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# Comparison between abdominal core muscle strength in males with and without frozen shoulder: A pilot study

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## Abstract

**Background:** The impact of adhesive capsulitis starts from the structures surrounding the shoulder complex and extends to overall deconditioning and affects neuromuscular control due to reduced daily living activities which may be passed along further in the kinetic chain.

**Context**: Studies show there may be a certain link between core muscle activation and shoulder function, however, the literature is scanty in this regard.

**Aims**: To compare the abdominal core muscle strength in males with and without frozen shoulder.

**Settings and Design**: In this observational comparative study, 20 males (40-60 yrs) from a tertiary care hospital visiting the physiotherapy department for the treatment of frozen shoulder were included along with age, Body Mass Index (BMI) and Waist to Hip Ratio (WHR) matched healthy controls.

**Methods and Material**: Abdominal core muscle strength was measured using a pressure biofeedback unit while progressive limb loading was performed.

**Statistical analysis used:** The ordinal data was compared using SPSS Version 24 and Man Whitney U and Wilcoxon W were obtained.

**Results**: The abdominal core muscle strength of male patients with frozen shoulder was weaker compared with healthy controls ($p > 0.0001$)

**Conclusions**: The abdominal core muscle strength was significantly weaker in the males with frozen shoulder compared to age, BMI and WHR matched healthy controls. Thus Inclusion of core muscle strengthening in the rehabilitation of patients with frozen shoulder may lead to better outcomes in rehabilitation.

**Keywords:** Frozen Shoulder; Abdominal Core Strength; Kinetic Chain

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## 1. Introduction

Frozen shoulder is a fibrotic, inflammatory contracture of the rotator interval capsule and ligaments. The most recognised mechanism for development of adhesive capsulitis is cytokine-mediated synovial inflammation with fibroblastic proliferation based on arthroscopic observations. [1]

Increased collagen and nodular band formation are also found and the most commonly affected structure is the coracohumeral ligament. [1] Contraction of the coracohumeral ligament limits external rotation of the arm, which gets affected first as per the capsular pattern. As the stages advance, the adhesions thicken and glenohumeral joint capsule contracts further thus limiting range of motion in all directions. [1]

The prevalence of adhesive capsulitis is between 3% and 5% in the general population.[2] The presentation of symptoms begins with unilateral anterior shoulder pain and follows a capsular pattern - external rotation followed by abduction and then internal rotation.[1] This interferes with the activities of daily living, work and leisure activities. It mainly affects overhead reaching or side to side activities which leads to affected capacity and performance in the domains of mobility, self care, domestic life and major life areas.[1]

The psychological impact of the debilitating and limiting condition along with the impact of contextual factors might lead to other associated conditions that have a psychogenic impact on the pain and recovery. It may affect interpersonal relationships and community social and civic life as well.[3]

The impact of adhesive capsulitis thus starts from the structures surrounding the shoulder complex and extends to overall deconditioning and affected neuromuscular control due to reduced daily living activities. This impact may also be passed along further in the kinetic chain.

The core is considered to be the centre of the kinetic chain whose stability is dependent on the motor control and muscular capacity of the lumbo-pelvic-hip complex. Neuromuscular control of the core is not only a requirement for the proper functioning of the spine and lower extremities but it also prevents injuries and imbalance. [4]

There have been studies which have found EMG activity in the back and core muscles during shoulder movements. The maximum activity of the back was observed during shoulder extension while greatest abdominal activity was seen during horizontal shoulder adduction and bilateral shoulder extension. [4]

This shows there may be a certain link between core muscle activation and shoulder function, however, the literature is scanty in this regard. A study on athletes proposed that integration of core and shoulder exercises could lead to better outcomes in terms of training and performance. [4]

The literature suggests that upper limb exercises performed in standing position activates abdominal and back muscles by producing torque with the torso. [4] In another study, the conscious contraction of abdominal muscles resulted in significant increase in serratus anterior, upper, middle and lower trapezius EMG amplitude during dynamic exercises.[5] In a study on athletes with shoulder dysfunction, balance was found to be affected.[6]

This poses a question whether reduced activity in the shoulder muscles extends further to the kinetic chain and weakens the core muscles. The reviewed and available literature fails to answer this question satisfactorily as it does not test the impact of shoulder dysfunction on core strength.

Thus the disease burden and its impact are concerning in itself and if combined with affected core stability which is imperative for balance and prevention of injuries may lead to further risks and challenges in the course of recovery.

Hence it is important to establish this link in order to include core strengthening in the rehabilitation program of upper limb conditions and not just lower limb dysfunctions.

## 2. Material and Methods

Departmental Research Board approval was sought before commencement of the study.

Patients and controls were screened for selection criteria and their consent was sought prior to the assessment and data collection after providing them with complete information about the study and answering all their questions.

In a single centre observational study in a tertiary care hospital, males between 40-60 years of age visiting the physiotherapy department were included in a period of 6 months.

Twenty males [7] diagnosed with adhesive capsulitis presenting with persistent intense pain, restricted range of motion limited in all directions, significant adhesions and limited GH movements with substitute movements at scapula and weakness of shoulder muscles, with a BMI between 20-29 and WHR up to 1.0 were included.

Twenty healthy males were included in the control group from the medical college staff and patient relatives matched with age, BMI and WHR. Males with low back pain or lower limb pain, any inflammatory or neurological condition leading to muscular weakness were excluded.

Abdominal core muscle strength was assessed with the help of a pressure biofeedback unit and progressive limb loading. Patients and controls were given one trial attempt before assessing the strength of the abdominal core muscles.

Data was collected by noting down the level of and analysed to compare abdominal core muscle strength of patients with frozen shoulder and age, BMI and waist to hip ratio matched subjects without any musculoskeletal/neurological complaints and conclusions were drawn.

Technique to determine Abdominal Core Muscle Strength [8]

Patient lies in a hook lying position (knees 90 degrees). Place the pressure cuff under the lumbar spine and inflate to 40 mm Hg. Begin each exercise with drawing-in manoeuvre to activate deep segmental muscles. Determine the level at which a patient can maintain pressure constant (stable pelvis) while performing either A, B or C limb load activity. If the patient/subject cannot maintain the pressure at level one, then decrease in pressure would be noted.

Activities (Progressive limb loading): [8]

- **A -** Lift bent leg to 90 degrees hip flexion
- **B -** Slide heel to extended knee
- **C -** Lift straight leg to 45 degrees

Levels (External Support): [8]

**Table 1** Levels (External Support)

| **Level** | **Position** |
|---|---|
| Level 1 | Draw in and hold 10 seconds |
| Level 2 | Opposite LE on mat, bent leg fall out |
| Level 3 A B or C | Opposite LE is on table |
| Level 4 A B or C | Hold opposite LE @ 90 degrees of hip flexion with UE |
| Level 5 A B or C | Hold opposite LE @ 90 degrees of hip flexion with no UE assistance |
| Level 6 A B or C | Bilateral LE movement |

LE: Lower Extremity UE: Upper Extremity

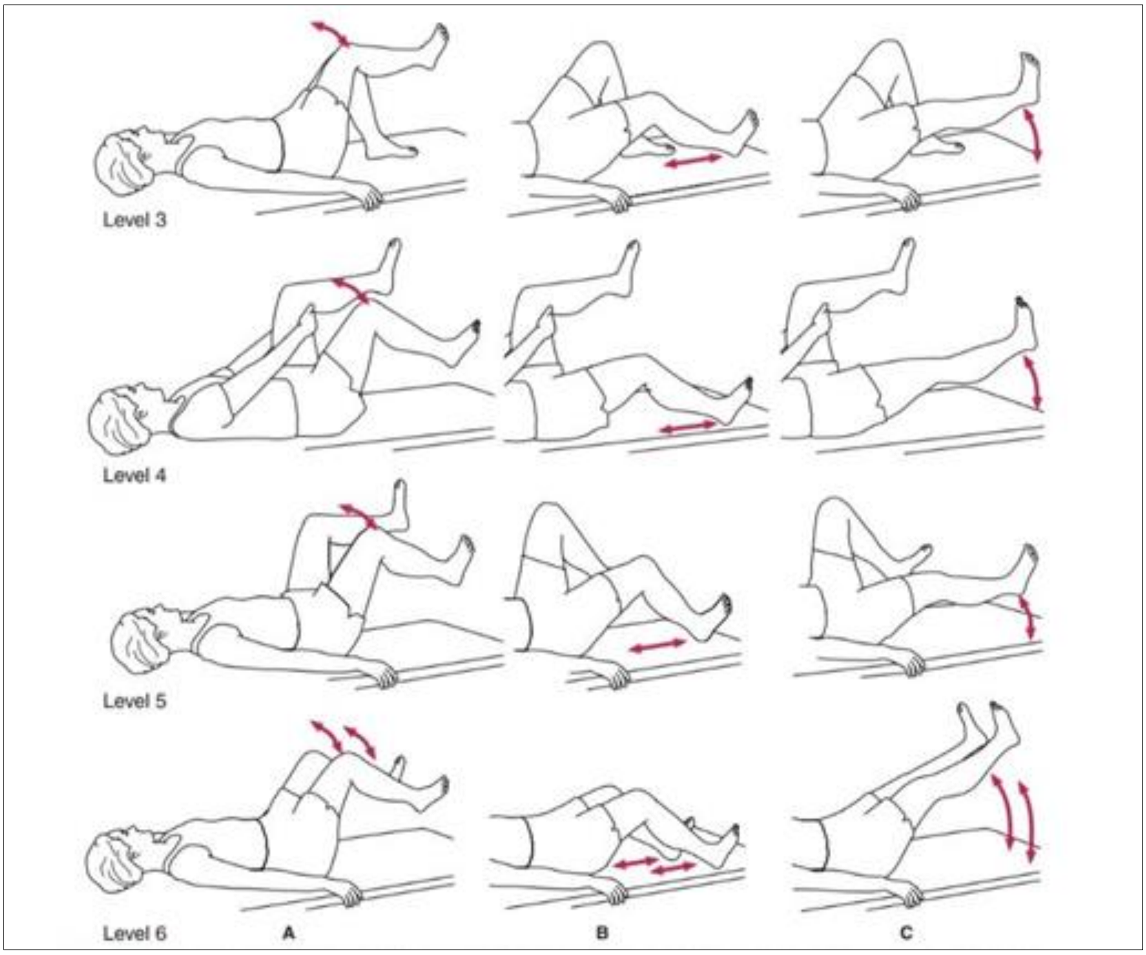


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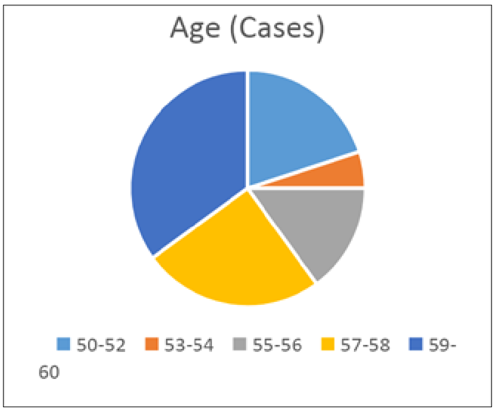
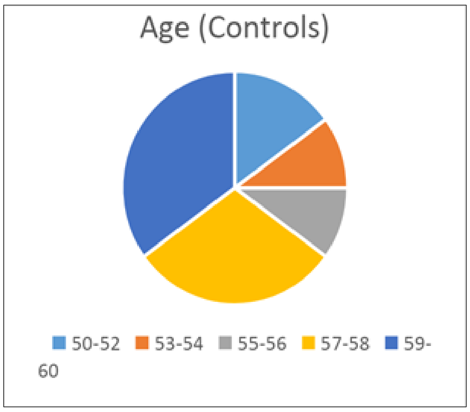
**Figure 1** Levels (External Support)

## 3. Results

### 3.1. Demographic Data



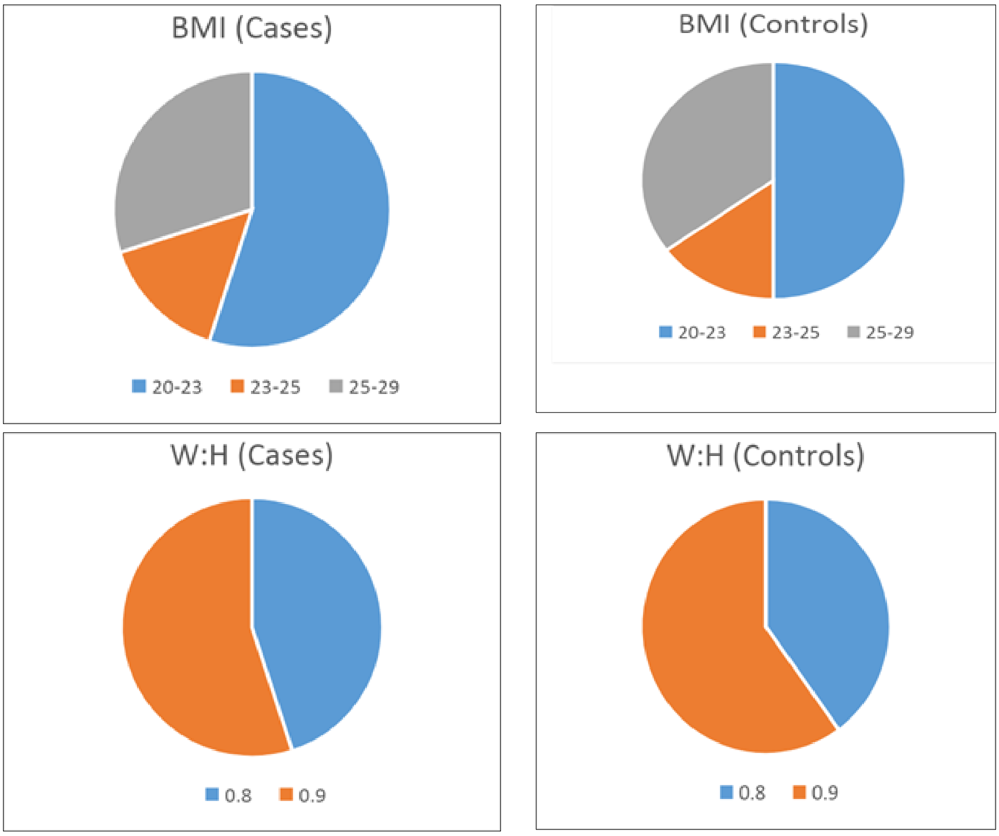



**Figure 2** Demographic Data

The demographic data suggests that the cases and controls were comparable by age, BMI and waist to hip ratio.

**Table 2** Frequency Distribution of Core Strength

| **Core Strength * Group Cross-tabulation** | | | | |
|---|---|---|---|---|
| **Count** | | | | |
| | | Group | | Total |
| | | Cases | Controls | |
| Core Strength | Less than Level 1 | 6 | 0 | 6 |
| | Level 1 | 13 | 5 | 18 |
| | Level 2 | 1 | 5 | 6 |
| | Level 3a | 0 | 6 | 6 |
| | Level 3b | 0 | 3 | 3 |
| | Level 4a | 0 | 1 | 1 |
| Total | | 20 | 20 | 40 |

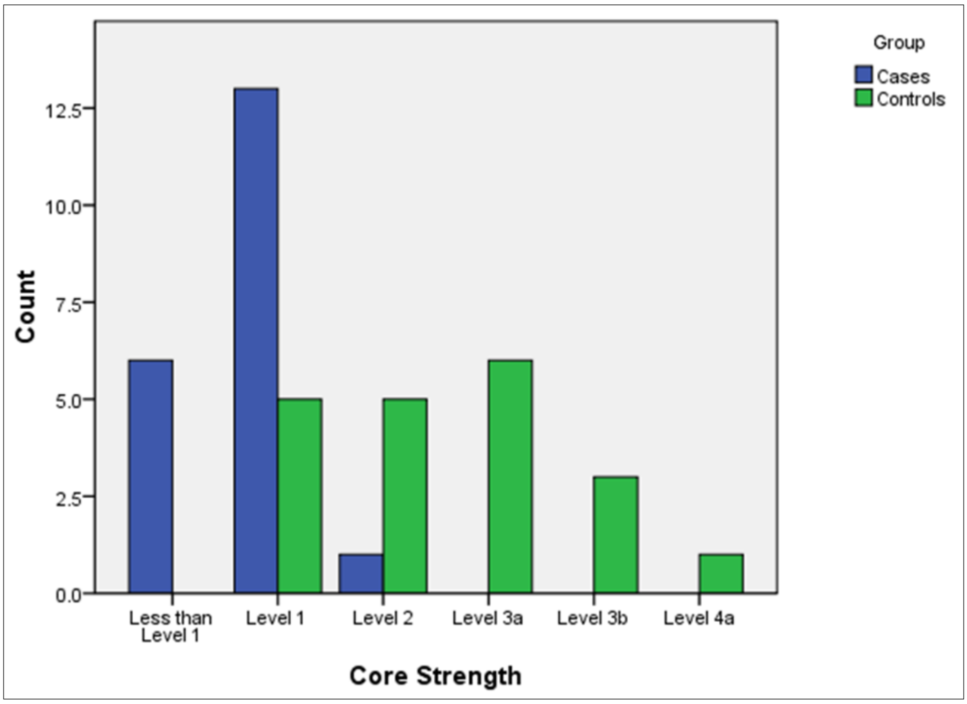



**Figure 3** Frequency Distribution of Core Strength

The data is ordinal and unpaired hence we have used following methods for data analysis:

**Table 3** Statistical Analysis of Core Strength

| **Ranks** | | | | |
|---|---|---|---|---|
| | **Group** | **N** | **Mean Rank** | **Sum of Ranks** |
| Core Strength | Cases | 20 | 12.50 | 250.00 |
| | Controls | 20 | 28.50 | 570.00 |
| | Total | 40 | | |

**Table 4** Test Statistics[b]

| **Test Statistics[b]** | |
|---|---|
| | **Core Strength** |
| Mann-Whitney U | 40.000 |
| Wilcoxon W | 250.000 |
| Z | -4.565 |
| Asymp. Sig. (2-tailed) | .000 |
| Exact Sig. [2*(1-tailed Sig.)] | .000[a] |
| a. Not corrected for ties. | |
| b. Grouping Variable: Group | |

The abdominal core muscle strength of male patients with frozen shoulder was weaker as compared to the abdominal core muscle strength of age, BMI and waist to hip ratio matched healthy male subjects.

The difference in the strengths was statistically significant with the p value of > 0.0001.

## 4. Discussion

This study was conducted to determine if core muscle strength was affected in patients with frozen shoulder. The demographic data from both the groups suggests that their age, BMI as well as waist to hip ratio was comparable. This was important to establish as muscle strength tends to decrease with age.[9] Core muscle strength is also directly correlated with abdominal obesity which is a common occurrence in males. [10]

The technique to determine the core muscle strength, although old, has been found to be effective till date. As per a recent study, the Pressure Biofeedback Unit has excellent inter-rater reliability in the measurement of Transverse Abdominis muscle activity in individuals with and without chronic nonspecific low back pain.[11]

The comparison of core muscle strength between males with and without frozen shoulder showed statistically significant difference with the males with frozen shoulder having a weaker core.

In a recent study the synergism between trunk and shoulder muscles was studied in a non-athletic population with pain. The study aimed to understand the effect of conscious activation of abdominals on the activity of the scapulothoracic muscles during shoulder exercises in subjects with subacromial pain syndrome.[12]

It was concluded that the conscious contraction of the abdominal muscle immediately alters the activation of the serratus anterior muscle during closed kinetic chain exercises on the asymptomatic side and increases the activation of trapezius on the symptomatic side during shoulder open kinetic chain exercise.[12]

This very synergism between trunk and shoulder muscles could be the reason for our findings. Most patients with frozen shoulder make adaptations in their daily activities in order to function optimally. Also, shoulder muscle weakness and imbalances are consistent findings in all frozen shoulder patients. [1]Thus, both these factors affect the kinetic chain.

With core strength reducing the patients are more prone to injuries and lower limb dysfunction.[13] Incidence of low back pain is found to be higher in patients with a weak core.[14] The age range of frozen shoulder patients falls into an ageing population which is already vulnerable to increased risk of falls.[15]

Thus, inclusion of core strengthening in the rehabilitation program of frozen shoulder patients is well justified. In another study conducted on healthy recreationally active adults it was found that isometric shoulder flexion peak torque was greater when the core was actively contracted compared with when the core was recruited subconsciously ($p \leq 0.001$). These findings suggest the clinicians should encourage the individual to activate their core musculature when performing upper extremity strength activities.[16]

Needless to say, if the activation of core is improving upper extremity torque generation and the reverse is also proved to be true on the basis of our study where shoulder dysfunction is causing core weakness, including core stability exercises in the rehabilitation program may improve outcomes. Further studies can be conducted to generate further evidence.

Another study conducted on athletes with shoulder pain recommends that while rehabilitating the overhead athlete with shoulder pain, engagement of shoulder muscles together with both thoraco-humeral and abdominal muscles produces better outcomes.[17] It is important to note that most studies that have suggested synergistic relations between trunk and shoulder muscles, were conducted on athletes or healthy population.

Our study is one of the few that highlight the relationship between shoulder dysfunction and core strength in the patient population. This opens avenues for further research which can highlight the impact of this finding.

Another study done in the female population with postural abnormalities and neck pain suggests that the addition of abdominal control feedback to the scapular stabilisation exercises was superior to the scapular stabilisation exercises alone for decreasing neck pain and improving proprioception, strength, and electromyography outcomes.[18]

Even though the literature on this subject is still scanty with none of the studies being conducted in large sample sizes and lack of review articles, all the evidence points towards the synergism between shoulder and trunk muscles and must be explored further.

## 5. Conclusion

The abdominal core muscle strength was found to be weaker in the males with frozen shoulder compared to age, BMI and WHR matched healthy subjects with the difference in strengths being statistically significant. Inclusion of core muscle strengthening in the rehabilitation of patients with frozen shoulder may lead to better outcomes.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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