Original Research Paper

Volume - 7 | Issue - 8 | August - 2017 | ISSN - 2249-555X | IF : 4.894 | IC Value : 79.96

Anatomy

Proprioception and Shoulder dysfunction: A correlative study

Allwyn Joshua — Assistant professor, Department of Anatomy, KVG Medical College, Sullia- 574327 DK, Karnataka, India.

Roopa Sebastian — Assistant professor Department of Biochemistry, KVG Medical College, Sullia- 574327 DK, Karnataka, India. Corresponding author

Shreya Sriram — Undergraduate student, KVG Medical College, Sullia

ABSTRACT

Aim: To evaluate the extent of loss in joint proprioception in subjects with shoulder dysfunction.

Materials and methods: 50 cases with shoulder dysfunction and 50 controls with no history of shoulder dysfunction, with the age group from 20-50 years were evaluated for the study. Motion tracking sense test was used to assess the shoulder proprioceptive function.

Results: Comparison of dominant and non-dominant limb proprioceptive sensation in 50 subjects with no history of shoulder dysfunction, as well as comparison of normal shoulder with subjects with shoulder dysfunction in 50 cases, showed highly significant variation in proprioceptive function ($p<0.001$).

Conclusion: Restoring the mechanical restraints or strengthening the associated muscles neglects the coordinated neuromuscular-controlling mechanism required for joint stability, therefore restoration and retraining proprioception becomes an integral aspect of joint rehabilitation.

KEYWORDS : Proprioception; shoulder injuries; Rehabilitation; Mechanoreceptors

Introduction:

Shoulder joint is among the most widely utilized joint in the body, which performs complex movements required for the daily activities. From the activities of daily living to the sporting actions, the contribution of shoulder joint is indispensible. With the burden of fulfilling wider range of movements, the joint's dependency on muscles and ligaments is way higher when compared to other joints. Muscles and ligaments around the shoulder joint not only assist in movement, but also provide stability to the joint [1]. Among the joints in our body, shoulder joint has always attracted much needed medical attention due to its frequency of injury and functional dependency. This joint offers luxurious mobility while joint stability becomes the factor at stake. The stability of shoulder joint is mediated by the mechanoreceptors present in the articular structures such as ligaments, muscles and articular surfaces. These articular mechanoreceptors are the anatomical basis for active proprioceptive perception in all joints of our body [2, 3, 4].

It was in the year 1906 the English neurophysiologist sir Charles Sherrington coined the word "proprioception". He explains it as "the perception of joint and body movement as well as position of the body, or body segments, in space" [5]. To be more specific, proprioception is the perception of body position and movements in the three-dimensional space, and overall proprioceptive performance is determined by the quality of both available proprioceptive information and individual's proprioceptive ability [6, 7]. A recent review by Witchalls et al explains that proprioception is the measure of neuro-muscular response to a stimulus must involve sensory input, central processing and motor output in a closed loop [8]. The sensory input to analyse the joint position sense or its movement is provided by peripheral mechanoreceptors in the articular, muscular and cutaneous structures [9].

This proprioceptive mechanism is an essential component for proper joint functioning during activities of daily living, sporting activities and occupational tasks [10]. Injuries to the articular structures would result in disruption of proprioceptive (mechanoreceptors) receptors, which will not only alter the joint sensation but also the joint stability. The coupling effect of ligamentous trauma resulting in mechanical instability, which ultimately will lead to further microtrauma and reinjury [11]. The primary concern of the athletic trainer and orthopaedic surgeon has been the mechanical restoration of these articular structures following injury in an attempt to re-establish joint proprioceptive function [10].

Shoulder joint dysfunction and dislocation are commonly observed. When such injuries or trauma occur to the joint it leaves a detrimental effect on the proprioception of the affected joint [10, 12]. With limited evidences proving the dependency of proprioceptive function and shoulder dysfunction. There was a greater necessity to objectively evaluate the proprioception in shoulder joint. Therefore, the present study has been major step towards analysing proprioceptive deficits in shoulder joint following injuries.

Methods and materials:

50 control subjects with no history of shoulder dysfunction, age group of 20-50 years (median age of 29 year) and 50 cases of patients with shoulder dysfunction with the age group of 20-50 years, (median age of 37) were included and evaluated for the study. Informed consent was taken from each patient/ representatives and the study was conducted in accordance with the ethical standards of KVG Medical College and hospital, Sullia. The present study was a comparative case-control study. The participants were selected based on convenience sampling method and the sample size was determined by the influx of patients.

- The study population further consisted of two groups:

1. *Group A [Control group]: N=50.*

- Age group of 20 – 50 years.
- No history of pre-diagnosed conditions of any shoulder injury.
- Exhibit free range of motion in the shoulder joint.

2. Group B [Test group]: N=50.

- Age group of 20 – 50 years.
- Diagnosed with conditions of shoulder dysfunction by pre evaluation by a physician or orthopaedic surgeon.
- Willing to participate in the study.

The following participants will be excluded from the study:

1. Group A or [Control group]:

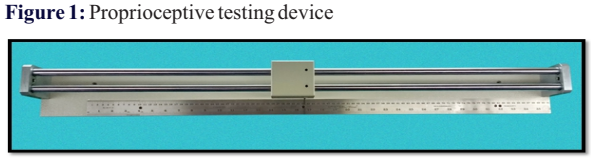
- Paediatric and elderly individuals.
- Not willing to participate in the study.

2. Group B or [test group]:

- Patients with limited range of movement in the shoulder joint like adhesive capsulitis or post fracture stiffness.
- Not willing to participate in the study.

The test performed was:

Figure 1: Proprioceptive testing device



- ***Motion tracking sense test:***
- The test was performed using proprioceptive testing instrument designed to measure the proprioceptive error in an individual quantitatively.
- The instrument is made of metal and has a slider to point out the reading on the scale which is fixed on the instrument (Fig1).
- Measurement was taken with subject seated in a comfortable position to minimise sensory input from other joints and to avoid muscular fatigue (Fig 2).
- They were then asked to slide the pointer in the instrument to a predetermined measurement on the scale with their eyes open and to maintain this position for 5 seconds. Subjects were then asked to repeat the same measurement for 5 times. This was done so that the subject can memorize the position.
- Next subject was blindfolded and was asked to reposition to the same predetermined measurement.
- The distance error in between the target distance and the subject's perceived distance respectively will be recorded [13].

Figure 2: Showing the position of the subject during measurement of proprioceptive function.

Statistical analysis:
The data has been depicted as mean +/- standard deviation. The statistical analysis was performed done using student't' test. The results were further being analysed using IBM SPSS statistics 20 software.

Results:
Table 1: Comparison of proprioceptive measurements in controls

Controls	Dominant side	Non dominant	P value
Difference (D)	0.46± 0.27	0.72±0.36	0.00009**

****Highly significant, values are mentioned as Mean ±SD, Student t test, P<0.05, 95%CI

Table 1 shows the proprioceptive difference in dominant and non-dominant shoulder of normal subjects belonging to the age group of 20-50 years. Here the non-dominant side showed higher difference of 0.72±0.36 (p<0.0009) when compared with dominant side with a mean of 0.46±0.27, indicating the reduced proprioceptive function on the non-dominant shoulder, which was statistically significant (p<0.05).

Table 2: Comparison of proprioceptive measurements in cases

Cases	Normal shoulder	Affected shoulder	P value
Difference (D)	0.57±0.36	5.66±2.28	0.0000**

**Highly significant, values are mentioned as Mean ±SD, Student t test, P<0.05, 95%CI
Table 2 shows the proprioceptive difference in 50 subjects with shoulder dysfunction in comparison with their unaffected shoulder. Here the affected shoulder showed significant difference when compared with normal side (p<0.05), indicating the detoriation of proprioceptive function in the affected joint.

Discussion:
Among the 50 subjects analysed, many were predominantly labourers, who had excessive utility of their shoulder during their work activities. They showed a distinct difference in the proprioceptive function between dominant and non-dominant shoulder. The dominant shoulder showed mean difference of 0.46 which was significantly lesser than non-dominant shoulder which had a mean difference of 0.72 [Table 1]. The difference in the proprioceptive function between the dominant and non-dominant shoulder can be explained as follows: (1) More employment of dominant shoulder for activities of daily living (2) Continuous stimulation of the mechano-receptors and the articular structures (3) Increased activation of musculo-tendinous units around the joint, are some of the benefits in the dominant shoulder, which increases its proprioceptive functions and joint stability.

With maximum utility of the joint for the functional and recreational activities, this joint has been prone for wear and tear, leading to disruption of articular structures. Present study provides concrete evidence about the reduction in proprioceptive function of a joint following any injuries [Table 2]. Recent observations have noted that athletes involved in throwing activities have shown increased laxity of the dominant gleno-humeral joint, which would result in symptomatic shoulder subluxation [14, 15]. Authors Jobe and Walsh et al have hypothesized that strain on the rotator cuff is increased due to micro-instability, which in turn would be the cause for failure in musculo-tendinous unit; finally in clinical scenario it will be manifested as rotator cuff inflammation or injury (partial or complete tear) or as posterior gleno-humeral impingement. [15, 16].

Whether the reduced proprioception caused the shoulder pain or is it vise versa is still a dilemma [17]. Theoretically, this proprioception deficit might further lead to an uncoordinated muscle firing and recruitment pattern that could exacerbate rotator cuff overload. Warner et al have shown that individuals with instability and impingement have altered scapulothoracic rhythm. This alteration in motion may be the result of an uncoordinated muscle firing pattern due to a proprioceptive deficit. This supports the paradigm explaining the relationship between proprioception and shoulder instability, which includes attenuation of the gleno-humeral capsule and ligaments over the course of time during repetitive overhead activities [18]. Lephart et al has hypothesize that this micro-trauma leads to degrees of instability that either damage peripheral afferent receptors found in the static structures of the shoulder joint or stretch the capsuloligamentous complex that reduces the stimulation of the mechanoreceptors [11]. The resultant deficits in proprioceptive feedback due to the partial deafferentation of these receptors contribute to the insidious cycle of shoulder instability due to decreased reflex muscle stabilization. Author Safran et al [19] believed that the instability and discoordinated muscular action may also be manifested as shoulder pain due to rotator cuff inflammation. The rotator cuff inflammation may be due to overuse or to impingement of the cuff between the humeral head and the acromion, as the dysfunctional rotator cuff cannot maintain the humeral head centered within the glenoid [20].

We hypothesize the advantages of proprioceptive functions as follows:
a. It would prevent joint injuries by increased awareness of joint position sense on the dominant side.
b. Increased efficiency of joint motion by the activation of the precise muscle group necessary for the particular action.
c. Enhances coordinated firing of muscle group.

Conclusion:
The link between proprioceptive deficits and joint pathology once established indicates the importance of assessing proprioception and subsequent planning of the rehabilitation programme. A rehabilitation programme would be one that addresses the need for restoring normal joint stability. Thus patients once injured lose proprioception to varying degrees and a treatment of such injuries is not complete until even the proprioception is constructed back, such that one has a total appreciation of both sensory and mechanical functions of articular joints. Simply restoring the mechanical restraints or strengthening the associated muscles neglects the coordinated neuromuscular-controlling mechanism required for joint stability. A lag time in the neuromuscular reaction time can result in recurrent joint subluxation and joint deterioration [14]. Thus restoration and retraining proprioception is an integral aspect of joint rehabilitation.

References:

1. Stephen WC, Dennis LH. Anatomy of shoulder joint. J Ortho Sports Phy Ther 1985;6(4):225-8.
2. Andrews JR, Carson WG, Mcleod WD. Glenoid labrum tears related to long head of biceps. Am J Sports Med 1985;13:337-41.
3. Vangness CT, Ennis M. Neural Anatomy of the Human Glenoid and Shoulder ligaments. AAOS 59th Annual meeting, feb 24 1992, Washington, D C. Paper No.335: 205.
4. Reimann BL, Lephart SM. The sensorimotor system part 1: The physiological basis of functional joint stability. J Athelet Train 2002;37(1):71-79.
5. Sherrington CS. The integrative Action of the nervous system in: Benjaminse Anne 1906, Reliability and precision of hip proprioception methods in healthy individuals. Clin J Sport Med 2009;19(6): 457-63.
6. Han J, Waddington G, Adams R, Anson J. A proprioceptive ability underlying all proprioceptive tests? Response to tremblay, Percept mot skills 2014;119:301-4.
7. Han J, Waddington G, Adams R, Anson J, Liu Y. Assessing proprioceptive: A critical review of methods journal of sport and health science 2016;5: 80-90.
8. Witchalls J, Blanch P, Waddington G, Adams R. Intrinsic functional deficits associated with increased risk of ankle injuries: a systematic review with meta-analysis. Br J Sports Med 2012;46:515-23.
9. Guyton A C. Text book of Medical Physiology (8th ed). Philadelphia: Saunders, 1976.
10. Borsa PA, Lephart SM, Kocher MS, Lephart SP. Functional assessment and

rehabilitation of shoulder proprioception for gleno-humeral instability. J sport rehb 1994; 3:84-104.
11. Lephart SM, Pincivero DM, Giraldo JL, Fu FH. The role of proprioception in the management and rehabilitation of athletic injuries. Am J Sports Med 1997;25:130-7.
12. Bankart AS. The pathology and treatment of recurrent dislocation of shoulder joint. Br j surg 1938;26:23-29.
13. Debnath U, Narkeesh A, Raghumant R. Formulation of integrated proprioception screening scale and testing of its sensitivity, reliability and validity. J Exers Scien and Physiother 2010; 6(2):78-87.
14. Glousmann R, Jobe f, Tibone J, Mognes D, Antonelli D, Perry J. Dynamic electromyographic analysis of the throwing shoulder with gleno-humeral instability. J bone joint surg 1998; 70A:220-26.
15. Jobe FW, Kvitne RS, shoulder pain in the overhand or throwing athlete: the relationship of anterior instability and rotator cuff impingement. Ortho Rev 1989;18:963-75.
16. Walsh G. Posterosuperior glenoid impingement in: Burkhead WZ, editor, rotator cuff disorders. Philadelphia: Williams and Wilkins: 1996:193-8.
17. Abrams JS. Special shoulder problems in the throwing athlete; pathology, diagnosis and non -operative management. Clin sports med 1991;10:839-61
18. Warner JJP, Micheli LJ, Arslanian LE, Kennedy J, Kennedy R. Scalpulothoracic motion in normal shoulder and shoulder with glenohumeral instability and impingement syndrome. A study using Moire topographic analysis. Clin Orthop 1992;285:191-9.
19. Safran M, Borsa P, Lephart S, Fu F et al. shoulder proprioception in baseball pitchers. J Shoulder Elbow Surg 2001;10(5):438-444.
20. Porcellini G, Campi F, Pegreffi F, Castagna A, Paladini P. Predisposing factors for recurrent shoulder dislocation after arthroscopic treatment. J Bone Joint Surg Am 2009;91:2537-42.