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Effectiveness of eccentric strength training and scapular stabilization on subacromial impingement syndrome: A comparative study

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Abstract
Introduction: Shoulder pain is the third most common musculoskeletal pain. Subacromial impingement syndrome has been found most common condition in shoulder. This study is to compare scapular stabilization exercise and eccentric strengthening exercise.
Objective of study: To compare the effectiveness of eccentric strength training and scapular stabilization exercise on subacromial impingement syndrome.
Methodology: 30 subjects were selected according to the selection criteria divided into two groups. Group A and Group B was given scapular stabilization exercise outcomes scores were taken before and after treatment.
Conclusion: Scapular stabilization exercise showed improvement in reducing pain and improvement function than eccentric strength training.

Keywords: Eccentric strength training, scapular stabilization, subacromial impingement syndrome

Introduction
Shoulder pain is the third most common musculoskeletal pain encountered in clinical practice after neck and low back pain. Subacromial impingement syndrome has been found to be most common diagnosis for shoulder pain [5]. Prevalence of subacromial impingement syndrome range from 44 to 65% [4].
Subacromial impingement syndrome represent a spectrum of pathology ranging from Subacromial bursitis to rotator cuff tendinopathy and full thickness Rotator cuff tears [4]. The syndrome has been described by NEER as impingement of the rotator cuff, biceps tendon long head and subacromial bursa against anterior under surface of the acromion and coraco-acromial ligament during elevation of the arm as a result of narrowing of sub acromial space [11]. Subacromial space is defined by the humeral head inferiorly, the anterior edge and under surface of the anterior third of acromion, coracoacromial ligament and acromioclavicular joint superiorly. Any abnormality that disturbs the relationship of these subacromial structures may lead to impingement. It was characterized by pain and functional activities during overhead activities.

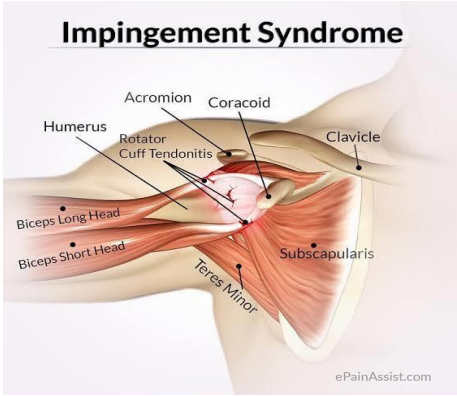


Fig 1: Impingement Syndrome

Neer described 3 stages of impingement

Stage 1: Impingement is characterized by edema and hemorrhage of the subacromial bursa and cuff. Person usually under twenty- twenty-five years of age.

Stage 2: Involves irreversible changes such as fibrosis and tendinitis of rotator cuff is typically found in patients who are 25- 40 years old.

Stage 3: Impingement is marked by more chronic change; such as partial or complete tears of the rotator cuff and is usually seen in patients who are more than 40 years old [2, 4, 6].

Many treatment alternatives as operative and non- operative ranging from rest to total craniectomy have been suggested commonly. The goals of non- operative treatment of SIS are to decrease subacromial inflammation, and to allow healing and to restore function of painful shoulder.

Stability at the scapulo thoracic joint depends on surrounding musculature. During all movements of glenohumeral joint (especially movement involving more than 90˚ of flexion or abduction) it is of paramount importance that the scapula stabilizing musculature be strong enough to properly position the scapula. For example, the biomechanical research of both Jobe and pink and Bak and Faunl demonstrated that if weakness or fatigue of scapulothoracic muscle potentially leads to disturbance in scapulothoracic rhythm and the secondary impingement ensues (relative decrease in subacromial space due to instability of glenohumeral joint or functional scapulothoracic instability) [12, 14]. Thus, role of scapula in upper extremity function must be considered in any shoulder rehabilitation program. So, the scapular stabilization exercise should be given in order to keep scapula in proper position to prevent impingement and maintain length tension relationship of musculature.

The eccentric muscle strength training should be included in the rehabilitation of tendon injuries and they showed promising results with an eccentric training model in patients with chronic tendinitis. It has been proposed that possible explanations for the positive effects of eccentric training on tendinitis might be either an effect of stretching, with a lengthening of the muscle-tendon unit and consequently less strain during shoulder joint motion or effects of loading within the muscle tendon unit with hypertrophy and increased tensile strength in the tendon [9, 19]. Thus, remodeling of the tendon is induced from eccentric loading.

The subjects were assessed by using outcome measure such as

1. **The Western Ontario Rotator Cuff Index:** It is a disease-specific quality of life questionnaire, evaluating the change in symptoms and functional ability [8].
2. **Numerical Pain Rating Scale:** A pain scale used to measure the patient's pain intensity.

   Therefore, the purpose of the study is to compare the effectiveness of scapular stabilization exercise versus eccentric strength training of the patients with subacromial impingement syndrome.

Aim of the study

This study aims to compare the analysis of eccentric strength training and scapular stabilization exercise on subacromial impingement syndrome.

Need of the study

Many studies were done to find the effect of eccentric strength training in subacromial impingement syndrome. In recent studies, it has been suggested that, the role of the scapula in upper extremity function must be considered in any shoulder rehabilitation program and also another states that scapular stabilization exercise is effective in subacromial impingement syndrome. So, there is a need arises to find out the effective exercise for shoulder rehabilitation program. Hence this study is analysis of eccentric strength training and scapular stabilization exercise in patients with subacromial impingement syndrome.

Objectives

To find out the effect of scapular stabilization exercise in patients with subacromial impingement syndrome.

To find out the effect of eccentric strength training for patients with subacromial impingement syndrome.

To compare the analysis of eccentric strength training and scapular stabilization exercise for patients with subacromial impingement syndrome.

Hypothesis

Null hypothesis

There is no significant difference in comparing the analysis of eccentric strength training and scapular stabilization exercise for patients with subacromial impingement syndrome.

Alternate hypothesis 1

Scapular stabilization exercise program would have more significance than eccentric strength training in patients with subacromial impingent syndrome.

Alternate hypothesis 2

Eccentric strength training program would have more significance than scapular stabilization exercise in patients with subacromial impingement syndrome.

Review of literature

Poul Frost *et al*., (1999) had conducted the cross-sectional study to analyses the risk of shoulder impingement syndrome related to shoulder intensive work. The study was conducted for the workers in chemical factory. They are assessed by using outcome measures such as video-based observation, and by questionnaires and by physical examination. This study concluded by supporting the hypothesis that shoulder intensive work is a risk factor for impingement syndrome of the shoulder.

Sneh Bansal *et al*., (2007) had conducted the prevalence in New Delhi study to determine the prevalence and intrinsic risk factors that predispose to shoulder impingement syndrome among male competitive swimmers aged between 17 and 35 years. This study was conducted for 161 subjects. They are using the outcome measures such as questionnaires and clinical evaluation. The findings have implications for training the symptomatic athlete and devising the safely recommendations.

Peter B Macdonald *et al*., (2000) had conducted the study to assess the diagnostic accuracy of the Neer and Hawkins impingement signs for the diagnosis of subacromial bursitis or rotator cuff pathosis. This study was conducted for 85 consecutive patients undergoing shoulder arthroscopy by a

single surgeon. The Neer sign was found to have a sensitivity of 75% for the appearance suggestive of subacromial bursitis, this compares with 92% for Hawkins sign. For the rotator cuff, the sensitivity of Neer sign was 85% and Hawkins sign was 88%. This study concluded that the Neer and Hawkins signs are sensitive for appearance suggestive of subacromial bursitis and rotator cuff partial or complete tearing with a high negative predictive value.

Per Johnsson *et al*., (2006) had conducted a pilot study to investigate the effect of painful eccentric supraspinatus and deltoideus muscle training in patients with long duration of pain- symptoms related to subacromial impingement syndrome in the shoulder. They are assessed by using the outcome measure VAS. This study was conducted for 9 patients with the age of 54 years. The study concluded that the specially designed painful eccentric model for the supraspinatus and deltoideus muscles showed promising short term clinical results on a small group of patients with severe pain from impingement of the shoulder.

Susanne Berhardsson *et al*., (2011) had conducted the single subject research design to evaluate the effect on pain intensity and function of an exercise concept focusing on eccentric strength training of the rotator cuff in patients with subacromial impingement syndrome. The study was conducted for 10 patients with the age of 54 years quality of life evaluated with WORC. They are assessed by using the outcome measures such as pain intensity by the VAS, shoulder function evaluated with the constant score, and shoulder related. It was concluded that eccentric strengthening programme targeting rotator cuff and incorporating scapular control and correct movement pattern can be effective in decrease pain and increasing function in patient with subacromial impingement syndrome.

Zeliha Baskurt *et al*., (2011) had conducted the experimental study to find out the effect of scapular stabilization exercise in patients with subacromial impingement syndrome. They are assessed by the outcome measure such as pain, ROM, muscle strength, JPS and QOL. This study was conducted for 40 patients, 27 women and 13 men with the mean age of 51(24-71) years old. The study concluded that the changes produced in the patients receiving scapular stabilization exercises are both statistically and clinically relevant.

Alexandra Kirkley *et al*., (2003) had designed a health-related quality- of- life measurement tool development to develop a valid and reliable tool for patients with rotator cuff index: The Western Ontario Rotator Cuff Index. Methodology for the development and evaluation of the tool included the following: 1) identification of specific patient population 2) generation of potential items 3) item reduction 4) presenting the prototype instrument 5) determination of reliability and 6) validation. The study concluded that this measurement tool can be used as the primary outcome in clinical trials evaluating treatments in this patient population, although its features are equally attractive for monitoring patients progress in clinical practice.

Andrea Diniz Lopes *et al*., (2009) had conducted the comparative study to compare the self-report and interview administration methods using the Western Ontario rotator cuff index (WORC) and Disabilities of the arm, shoulder and hand questionnaire (DASH) in patients with rotator cuff disorders. This study was conducted for 30 patients over 18 years of age with rotator cuff disorders. A randomized method was used to determine whether the questionnaires would be self- reported (n= 15) or administered by an interviewer (n=15). The study concluded that there are no differences between the western Ontario rotator cuff index and disabilities of the Arm, shoulder and Hand Questionnaire administration methods with regard to administration time or correlations between the questionnaire.

Rajiv D Limbasiya *et al*., (2014) had conducted the experimental study to find out the effectiveness of scapula focused exercise program on shoulder pain in paraplegic patients using wheelchair. The study was conducted for 30 patients who have shoulder pain and using wheelchair for 6 months. They are assessed by using the outcome measure WUSPI (Wheelchair user shoulder pain Index). The study concluded that scapula focused program resulted in significant reductions in shoulder pain in wheel chair users with spinal cord injuries and shoulder pain.

Methodology

Study Design: A comparative study

Study Setting: Aarupadai Veedu College of physiotherapy, Department of physiotherapy

Collection of Data: Patients with shoulder pain were selected under selection criteria

Sample Groups: 30 subjects [15 subjects- scapular stabilization exercise] [15 subjects- eccentric strength training]

Sampling Method: Randomized sample method

Outcome Measures: NPRS Scale & Western Ontario Rotator Cuff Index

Study Duration: 6 months

Materials used in the study

1. Assessment sheet
2. Consent form
3. Couch
4. Swiss Ball
5. Towel
6. Thera Band

Selection Criteria

Inclusion Criteria

- Age between 35-45 years
- Male alone
- Three positive of five following tests:
  - Neer impingement sign
  - Hawkins Kennedy test
  - Jobs supraspinatus test
  - Painful arc between 60˚ to 120˚ of abduction
  - Tenderness on palpation of supraspinatus or infraspinatus tendon insertion

Exclusion Criteria

Subject with history of shoulder surgery

- Neurological deficits
- Adhesive capsulitis
- Diagnostic instability or previous history of dislocation
- Systemic inflammatory condition
- Rom was restricted due to burns or postoperative scar

Outcome Measure

NPRS Scale: This is the 10-point scale with 0- Representing no pain

1-3 representing mild pain (nagging, annoying, interfering with ADLs) 4-6 representing moderate pain (interference

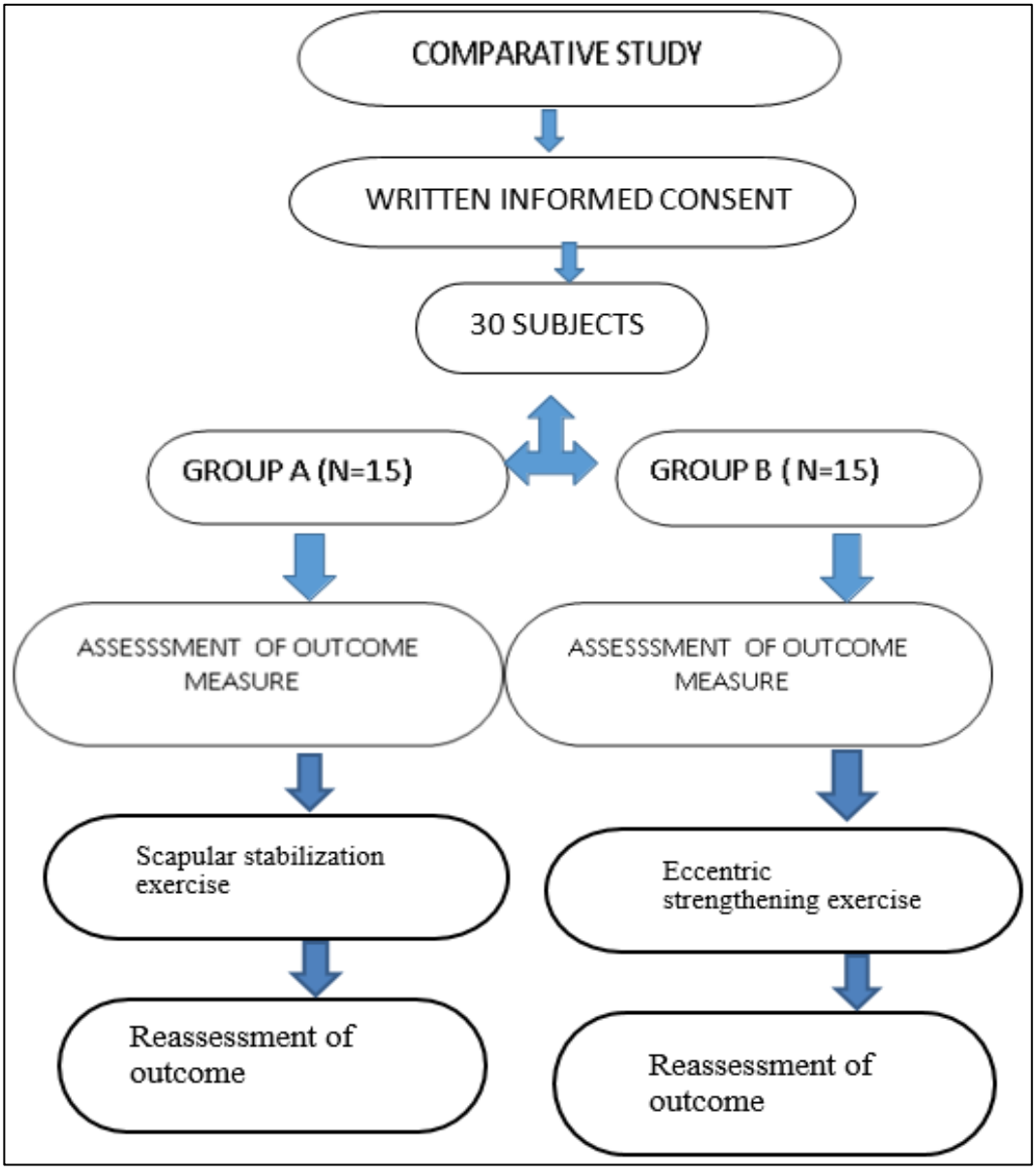
significantly with ADLs) 7-10 representing severe pain (disabling, unable to perform ADLs)
The subjects been asked to make a mark and selects the number that best represents his/ her intensity of pain experienced on the same day.

Western Ontario rotator cuff index (WORC)
The Western Ontario Rotator Cuff Index is a self-report questionnaire that was designed to measure "Health related quality of life". This score included items of 5 domain in the questionnaire:

1. Pain and physical symptoms
2. Sports and recreation
3. Work
4. Lifestyle
5. Emotions

The authors followed a systemic, clinometric method of generating and reducing the items. This resulted in 21 items that respondents answered on visual analogue scale (VAS) with anchors such as no pain/difficulty and extreme pain/ difficulty.

Study Protocol



Flow chart representation of methodology

Procedure
Patient who fulfilled the inclusion criteria were included in the study. The benefit of the study and the treatment were explained to the patient and written consent was taken. All subjects (n=30) included in the study were randomly allocated into 2 groups consisted of 15 subjects each.

Group A: scapular stabilization exercise Group B: Eccentric strength training

Group a-scapular stabilization exercise
Each exercise was done as 3 sets of 10 repetition – 3 times a week for 6 weeks.

Scapular clock exercise
The patient places the hands of the injured arm on a ball on a plinth. The patient then moves the shoulder in the direction of 12 o' clock, 3 o'clock, 6 o' clock, and 9 o'clock which facilitates elevation, retraction, depression and protraction.

Blackburn Exercise

(1) Prone horizontal abduction (neutral)

Lie on the table, face down with arms hanging straight down to floor and palms facing down. Raise arms to the side, parallel to the floor. Hold for 2secs and lower slowly.

1) **Prone horizontal abduction (full ER)**
   Lie on the table, face down, with arms hanging straight to the floor, and thumbs rotated up. Raise arms out to the side, parallel to the floor. Holds for 2 secs and lowered slowly.
2) **Prone horizontal scaption (neutral)**
   Lie on the table, face down, with arms hanging straight to the floor, and palm facing down. Raise arms out to the side by 120˚ of horizontal abduction. Holds for 2 secs and lowered slowly.
3) **Prone horizontal scaption (full ER)**
   Lie on the table, face down, with arms hanging straight to the floor, and thumbs rotated up. Raise arms out to the side by 120˚ of horizontal abduction. Holds for 2 secs and lowered slowly.
4) **Prone horizontal external rotation:**
   Lie on the table, face down, with arms abducted horizontal to side and elbows bent 90 pointing down. Rotate arms externally so that forearm come parallel to ground pointing forward. Hold for 2 secs and lower slowly.
5) **Prone horizontal extension:**
   Lie on table, face down with arms hanging straight to the floor and palm facing forward. Raise your arms to the horizontal parallel the thorax. Hold for 2secs and lower slowly.

Ball stabilization on the wall

The patient should stand near the wall with the injured side hands on the ball. Instruct the patient to prevent the ball from moving in different directions.

Towel slide

In a towel, the patient stands near the plinth with the hand of the injured arm on a towel at the side. Instruct the patient to forward flex at the hips such that shoulder flexion is induced, producing a light stretch. Then instruct the patient to straighten up and extend the shoulder.

Group B- Eccentric strength training

3 sets of 15 repetitions, 7 days per week for 6weeks.

Diagonal pattern D2 Extension

Involved hand will grip Thera Band overhead and out to the side. Pull Thera Band down and across the body to the opposite side of leg.

D2 Flexion

Opposite action of D2 extension

External rotation at 0˚ abduction

Stand with involved elbow at the side, elbow at 90˚ and involved arm across front of the body. Grip Thera Band and pull out with arm, keeping elbow at side. Return theraband slowly and in controlled manner

Internal rotation at 0˚ abduction

Stand with elbow at side, fixed at 90˚ and should rotated out. Grip theraband and pull arm across body, keeping elbow at side.

External rotation at 90˚ abduction

Stand with shoulder abducted 90˚ and elbow fixed 90˚ fixed. Grip theraband, slightly lower than shoulder. Keeping shoulder abducted, rotate the shoulder back, keeping elbow at 90˚. Hold 2 secs and lower slowly.

Internal rotation at 90˚ abduction

Stand with shoulder abducted to 90, with elbow flexed 90. Keeping shoulder abducted, rotate shoulder forward. Hold 2 secs and lower slowly.

Shoulder abduction to 90

Stand with arm at side, elbow straight. Raise arm to the side, palm down until arm reaches 90 (shoulder level). Hold 2 seconds and lower slowly.

Scaption, internal rotation

Stand with elbow straight and thumbs up. Raise arm to shoulder level at 30 angles in front of body. Do not above shoulder height. Hold two seconds and lower slowly

Statistical Analysis

Statistical formula

In this study, pre and post interventional differences within the two test and between the two groups were analyzed using unpaired 't' test for each of the outcome measures. Statistical significance was set at $p<0.0001$.

The paired 't' test is formulated as:

$$t = \frac{\bar{d}}{\frac{S}{\sqrt{n}}}$$

$$Where\ S = \sqrt{\frac{\sum(d-\bar{d})^2}{n-1}}$$

Were,
D= mean difference d= mean
n= total no. of sample

For the between group analysis, 't' test is used

The unpaired 't' test is formulated as

$$t = \frac{x1-x2}{S\sqrt{\frac{1}{n1}-\frac{1}{n2}}}$$

$$S = \sqrt{\frac{n1s1^2+n2s2^2}{n1+n2-2}}$$

Were,

x1 and x2 are means of group A and group B n1 and n2 are sample sizes of two groups.

Variance of sample 1 $(s1^2)$

$$= \frac{\sum(x1-x)^2}{n1-1}$$

Variance of sample 2 ($s2^2$)

$$= \frac{\sum (x2-x)^2}{n2-1}$$

The outcome values obtained were manually calculated.
In this study, to find out the effectiveness of scapular stabilization exercise and eccentric strength training on rotator cuff patients with subacromial impingement syndrome was founded by comparing the significance difference between the both groups. The pre- test and post-test interventional differences within the two groups were analysed using paired
't' test for outcome measures. Statistical significance was set at p<0.01 was considered as a significance difference.
The p- value was chosen as per the description given by research book.

Table 1: Description of p value

P- value	Description
<0.0001	Extremely significant
0.0001 to 0.01	Very significant
0.01 to 0.05	Significant
>0.05	Not significant

All data analysis was done using presented as, an value SD. For using the above said outcome measure, data were regarding pre and post values. The related paired 't' test was performed to find the significant changes after treatment using the formula.

Table 2: Within the group analyzis of pain in group a

Group A	Mean	SD	T- value	P- value
Pre-test	7.67	0.98	17.7482	<0.001
Post test	4.67	0.72		

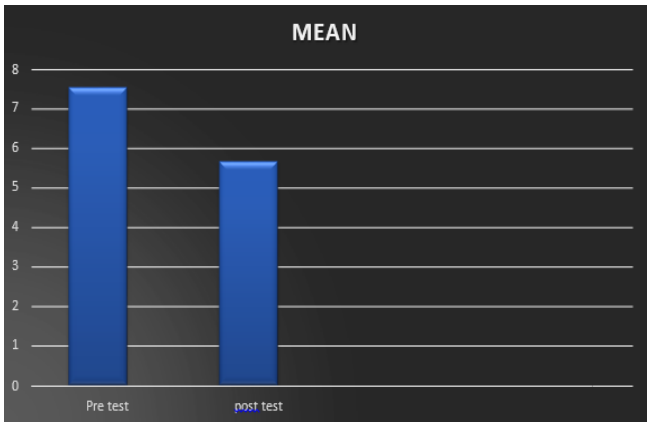
Showing the pre and post values of group A: paired 't' test values
The 'p' value of pain in group A is <0.001 considered significant. The 't' value of pain in group A is 17.7482 with 14 degree of freedom

Graph 1: within the group analysis of pre and post test of pain in group A

Table 3: Within the group analyzis of pain in group b

Group B	Mean	SD	T- value	P- value
Pre -test	7.53	1.06	14.000	<0.001
Post test	5.67	1.05		

Showing the pre and post values of group B: paired 't' test values
The 'p' value of pain in group B is <0.001 considered significant. The 't' value of pain in group B is 14.000 with 14 degrees of freedom

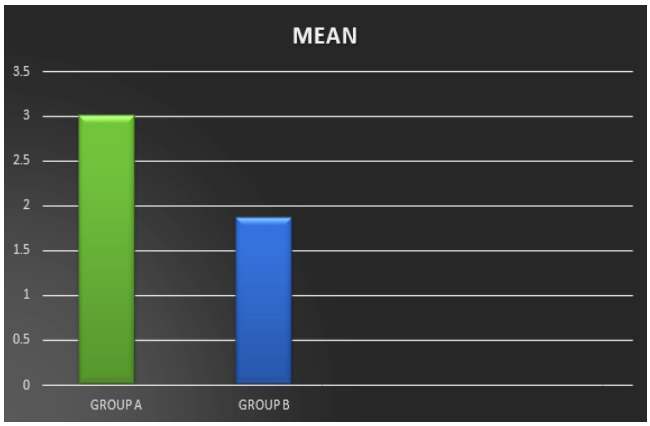


Graph 2: within the group analysis of pre and post test of pain in Group B

Table 4: Between the group analyzis of pain in group a and Group B

	Mean	SD	T- value	P- value
Group A	3.00	0.65	5.2643	<0.001
Group B	1.87	0.52		

Showing the pre and post values of group A and B: unpaired 't' test values.
The 'p' value of pain is <0.001 considered significant.
The 't' value of pain is 5.2643 with 28 degrees of freedom

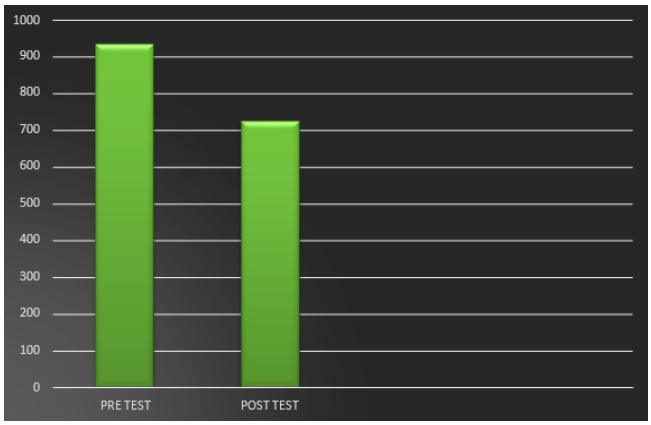


Graph 3: between the group analysis of pain in group A and B

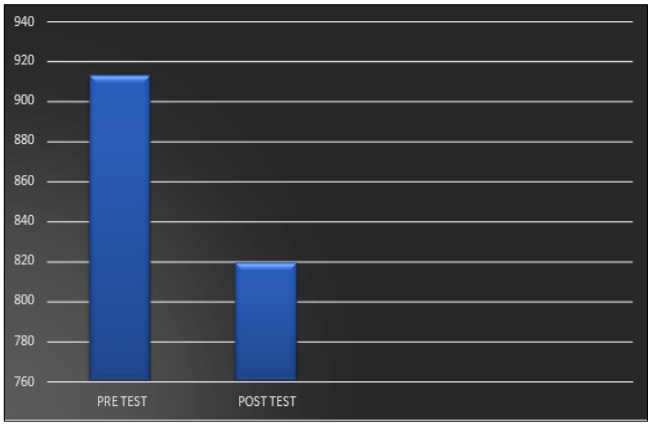
Table 5: Within the group analyzis of functional score in group a

Group A	Mean	SD	T- value	P- value
Pre -test	933. 67	89.13	17.7438	<0.001
Post test	722	74.57		

Showing the pre and post values of group A: paired 't' test values
The 'p' value of functional score in group A is <0.001 considered significant.
The 't' value of functional score in group A is 17.7438 with 14 degrees of freedom
Mean



Graph 4: within the group analysis of pre and post test of functional score in group A



Graph 5: Within the group analysis of pre and post-test of functional score in group B

Table 6: Within the group analyzis of functional score in group b

Group B	Mean	SD	T- value	P- value
Pre-test	913	94	13.7138	<0.001
Post test	819	82.90		

Showing the pre and post values of group B: paired 't' test values

The 'p' value of functional score in group B is <0.001 considered significant. The 't' value of functional score in group B is 13.7138 with 14 degrees of freedom

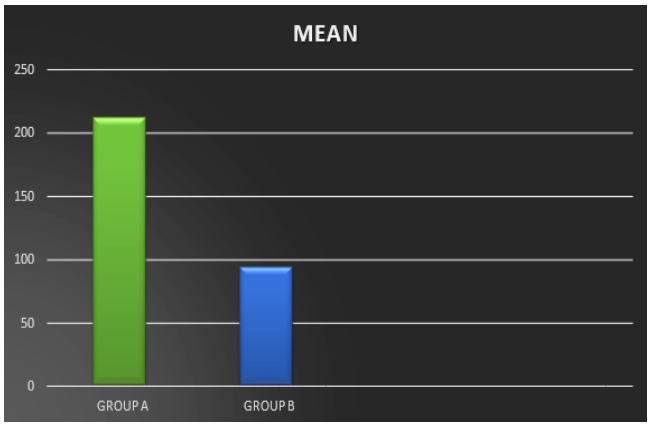
Table 7: Between the group analyzis of functional score in Group A and Group B

	Mean	SD	T- value	P- value
Group A	211.67	46.20	8.5532	<0.001
Group B	94	26.54		

Showing the pre and post values of group A and B: unpaired 't' test values

The 'p' value of functional score<0.001 considered significant.

The 't' value of functional score is 8.5532 with 28 degree of freedom



Graph 6: Between the group analysis of functional score in group A and group B

Result

The data were analysed using paired 't' test to find the significance of intervention used among groups. The analytical test showed significance for both groups in scapular stabilization exercise (group A) and eccentric strength training (group B) were effective in reducing the pain and improvement in functional score among both groups p<0.001. According to mean difference group A showed more significance than group B.

Discussion

The present study is a comparative study conducted to find out the effectiveness of scapular stabilization exercise versus eccentric strength training of the rotator cuff for patients with subacromial impingement syndrome.

Pre and post values were assessed before and after 6 weeks using the outcome measures such as pain and the functional score. These values were statistically analysed using repeated measure of paired 't' test.

The most common cause of the shoulder pain and an increasingly used diagnosis is subacromial impingement syndrome. The participants in this study were selected based on the inclusion, exclusion criteria.

The incidence of subacromial impingement syndrome has been reported to be 44 to 60% in a general population. 66% in swimmers, 57% of professional pitcher, 44% of collegiate volleyball player and 20% of collegiate javelin thrower.

In this study, 30 subjects who fulfilled the inclusion and exclusion criteria were taken with age group between 45 to 60 years. They were randomly allocated to 2 groups: group A and group B, each containing 15 subjects. Scapular stabilization exercise was given to group A and eccentric strength training was given to group B. The outcome was assessed by using the NPRS scale and the Western Ontario Rotator Cuff Index score. The outcome measure is used to measure the pain and quality of life before and after the

treatment.

The shoulder must be considered a kinetic chain made up of several joints. The normal function of the scapula and the surrounding musculature is vital to the overall normal function of the shoulder. Belmont *et al*., 2000 stated that, when the scapula fails to perform its stabilization role, shoulder function is inefficient and may predispose to subacromial impingement syndrome. zeliha baskurt *et al*., 2011 studied the effectiveness of scapular stabilization exercise in patients with subacromial impingement syndrome which concluded as significant. It can be more effective in muscle strength, developing the JPS, and decrease scapular dyskinesias.

Eccentric strength training, first introduced in 1984 by stanish *et al*., have for many years used successfully to treat other tendinopathies. Histological changes in supraspinatus tendon have been found to have similarities with those of Achilles tendon. Per Johnson *et al*., 2006 done a pilot study on eccentric training programme for patients with chronic impingement syndrome has shown promising results. Susanne bernhardson *et al*, 2010 did the 12-week eccentric strengthening program, which concluded as significant.

Result of the concurrent study demonstrated that six week of scapular stabilization exercise helps in reducing pain and improvement in functional score for the Patient with subacromial impingement syndrome than compared with eccentric strength training.

Scapular stabilization exercise helps to improve the strength and function of the muscles that control the position of scapula. Eccentric muscle strengthening helps in remodeling of tendon, thus reducing pain and improvement in functional score but comparatively scapular stabilization exercise is more effective in reducing pain and improvement in functional score in patients with subacromial impingement syndrome.

Conclusion

The result of the study concluded that scapular stabilization exercise showed marked improvement in reducing the pain and improvement of functional score than the eccentric strength training.

Limitation and Recommendation

Limitations

- Follow- up was difficult.
- Age between 35 to 40 years only were taken.

Recommendation

- Sample size should be increased**.**
- Study duration must be longer.
- Pamphlets printed of exercise procedure with proper guidelines should be given to the patient.

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