent of 180° = 18°; therefore, 100° - 18° = 82° was the target angle for external rotation for the said subject. Likewise for internal rotation, 80° - 18° = 62° was the target angle for internal rotation for the said subject. Then the joint position testing was done, first with eyes open and then with a blind fold.

For proprioceptive acuity above 90° and below 90° of shoulder elevation, fixed target of 45° Flexion and 45° Abduction was given. Subjects were specifically instructed to actively reach the target angle and were asked to hold it in place for 3 seconds. They were then told to relax and actively return the arm to the neutral starting position.

During the internal or external rotation testing, the neutral position was achieved when the forearm was perpendicular to the table. During the Flexion, Extension and Abduction testing, the neutral position was achieved when the subjects arm was relaxed at their side. Each subject was then instructed to actively return their arm to the target angle and to inform when they felt they had reproduced the original target angle. The arm was held motionless while angle measurement was recorded. The repositioning was repeated 3 times for each of the 5 movements. Average of 3 repositioning trials of each movement was calculated and the error scores were derived as the difference between target angle and the average.

Statistical analysis

Statistical analysis was carried out. Results were statistically analysed using Wilcoxon Rank Sum Test for the level of significance (<0.05). GraphPad Instat 3.1 software was used for the same.

RESULTS

Table 1: Patients

Test (Shoulder)	Result*	P Value
Eyes Closed Affected V/S Eyes Closed Un-Affected	VS**	0.0001
Eyes Open Affected V/S Eyes Closed Affected	NS	0.2525
45° - Eyes Closed Affected V/S Un-Affected	NS	0.2567
Eyes Closed Affected 90° V/S Eyes Closed Affected 45°	VS**	0.0001

Interpretation

VS** - Very Significant - Depiction of decreased Joint Position Sense

NS - Not Significant - No Significant difference found between Affected and Un-Affected Shoulder of patients

Table 2: Control Group

Test (Shoulder)	Result*	P Value
Eyes Open 90° V/S Eyes Open 45°	ES***	0.0001
Eyes Closed Dominant V/S Eyes Closed Non Dominant	NS	0.5108

Interpretation

ES*** - Extremely Significant - There is a difference between Proprioception when assessed for 90° VS 45°

NS - Not Significant - No Significant difference between Dominant and Non-Dominant Shoulder

DISCUSSION

The purpose of the present study was to determine the proprioception in shoulder pain patients. The hypothesis, that proprioception is affected in patients with shoulder pain was supported as the degree of proprioception impairment was significantly decreased at higher elevations in patients with shoulder pain and stiffness.

The effects of injury on the sensorimotor system: Lephart and Henry presented a shoulder functional joint stability paradigm which illustrated the cyclic role that joint injury plays on functional joint stability. The physical disruption of the mechanical stabilizers alters the sensorimotor contribution to dynamic restraint and joint stability. This combination of mechanical deficits and sensorimotor alterations contribute to deficits in functional stability. Capsuloligamentous mechanoreceptor stimulation decreases resulting from tissue deafferentation and/or increased tissue laxity limiting mechanoreceptors stimulation, thus decreasing proprioception. Proprioceptive deficits were attributed to decreases in shoulder muscle activity levels combined with local muscle atrophy. [7]

Injury to the stabilizing structures of the shoulder (capsuloligamentous, articular, and musculotendinous) whether caused by a traumatic or atraumatic mechanism, results in mechanical instability. [8]

The work by Safran et al. (2001) [9] supports the role of pain in adversely affecting proprioception. Their results demonstrated that throwers with shoulder pain have decreased proprioception most likely due to increased nociceptor activity in the painful shoulder of baseball players. Given the proprioceptive deficits associated with shoulder joint injury, neuromuscular control is hypothesized to be altered as well. The results indicate that the JPS of participants from the Control Group was affected and showed increased errors at higher elevations above 90° and no significant difference in dominant and non-dominant arm. According to results the plausible reason is that as the shoulder elevation angle increases, the force applied to the shoulder increases with the increasing moment arm of the center of mass of the upper limit. This force which is applied to the shoulder increases due to the gravity.

This causes the muscular effort required and the tendon tension developed in both- attaining and remaining- in the target position for 3 seconds period and then returning it back to the position getting increased as elevation angle approaches 90°. [10]

The work of Skoglund (1956) and Boyd and Roberts (1953) demonstrate that joint afferent discharge is angular specific. Single neurons from slowly adapting receptors in the capsule of the cat knee joint were shown to fire maximally at particular joint angles. Recent and extensive data fail to confirm the early findings that joint afferents discharge at intermediate angles, although they support the view that much more activity is seen at the very extremes of flexion and extension (Burgess & Clark, 1969; Lynn, 1975). [11]

Capsuloligamentous mechanoreceptors are stimulated more in the end ranges of motion, compared to the mid ranges, due to the elongation of their parent tissues in these ranges. [12-14] They attributed this effect to a heightened sensitivity of the muscle spindle afferents associated with the involved musculature. This result has been supported and verified by various authors examining muscle spindle clear, distinct responses to passive versus active stretching perturbations [15] and to increases in γ motor neuron stimulation. [16]

Group I B GTO afferents respond to tension developed within the tendons associated with contracting or stretched muscle fibers. As tension within the tendon increases, I B afferent stimulation rises. [17] As the elevation angle increases, the changes in muscle length, capsular tightness, and scapular orientation also take place.

Assessment of Proprioception in Eyes Open and Eyes closed had no significant results; however, it is essential for assessing Joint Position Sense in Eyes Open and Eyes Closed for the individual's proprioceptive training.

Jennifer A. Stone et al, in their study of Upper Extremity Proprioceptive Training used various exercises for analyzing activity. First, the activities were performed in Eyes Open and then in Eyes Closed. They observed that the activities got more challenging through the progression from eyes open to eyes closed. [18]

In the present study, it was found that JPS was decreased in shoulder pain patients and did vary with alterations in elevation angle. Signals arising from capsuloligamentous and musculotendinous mechanoreceptors are an increasingly important source of afferent feedback contributing to shoulder JPS. The disruption of these muscle and joint mechanoreceptors from physical trauma result in partial deafferentation of the joint and surrounding musculature, thus resulting in diminished proprioception. [19,20]

CONCLUSION

Shoulder pain patients show significant JPS deficits and a significant difference between their affected and the non-affected shoulders. However, there is no significant difference observed in the proprioception assessed at angles below 90°. Significant JPS errors are found in normal individuals (Control Group) at higher angle elevations. However, no significant difference is observed in JPS in dominant and non-dominant shoulder.

The study clinically signifies that the Assessment of Proprioception is essential and must be carried out routinely in all shoulder conditions. Also, Rehabilitation process should include Proprioception training in their protocol as an important treatment regime.

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