ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

Assessment of Scapular Muscle Strength and Lumbar Core Strength in Gymers. A Case Control Study

Rachana Dabadghav[1]* and Pratha Mehta[2]

[1]*Research Coordinator and Lecturer, Sancheti Institute College of Physiotherapy, Pune, Maharashtra, India*

[2]*BPTh, Sancheti Institute College of Physiotherapy, Pune, Maharashtra, India*

***Corresponding Author:** Rachana Dabadghav, Research Coordinator and Lecturer, Sancheti Institute College of Physiotherapy, Pune, Maharashtra, India.

Received: February 05, 2020; **Published:** April 29, 2020

Abstract

Purpose: Shoulder pain and back ache are two most common problems emerging among the gym goers. Hence the objectives were to assess the scapular muscle strength and lumbar core strength in gym goers and normal individuals.

Method: It was a case control study done on 50 gym goers and 50 age, weight and height matched non gym goers. Both the groups were assessed for scapular muscle strength using the scapular load test and lumbar core strength using pressure biofeedback. Scapular load test was measured in standing at 0°, 45°, 90° and 180° at superior angle of the scapula, spine of the scapula and inferior angle of the scapula. The core strength was measured in supine by drawing in maneuver.

Results: There was a significant difference present in the scapular position between gym goers and non gym goers at all angles of shoulder abduction, i.e. 0°,45°, 90° and 180° at all scapular positions with $p \leq 0.05$, but scapular dyskinesia was evident at 180° at superior angle, 90° and 180°at spine of scapula and 45°, 90° and 180° at inferior angle of scapula. Also, there was weakness of lumbar core muscles in gym goers as compared to non-gym goers with $p \leq 0.05$.

Conclusion: The study concluded that there is a scapular muscle weakness and lumbar core muscle weakness in gym goers, hence it is important to include core muscle strengthening exercises in the regular gym protocols.

Keywords: *Lumbar Muscles; Shoulder; Muscle Imbalance; Injury*

Introduction

Shoulder pain and backache are the most common problems emerging in gym goers. According to a study from the University of Arkansas, there has been a 35% rise in gym injuries in recent years. In a survey done by mensfitness.com, shoulder and back injuries are listed amongst the top five most common gym injuries [1]. A study by McQuade and colleagues showed that high resistance training causes fatigue of the muscles resulting in alteration of the scapulo-humeral rhythm [2]. Scapular dyskinesia is defined as visible alterations in scapular positions and motion patterns and is believed to occur as a result of changes in activation of the scapular stabilizing muscles [3,4]. These alterations in scapular positions result in a reduction in muscle function, thus leading to shoulder injuries [5-7]. The key scapular muscles for scapular stability and mobility are the upper and the lower trapezius muscle and serratus anterior. The muscles responsible for scapular dyskinesia are lower trapezius and serratus anterior weakness and upper trapezius hypertrophy [8,9]. The protocols followed in the gyms promote strengthening of mostly the following muscles-deltoid, pectoralis minor, upper trapezius, latissimus dorsi, biceps brachii and triceps. No focus is given on strengthening of the scapular stabilizers that are lower trapezius, serratus anterior, rhomboids major and minor, and the important shoulder rotators that play a major role in stabilizing the shoulder joint [10]. Hence there is an imbalance in training protocols, thus weakening the core muscle groups [9].

Assessment of core strength is another important factor in gym goers, as the incidences of back injuries post workout is also increasing. The core has been defined as the lumbopelvic-hip complex, which is composed of the lumbar vertebrae, pelvis, and hip joints and the

active and passive structures that either produce or restrict movements of these segments [11]. Core stability has been defined as "the ability to control the position and motion of the trunk over the pelvis and leg to allow optimum production, transfer and control of force and motion to the terminal segment in integrated kinetic chain activities [12]. Generally, the lumbar core muscles namely: transversus abdominus and multifidus are overlooked while training of the abdominals leading to low back injuries. Hence, while exercising overuse of back muscles combined with inadequate rest periods between workouts causes microscopic tears in the muscle tissue. This leads to chronic pain. Chronic low back pain and continuous overuse can later lead to serious spinal disc injuries. Hence, it was hypothesized that there would be scapular muscle weakness and lumbar core strength weakness in gym goers.

Objective of the Study

The objectives for our study were to assess scapular dyskinesia and lumbar core strength in gym goers and compare it with a control group.

Methods

Participants

Hundred participants volunteered to participate in the study, out of the total 100, 50 were gymers and 50 were age, height and weight matched individuals who did not go to the gym and did not do any form of exercise. Out of the total 100 participants 62 were males and 38 were females within the age group of 18- 40 years were included in the study (Table 1). Participants who were going to the gym for more than 6 months regularly at least 5 times per week were included in the study [13,14]. Participants whose aim was fitness and strength training were included in the study. Participants with any history of shoulder, scapulothoracic or acromioclavicular joint injuries or back injuries due to some other primary cause were also excluded.

N= 100	Gymers	Control Group
Age	28.08 ± 6.25	68.46 ± 7.06
Height	169.28 ± 6.67	169.52 ± 6.9
Weight	68.46 ± 7.06	68.62 ± 7.23
Males N=62		
Age	28.61 ± 5.41	28.52 ± 5.22
Height	174 ± 3.04	174.45 ± 3.09
Weight	73.58 ± 3.02	73.87 ± 3.06
Females N=38		
Age	27.21 ± 7.52	27.26 ± 7.64
Height	161.58 ± 2.17	161.47 ± 2.20
Weight	60.11 ± 1.41	60.05 ± 1.35

Table 1: *Demographic details of the gymers and the control group.*

Procedure

The study was approved by the Institutional Review Board. All the participants were explained about the study procedure in detail and a written informed consent was taken from all the participants. The study was done across various gyms in the city. All the participants were assessed first for scapular dyskinesia followed by the lumbar core strength.

Scapular dyskinesia was assessed using the scapular load test [15]. The assessment of scapular dyskinesia and lumbar core strength in the gym goers was done prior to the gym session to maintain uniformity and to avoid influence of fatigue. This test is done to determine the stability of the scapula during glenohumeral movement under dynamic load. All the participants were asked to adequately expose to allow accurate readings. The participants were asked to stand with their arms resting at the side of the body; one kg weight cuff was tied around the wrist joint. The superior angle, spine of scapula and the inferior angle were marked with a pen on both the sides. Then, the distance from the base of the spine of scapula to the spinous process of T2 or T3 (most common) from the inferior angle of the scapula to the spinous process of T7-T9, or from T2 to the superior angle of the scapula was calculated. The same assessment was carried out with the patient's arms kept at the waist, thumbs posteriorly (45˚ shoulder abduction), arms kept at 90˚ shoulder abduction with medial rotation and 180˚ shoulder abduction. A difference of one to 1.5 cm (0.5 to 0.75 inches) is considered normal [15].

The lumbar core strength was assessed using biofeedback method by drawing-in maneuver by sphygmomanometer (Diamond Deluxe B.P apparatus) [16]. The participants were asked to lie in hook lying position with spine in neutral. The cuff of the sphygmomanometer was kept at the highest point of lumbar lordosis and the pressure in the sphygmomanometer was increased to 40mmHg and then the participants were asked to draw in the stomach. The core muscles were palpated medially and inferiorly to the anterior superior iliac spine (ASIS) and lateral to Rectus Abdominis, the index, middle and ring fingers were used to sink gently, but deeply into the abdominal wall. The examiner felt a developing tension in the abdominal wall when there was a correct contraction of transversus abdominus. Care was taken that there was no flaring of lower ribs, bulging of abdominal wall or increase of pressure through feet. After the drawing-in, the participants were asked to maintain the belly-in position while the evaluator palpated the activation of the core muscles and observed the rise in BP machine. The activation of the core was timed untill the muscle contraction was lost or fall in BP was observed. The rise in mmHg was noted along with the seconds of hold that the patient could maintain the lumbar contraction [17].

Statistical analysis

The data was documented and analysed using SPSS V.26. The data was analysed using an unpaired 't' test with the statistical power of 0.8 and alpha was set $p \leq 0.05$.

Results

There was significant difference in lumbar core muscle strength in gymers and the control group $p = 0.00$. When the data was studied differently for males and females, there was a significant difference in male gymers and the control group $p = 0.001$ but no significant difference was found in female gymers and the control group $p = 0.197$.

Position	Angle	Gymers	Control group	p value
Superior angle	0°	1.28 ± 0.97	0.64 ± 0.63	0.0001*
	45°	1.34 ± 0.72	0.84 ± 0.68	0.0005*
	90°	1.41 ± 0.7	0.74 ± 0.7	0.00*
	180°	1.62 ± 0.78	0.8 ± 0.639	0.00*
Spine of scapula	0°	1.56 ± 0.81	0.64 ± 0.6	0.00*
	45°	1.54 ± 0.81	0.74 ± 0.69	0.00*
	90°	1.66 ± 0.66	0.7 ± 0.79	0.00*
	180°	1.68 ± 0.7	0.82 ± 0.7	0.00*
Inferior angle	0°	1.52 ± 0.9	0.66 ± 0.7	0.00*
	45°	1.71 ± 0.94	0.66 ± 0.63	0.00*
	90°	1.8 ± 0.81	0.68 ± 0.62	0.00*
	180°	1.92 ± 0.53	0.7 ± 0.65	0.00*

Table 2: *Mean and standard deviation of scapular dyskinesia in Gymers and the control group (cm). $p \leq 0.05$ was significant.*

Position	Angle	Males		
		Gymers	Control	P value
Superior Angle	0°	1.32 ± 1.01	0.48 ± 0.63	0.00*
	45°	1.26 ± 0.77	0.94 ± 0.63	0.077
	90°	1.37 ± 0.71	0.71 ± 0.74	0.001*
	180°	1.55 ± 0.77	0.74 ± 0.68	0.00*
Spine of scapula	0°	1.48 ± 0.63	0.52 ± 0.57	0.00*
	45°	1.45 ± 0.72	0.71 ± 0.78	0.00*
	90°	1.61 ± 0.67	0.58 ± 0.67	0.00*
	180°	1.65 ± 0.75	0.87 ± 0.85	0.00*
Inferior angle	0°	1.52 ± 0.77	0.61 ± 0.80	0.00*
	45°	1.53 ± 0.87	0.55 ± 0.51	0.00*
	90°	1.81 ± 0.70	0.68 ± 0.65	0.00*
	180°	1.90 ± 0.54	0.65 ± 0.61	0.00*

Table 3: *Gender wise (Males) mean and standard deviation of scapular dyskinesia. $p \leq 0.05$ was significant.*

Position	Angle	Females		
		Gymers	Control	P value
Superior Angle	0°	1.21 ± 0.92	0.89 ± 0.57	0.21
	45°	1.47 ± 0.61	0.68 ± 0.75	0.001*
	90°	1.47 ± 0.70	0.79 ± 0.71	0.005*
	180°	1.74 ± 0.81	0.89 ± 0.57	0.001*
Spine of scapula	0°	1.68 ± 1.06	0.84 ± 0.60	0.005*
	45°	1.68 ± 0.95	0.79 ± 0.54	0.001*
	90°	1.74 ± 0.65	0.89 ± 0.94	0.003*
	180°	1.74 ± 0.45	0.74 ± 0.56	0.000*
Inferior angle	0°	1.53 ± 1.12	0.74 ± 0.65	0.012*
	45°	2.00 ± 1.00	0.84 ± 0.76	0.000*
	90°	1.79 ± 0.98	0.68 ± 0.58	0.000*
	180°	1.95 ± 0.52	0.79 ± 0.71	0.000*

Table 4: *Gender wise (Females) mean and standard deviation of scapular dyskinesia. $p \leq 0.05$ was significant.*

Discussion

The study was done to assess scapular muscle strength and lumbar core strength in gym goers. It was found that at all angles of shoulder abduction and at all the scapular positions, the scapula moved more than 1.5 cm indicating scapular muscle weakness. Also, when this distance was compared with the control group there was significant difference at all the angles of scapular positions $p \leq 0.05$ (Table 1).

Same was seen with respect to gender distribution (Table 2 and 3). This indicates that there is scapular dyskinesia in gymers as compared to control group. During abduction of shoulder, the scapula seeks a position of stability in relation to the humerus. Hence, it is called the setting phase [18,19]. However, due to the lack of strengthening of the scapular stabilizers and over strengthening of the shoulder abductors in the gym leads to inability of scapular stabilizers to work efficiently and hence leading to presence of scapular dyskinesia [20].

Scapular dyskinesia is an alteration in the normal position or motion of scapula during coupled scapula-humeral movements. Types of scapular dyskinesis include inferior angle prominence (type 1) indicating presence of weak muscles (serratus anterior, latissimus dorsi, lower trapezius), medial border prominence (type 2) including winging of scapula, superior angle prominence (type 3) indicating over activity of levator scapulae and upper trapezius along with imbalance of the upper and lower trapezius force couple associated with impingement and rotator cuff lesions, symmetric scapula motion (type 4) where both scapula move symmetrically upward with the inferior angles rotating laterally away from the midline indicating scapular control muscles are not stabilizing the scapula [3]. The serratus anterior and lower trapezius are the most commonly affected muscles and hence become weak [21]. The serratus anterior and lower trapezius contribute to the important upward rotation force couple that produces acromial elevation.

Thompson and Mitchell suggested that a fatigue-induced strength deficit of the shoulder musculature can have an adverse effect on scapular positioning by allowing the scapula to glide more laterally during functional activities [22]. Inman., *et al*. found that between the 30° and 170° range of shoulder flexion, the glenohumeral joint provided 10° of shoulder flexion, and scapular rotation of 5°, for every 15° of motion [23].

Studies investigated the effects of exercise and muscle fatigue on shoulder proprioception. There is a significant decrease in joint kinesthesia, after fatiguing exercise. It is hypothesized that a decrease in position sense as a result of fatigue of the shoulder girdle musculature could interfere with the normal coordination and joint stability, thus impairing function around the shoulder girdle [24,25]. As the weak scapular muscles have to stabilize the shoulder while upper body resistance training, it can cause microtrauma to the scapular muscles leading to hyperlaxity, instability or impingement. In our study it was seen that there was more weakness at the inferior angle of the scapular as the scapular dyskinesia was maximum (Table 2).

As we know serratus anterior muscle is the primary stabilizer of the inferior angle and medial border of scapula to the thorax [26]. It is the only muscle capable of producing simultaneous scapular upward rotation, posterior tipping and external rotation. Also, rhomboid major and minor muscles help in serratus anterior function to stabilize the scapula and the upward rotation of scapula [27]. Due to overuse during gyming, the main stabilizing muscle of inferior angle of scapula, i.e. serratus anterior may undergo weakness. Hence to avoid hyper laxity, instability or impingement due to weight training proper exercise and techniques should be incorporated by the trainers while training a person [28].

There was a significant weakness in the lumbar core strength $p \leq 0.05$. There was significant difference in male gymers and the control group with respect to the core, but no significant difference was found in female group. The females had equally weak core in both gymers and the control group. There have been studies, wherein they mention that with upper limb and lower limb activity, there is an activation of core muscles [12,29]. Gymers also do abdominal muscle strengthening, but the focus is mainly on rectus abdominis, internal and external obliques and not on transverse abdominis and multifidi. Hence despite of this, there was weakness of core muscles in gymers when compared with the control group. The transverse abdominis have shown to be an important muscle in stabilization of lumbar spine [12]. Moreover, while lifting or carrying weights in front of the body there is increase in intradiscal pressure, thereby causing stress on the surrounding musculature [30]. This repetitive increase in intradiscal pressure can give rise to back injuries if the core muscles are weak. Hence it is important to concentrate on the core muscles as well while strengthening the abdominals in the gym.

There are various articles mentioning about incidence of shoulder and low back injuries, hence the study was designed to know the underlying probable cause of injuries. This article found that there was a lumbar core weakness and scapular dyskinesia in gymer as

compared to the control group. These factors could be one of the major risk factors for injuries while gyming. Hence it is also important to concentrate on the core muscles of shoulder and spine to avoid injuries while lifting heavy weights. As there is lack of knowledge about the causative factors of spine and shoulder injuries in gym, this article is one its kind in finding and identifying the risk factors for injuries while gyming.

Conclusion

The study concluded that there was scapular dyskinesia and lumbar core weakness was present in gym goers.

Clinical Implication

In the present study it was found that scapular dyskinesia and lumbar core weakness was seen in gym goers as compared to normal individuals. As the study showed significant weakness in scapular and lumbar core muscles, the gym protocols should include strengthening of these muscles as well, thus minimizing the incidences of shoulder and back injuries in gym goers.

Bibliography

1. Mensfitnesscom. Men's Fitness (2016).
2. Mcquade KJ., *et al*. "Scapulothoracic muscle fatigue associated with alterations in scapulohumeral rhythm kinematics during maximum resistive shoulder elevation". *Journal of Orthopaedic and Sports Physical Therapy* 28.2 (1998): 74-80.
3. Kibler WB and Sciascia A. "Current concepts: Scapular dyskinesis". *British Journal of Sports Medicine* 44.5 (2009): 300-305.
4. Warner JJ., *et al*. "Scapulothoracic Motion in Normal Shoulders and Shoulders with Glenohumeral Instability and Impingement Syndrome". *Clinical Orthopaedics and Related Research* 285 (1992): 191-199.
5. Kibler WB. "The role of the scapula in athletic shoulder function". *American Journal of Sports Medicine* 26.2 (1998): 325-337.
6. Kibler BW and Mcmullen J. "Scapular Dyskinesis and its Relation to Shoulder Pain". *Journal of American Academy of Orthopaedic Surgeons* 11.2 (2003): 142-151.
7. Kibler WB., *et al*. "Evaluation of apparent and absolute supraspinatus strength in patients with shoulder injury using the scapular retraction test". *American Journal of Sports Medicine* 34.10 (2006): 1643-1647.
8. Kibler WB., *et al*. "Scapular Summit 2009, July 16, 2009, Lexington, Kentucky". *Journal of Orthopaedic and Sports Physical Therapy* 39.11 (2009): A1-A13.
9. Kibler BW., *et al*. "Scapular Dyskinesis and Its Relation to Shoulder Injury". *Journal of the American Academy of Orthopaedic Surgeon* 20.6 (2012): 364-372.
10. Sharkey NA and Marder RA. "The Rotator Cuff Opposes Superior Translation of the Humeral Head". *The American Journal of Sports Medicine* 23.3 (1995): 270-275.
11. Willson JD., *et al*. "Core Stability and Its Relationship to Lower Extremity Function and Injury". *Journal of the American Academy of Orthopaedic Surgeons* 13.5 (2005): 316-325.
12. Kibler WB., *et al*. "The Role of Core Stability in Athletic Function". *Sports Medicine* 36.3 (2006): 189-198.

13. Nelson ME., *et al*. "Physical Activity and Public Health in Older Adults". *Medicine and Science in Sports and Exercise* 39.8 (2007): 1435-1445.

14. Haskell WL., *et al*. "Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association". *Medicine and Science in Sports and Exercise* 39.8 (2007): 1423-1434.

15. Magee D. "The shoulder". In Magee, D (Ed), Orthopaedic Physical assessment. Saunders: Elsevier publication (2008): 303-304.

16. Schellenberg KL., *et al*. "A Clinical Tool for Office Assessment of Lumbar Spine Stabilization Endurance". *American Journal of Physical Medicine and Rehabilitation* 86.5 (2007): 380-386.

17. Richardson C. "Local segmental control". In Hides, J, Richardson, C and Hodges, P (Eds), Therapeutic exercise for lumbopelvic stabilization: Churchill Livingstone (2004): 192.

18. McClure PW., *et al*. "Direct 3-dimensional measurement of scapular kinematics during dynamic movements *in vivo*". *Journal of Shoulder and Elbow Surgery* 10.3 (2001): 269-277.

19. Dvir Z and Berme N. "The shoulder complex in elevation of the arm: A mechanism approach". *Journal of Biomechanics* 11.5 (1978): 219-225.

20. Doody SG., *et al*. "Shoulder movements during abduction in the scapular plane". *Archives of Physical Medicine and Rehabilitation* 51.10 (1970): 595-604.

21. Glousman R., *et al*. "Dynamic electromyographic analysis of the throwing shoulder with glenohumeral instability". *Journal of Bone and Joint Surgery American Volume* 70.2 (1988): 220-226.

22. Thomson BC and Mitcheli LJ. "The effects of repetitive exercise of the shoulder on the lateral scapular stability". Presented at: American Physical Therapy Association Combined Sections Meeting, New Orleans, LA (2000).

23. Inman VT., *et al*. "Observations of the Function of the Shoulder Joint". *Clinical Orthopaedics and Related Research* 330 (1996): 3-12.

24. Carpenter JE., *et al*. "The effects of muscle fatigue on shoulder joint position sense". *American Journal of Sports Medicine* 26.2 (1998): 262-265.

25. Voight ML., *et al*. "The Effects of Muscle Fatigue on and the Relationship of Arm Dominance to Shoulder Proprioception". *Journal of Orthopaedic and Sports Physical Therapy* 23.6 (1996): 348-352.

26. Ellenbecker TS., *et al*. "Reliability of Scapular Classification in Examination of Professional Baseball Players". *Clinical Orthopaedics and Related Research* 470.6 (2011): 1540-1544.

27. Steindler A. "Kinesiology of the human body: Under normal and pathological conditions". Springfield: Charles C. Thomas (1955).

28. Durall CJ., *et al*. "Avoiding Shoulder Injury from Resistance Training". *Strength and Conditioning Journal* 23.5 (2001): 10-18.

29. Petrofsky JS., *et al*. "Muscle Use During Exercise: A Comparison of Conventional Weight Equipment to Pilates With and Without a Resistive Exercise Device". *The Journal of Applied Research* 5.1 (2005): 160-173.

30. Wilke H., *et al*. "Intradiscal pressure together with anthropometric data – a data set for the validation of models". *Clinical Biomechanics* 16.1 (2001): S111-S126.

Volume 11 Issue 5 May 2020