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Difference in Scapular Muscle Strengthening and Combined Core and Shoulder Exercises in Quantifying AHD in Overhead Athletes with Scapular Dyskinesia

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ABSTRACT

Purpose

The aim of the study is to find the difference between Scapular Muscle strengthening and Combined Core and Shoulder exercises in Quantifying Acromiohumeral distance (AHD) in overhead athletes with Scapular Dyskinesia.

Method

80 athletes diagnosed with scapular dyskinesia, meeting the predefined criteria were included in the sample. The subjects were randomly assigned into 2 experimental groups. Group A received scapular muscle strengthening for 4 weeks (4 days per week) and Group B received cyhnore muscle strengthening and shoulder exercises. AHD readings (USG scans) were taken at baseline and after 6 weeks of intervention by an assessor blinded to an treatment allocation of the patients.

Results

The mean difference of pre and post AHD at 0^0, 45^0, and 60^0 was significant within group A and group B**.** On comparison between post intervention values of AHD using Un paired t-test, more significant difference was found in group B ($p< 0.0001$) when compared with group A .

Conclusion

The results indicate that both group A and group B increases AHD. But when compared between both groups, group B shows more significant improvement than group A in increasing AHD.

Keywords

Scapular dyskinesia, Acromiohumeral distance (AHD).

INTRODUCTION

Shoulder joint is the most movable and unstable joint in the body .This complex joint relies on its muscles to provide dynamic stability during its large range of mobility. Proper balance of the muscles surrounding the shoulder complex plays an important role in maintaining joint flexibility and strength. High demands are placed on shoulder during overhead motion and it is subsequently one of the commonly injured sites of human body.[1]

The coordinated coupled motion between the scapula and humerus, is needed for efficient arm movement and allows GH alignments to maximize joint stability.[2] Athletes performing overhead activities are at a risk of both over use and traumatic shoulder injuries.[1] Common sports that cause shoulder injuries are tennis, baseball, volley ball, badminton, cricket, elite pitchers leading to injuries to rotator cuff, posteroinferior capsule contracture leading to glenohumeral internal rotation deficit (GIRD), capsulolabral pathologies and impingement. There are substantial evidence of scapular kinematic abnormalities in athletes with shoulder pain, this alteration in scapular kinematics is termed as scapular dyskinesia.

Dyskinesia by itself is not an injury or musculoskeletal diagnosis but it is hypothesized to relate to changes in glenohumeral angulations, acromioclavicular joint strain, subacromial space dimension, shoulder muscle activation and humeral position and motion. Causes of abnormal scapular motion or scapular dyskinesia have been described as non specific response to painful condition in shoulder rather than a specific defined cause of shoulder pathology.[2] Position and control of the scapula on thorax play the critical role in normal function of shoulder. Scapular motions on the thorax align the glenoid fossa with the humeral head maximizing joint congruency and providing stable base for humeral motion. Alteration in normal motion of the shoulder has been associated with shoulder pathologies such as shoulder impingement.[3] According to Annelies Maenhout there is relationship between scapular dyskinesia and AHD and the study concluded that after the fatiguing protocol changes in acromiohumeral distance and scapular position that corresponded with an impingement – sparing situation.[4]

The upper trapezius, lower trapezius, and serratus anterior are the upward rotators of scapula, therefore these muscles play an important integral part in scapular movement. Scapular rotation force couple imbalance leads to altered muscular activation pattern. Researchers reported that patients with shoulder impingement had increase in upper trapezius EMG activation coupled with decreased in activation of the middle trapezius, lower trapezius, and the serratus anterior during shoulder elevation in the scapular plane inturn leads to an upward migration of the axis of rotation of glenohumeral joint, thus causing impingement.[5]

Scapular muscles plays an important role in producing and controlling shoulder motion, impairment of these muscles and altered scapular kinematics influences acromiohumeral distance. Researchers found a decreased upward rotation, increased anterior tipping and increased scapular rotation under load in subjects with shoulder impingement due to reduce strength of scapular muscles inturn which lead to altered scapular position. Muscle fatigue can be defined as reduce ability of muscle to generate force, researchers reported sports demanding overhead motion leads to narrowing of acromiohumeral distance from 0^0-90^0 of shoulder abduction using imaging techniques (USG)[6]. Researchers concluded that strengthening of scapular muscles decreases disability and improves function in athletes with symptoms of shoulder impingement and altered scapular position[7].

Over head tasks are performed through utilization and integration of multiple body segments and muscles. Sequential activation of specific muscle groups resulting in the performance of specific dynamic action is known as kinetic chain function. During throwing and serving tasks, the scapula is the pivotal link between the larger centralized body segments of the arm that produce stability and generate force and the smaller localized segments of arm that produce mobility and apply force to the ball. It is linked within the kinetic chain which allows the transfer of energy from the pelvic and trunk muscles to the overhead motion.[2]

According to kibler and Ahmed radwan core muscle instability plays an important role in scapular dyskinesia. In order to maintain functional stability during limb movement, muscular strength and endurance is required around lumbar spine. This area is referred to as the core and includes the abdominal muscles anteriorly, the paraspinals, gluteus posteriorly, diaphragm superiorly, and the pelvic floor and hip girdle musculature inferiorly. The core musculature becomes active in a feed-forward fashion during upper extremity movement. This mechanism occurs as the body prepares for potential pertubation of spinal stability when movement begins. In sports that require great degree of overhead skill, the core provides a foundation upon which muscles of upper extremity rely. Athletes performing overhead motions require highly skilled movements performed at high velocity requires flexibility, muscular strength, co-ordination, synchronicity and neuromuscular control at shoulder complex. Core stability has been proven to be an essential component of biomechanical efficiency, allowing the athlete to maximize the force production while minimizing loads placed on peripheral joints. Focusing on nature of complex movements athletes must have adequate core strength in order to provide effective stability during a wide variety of movements.[8]

Though the research has been done on scapular and core muscle strengthening for the various shoulder injuries research on its relationship with AHD is relatively new, so the purpose of study was to find out the effectiveness of scapular muscle strengthening and combined core and shoulder exercises in AHD.

RESEARCH QUESTIONS

1. Is there any biomechanical relationship between scapular dyskinesia with acromiohumeral distance?
2. Will combined core and shoulder exercises have more influence on acromiohumeral distance?

AIMS AND OBJECTIVES

AIM:

Difference in Scapular Muscle strengthening and Combined Core and Shoulder Exercises in Quantifying AHD in Overhead Athletes with Scapular Dyskinesia.

OBJECTIVES:

1. To find out the effectiveness of scapular muscle strengthening on AHD in overhead athletes.

2. To find out the combined effects of core muscle strengthening with shoulder muscle

exercises on AHD in overhead athletes.

3. To find out effectiveness between scapular muscle strengthening and combined core and shoulder exercises on AHD in overhead athletes with scapular dyskinesia.

NEED FOR STUDY

As recent literature has found correlation between scapular and core muscle strengthening for various shoulder injuries but results are not very well established, and research on its relationship with AHD is relatively new. Hence the study was undertaken with an intension to find out effectiveness of scapular muscle strengthening and combined coe and shoulder exercises on scapular dyskinesia and its influence on AHD.

HYPOTHESIS

Experimental Hypothesis-

Core muscle strengthening and shoulder exercises will have more effect than scapular muscle strengthening on AHD in overhead athlete with scapular dyskinesia.

Null Hypothesis-

There will be no significant difference between scapular strengthening exercises and combined core and shoulder exercises on AHD in overhead athletes with scapular dykinesia.

OPERATIONAL DEFINITION

Scapular Dyskinesia:

The alteration of normal scapular kinematics or altered scapular motion and position is termed as scapular dyskinesia.[1]

Acromiohumeral distance:

Measurement of the distance between acromion and the most cranial part of the humeral head, which is referred to as acromiohumeral distance.

Overhead athlete:

An amateur or professional athlete who participates in an overhead sports .Eg.baseball throwing, volleyball, tennis, etc in which the upper arm and shoulder arcs over the athletes head to propel a ball at opposing team.

REVIEW OF LITERATURE

ATHLETES SHOULDER

Jason and brumitt, et al., in (2009), Conducted a study on integrating shoulder and core exercises when rehabilitating athletes performing overhead activities. The purpose of this study was to review the activity of trunk musculature during upper extremity exercise and present a rehabilitation exercise progression for the shoulder girdle that integrates core muscle strengthening and activation. This progression reflects a transition into traditional function core strengthening. The study concluded that the inclusion of integrated core and shoulder exercises may help to bridge the gap between the initial rehabilitation exercises and later functional rehabilitation exercises[1]. **H van der Hoeven, W B Kibler (2006),** conducted a study on**,** shoulder injuries in tennis players, this study highlights about shoulder injuries, related to risk of shoulder injury in tennis, careful evaluation of kinetic chain function, scapular function, rotator cuff muscle balance, and the integrity of the capsular structure should be carried out. Author have explained kinetic chain theory and explained types of scapular dyskinesia and introduced a term SICK scapula to describe pathological state of scapula characterised by scapular mal-position, inferior medial border prominence, coracoid pain, and mal-position and kinesis abnormalities of the scapula. The study concluded that specific training programmes incorporating scapular stabilization and capsular stretching at an early, stage of shoulder injury can prevent intra-articular damage of the shoulder.[8]

SCAPULAR DYSKINESIA

Altered scapular motion and position have been termed as scapular dyskinesia. Dyskinesis by itself is not a injury or musculoskeletal diagnosis but has been hypothesized to relate to changes in GH angulation, AC joint strain, subacromial space dimension, shoulder muscle activation and humeral position and motion. Causes that lead to scapular dyskinesia are high grade AC joint instability, AC arthrosis and GH joint internal derangement. According to **Ben Kibler (2013)** altered scapular motion and position have been termed as scapular dyskinesia; the definition of dyskinesia is the alteration of normal scapular kinematics.[2] According to **Phil Page (2011)** subacromial impingement is a frequent and painful condition among athletes, particularly those involved in overhead activities. Janda's approach to muscle imbalance suggests a possible neuromuscular component to functional impingement due to predisposition of certain muscles to be tight or weak. The literature substantiate that imbalances in glenohumeral and scapulothoracic musculature are present in patients with subacromial impingement. There is substantial evidence of scapular kinematic abnormalities in person with shoulder pain across a variety of shoulder pathologies. Three- dimensional scapular kinematic pattern.[15] **Ahmed Radwan(2014)** conducted a study to analyze the difference between healthy athletes and those with shoulder dysfunction in regard to core stability measures. The study concluded that greater shoulder dysfunction is correlated with greater balance and stability deficiency. [7]

Sakiko Oyama , Joseph B Myers.et.al. 2008 conducted a study on asymmetric resting posture in healthy overhead athlete. Objective of this study was to quantify the differences in resting scapular posture between the dominant and non-dominant sides in 3 groups of healthy overhead athletes using an electromagnetic tracking device. The study concluded that scapula on dominant side was more anteriorly tilted and internally rotated along with the shoulder of the dominant was more protracted than the non dominant side in healthy overhead athletes. The results emphasize the importance of the baseline evaluation in this population in order to accurately assess pathologic change in bilateral scapular positions and orientations after injury.[10] **Philip McClure, Angel, et al. (2009)** conducted a study on A clinical method for identifying Scapular Dyskinesis, Part 1: Reliability, objective of this study was to determine the inter-rater reliability of a new test designed to detect abnormal scapular motion. In this study Kibler reported the reliability of a visually based classification system for scapular dysfunction that defined three type of motion abnormalities: type 1- inferior angle prominence, type 2- medial border prominence, type 3- excessive superior border elevation, type 4- normal symmetric scapular motion. This study concluded that the test for scapular dykinesis showed satisfactory reliability for clinical use in a sample of overhead athletes known to be at increased risk for shoulder symptoms.[11] **Madsen PH el al.(2011)** conducted a study on prevalence of scapular dyskinesia in swimmers and concluded that the prevalence of abnormal kinematics increases with more training sessions.[12]

Babette M Pluim. et.al(2013), conducted a study on Scapular Dyskinesis: pratical applications, objective of this study was to how to assess scapular dyskinesis using scapular assistance test and scapular repositioning test, lateral scapular test , conclusion of this study was to provide detailed examples of rehabilitation programmes that have been specifically developed to improve scapular muscle strength and movement.[13]

STRENGTHENING OF SCAPULAR AND CORE MUSCLES.

Dr Dabholkar Ajit S, et al.conducted a study on scapular muscle strengthening on shoulder function and disability in patients with shoulder impingement. In clinical literature, a relationship of scapula-thoracic muscles to shoulder pain has been suggested, these imbalances result in scapular instability, potentially increasing the risk of shoulder problems, thus this study investigates role of scapular muscle strengthening on shoulder function and disability and concluded that scientifically based on rehabilitation exercise to strengthen the scapular muscles thus influencing function and decreasing disability in patients with impingement syndrome.[6] **Jason Brumitt.et al.,** Conducted a study on integrating shoulder and core exercises when rehabilitating athletes performing overhead activities and concluded that core and shoulder exercises help to bridge the gap between the initial rehabilitation exercises and later functional rehabilitation exercises. [1]**W. Ben Kibler**, conducted a study on role of core stability in overhead athletic function and the study concluded that strengthening of core muscles in overhead athlete is beneficial in maximizing the effect of rehabilitation and conditioning program in athletes, and also,conducted a study on implications of scapular dyskinesia in shoulder injury, and concluded that by improving scapular muscle strength, alter scapular position and alter shoulder symptoms.[14]

Phil Page,conducted a study on shoulder muscle imbalance and subacromial impingement syndrome in overhead athlete, concluded that subacromial impingement may be associated with muscle imbalance and substantiates that imbalances in glenohumeral and scapulothoracic musculature are present in patients with subacromial impingement.[15]**Eduardo luizstapiat, et al.,** in **September 2013**, conducted a study on role of scapular stabilizers strengthening in painful shoulder and the study concluded that strengthening of stabilizer muscles decreases pain and improves shoulder function[16]**Richard A. Ekstrom , et.al., (2003)** conducted a study on surface electromyographic analysis of exercises for the trapezius and serratus anterior muscles, Objective of this study was to identify high-intensity exercises that elicit the greatest level of EMG activity in the trapezius and serratus anterior muscles and concluded that exercises that maximally activate the trapezius and serratus anterior muscles, the unilateral shoulder exercise was found to produce the EMG activity in the upper trapezius, for middle trapezius greatest EMG activity with shoulder horizontal extension with external rotation and overhead the overhead arm raise in line with lower trapezius.The arm raise overhead exercise in prone position produced maximum EMG activity in lower trapezius.[4]

ULTASONOGRAPHY: RELIABILITY AND VALIDITY.

Demeules, et al., conducted a study on acromio-humeral distance variation measured by ultrasonography and its association with the outcome of rehabilitation for shoulder impingement syndrome, and concluded that the ultrasound measure of AHD reliable and sensitive. Although a distinct pattern of AHD variation in SIS patients could not be confirmed, a strong positive relationship was found between the reduction of AHD narrowing and functional improvement following rehabilitation.[17] Ultrasound measurement **Annelies maenhout,et al., (2012)** conducted a study on quantifying acromiohumeral distance in overhead athletes with glenohumeral internal rotation loss and the influence of a stretching program. The AHD, a 2-dimensional measure for subacromial space, was found to be smaller on the dominant side in the athletes with GIRD and was found to increase with 6-week sleeper stretch program.[18] **Haroo Kim, et.al.,(2014)** conducted a study on Comparative analysis of acromiohumeral distances according to the location of arms and humeral rotation ,This study performed a comparative analysis of effect of resistance exercise on subacromial space according to the location of arm and the rotation of humerus, the study concluded that the AHD distance was significantly different among the positions of humeral rotation and the different locations of arm ,AHD was largest when humerus was internally rotated in 90deg of abduction, when compared among rotation of humerus the difference in the distance between neutral and internal rotation of humerus in 90 deg abduction position was significant. The difference in distance between external and internal rotation was also significant.[19]

Kevin A.etal., conducted a study on , Effect of shoulder positions on the acromiohumeral distance following upper extremity fatiguing exercises, the purpose of this study was to determine what positions are most sensitive to detecting changes in AHD following repeated upper extremity exercises. Authors hypothesize that manual wheelchair users show a more statistically significant change in AHD, and they additionally hypothesize that increased levels of shoulder abduction will be correlated to lesser change in AHD following repeated upper extremity exercises and concluded that , ultrasonography proved a reliable means to evaluate the subacromial space and measure the AHD. Shoulders actively positioned in a 90^0 abducted posture showed narrowing of the AHD following rotator cuff fatiguing exercise.AHD consistently narrowed throughout the range of shoulder abduction movement in manual wheel chair users.[5]

Annelies maenhout, (2015) conducted a study on acromiohumeral distance and 3- dimensional scapular position change after overhead muscle fatigue, the purpose of this study was to investigate the effect of a fatigue protocol resembling overhead sports activity on AHD and 3- dimensional scapular position in overhead athlete and concluded that after a fatigue protocol, significant changes were found in AHD and scapular position corresponded with impingement sparing situation.[3]

RESEARCH DESIGN AND METHODOLOGY

Sample Size-80

Source of Subjects-

MGM Hospital Research Centre, Physiotherapy Department (Out Patient Department) Aurangabad, Ulhas Patil Medical College Jalgaon.

Type Of Sampling-

Stratified random sampling.

Study design-

Comparative observational study.

Study Duration

One year study.

Materials-

- Consent form
- Data collection sheet
- USG machine
- Theratube
- Dumbells-1.5 kg(1.1)
- Dumbells-2 kg(1.1)
- Scapular strengthening(photo 3.1-3.4)
- Core strengthening (photo 4.1-4.4)

Picture1.1- Dumbells- 1.5 kg and 1.2 kg and Theratube

STUDY POPULATION

Inclusion criteria

- Athlete between age group 18-30
- Male patients
- Overhead athlete with scapular dyskinesia.
- Athlete involved in sport since 6 months.

Exclusion criteria

- Any shoulder pathology
- Involvement of any cervical pathology

Variables

Dependent Variable

- AHD

Independent Variable

- Strengthening of scapular muscles
- Strengthening of core muscles with shoulder muscle exercises.

METHOD OF MEASUREMENT OF OUTCOME OF INTEREST

- AHD

STUDY PROCEDURE and INTERVENTION

The aim and objective of study was established and permission for research was obtained from the Ethical Committee for research on Human subjects, MGM Medical college Aurangabad.

The athletes were explained about purpose and nature of the study. Informed consent (Appendix A) was taken from the subjects after their inclusion in the study. Scapular dyskinesia was diagnosed through video-analysis according to Philip McClure (Appendix-C).[11]

AHD was measured for all the athletes by using USG at 0^0, 45^0, 60^0 (picture 2.1-2.3) before and after 6 weeks of strengthening.

Once scapular dyskinesia was diagnosed patient were allotted in Group A and Group B by simple randomized sampling through lottery method.

Group A - Participants were given scapular strengthening exercises.

Group B - Participants were given combined core and shoulder exercises.

After a division of participants the participants underwent Ultrasonography for determining AHD distance before i.e and post exercises i.e. after 4 weeks.

Picture2.1- AHD measurement at 0^0

Picture 2.2- AHD measurement at 45^0

Picture2.3- AHD measurement at 60^0

Isolated serratus anterior

Athlete were asked to perform shoulder abduction in the plane of scapula above 120^0 in the standing position

Picture 3.1– Isolated serratus anterior

Isolated middle trapezius

Athlete were asked to perform shoulder horizontal extension with external rotation in prone position

Picture 3.2– Isolated middle trapezius

Isolated lower trapezius

For activating the lower trapezius the athlete was asked to be in prone position, and was asked to extend his arm at 110^{0}.

Picture 3.3– Isolated lower trapezius

Combined middle and lower trapezius and serratus anterior

T-Exercises theratube was fasten to a fixed support point and the athlete was asked to grasp the Theratube and move his shoulder back while his arms stay straight.

Theratube was fasten to a fixed support point and the athlete was asked to grasp the Theratube and move his shoulder back while his arms stay straight.

Starting Position

End Position

Picture 3.4– Starting position and End position

Combined core muscle strengthening and shoulder exercises

Prior to initiating any shoulder movement, instructions were given to the athlete to retract scapula and to perform abdominal brace.

Picture 4.1– Side plank with shoulder external rotation

Three point plank with shoulder horizontal abduction. Horizontal abduction of arm with shoulder in external rotation .

Picture 4.2 – Three point plank

Three point plank with shoulder extension. Extension of shoulder .

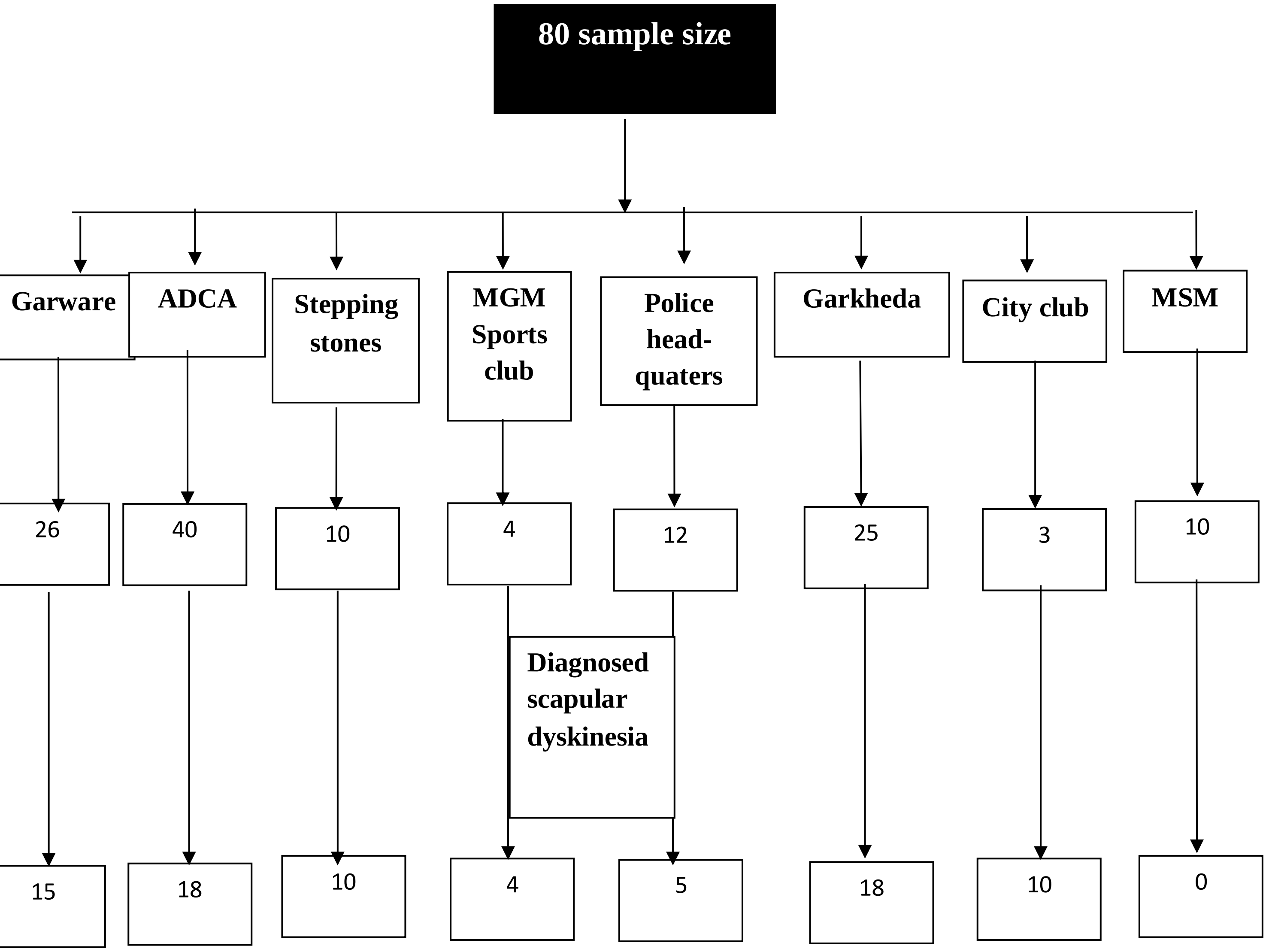
Picture 4.3 – Three point plank

The shoulder row

Picture 4.4 – Shoulder row

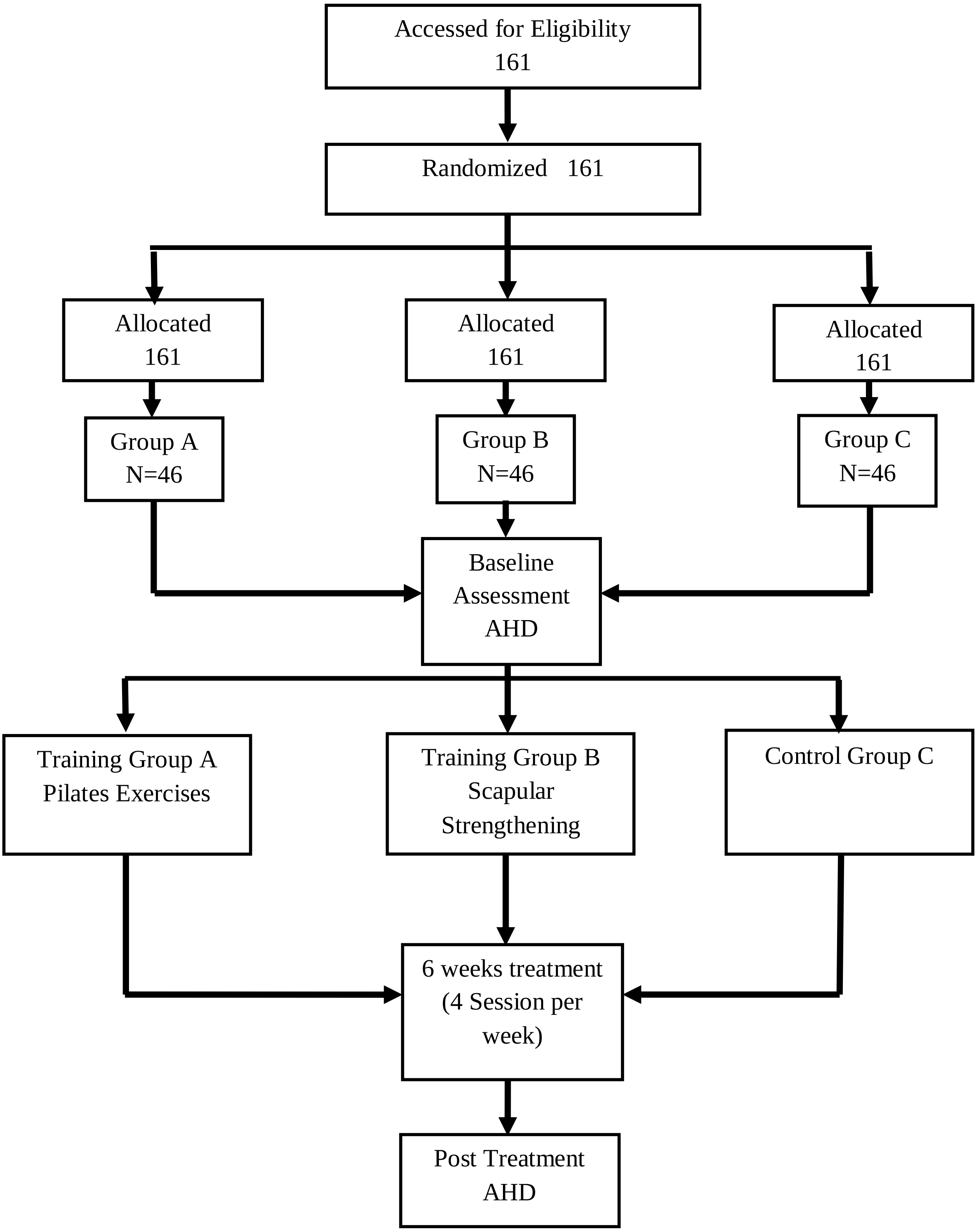
Picture 5.1– Scapular dyskinesia

SamplingTechnique Procedure



CLUB	NO. OF Athletes dignosed with S.D
Garware	15
ADCA	18
Stepping stone	10
MGM Sports Club	4
Police headquarters	5
Garkheda	18
City Club	10
MSM	0

FLOW CHART



DATA ANALYSIS

The data was incompiled in MS excel sheet 2007. For analysis of this data SPSS version 20th software was applied. Qualitative data was represented in the form of frequencies and percentiles. Quantitative data was represented form of mean, standard deviation. Both these qualitative and quantitative data was represented on visual impression like bar diagram, pie diagram, etc. For inter-comparision between two groups Unpaired t test was applied. P value was checked at 5% level of significance. For intra-comparison within the group Paired t test was applied.

RESULT

Subject Information

There were two groups, Group A (n= 40) (Scapular strengthening) and Group B (n= 40) (Core muscle strengthening and shoulder exercises) were included. The mean age for group A was 13.33 with a SD of 3.78 and for group B mean age was 13.33 with a SD of 3.78 (table.1).

Paired t-test

Comparison of mean difference of post AHD was done by using paired t-test . The mean difference at 0^0 was 0.285 (p<0.0001) at 45^0 was 0.19 (p < 0.0001), and at 60^0 was 0.21(p=0.009). The mean difference of pre and post AHD at 0, 45, and 60 was significant for group A.(table .2 and graph .2)

Comparison of mean difference of post AHD was done by using paired t-test . The mean difference at 0^0 was 0.861 (p<0.0001) at 45^0 was 0.76 (p<0.0001), and at 60^0 was 0.71(p<0.0001). The mean difference of pre and post AHD at 0, 45, and 60 was significant for group B.(table 2 and graph 2)

UnPaired 't' test

The mean difference and standard deviation at 0^0 between group A and B was 6.375 ± 0.799 and 7.077±0.699 (p<0.0001) respectively. The mean difference and standard deviation at 45^0 between group A and B was 5.47± 0.742and 6.04± 0.570 (p<0.0001) respectively. The mean difference and standard deviation at 60^0 between group A and B was 4.9± 0.766 and 5.28±0.508 (p=0.011) respectively. The mean difference of post AHD at 0^0,45^0 and 60^0 between group A and B was significant.

Table 1: Comparison of mean difference and standard deviation of AGE for Group A and B

Mean and SD of AGE for group A and B

	Mean Age	**SD**
Group A	13.3333	3.78594
Group B	13.3333	3.78594

Graph 1: Mean and SD of AGE for Group A and B

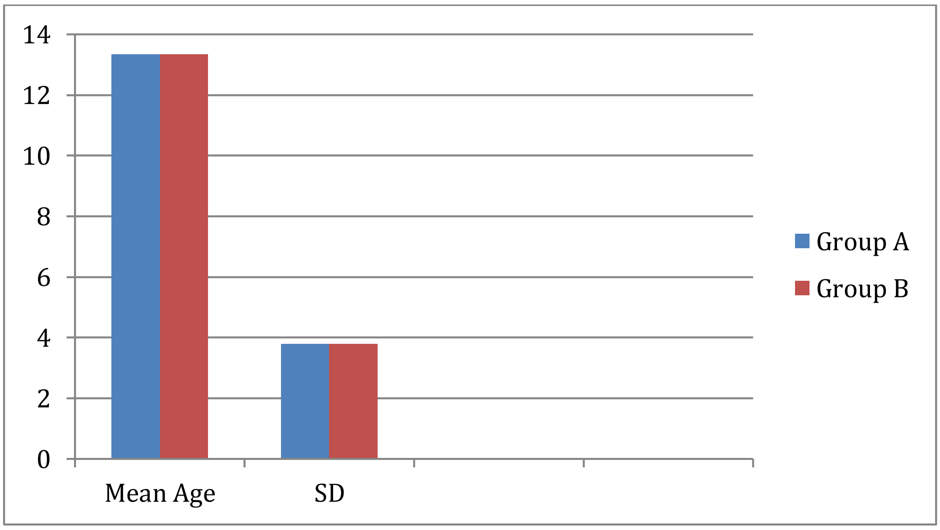


Table 2: Comparison of mean difference of PRE and POST AHD for Group A

Degree of abduction	**Mean Difference**	**t- value**	**p- value**	**Significance**
0^0	0.285	5.67	P<0.0001	S
45^0	0.19	4.46	P<0.0001	S
60^0	0.21	2.76	P=0.009	S

AHD in mm

Graph 2: Mean difference of PRE and POST treatment for group A

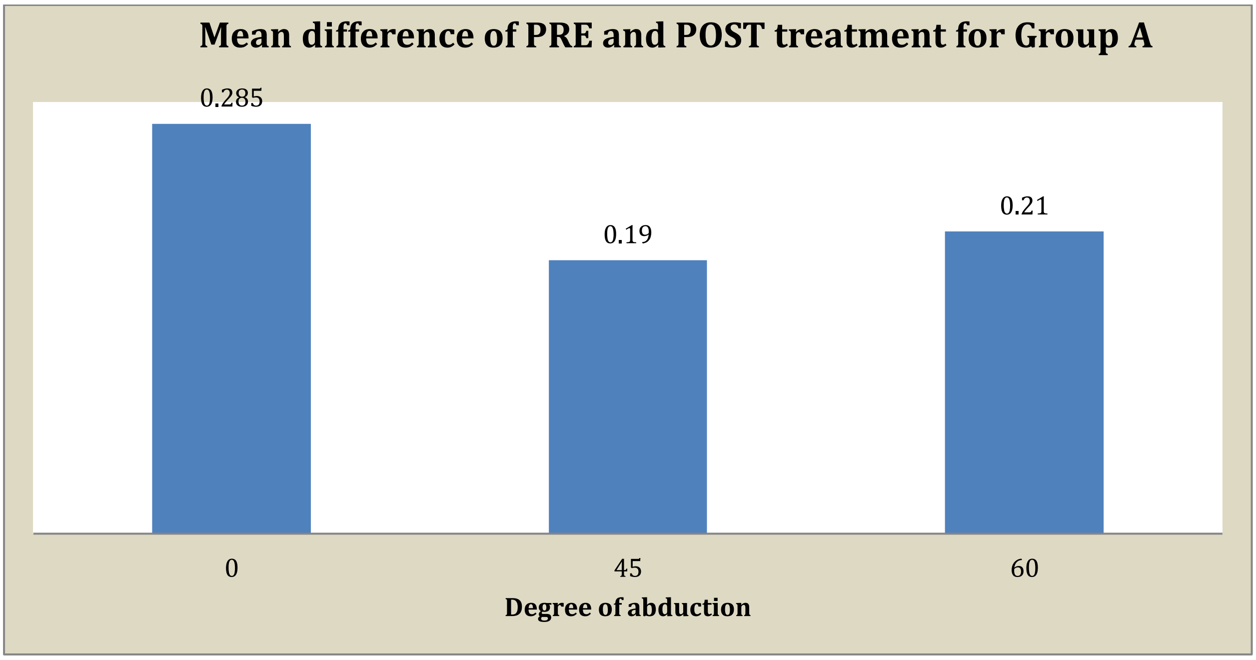


Table 3: Comparison of mean difference of PRE and POST treatment AHD for Group B

Degree of abduction	Mean difference	t- value	p- value	Significance
0^0	0.861	11.45	P<0.0001	S
45^0	0.76	16.01	P<0.0001	S
60^0	0.71	12.93	P<0.0001	S

AHD in mm

Graph 3: Mean difference of PRE and POST treatment for group B

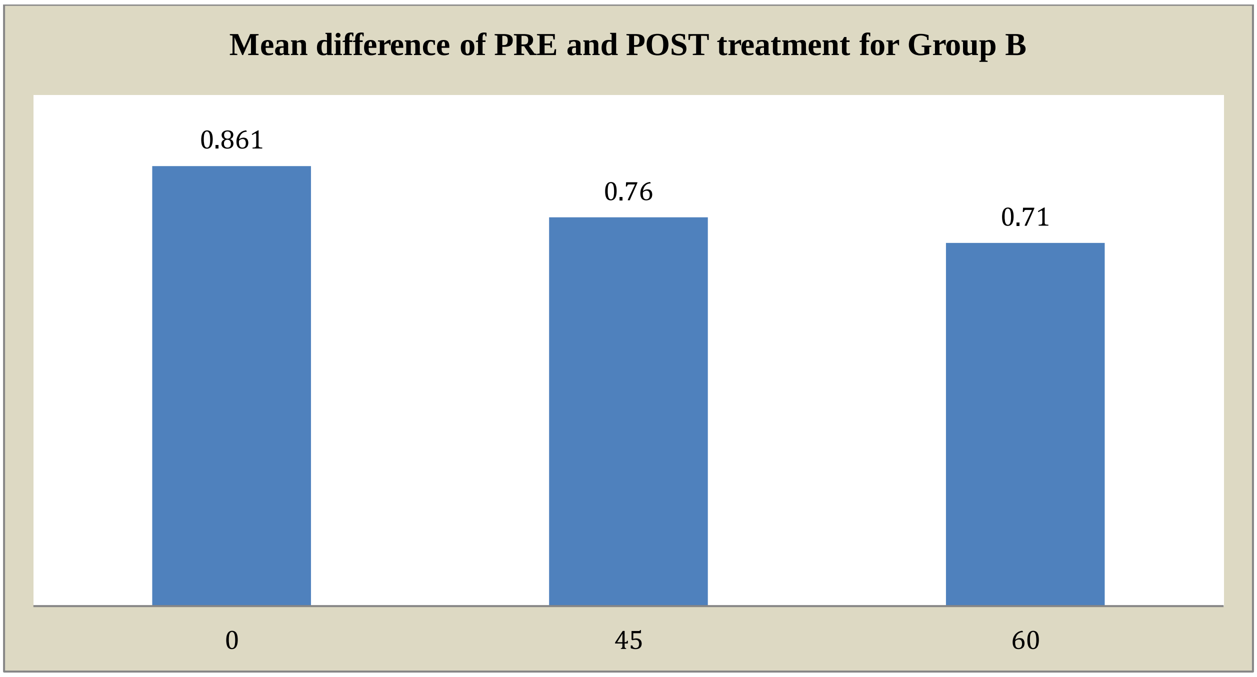
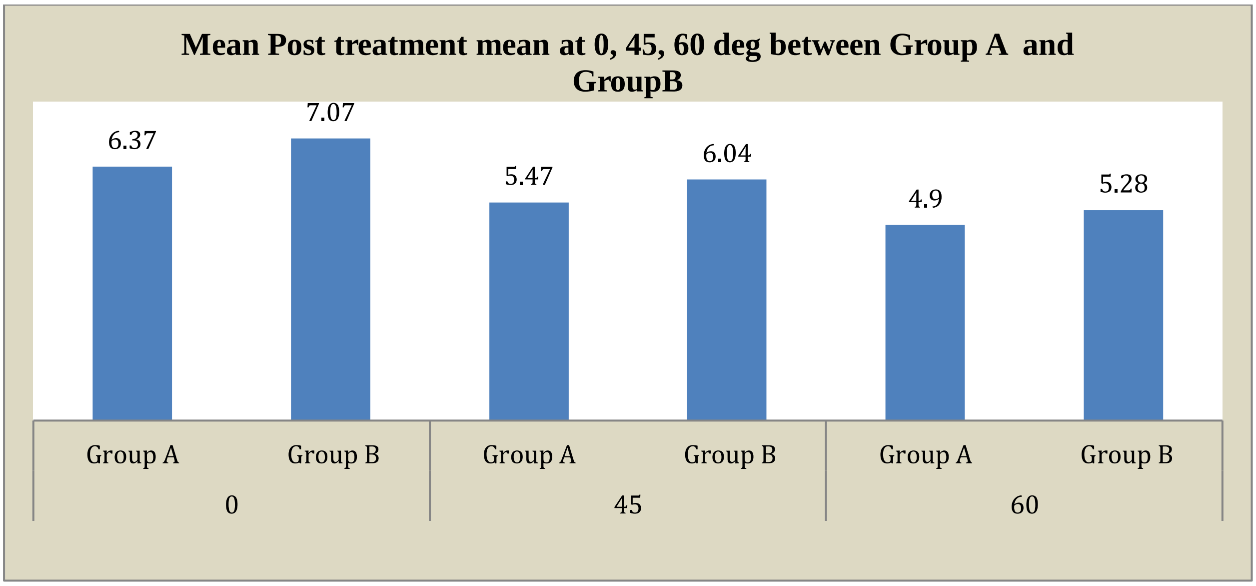


Table 4 : Comparison of POST treatment mean of AHD at 0, 45, 60 deg between Group A and Group B

Degree of abduction	Group	Mean ±SD	t- value	p- value	Significance
0^0	**A**	6.375±0.799	4.19	P<0.0001	S
	B	7.077±0.699			
45^0	**A**	5.47±0.742	3.85	P<0.0001	S
	B	6.04±.570			
60^0	**A**	4.9±0.766	2.62	P=0.011	S
	B	5.28±0.508			

AHD in mm

Graph 4: Comparison of POST treatment Mean for Group A and B



DISCUSSION

This study was done to compare the effectiveness of scapular muscle strengthening and combined core and shoulder exercises on acromio-humeral distance (AHD) in athletes with scapular dyskinesia. While analyzing the outcome variable of this study it was observed that group B (combined core and shoulder exercises) showed significant improvement in acromiohumeral distance than group A (scapular muscle strengthening), thus supporting the experimental hypothesis.

Based on AHD obtained through ultrasonography, we found the effectiveness of each treatment technique individually. The results also showed that increase in AHD within group A and group B when it was compared between pre and post treatment sessions. This is in agreement with previous study done by **Jason Brumitt et al. (2009)** suggesting that scapular muscle strengthening alone have a short term effect on disability and function in treatment of athletes with scapular dyskinesia. Inclusion of integrated core and shoulder exercises may help to bridge the gap between the initial rehabilitation exercises and later functional rehabilitation exercises.[1]

Scapulothoracic muscles training:

The scapula plays a major role in sports participation performance as a central segment in kinetic chain, overhead tasks are performed through the utilisation and integration of multiple body segments and muscles, sequential activation of specific muscle group resulting in performance of a specific dyanamic action is known as kinetic chain function. In clinical literature, a relationship of the scapulothoracic muscle to shoulder pain has often been suggested, these imbalances result in scapular instability, potentially increasing the risk of shoulder problems, and would be present in muscle recruitment as well as in force output. According to **W Ben Kibler, et al ., (2013),** the treatment strategies for shoulder injury can be more effectively implemented by evaluation of the dyskinesis and rehabilitation programmes to restore scapular position and motion can be effective within a more comprehensive shoulder rehabilitation programme. Recent evidence on Shoulder Impingement Syndrome (SIS) has highlighted the role of scapular muscles in maintaining stability , thus literature study showed scapular muscle strengthening group had better outcomes with respect to disability and function thus decreasing disability in patients with impingement syndrome.[2]The same also was agreed by **Sakiko Oyama, et al (2008)** suggesting that scapular posture is one of the most important components of the physical examination in overhead athletes, according to this study postural asymmetry is typically considered to be associated with shoulder injuries. The results of his study stated that in overhead athletes, the dominant- side scapula was more internally rotated, anteriorly tilted and protracted than the non-dominant side. Clinicians evaluating overhead athletes need to recognize that scapular posture symmetry in unilateral overhead athletes may be normal. Results emphasize the importance of the baseline population in order to accurately assess pathologic change in bilateral scapular positions and orientations after injury.[8] According to **Philip McClure (2009)**, shoulder injuries are common in athletes involved in overhead sports, and scapular dykinesis is believed to be one causative factor of these injuries, it is asserted that abnormal scapular motion (dyskinesis) is related to shoulder injury. Also satisfactory reliability has been proved to diagnose scapular dyskinesia by videotaped method from posterior aspect.[23] This is in agreement with a study done by **Babette M Pluim (2013),** suggested that though scapular dyskinesis is most commonly seen in overhead athletes with shoulder injuries but can also be present in asymptomatic individuals, which was a consensus statement ,this consensus conference aimed in evaluating and treating scapular dykinesis and also stated that shoulder impingement syndromes are associated with scapular dyskinesis, This consensus concluded that evaluation and rehabilitation programme have been specifically developed to improve scapular muscle strength and movement. **Dr. Janda** suggested that subacromial impingement results from a characteristic pattern of muscle imbalance including weakness of the lower the lower and middle trapezius, serratus anterior, infraspinatus, and deltoid, coupled with tightness of the upper trapezius pectorals and levator scapula. The literature substantiates that the imbalances in glenohumeral and scapulothoracic musculature are present in patients with subacromial impingement.[9] This is in agreement with a study done by **Dr. Dabholkar (2015)**, suggesting that, kinematic alterations have been associated with shoulder pathologies, such as shoulder impingement syndrome. The same agreed by **Annelies Maenhout** that altered motion pattern has been shown to change glenohumeral and scapular kinematics, this could compromise the subacromial space.[6] **Graichen (1999),** conducted a study on 10 patients with impingement syndrome, muscle activity led to a significant decrease in the width of the subacromial space compared with of healthy contralateral side($p<0.05$). This study concluded that, muscle activity and arm position were found to cause systematic changes in the width of the subacromial space.[11] **Phil Page (2011)** suggesting the relation between shoulder muscle imbalance and subacromial impingement syndrome in overhead athletes, according to this study shoulder impingement accounts for 44 to 65% of shoulder complaints, the purpose of this study was to describe the role of muscle imbalance in subacromial impingement in order to guide sports physical therapy evaluation and interventions, the muscular imbalance lead to changes in arthrokinematics and movement impairements, which may ultimately cause structural damage.[25]

Core with shoulder muscle training:

Core stability has been proven to be an essential component of biomechanical efficiency, allowing the athlete to maximize force production while minimizing loads placed on peripheral joints. This is especially important during complex movements such as: running, jumping, swimming, throwing, and spiking.[12] Due to the three-dimensional nature of complex movements, athletes must have adequate core strength in order to provide effective stability during a wide variety of movements.[13,14] **Ahmed Radwan** in 2004 done a study to find out any correlation between shoulder dysfunction and core instability. The results of this study demonstrated that collegiate overhead athletes with shoulder dysfunction had less balance compared to healthy athletes. Additionally, poor performance of these athletes in some of the core stability measures was correlated to the extent of their shoulder dysfunction. Such results may support the use of balance and core stability training in the design of successful rehabilitation protocols for overhead athletes with shoulder dysfunction. [7] **Kibler et al** advocate a shoulder rehabilitation strategy that addresses proximal dysfunction in the kinetic chain first by targeting scapulathoracic dyskinesis. [15,16] Research shows that glenohumeral external rotator fatigue is associated with altered scapular kinematics during elevation, which may be related to concomitant fatigue of the scapular and trunk stabilizers.[24,17,18]

Literature documenting the activation of trunk musculature during slower isotonic speeds suggests a delay in the feed-forward mechanism.[19] Therefore, exercises known to activate the trunk could be performed simultaneously with isotonic glenohumeral exercises in order to prepare the athlete for more advanced functional exercises. Dysfunction within the kinetic chain will affect how forces are generated, summated, or transferred from proximal segments (legs, hip, torso) to the upper extremity.[12,20, 21] Weakness within the core may contribute to the development of an overuse upper extremity injury.[12,14,22]

The importance of core muscle strengthening for various musculoskeletal dysfunction was already proved. According to **Ahmed Radwan, et al., (2014)** there is a relation between shoulder dysfunction and core instability, greater shoulder dysfunction is correlated with greater balance and stability deficiency , and also suggested that core stability is an essential component of biomechanical efficiency, allowing the athlete to maximize force production while minimizing loads placed on peripheral joints. He found that collegiate overhead athletes with shoulder dysfunction had less balance compared to healthy athletes.[7] But in a study of **McManus et al**., the effectiveness of the core intervention on various functional performance aspects was not supported though there was improvement in core endurance parameters in the 8-week training program for healthy men.[30]

When combined core and shoulder exercises were given in plank position, it creates a functional midsection because they work on the entire core, which encompasses the whole trunk from the pelvic girdle to the shoulder girdle. Plank position activates core muscles and strength of these core muscles have been linked to function and injury to extremities. Activated core muscles act as a muscular box or cylinder and the centre of kinetic chain, these muscles get activated in a feed forward fashion during upper extremity movement, This feed-forward mechanism occurs as the body prepares for potential perturbation of spinal stability when extrimities begin movement, the thoracic spine has been shown particularly to undergo perturbation during glenohumeral elevation, thus if core muscle are strong to take the load during overhead sports then there will be reduced chances of injury to upper extremity. Thus incorporating core along with shoulder exercises are more effective than scapular strengthening alone.[1]

Scapular muscles (serratus anterior, middle trapezius, lower trapezius and upper trapezius) works in co-ordination with rotator cuff muscles, (supraspinatus , infraspinatus, rhomboids, subscapularis, teres minor) and core muscles. When these muscles work in synchrony they provides effective force couple and smooth glenohumeral joint kinematics. Any alteration in the synchrony of these muscles due to abnormal scapular position or abnormal scapular motion (lack of scapular upward rotation) or weakness of scapular musculature, core musculature or glenohumeral musculature will disturb the scapular kinematics and disturbed force couple action lines and thus affecting acromiohumeral distance (decreased acromiohumeral distance) leading to impingement symptoms in overhead athletes.[31] Strengthening of combined core and shoulder muscles along with rotator cuff muscles (glenohumeral musculature) will affect AHD leading to increase in AHD. By the compressive force provide by the rotator cuff to stabilize the humerus head against the glenoid, providing dyanamic stabilization of glenohumeral joint and thereby reducing impingement.[31]

Failing to identify and address contributing musculoskeletal dysfuctions may delay an athletes successful return to sport, hence integrating shoulder and core addressed potential musculoskeletal dysfunctions while serving as a transitional program exercises and terminal return to sport rehabilitation program and help to bridge the gap between initial rehabilitation exercises and later functional rehabilitation exercises, hence we came to a conclusion that combined core and shoulder exercises are more effective than scapular strengthening alone in athletes with scapular dyskinesia. The limitation of the study included active shoulder position maintained by athletes during USG was difficult to monitor.

CONCLUSION

The study concluded that scapular strengthening exercises and combined core with shoulder exercises are effective in overhead athletes with scapular dykinesia and has a influence on AHD.

But when compared the scapular strengthening exercises and combined core with shoulder exercises the study concluded that the combined core with shoulder exercises are more effective in overhead athletes with scapular dykinesia and has a influence on AHD.

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INFORMED CONSENT FORM

Subject identification number for this trail ______________________________

Difference in Scapular Muscle strengthening and Combined Core and Shoulder Exercises in Quantifying AHD (Acromiohumeral distance) in Overhead Athletes with Scapular Dyskinesia- A Comparative ObservationalStudy.

Name of the principal investigator: Rathod Arpita Tel. No 7020559059

I have received the information sheet on the above study and have read and/or understood the written information.

I have been given the chance to discuss the study and ask the questions.

I consent to take part in the study and I am aware that my participation is voluntary.

I understand that I may withdraw at any time without this affecting my future care.

I understand that the information collected about me from participation in this research and sections of any of my medical notes may be looked at by responsible persons (ethics committee members/ regulatory authorities).I give the access to these individuals to have access to my records.

I understand I will receive a copy of the patient information sheet and the informed consent form.

______________________ ______________________

Signature / Thumb impression of subject Date of signature

Signature/ Thumb impression of Witness Date of signature

______________________ ______________________

DATA COLLECTION FORM

Name:
Age:
Gender:
Sport:
Duration of play:
Dominant Side:
Groups: Group A-Scapular muscle strengthening

Group B-Core muscle strengthening with shoulder muscle strengthening.

Group	**Treatment**	**AHD Distance before strengthening exercises.**	**AHD Distance after 4 weeks of strengthening exercises.**
A	Scapular muscle strengthening		
B	Core muscle with shoulder muscle strengthening.		

A clinical method of identifying scapular dyskinesis

Philip McClure, PhD, PT conducted a study to determine inter-rater reliability of a new test designed to detect abnormal scapular motion.

METHOD:

Participants were asked to simultaneously elevate their arms overhead as far as possible to a 3-second count using the ‘‘thumbs-up’’ position and then lower to a 3-second count. Tests were performed with volunteers grasping dumbbells according to body weight, 1.4 kg (3 lb) for those weighing less than 68.1 kg (150 lb) and 2.3 kg (5 lb) for those weighing 68.1 kg or more. The ratings of flexion and abduction motions were combined such that if both motions were rated normal or 1 was judged normal and the other, subtle dyskinesis, the final rating was normal; if both were judged as subtle dyskinesis, the final rating was subtle dyskinesis; and if either test motion was rated obvious dyskinesis, the rating was obvious dyskinesis.

CONCLUSION:

The study conclude that the tests for scapular dyskinesis showed satisfactory reliability for clinical use in a sample of overhead athletes known to be at increased risk for shoulder symptoms.

GROUP A							
sr no.	AGE	PRE			POST		
		0	45	60	0	45	60
1	18	5.4	4.7	3.9	5.6	4.8	4.5
2	19	6	5.6	4.8	6.2	5.8	5.1
3	18	5.9	5.4	4.4	6.1	5.7	4.7
4	18	5.9	4.8	4.6	6.1	5.1	4.7
5	20	5.9	5.3	4.2	6.1	5.5	4.6
6	30	5.4	4.9	4.9	5.6	5.3	5
7	20	6.1	4.9	4.2	6.2	5.2	4.4
8	20	5.8	5.2	4.1	6.2	5.3	4.3
9	21	6.1	5.5	4.3	6.2	5.6	4.6
10	24	6	5.2	4.6	6.3	5.5	4.7
11	24	5.8	4.3	4.4	5.9	4.8	4.4
12	24	5.6	5.3	4.6	5.8	5.5	4.7
13	26	5.5	4.8	4.4	5.6	4.9	4.6
14	20	6.4	4.5	4.2	6.7	4.7	4.3
15	18	6.1	4.9	4.8	6.3	5.1	5
16	20	5.8	4.3	4.2	5.9	4.6	4.4
17	30	4.9	4.4	4.2	5	4.6	4.4
18	27	5.8	4.7	4.3	6.1	4.9	4.4
19	20	6.1	4.9	4.2	6.3	5.3	4.3
20	21	5.8	4.6	4.3	6.1	4.7	4.4
21	22	5.9	5.2	5	6.1	5.4	5
22	22	6	4.6	4.1	6.1	4.9	4.5
23	23	5.7	4.9	4.3	5.7	5.1	4.3
24	29	7	5.4	4.8	7.2	5.6	5
25	26	5.7	4.7	4.3	6	4.9	4.5
26	28	5.8	4.9	4.2	5.9	5.1	4.4
27	18	5.7	4.8	4.3	5.8	5	4.5
28	18	5.2	5	4.8	5.6	5.1	5.1
29	23	5.6	5.4	4.3	5.9	5.5	4.6
30	22	6.6	5	4.3	6.8	5.3	4.5
31	24	5.9	5.9	5.2	7.3	6.5	5.5
32	20	6.1	5.5	5.8	6.7	5.3	5.2
33	25	6.2	5.8	5.8	7.3	6	5.9
34	22	7.1	6.7	6.6	7.5	6.6	5.5
35	26	7.1	6.8	5.6	7.7	5.9	6.7
36	19	6	6	4	6	6.1	4.1
37	17	8	7	5	9.3	8.1	7.5
38	27	7.8	7.4	7	7.8	7.5	7.1
39	23	7.5	6.4	5.9	7.5	6.4	5.9
40	25	6.4	5.9	5	6.5	5.9	5

GROUP B						
AGE	PRE			POST		
	0	45	60	0	45	60
27	6.4	5.8	5.4	7.1	6.5	5.7
27	6.1	5.4	5.1	7	6.3	5.7
20	6.6	5.4	4.7	7.3	5.9	5.6
18	6.2	5.1	4.3	7.1	6.1	4.8
20	5.7	4.4	4.2	6.2	5	4.6
23	6.4	5.5	4.3	7.2	6.2	5.1
27	5.6	5.1	4.1	6.3	5.9	4.6
25	5.9	4.9	4.2	6.5	5.4	4.8
17	5.7	4.6	4.2	6.6	5.8	4.9
19	5.3	4.4	3.8	6.2	5.6	4.6
18	5.5	4.7	4	6.7	5.8	5.4
28	5.6	4.7	4.3	6.1	5.3	5
23	5.5	4.7	4.3	6.2	5.2	5
18	6.8	4.5	4.2	7.6	5.8	5.3
22	6	5.2	4.1	7.9	6.1	5.9
22	5.9	5.1	4.5	6.5	5.7	4.9
28	6.2	5.4	4.2	6.8	5.7	4.8
30	6.2	5.4	4.4	6.7	6	5.1
20	6.4	5.2	4.4	6.8	5.9	5.1
21	6.5	5	4.2	7	5.8	4.9
24	6.2	4.8	4.1	6.7	5.7	5.5
22	6.3	5.6	4.6	7	6	5.2
18	6.2	4.8	4.3	6.8	5.6	4.8
22	6.5	4.7	3.6	6.8	5.3	4.3
20	6.6	5.4	4.2	7.6	6	5.2
27	6.3	5.5	4.3	6.8	5.9	5
23	6.6	5.6	5.1	7.3	6.2	5.6
30	6.5	5.3	4.6	7	5.9	5
18	5.9	5.1	4.1	6.2	5.6	5.3
25	5.7	4.9	4.3	6.3	5.9	4.8
21	6	5.5	5.2	7.3	6.5	5.5
27	6.1	5.6	4.6	6.7	6.1	5.9
24	6.7	6.1	5.8	7.3	6.7	6.3
20	6.3	6.1	5.9	7.5	6.7	6.5
17	6.1	5.9	5.2	8.1	6.6	5.6
22	6.8	6.2	5.3	7.9	7.1	5.8
19	6.2	5.8	5.1	8.6	7.2	5.9
25	6.2	5.5	4.6	7.9	6.6	5.9
18	7.1	6.2	5.3	8.6	6.4	5.6
24	7.6	6.4	5.7	8.9	7.9	6