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# Measurement of Strength and Flexibility Parameters of Badminton Players of Indian Origin: A Normative Data

**Jyoti Aggarwal[1], Davinder Kumar Gaur[2]**

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**ABSTRACT**

Badminton is an extremely demanding sport and has emerged significantly in India presently. At an elite level, players are often required to perform at their limits of speed, agility, flexibility, endurance and strength. While many tests are used for measuring aforesaid parameters, field tests are found to be practically more feasible for sports population. Badminton is a sport which requires upper limb strength and flexibility supplemented by agility, speed and flexibility of lower limb along with endurance of the body. Since Indian athlete's normative data is comparatively less available therefore more researches have been focusing on sports data collection.

***Methodology***: 30 badminton players of Indian origin were randomly selected for examination of their upper extremity and lower extremity strength and flexibility. Subjects who fulfilled the inclusion criteria were included in the study. Four tests were performed by all the selected subjects, sit and reach test, static shoulder flexibility test, standing long jump test, and push up test.

***Result:*** Average shoulder flexibility score obtained was 11.51", standing long jump test score was 1.68m, push up test score was 38.86 while sit and reach test score was 26.08cm for male subjects and for females it was 13.22 ", 1.56m, 36.66, and 34.75cm respectively.

***Conclusion:*** Hencemale subjects were found with good flexibility and above average strength for upper extremity and under average flexibility and poor muscle strength for lower extremity and whereas, female subjects had excellent flexibility and excellent muscle strength for upper extremity and above average flexibility and below average muscle strength for lower extremity.

**Keywords:** Badminton; Strength; flexibility; fitness.

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## INTRODUCTION

Badminton is an extremely demanding sport. At an elite level, players are often required to perform at their limits of speed, agility, flexibility, endurance and strength. On top of all of this, players must maintain a high state of concentration in order to meet the tactical / mental demands of dealing with their opponents. The varied potential stresses of competitive play are considerable. It is

therefore essential that everyone involved with the modern game ought to be familiar with the fitness (physiological) requirements of the game and how 'Badminton fitness' can be enhanced. Badminton is one of the, fastest games with its, long history spanning more than three thousand years. Badminton refers to a sport that is played with racket in which a shuttlecock is volleyed across a net. World federation define, any person playing badminton, as a badminton player. The game, involves most of the body muscles with the energy, acquired from both aerobic and anaerobic processes. Regular badminton training, enhances physical fitness, especially speed, strength and, aerobic fitness. Badminton also requires a constant, analysis of continuously changing, situation on the court, focusing the player to racket, precisely and quickly, improving his or her assessment and anticipating the next move.[1] It is a sport that is related to strength, rather than strength-limited in that the performance of a player is influenced by strength, and not limited by it. Strength training is best optimised with 3-4 sets of 4-8 repetitions. The recovery between each set should be about 120 sec. Strength training sessions should generally be performed up to three times per week. True strength gains are unlikely unless training is performed at least twice a week. Once a player has become accustomed to performing the strength training movement appropriately, it should be ensured that weights are selected which cause fatigue after the required number of repetitions (in this case between 4 and 8 reps). The subsequent 2 minute recovery should be enough to allow the same (or similar) number of repetitions to be lifted. There are several exercises that target different muscle groups in this sports but ideal training programme should consist of both badminton specific and general exercises. Valuable exercises for badminton would include, Rotator cuff, Seated row, Lunges, Squats, Calf raises, Triceps press, Dumbbell flies It is preferable to use free weights (bars, dumbbells, etc.) as opposed to machine weights as the adaptations to free weight-training exercises are more functional to sporting performance. Correct movement technique is essential for appropriate strength development without injury risk. However, it is beyond the scope of this booklet to instruct on the technique of specific exercises: qualified instructors should be used for this purpose. There is a direct effect on certain muscle groups associated with wrist, elbow shoulders, neck, chest, abdomen, back, thigh, knees and ankles during this game. Muscle power or explosive strength is one such element and the ability to generate great amount of power is recognized as a primary factor in athletic success.[2,3] The badminton players use their flexibility to reach, dive and turn to cover all parts of the court. It is an advantage to have an above-average flexibility level of the trunk and shoulder region for sports. The greater flexibility of the stork arms undoubtedly an important factor, as well as hip and hamstring flexibility. Therefore, in badminton, above average flexibility of the shoulder, trunk and hip is expected of players, as flexibility also allows players to perform various strokes efficiently as much retrieval are made with the spine and shoulder joint in hyperextension and with the hips fully flexed by hamstrings when lunge jumps are made at the net. This flexibility allows for more fluent stroking when forced to stretch and facilitates agility on the court.[4,5,6] There are a number of different situations where flexibility (stretching) work is performed. Stretching should be part of any warm-up and warm-down but stretching should also be performed by Badminton players with a view to promoting long-term increases in joint flexibility. High flexibility is essential in our sport and separate flexibility sessions should be performed regularly in addition to the stretching done as part of a warm-up / down. If flexibility is performed as part of a warm up (and it should be), the aim is to make dynamic movements (i.e., not static stretches) throughout the range of motion for the main joints used in Badminton. This should involve focussing on the joints in the shoulder and lower body. Flexibility should also be used in warm down as this helps to reduce subsequent injury risk. In case, flexibility should involve static stretches where a muscle is stretched to close to its limit. At this point, there should be a very slight pain in the stretched muscle. This point should be held for 20-30 seconds before relaxing and repeating the same stretch 2-3 more times. The body mass index (BMI) or Quetelet index is a value derived from the mass (weight) and height of an individual. The BMI is defined as the body mass divided by the square of the body height, and is universally expressed in units of kg/m2, resulting from mass in kilograms and height in metres. The BMI is an attempt to quantify the amount of tissue mass (muscle, fat, andbone) inanindividual, and then categorize that person as underweight, normal weight, overweight, or obese based on that value. Commonly accepted BMI ranges are underweight: under 18.5 kg/m2, normal weight: 18.5 to 25, overweight: 25 to 30, obese: over 307,8. The aim of the study was to measure physical fitness parameters of badminton players in Delhi.

## METHODOLOGY

A descriptive survey, study design was conducted to determine the physical fitness parameters (BMI, strength, and flexibility) in district level badminton players in Delhi. 30 subjects of age group 14-28 were apprised for the procedure of the study. The subjects who fulfill the inclusion criteria were selected in the study. An appropriate training was given to the investigating team on the operation of equipment and the use of standardized test protocols to ensure that the tests are conducted in a valid and reliable manner. Planned visits were made according to the dates agreed by the stadium authorities. Consent letters were collected and the procedure, purpose of the study was explained to the in-charge, coach and the participating students. All the subjects were familiarized about testing procedure with demonstration of activity if needed. The data collection form were filled by the investigators while athlete performing the tests. Warm up and stretching exercises were done 15 min before starting the test procedure. Age, Height & weight were recorded followed by sit and reach test, shoulder flexibility test, push up test, and standing long jump test were perform. Three trials were recorded for sit and reach test, standing long jump test, and shoulder flexibility test followed by taking their average for statistical analysis.

## RESULTS

Results of the present study indicates that average shoulder flexibility of professional badminton players was 11.51'' which tends to fall under good category. Standing long jump test score was 1.68m which tends to fall under poor category. Push up test score was 38.86 which tends to fall under above average category. Sit and reach test score was 26.08cm which tends to fall under average category for male badminton players. For female badminton players average shoulder flexibility was 13.22 '' which tends to fall under excellent category. Average standing long jump test score was 1.56m which tends to fall under below average category. Average push up test score was 36.66 which tends to fall under excellent category. Average sit and reach test score of professional badminton players was 34.75cm which tends to fall under above average category.

**Table 4.1:** Demographic data table(female)

| Variable measured | N=Total subjects | Mean | Standard Deviation |
|---|---|---|---|
| Age | 6 | 16.16 | 0.40 |
| Height | 6 | 1.57 | 0.06 |
| Weight | 6 | 49.16 | 4.79 |
| BMI | 6 | 17.42 | 2.58 |

**Table 4.2:** Physical fitness test scores (females)

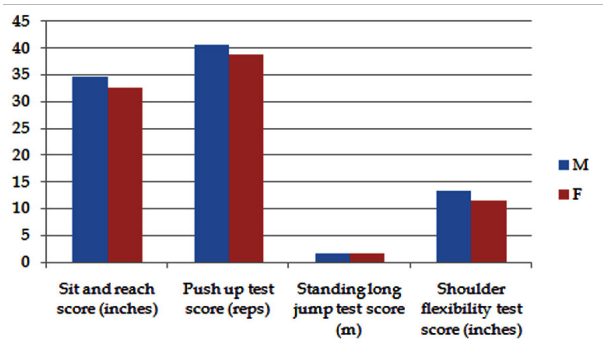
| Variable measured | N | Mean | Standard Deviation |
|---|---|---|---|
| Sit and reach score (inches) | 6 | 34.75 | 9.80 |
| Push up test score (reps) | 6 | 40.66 | 13.54 |
| Standing long jump test score (m) | 6 | 1.56 | 0.17 |
| Shoulder flexibility test score (cm) | 6 | 13.22 | 2.28 |

**Table 4.3:** Demographic data table (male)

| Variable measured | N=Total subjects | Mean | Standard deviation |
|---|---|---|---|
| Age | 24 | 18.71 | 3.07 |
| Height | 24 | 1.71 | 0.07 |
| Weight | 24 | 59.08 | 9.57 |
| BMI | 24 | 16.15 | 2.75 |

**Table 4.4:** Physical fitness test scores (male)

| | N | Mean | Standard Deviation |
|---|---|---|---|
| Sit and reach score (inches) | 24 | 32.60 | 7.71 |
| Push up test score (reps) | 24 | 38.86 | 12.18 |
| Standing long jump test score (m) | 24 | 1.68 | 0.37 |
| Shoulder flexibility test score (cm) | 24 | 11.51 | 3.05 |




**Graph 4.1:** Graphical representation of male and female fitness test scores.

## DISCUSSION

Badminton is a sport requiring high strength and flexibility. Indian athlete's physical fitness variables

normative data for different sports is scarcely available. Therefore in present study 30 professional badminton players were included for research. Appropriate training was given to the investigator on the operation of equipment and the use of standardized test protocols to ensure that the tests are conducted in a valid and reliable manner. Results of the present study indicate that average shoulder flexibility of professional badminton players was found to be 11.51 inches which tends to fall under good category, the average standing long jump test score of professional badminton players was found to be 1.68m which tends to fall under poor category, the average push up test score of professional badminton players was found to be 38.86 which tends to fall under above average category, the average sit and reach test score of professional badminton players was found to be 26.08cm which tends to fall under average category. In the female results of the present study indicates that average shoulder flexibility of professional badminton players was found to be13.22 inches' which tends to fall under excellent category, the average standing long jump test score of professional badminton players was found to be 1.56m which tends to fall under below average category, the average push up test score of professional badminton players was found to be 36.66 which tends to fall under excellent category, the average sit and reach test score of professional badminton players was found to be 34.75cm which tends to fall under above average category. Given the potential benefits of fitness testing, the Committee on Fitness Measures and Health Outcomes in Youth Russell Pate, Maria Oria, and Laura Pillsbury, et al, Food and Nutrition Board, Washington DC, national academic press, in 2012 recommends the use of Push-up for Upper-body strength, Vertical Jump for explosive power, lower-body strength and athletic ability are some measures that should be used in schools (and other educational settings)even though the evidence for their relationship with health is only promising at this time. The committee recommends these additional measures with the expectation that future research will elucidate whether they are related to health in youth.

## CONCLUSION

From the present study we conclude that male subjects have good flexibility and above average strength for upper extremity and under average flexibility and poor muscle strength for lower extremity and Female subjects have excellent flexibility and excellent muscle strength for upper extremity and above average flexibility and below average muscle strength for lower extremity.

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# Immediate Effectiveness of Subscapularis Positional Release Technique in Unilateral Adhesive Capsulitis: A Comparative Study

**Girija Murugan[1], Misbah Kaunain Khan[2], Vijay Krishna Kumar[3]**

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## ABSTRACT

***Background:*** In adhesive capsulitis, subscapularis, the largest and strongest muscle of the rotator cuff, undergoes tightness, which affects the abduction and external rotation of shoulder. There are many physiotherapy interventions used in treatment of adhesive capsulitis and among them, positional release technique is a method in which evaluation and treatment is done using tender/trigger points and a position of comfort to resolve the associated dysfunctions like pain and tightness.

***Objective:*** To compare the immediate effectiveness of subscapularis positional release technique in combination with shoulder capsular stretches over shoulder capsular stretches alone in patients with unilateral adhesive capsulitis.

***Methodology:*** 20 Patients with unilateral adhesive capsulitis were selected and divided into two groups based on the selection criteria. Group A received Subscapularis Positional Release Technique along with capsular stretches and Group B received capsular stretches alone. Numerical Pain Rating Scale and Active Shoulder range of motion using Goniometry were used as outcome measures pre and post treatment.

***Result:*** On comparing pre to post intervention values in Group A and Group B, there was significant improvement noted in terms of pain and shoulder ROM statistically, in both the both groups, but Group A showed more significant improvement.

***Conclusion***: The present study concluded that both the groups showed improvement statistically and clinically in terms of pain and shoulder ROM, but the participants who were given Subscapularis Positional Release Technique with capsular stretches showed more improvement compared to participants who were given capsular stretches alone.

**Keywords:** Adhesive capsulitis; Subscapularis; Positional release technique; Pain, ROM

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## INTRODUCTION

Adhesive capsulitis is an inflammatory condition which causes fibroses of the glenohumeral joint capsule, it is accompanied by gradual progressive stiffness and significant restriction of range of motion, typically external rotation, abduction, and flexion.[1] Adhesive capsulitis is more prevalent in women and within diabetic population with an occurrence rate of 20%.[2] About 10% of people may

develop adhesive capsulitis in the other shoulder within 5–7 years of the first one and it has been estimated to affect at least one person in 50 every year. However, it tends to resolve more quickly than the first.[3] Adhesive capsulitis is also popularly known as frozen shoulder. It is characterized by initial painful and later progressively restricted active and passive Glenohumeral joint range of motion with spontaneous complete or nearly complete recovery over a varied period.[4]

Frozen shoulder is one of the most common musculoskeletal conditions encountered in the Indian population with a prevalence of almost 50% of older patients with diabetes and 10% in non-diabetic patients.[5] A primary frozen shoulder is when the exact cause is not known. It is more common in people with diabetes and with a thyroid gland problem. About 15% of patients link it to a minor injury to the shoulder. A secondary frozen shoulder can develop if the shoulder area is kept still for some time, for example, after a stroke or heart attack.[6,7] There are 3 phases of frozen shoulder, The painful/freezing phase, which can last for 2-9 months with gradual onset of pain at rest and sharp pain at extremes of motion. Stiff/ frozen phase which can last for 4-12 months. In this phase, the pain starts to subside, and there is progressive loss of Glenohumeral motion in a capsular pattern. And the Recovery/thawing phase which can last for 5-26 months, in this phase there is spontaneous, progressive improvement in the functional range of motion. It can also occur after major injury or surgery to the shoulder.[8,9,10] There is a change in the available space and the available volume around the Glenohumeral joint as the patient develops contractures through a frozen shoulder.[11] The capsule allows an estimated 2 to 3 millimeters of distraction, which is important for the glenohumeral joint. On its own, it provides little contribution to joint stability. However, the tendons of the rotator cuff muscles insert into the capsule. Therefore, the dynamic action of the rotator cuff can influence the tension within the capsule. Overall, both ligaments and muscles insert directly into the capsule, providing an indirect link to the joint stability of the glenohumeral joint.[12,13] Frozen shoulder has a distinct capsular pattern of stiffness in which external rotation is the most restricted followed by abduction, flexion, and internal rotation. Normally, the rotator cuff strength will still be normal except for pain inhibition.[14]

In Adhesive capsulitis, subscapularis, the largest and strongest muscle of the rotator cuff muscles covering the anterior surface of the scapulae undergoes tightness, which affects the abduction and external rotation of shoulder.[15] It originates from medial two-third of the subscapular fossa and inserts into the fibers from a tendon which inserts into the lesser tuberosity of the humerus and the front of the shoulder joint capsule. Supplied by upper and lower subscapular nerves which are innervated by posterior cord of the brachial plexus.[16,17] Subscapularis produces an inferior directed translation force on the humeral head, and it is the primary muscle that internally rotates the glenohumeral joint. Long term reduction of mobility and capsular irritation from subscapularis dysfunction results in adhesive capsulitis.[18,19]

The physiotherapy treatment for adhesive capsulitis includes use of modalities like Transcutaneous Electrical Nerve Stimulation, Interferential Therapy, Ultrasound therapy, Moist Heat Therapy etc.[20,21] Manual therapy for joint includes Mulligan's mobilization technique, Maitland's mobilization technique, etc. and for soft tissue release, techniques like myofascial release, trigger point release technique etc are administered.[22,23] Among them, Positional release technique is a method in which evaluation and treatment is done using tender/trigger points and a position of comfort to resolve the associated dysfunctions like pain and tightness.[24] It is an indirect and passive treatment accomplished by placing the involved tissue in an ideal position of comfort.[25] It acts on the muscle spindle and controls the muscle spasm.[26]

## METHODOLOGY

***Study Design:*** Experimental

***Study Setting:*** Dr BR Ambedkar College of Physiotherapy, Dr BR Ambedkar Medical College and Hospital, Bangalore 560045.

***Criteria For Sample Selection:***

The patients were selected for the study based on the following criteria:

***Inclusion Criteria***

- Patient diagnosed with idiopathic unilateral adhesive capsulitis
- Pain in the shoulder joint ≥40% loss of active shoulder abduction and external rotation range of motion
- Aged between 40-60 years
- Duration of symptoms between 3-12 months

***Exclusion Criteria:***

- Secondary adhesive capsulitis associated with systemic diseases (diabetes, cardiovascular disorders etc.)
- Surgical procedures to shoulder (Total shoulder arthroplasty, manipulation under anaesthesia etc.)
- Any shoulder injuries or trauma

***Sample Size:*** 20 participants

***Sampling Method:*** Simple Random Sampling

The patients were randomly assigned into 2 groups, Group A and Group B in which Group A received subscapularis positional release technique with capsular stretches and Group B received capsular stretches alone.

***Study Duration:*** 6 Months Treatment Duration: 10-15 minutes Procedure And Treatment:

Both, the Group A and Group B were assessed with the outcome measures, followed by administration of the treatment techniques, and were immediately reassessed with the same outcome measures.

***Subscapularis Positional Release Technique***

- The patients were asked to be in supine lying and close to the edge of the table with their arm held by the therapist slightly in abduction, extension, and internal rotation at the shoulder.
- The therapist palpated for the tender point which lies close to the lateral border of the scapula, on its anterior surface.
- The therapist applies a constant pressure over the tender point using two fingers for a duration of 30 seconds of 3 repetitions with 30 seconds of interval between each repetition.
- Subscapularis PRT was administered to Group A

**Fig. 1:** Therapist performing Subscapularis Positional Release Technique on model

## CAPSULAR STRETCHES

***Anterior Capsule Stretch***

- Patients were asked to sit or kneel with their elbow and hand supported by a table beside the body and use hand of the uninvolved arm pressing down on the back of the closest part of their upper arm bone.
- They were asked to hold the position for 30 seconds of 3 repetitions with 30 seconds interval between each repetition.

**Fig. 2:** Model performing anterior capsular stretch

***Inferior Capsule Stretch***

- The patients were commanded to kneel with their elbow supported by a table beside and use their uninvolved arm and press down on the closest part of the upper arm bone.
- They were asked to hold the position for 30 seconds of 3 repetitions with 30 seconds interval between each repetition.

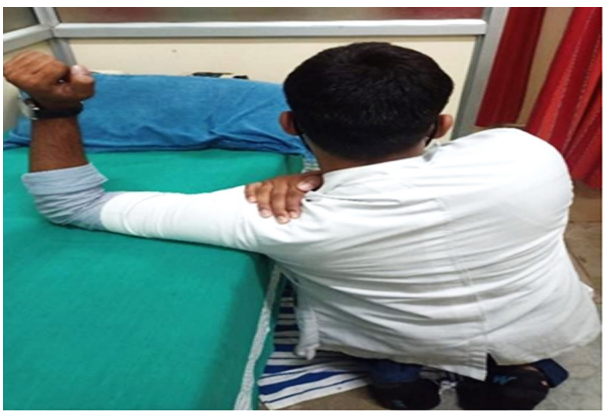


**Fig. 3:** Model performing inferior capsular stretch

- Capsular stretches were administered to both Group A and Group B

### *Outcome Measures*

- Numerical pain rating scale – for pain assessment
- Goniometer – for assessing the active shoulder abduction and external rotation range of motion.

## DATA ANALYSIS / RESULTS

Statistical analysis was done using SPSS 24 version. Descriptive statistics found using mean, SD and frequency percentage. Pre post comparison was done by paired t test between group comparison is done by unpaired t test. Significant level was set at 5%.

### *Demographic Data*

**Table 1:** Distribution of units based on gender

| Gender | Group | | Total |
|---|---|---|---|
| | A | B | |
| Female | 7 | 6 | 13 |
| | 70.0% | 60.0% | 65.0% |
| Male | 3 | 4 | 7 |
| | 30.0% | 40.0% | 35.0% |
| Total | 10 | 10 | 20 |
| | 100.0% | 100.0% | 100.0% |

In Group A 70% are female and 30% are male

In Group B 60% are female and 40% are male

**Graph 1:** Distribution of units based on gender

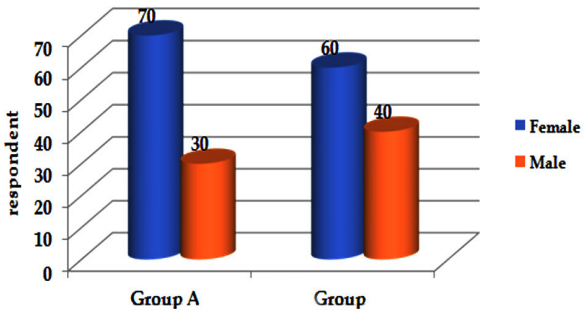
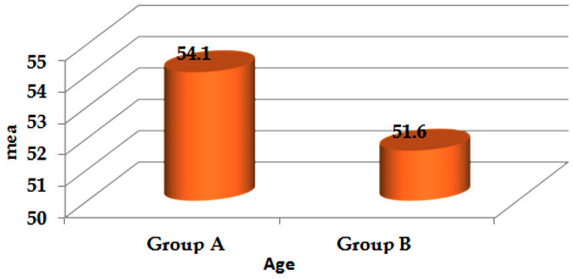



**Table 2:** Mean and SD of age

| | Group | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Age | A | 10 | 54.10 | 8.184 |
| | B | 10 | 51.60 | 6.345 |

In Group A average age is 54.1 ± 8.184 and in Group B average age is 51.6 ± 6.345

**Graph 2:** Mean and SD of age



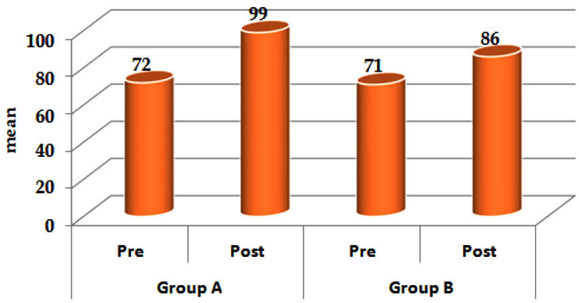

Shoulder Abduction Rom in Group A And Group B

**Table 3:** Mean and SD of active shoulder abduction ROM in Group A and Group B.

| | | Mean | Std. Deviation |
|---|---|---|---|
| Group A | Pre | 72.00 | 18.135 |
| | Post | 99.00 | 18.529 |
| Group B | Pre | 71.00 | 11.972 |
| | Post | 86.00 | 12.649 |

The above table show pre post mean score and SD of shoulder abduction ROM. IN Group A, pre-ROM is 72±18.135 and post treatment the ROM increased to 99±18.529. In Group B, pre-ROM is 71±11.972 and post treatment the ROM increased 86±12.649.

**Graph 3:** Mean and SD of active shoulder abduction ROM in Group A and Group B




Pre-post comparison of active shoulder abduction rom in group a and group b.

**Table 4:** t value and P value of active shoulder abduction ROM in Group A and Group B

| | | Mean | t value | P value | Result |
|---|---|---|---|---|---|
| Group A | Pre to Post | 27.00 | 8.487 | 0.000 | P<0.05 |
| Group B | Pre to Post | 15.00 | 6.708 | 0.000 | P<0.05 |

Pre post comparison shows significant improvement in ROM from pre to post in Group A and Group B.

Comparison of Active Shoulder Abduction Rom Improvement Between Group A and Group B

**Table 5:** t value and p value of pre post comparison in active shoulder abduction ROM

| | | Average improvement | t value | P value | Result |
|---|---|---|---|---|---|
| Shoulder abduction | Group A | 27.00 | 2.979 | 0.008 | P<0.05 |
| | Group B | 15.00 | | | |

Comparison between Groups shows p<0.05. Therefore, there is statistically significant difference between Group A and Group B. Group A's improvement is better than Group B.

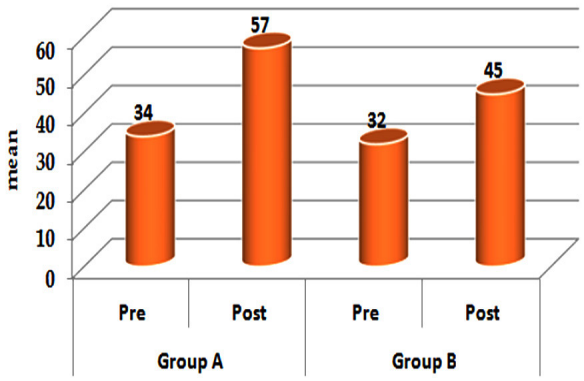
Active external rotation rom of shoulder in group A and group B

**Table 6:** Mean and SD of active External rotation ROM in Group A and Group B

| | | Mean | Std. Deviation |
|---|---|---|---|
| Group A | Pre | 34.00 | 9.660 |
| | Post | 57.00 | 12.516 |
| Group B | Pre | 32.00 | 9.189 |
| | Post | 45.00 | 7.071 |

The above table show pre post mean score and SD of active External rotation ROM. In Group A, pre-ROM is 34 ± 9.660 and post treatment the ROM increased to 57 ± 12.516. In Group B, pre-ROM is 32 ± 9.189 and post treatment the ROM increased to 45 ± 7.071.

**Graph 4:** Mean and SD of Active External rotation ROM in Group A and Group B




Pre-post Comparison of Active Shoulder External Rotation rom in Group A and Group B

**Table 7:** Pre post comparison of active external rotation ROM in Group A and Group B

| | | Mean | t value | P value | Result |
|---|---|---|---|---|---|
| Group A | Pre to Post | 23.00 | 10.371 | 0.000 | P<0.05 |
| Group B | Pre to Post | 13.00 | 8.510 | 0.000 | P<0.05 |

Pre post comparison shows significant improvement in ROM from pre to post in Group A and Group B.

**Table 8:** t value and P value of active shoulder external rotation ROM in Group A and Group B

| | | Average improvement | t value | P value | Result |
|---|---|---|---|---|---|
| External rotation | Group A | 23.00 | 3.810 | 0.001 | P<0.05 |
| | Group B | 13.00 | | | |

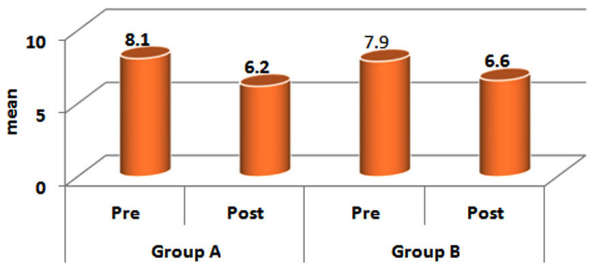
Comparison between group shows p<0.05. Therefore, there is statistically significant difference between Group A and Group B. Group A's improvement is better than Group B.

Numerical Pain Rating Scale in Group A and Group B

**Table 9:** Mean and SD of NPRS in Group A and Group B

| | | Mean | Std. Deviation |
|---|---|---|---|
| Group A | Pre | 8.10 | .737 |
| | Post | 6.20 | 1.135 |
| Group B | Pre | 7.90 | .994 |
| | Post | 6.60 | .843 |

The above table show pre post mean score and SD of NPRS. In Group A, pre-ROM is 8.1 ± 0.737 and post treatment the ROM reduced to 6.2 ± 1.135. In Group B, pre NPRS is 7.9 ± 0.994 and post treatment the ROM reduced to 6.6 ± 0.843.




**Graph 5:** Mean and SD of NPRS in Group A and Group B

Pre-Post Comparison of NPRS in Group A and Group B

**Table 10:** Pre post comparison of NPRS in Group A and Group B

| | | Mean | t value | P value | Result |
|---|---|---|---|---|---|
| Group A | Pre to Post | 1.900 | 8.143 | 0.000 | P<0.05 |
| Group B | Pre to Post | 1.300 | 8.510 | 0.000 | P<0.05 |

Pre post comparison shows significant improvement in VAS from pre to post in Group A and Group B.

Comparison of NPRS improvement between Group A and Group B

**Table 11:** t value and P value of NPRS in Group A and Group B

| | | Average improvement | t value | P value | Result |
|---|---|---|---|---|---|
| NPRS | Group A | 1.900 | 2.152 | 0.044 | P<0.05 |
| | Group B | 1.300 | | | |

## DISCUSSION

Comparison between groups shows p<0.05. Therefore, there is statistically significant difference between Group A and Group B.

Adhesive capsulitis is one of the most common causes of inappropriate shoulder function. This study was conducted to examine the immediate effectiveness of subscapularis positional release technique in patients with unilateral adhesive capsulitis.

**In Group A**, the mean shoulder abduction ROM post intervention was 99° with a difference of 27° from pre to post intervention, with a t value of 8.487 indicating that there was significant improvement in shoulder abduction ROM post intervention. The mean shoulder external rotation ROM post intervention was 57° with a difference of 18° from pre to post intervention, with a t value of 12.516 indicating that there was significant improvement in shoulder external rotation ROM post intervention. The mean NPRS post intervention was 6.20 with a difference of 1.900 from pre to post intervention, with a t value of 8.143 indicating that there was significant improvement in NPRS post intervention.

**In Group B**, the mean shoulder abduction ROM post intervention was 86° with a difference of 15° from pre to post intervention with a t value of 6.708 indicating that there was significant improvement in shoulder abduction ROM post intervention.

The mean shoulder external rotation ROM post intervention was 45° with a difference of 13° from pre to post intervention, which gave a t value of 8.510 indicating that there was significant improvement in shoulder external rotation ROM post intervention. The mean NPRS post intervention was 6.60 with a difference of 1.300 from pre to post intervention, which gave a t value of 8.510 indicating that there was significant improvement in NPRS post intervention.

On comparing Group A and Group B, the t value of shoulder abduction ROM was 2.979, the t value of shoulder external rotation ROM was 3.810, and the t value of NPRS was 2.152 which showed that there was significant improvement in Group A over Group B.

The possible physiology of reduction in pain and improved range of motion may be due to the following reasons, Positional Release Technique is thought to decrease tissue tenderness by altering nociceptor activity in the soft tissues. Based on previous literature and our current findings, it appears that PRT techniques have the capacity to provide immediate relief of tenderness. Also, PRT apparently begins to engage the fascial tension patterns associated with trauma, inflammation, and adhesive pathology. This process may involve an "unwinding" action in the myofascial tissue. Kerry and George concluded that the application of PRT may be effective in producing reduction of joint hypomobility. When the muscles crossing joints become hypertonic or tight, the result is joint hypomobility. By using PRT, the affected muscles and fascial tissues relax. PRT appears to affect inappropriate proprioceptive activity during this phase, thus helping to normalize tone and set the normal length-tension relationship in the muscle by elongation of the involved muscle fibers to their normal state. It also reduces fascial tension, and joint hypo-mobility and subsequently increase the ROM and decrease in pain.[26,27,28] With Capsular stretches, when tissues are stretched with a low intensity, prolonged stretch force, plastic deformation occurs, and the length of the tissue increases. The increase in range may be attributed to stretching of muscles and the capsule that becomes shortened because of decreased mobility and pain.[29]

## CONCLUSION

The conclusion of this study is based on the comparison of pre post mean measures of Active Shoulder Abduction ROM, Active Shoulder External Rotation ROM, and Numerical Pain

Rating Scale within and between Group A and Group B which concluded that there is significant improvement in both the groups but participants who received subscapularis positional release technique with capsular stretches (Group A) showed more improvement than participants who received capsular stretches alone (Group B) in terms of pain. The difference was significant statistically.

As per Data analysis and interpretation and Clinical improvement, Null hypothesis is rejected, and Alternate hypothesis is accepted which states "There was significant difference in-terms of pain and range of motion among the patients who received subscapularis positional release technique along with capsular stretches and patients who received capsular stretches alone."

## LIMITATIONS AND RECOMMENDATIONS

This study was conducted with 20 patients only and in future, studies with a larger sample size can be conducted for better results. This study showed the immediate effectiveness of the treatment; therefore, it is not possible to know the long-lasting effects of the treatment, for which a study of longer duration can be conducted.

## IMPLICATIONS TO PRACTICE

As this study has shown significant immediate improvement in participants who received subscapularis positional release technique in terms of pain and range of motion, it can be used in the treatment protocol of adhesive capsulitis as with its immediate effectiveness, and it may also increase the patient therapist adherence and treatment adherence.

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# To Compare the Effects of VMO Strengthening Exercise wth Quadriceps Isometric Exercise versus VMO Strengthening with Gluteus Medius Strengthening Exercise to Normalize Q Angle in Patients with Knee Osteoarthritis

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**ABSTRACT**

***Introduction:*** Trapezitis is defined as the 'inflammation of trapezius muscle'. The upper trapezius muscle designed as postural muscle and its highly susceptible to overuse. people who use their arms for extended periods of time that requires holding their arms out in front, like operating mobile, computer, bike riding, car driving or an assembly line worker will recognize a burning pain between the shoulder blades. Myofascial release which eliminates the fascia's excessive pressure on the pain sensitive structure and restores proper alignment. Hence this technique is proposed to act as a catalyst in cupping therapy (CT) a traditional chinese medicine therapy, has used for >2000 years and uses a negative pressure mechanism the resolution of trapezius spasm.

***Aim:*** The aim of study is to compare the effectiveness of cupping therapy vs. myofascial release technique in trapezitis caused by digitalization.

***Method:*** Total 30 patients were included in the study by simple random sampling method. Subjects were divided into two groups with 15 patients in each group. Group A was receive UST with myofascial release technique, Group B was receive UST with cupping therapy. The patient was assessed pre and post intervention through visual analog scale (VAS), neck disability index (NDI), and cervical range of motion (CROM).

***Result:*** Data was analyzed by using paired t-test. Pre and post score were taken via VAS, NDI, CROM. P value <0.05.

***Conclusion:*** The study concluded that both the groups has shown significant improvement in reduction of pain and improve functional limitation and range of motion. However MFR with UST has shown a better improvement than cupping therapy with UST when the subjects in both the groups are compared.

**Keywords:** Trapizitis, Mfr, Cupping Therapy, Vas, Ndi, Crom.

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## INTRODUCTION

Osteoarthritis (OA) is a common disease associated with significant morbidity. This is particularly apparent at the knee joint, one of the commonest sites to be affected. As prevalence of OA increases with age and aging is associated with decreasing physiological function, the combination has major health implications. Symptoms cannot, however, be predicted merely by the degree of

structural damage. The quadriceps weakness commonly associated with osteoarthritis of the knee is widely believed to result from disuse atrophy secondary to pain in the involved joint.[1] Osteoarthritis is degenerative joint disease. Commonly it is thought to be wear and tear of joints as one ages. Two types of OA are recognized-primary and secondary.

1. ***Primary OA:*** It occurs in old age mainly in the weight bearing joints.
2. ***Secondary OA:*** In this type, t here is an underlying primary disease of the joint which leads to degeneration of the joint.[2]

A high Quadriceps angle increases the chance of developing the various knee problems. One of the most common problems associated with increased Quadriceps angle is patellofemoral tracking syndrome. A high Quadriceps angle interferes with the smooth gliding movement between the patella & the knee. Overtime, especially with repetitive activities, this type of microtrauma causes non specific pain to the front of the knee. As this abnormal tracking continues, various knee muscles like hamstrings, quadriceps & calf muscle become imbalanced, and the cartilage on the underside of the patella begins to wear & thin, Eventually knee becomes degenerative & develops osteoarthritis.[3]

Isometric quadriceps exercise program showed beneficial effects on quadriceps muscle strength, pain, and functional disability in patients with osteoarthritis of the knee.[4] The Q angle have shown to be increased in the OA knee, possibly as the degeneration progresses and more pain and immobility could be aggravating factor. The Q angle of knee is measurement of the angle between quadriceps muscle and Patella tendon and it provides useful information about the alignment of knee joint. It is likely to be influenced by the muscle strength of varying group of muscles that alter the mechanics of knee other that Quadriceps alone. Gluteus Medius weakness is very common among people above age 50 and more evident with obesity indicating the mechanics change in the knee joint too.[5] Both Quadriceps isometric and VMO strengthening are effective in decreasing qangle.[6]

Knee osteoarthritis (OA), also known as degenerative joint disease of the knee, is typically the result of wear and tear and progressive loss of articular cartilage. It is most common in elderly women and men. Knee osteoarthritis can be divided into two types, primary and secondary. Primary osteoarthritis is articular degeneration without any apparent underlying reason. Secondary osteoarthritis is the consequence of either an abnormal concentration of force across the joint as with post-traumatic causes or abnormal articular cartilage, such as rheumatoid arthritis (RA). Osteoarthritis is typically a progressive disease that may eventually lead to disability. The intensity of the clinical symptoms may vary from each individual. However, they typically become more severe, more frequent, and more debilitating over time. The rate of progression also varies for each individual. Common clinical symptoms include knee pain that is gradual in onset and worse with activity, knee stiffness and swelling, pain after prolonged sitting or resting, and pain that worsens over time. Treatment for knee osteoarthritis begins with conservative methods and progresses to surgical treatment options when conservative treatment fails.[7]

Q-angle: The Q angle of knee is measurement of the angle between quadriceps muscle and Patella tendon and it provides useful information about the alignment of knee joint.[8]

Q angle is likely influenced by muscle strength of varying group of muscles that alterthe mechanics of knee other that quadriceps muscle alone. Strengthening exercise is widely recommended for the condition.[9]

Osteoarthritis is the second most common rheumatological problem and it is the most frequent joint disease with a prevalence of 22 to 39% in India.

## AIM OF STUDY

To Compare the effect of VMO strengthening with Quadriceps Isometric Exercise Versus VMO strengthening with Gluteus Medius Strengthening Exercise to Normalize Q Angle in Patients with Knee Osteoarthritis.

## NEED OF STUDY

A high Q angle increase the chance of knee osteoarthritis. This affects the biomechanics of knee joint. The muscle strength affects Q angle variation of osteoarthritis of knee. Some studies have shown that vastus medialis oblique strengthening exercise combined with quadriceps isometric exercise is effective in normalizing Q anglein in Patients with knee osteoarthritis. The weakness of hip gluteus medius (hip abductor) can be attributed to gender and obesity. Gluteus Medius (hip abductor) strengthening exercise combined with vastus medialis obique strengthening exercise helps in

reducing pain and can normalize q anglein knee osteoarthritis.

## PURPOSE OF STUDY

The purpose of present study is to normalize Q angle in patients with knee osteoarthritis by strengthening the weak muscles.

The importance of muscle strengthening is to treat Q angle in patients with knee osteoarthritis.This will help in correcting the alignment of the knee joint. This will alter the mechanics of the knee joint.

Muscle strength of varying group of muscles alter the mechanics of the knee joint.

### *Experimental Hypothesis*

There may be significant difference between effects of VMO strengthening exercise combined with Quadriceps isometric exercise versus VMO strengthening exercise combined with hip abductors to normalize Q angle in patients with knee osteoarthritis.

### *Null Hypothesis*

There may or may not be no significant difference between effects of VMO strengthening exercise combined with quadriceps isometric exercise versus VMO strengthening exercise combined with hip abductors to normalize Q angle in patients with knee osteoarthritis.

## REVIEW OF LITERATURE

***Santhi Venkatapathy et al.*** did a study on the effect of Isometric Quadricep Activation and Vastus Medialis Obliqus Strengthening in Decreasing Q-Angle amongYoung Females and concluded that both isometrics quadriceps activation and VMO strengthening reduced Q angle significantly and there was no difference between the two procedures. [33]

***Ayşe Aydemir EKİM et al.*** 2017did a study on Relationship Between Q-Angle and Articular Cartilage in Female Patients with Symptomatic Knee Osteoarthritis: Ultrasonographic and Radiologic Evaluation and concluded that HQ-angle was associated with cartilage thickness measurements of the medial femoral condyle and cartilage grading by ultrasonography and the Kellgren-Lawrence grading system in patients with knee OA.[34]

Ved Prakash et al. did a study on Correlation between body mass index, waist hip ratio & quadriceps angle in subjects with primary osteoarthritic knee and concluded that these 3 independent parameters as risk factors for primary oa were alsoa risk factors for the same interdependently.[35]

Sudhan 2018 did a study on Relationship of Muscle Strength and 'Q' Angle in Knee Osteoarthritis and concluded that there is positive relationship betweenmuscle strength, Q angle and Osteoarthritis knee and negative relation between musclestrength OA knees.[36]

***Laura H. Lathinghouse et al*** 2000 did a study on Effect of Isometric Quadriceps Activation on q angle in Women Before and after Quadriceps Exercise and concludedthat Q angle decreases with IQA.[38]

***Varah Yuenyongviwat et al*** 2020 did a study on Effect of hip abductor strengthening exercises in knee osteoarthritis: a randomized controlled trial and concluded that either hip abductor exercises combined with quadriceps exercises or quadriceps exercises alone could lessen patient pain and improve function. Adding quadriceps exercises could expedite improvement of less pain, symptoms, activity in daily living and quality of life faster than quadriceps exercises alone; however, this onlyappeared to be over a 2–4 weeks period with small effect size, after which there was there were no differences. Hence, considering to add hip abductor exercises in the treatment protocol should be based on the patients and doctors perspective.[39]

***Elizabeth A.*** Sled et aldid a study on Hip Abductor Muscle Strengthening In Persons with Knee OA: Effect on Knee Joint Loading During Gait and concluded that8 week home program of hip abductor muscle strengthening did not reduce knee joint loading, but improved function , in a group of participants with medial knee OA.[40]

## METHODOLOGY AND METHODS

***Sample Size:*** 30 osteoarthritis patient between 50 to 65 years of age group participate in thestudy. They will randomly divided into 2 groups. Group A (Experimental Group) and Group B (Experimental Group) with each group having 15. The confidence level 95% and confidence interval 5% will be used to calculate the sample size. Dehradun Census (Uttarakhand) population (6797970 in 2018) was included (census and sample survey, Dehradun 2018). This formula will beused in this study. Simple random sampling technique will be used. Study

will be conducted at Department of Physiotherapy, Shri Mahant Indiresh Hospital Patel Nagar.

***Study will be completed in 8 weeks. Sample selection:*** Consist of inclusion and exclusion criteria: Inclusion Criteria Age Group 60-65 years. Both sex, Experienced symptoms for atleast 4 weeks or more. Exclusion Criteria-Recent Traumatic Injury, Recent Knee Fracture, Recent injury to hip, Past surgery, Lower Limb Deformity, Scoliosis. Variables of the study: The independent variables areQuadriceps Isometric, Vastus Medialis Oblique Strengthening, Gluteus Medius Strengthening Quadriceps Isometric Vastus Medialis Oblique Strengthening Hip Abductor Gluteus Medius Strengthening Dependent Variables are Pain, Incorrect Q angleMuscle Srength. Outcome Measurement womac. Materials Used Goniometer Towel, roll, Pen, PillowSocks, Data Collection sheet.

## PROCEDURE

30 patients between the age group of 50-65 years were included in the study after taking a written consent from either the patient or their relative. Patient were made aware of the research and the procedure to be followed. Patient were divided into two groups. Each group consist of patients of both the gender. Group A received VMO strengthening with Quadriceps Isometric Exercise and Group B received VMO strengthening with Gluteus strengthening exercise. Both groups had received the rehabilitative exercise program to normalize Q-angle in Knee Osteoarthritis. The study was 8 weeks 6 days per week at department of Ortho in Shri Mahant ndresh Hospital, physiotherapy OPD. Examination included assessment which was performed on first and last day of treatment and data was recorded Group A-VMO strengthening exercise with quadriceps isometric exercise VMO strengthening Exercise.

Patients were instructed to lie in supine position with extended knee. Patients were instructed to rotate their leg laterally. Maintain the position for 10 seconds and then slowly lower the leg down. Relax and repeat the procedure for 10 times. Quadriceps Isometric Exercise: Patient is in supine position with extended knee. Arolled towel was placed under the knee. Next the patient was instructed to press thetowel hold iot for about 10 seconds and then relax. The procedure was repeated 10 times (Fig. 1)

**Fig. 1:** Patient Performing Quadriceps Isometric Exe

Group B: VMO strengthening Exercise with Gluteus Medius Strengthening Exercise VMO Strengthening Exercise. VMO strengthening exercise through squat with isometric hip adduction. (Fig. 2)

**Fig. 2:** Patient Performing VMO strengthening Exercise

Gluteus Medius Strengthening Exercise - Lie on one side with with bottom leg bent to 45 degree and the top leg straight. Stack the hips and shoulders directly on top of one another. There is a strong tendency to roll the hips forward or back here engage the gluteus medius to lift the upper leg to wards the ceiling: squeeze and hold the top position and then slowly lower the leg (Fig. 3).

**Fig. 3:** Patient Performing Gluteus Medius Strengthening

## RESULT

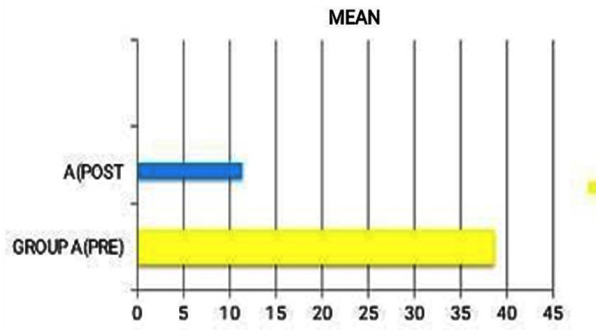
The chapter deals with result of data analysis of data ofone outcome measure that is WOMAC within

group A and Group B. The score were analyzed and interpreted and interpreted to determine which intervention is more effective in normalizing Q-angle in patiernts with knee osteoarthritis.

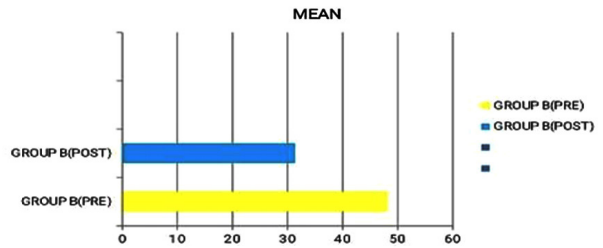
The data were analyzed using statistical software SPSS 15 version. To analyze the difference in the Womac scale between Group-A and Group-B, paired t-test was used. The p values <0.0001 in both the groups showing extremely significant but the Womac score in Group A is more effective as compared to Group B .(Table1)

**Table 1:** Mean Difference in Womac Score between Group A & Group B

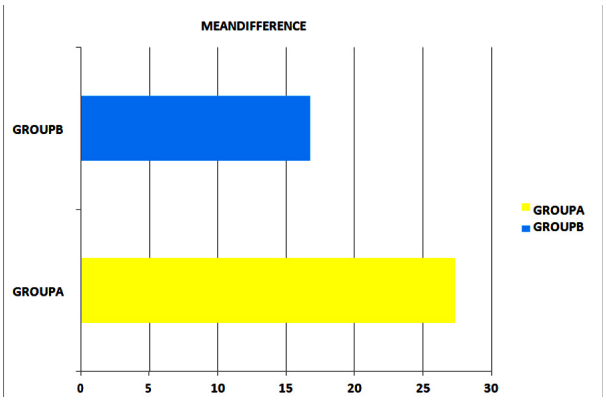
| Difference in Womac Score | Group A | Group B |
|---|---|---|
| Mean | 27.66 | 16.73 |
| SD | 2.79 | 5.81 |
| t value | 37.86 | 11.15 |
| P value | <o.ooo1 | <0.0001 |




**Graph 1:** Comparing mean pre and post of Group A




**Graph 2:** Comparingmean pre and post of




**Graph 3:** Comparingme and ifference of Group A and Group B

Osteoarthritis (OA) is a common disease associated with significant morbidity. This is particularly apparent at the knee joint, one of the commonest sites to be affected. As prevalence of OA increases with age and aging is associated with decreasing physiological function, the combination has major health implications. Symptoms cannot, however, be predicted merely by the degree of structural damage. The quadriceps weakness commonly associated with osteoarthritis of the knee is widely believed to result from disuse atrophy secondary to pain in the involved joint. Osteoarthritis is degenerative joint disease. Commonly it is thought to be wear and tearof joints as one ages. Two types of OA are recognized primary and secondary.

***Primary OA:*** It occurs in old age mainly in the weight bearing joints.

***Secondary OA:*** In this type ,there is an underlying primary disease of the joint which leads to degeneration of the joint.

The Q angle have shown to be increased in the OA knee, possibly as the degeneration progresses and more pain and immobility could be aggravating factor. The Q angle of knee is measurement of the angle between quadriceps muscle and Patella tendon and it provides useful information about the alignment of knee joint. It is likely to be influenced by the muscle strength of varying group of muscles that alter the mechanics of knee other that Quadriceps alone. Gluteus Medius weakness is very common among people above age 50 and more evident with obesity indicating the mechanics change inthe knee joint too.

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is widely used in the evaluation of Hip and Knee Osteoarthritis. It is a self-administered questionnaire consisting of 24 items divided into 3 subscales.

***Pain (5 items):*** During walking, using stairs, in bed, sitting or lying, and standingupright.

***Stiffness (2 items):*** After first waking and later in the day

***Physical Function (17 items):*** Using stairs, rising from sitting, standing, bending,walking, getting in / out of a car, shopping, putting on / taking off socks, risingfrom bed, lying in bed, getting in / out of bath, sitting, getting on / off toilet, heavy domestic duties, light domestic duties WOMAC Index was developed in 1982 at Western Ontario and McMaster Universities.

Area of assessment of WOMAC are activities of daily living, functional mobility, gaitgeneral health,

quality of life.

The WOMAC takes approximately 12 minutes to complete.

*The test questions are scored on a scale of 0-4 , which correspond to:*

None (0), Mild (1), Moderate (2), Severe (3), and Extreme (4) The scores for each subscale are summed up, with a possible score range of 0-20 for Pain, 0-8 for Stiffness, and 0-68 for physical function High scores on the WOMAC indicate worse pain, stiffness, and functional limitations. The WOMAC Index has been used extensively in clinical trials.

WOMAC Index can be a useful screening tool for people at risk for Osteoarthritis andwill help in identifying the disease early.

Isometrics quadriceps exercise strengthen the quads by contracting the muscle.

Vastus Medialis Oblique Strengthening is important in knee rehabilitation as it helpscontrol the position of patella Gluteus Medius weakness cause knee pain. Gluteus Medius is weak in patients with knee osteoarthritis. Gluteus Medius weakness is very common among people above age 50 and more evident with obesity indicating the mechanics change in the knee joint too.

Strengthening gluteus medius helps in reducing knee pain in patients with knee osteoarthritis.

VMO strengthening with quadriceps isometrics along with stretching is more effective according to WOMAC.

Supported by Santhi Venkatapathy et al there is significant change in post interventionin group a p value is less than less than 0.05 which approved that VMO strengthening with quadriceps isometrics along with stretching is more effective according to WOMAC.

The improvement was seen after 8 weeks but continued improvement was not found. The group B show non significant result of $P > 0.05$. In this group VMO with gluteus medius strengthening was given to the patient and shows non significant result after 8 weeks when compared to pre-intervention score this states that VMO strengthening with gluteus medius strengthening are not sufficient outcome clinically this study demonstrated that VMO strengthening with Quadriceps isometrics with stretching as treatment tool improvement was seen in normalizing Qangle in Ostearthritis.

*Limitation of Study*

The duration of study was only 8 weeks so further progressive long term benefit couldnot be recorded whom exercise was prescribed to the patient.

Proper follow up would not be done due to Covid-19

*Future of Study*

Study can be done on larger population. Further study can be done to check to comparethe effect of VMO strengthening with quadriceps isometric exercise versus VMO strengthening with Gluteus Medius strengthening exercise to normalize Q-angle in patients with knee osteoarthritis.

The exact mechanism of incorrect Q - angle in knee osteoarthritis and the muscle weakness affecting Q - angle in knee osteoarthritis can be studied in more detail.

The duration of the study can be increased further studies are recommended to minimize these limitation in search way that larger sample size that included various age group of people are studied. Various outcome measure can be used to record the pain.

## CONCLUSION

The study provided evidence to support the use of VMO strengthening exercise with quadriceps isometric and VMO strengthening with gluteus medius strengthening exercise to normalize Q-angle in patients with knee osteoarthritis.

In conclusionVMO strengthening exercise with quadriceps isometrics was found to beeffective in normalizing Q-angle in patients with knee osteoarthritis.

When VMO strengthening exercise and quadriceps isometrics exercise is administered to patients suffering from knee osteoarthritis with affected Q-angle over a period of 8weeks it result in normalizing Q-angle in patients with knee Osteoarthritis.

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[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540–7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347–55.

**Article in supplement or special issue**

[3] Fleischer W, Reimer K. Povidone-iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3–9.

**Corporate (collective) author**

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792–801.

**Unpublished article**

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

**Personal author(s)**

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**Chapter in book**

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O,

Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. pp 7–27.

**No author given**

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

**Reference from electronic media**

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979–2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7–18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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