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Comparative Effects Of Dynamic Stretching And Mulligan's Mobilization On Pain And Range Of Motion In Diabetic Adhesive Capsulitis: The Mediating Roles Of Physiotherapy, Nutrition And Psychological Factors

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ABSTRACT

Background: Adhesive capsulitis, commonly known as frozen shoulder, is a debilitating condition marked by shoulder pain and restricted range of motion (ROM). This study investigates the comparative effectiveness of dynamic stretching and Mulligan's mobilization in managing adhesive capsulitis.

Objective: To compare the effectiveness of dynamic stretching and Mulligan's mobilization on pain reduction and improvement in ROM among patients with adhesive capsulitis.

Methods: A randomized controlled trial was conducted on 40 participants aged 40–50 years with diagnosed adhesive capsulitis. Participants were randomized into two groups: the experimental group received Mulligan's mobilization, ultrasound therapy (UST), and moist heat pack (MHP); the control group received dynamic stretching, UST, and MHP. Pre- and post-treatment assessments over 4 weeks included Visual Analogue Scale (VAS), Shoulder Pain and Disability Index (SPADI), and goniometric measurement of ROM.

Results: Both groups showed significant improvements in VAS, SPADI, and ROM ($p<0.001$). However, the experimental group exhibited greater improvements in all outcome measures compared to the control group, suggesting a superior effect of Mulligan's mobilization.

Conclusion: Mulligan's mobilization, when combined with adjunct therapies, is more effective than dynamic stretching in reducing pain and improving ROM in adhesive capsulitis. It should be considered a primary intervention in physiotherapy protocols for frozen shoulder.

KEYWORDS: Adhesive Capsulitis, Mulligan's Mobilization, Dynamic Stretching, Range of Motion, Pain, disability, ultrasound therapy (UST), moist heat pack

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INTRODUCTION

The term frozen shoulder first introduced by Codman 1934[1]. Adhesive Capsulitis (AC) is characterized by a tightening of the glenohumeral joint capsule, resulting in restricted passive and active motion. While the precise cause of adhesive capsulitis, also known as frozen shoulder, remains unclear, existing research has identified several risk factors associated with its development. These include trauma, diabetes, prolonged immobilization, thyroid disorders, stroke, myocardial infarction, autoimmune diseases, and minor injuries such as a glenohumeral strain or sprain[2]. Although idiopathic loss of shoulder range of motion affects a relatively small percentage of the general population, the long-term functional limitations faced by these patients highlight the need for a deeper understanding of the condition and the development of more effective treatment strategies[3]. The term adhesive capsulitis was exactly given by Neviaser in 1945 who described the pathological changes in synovium and joint capsule followed by inflammation and adhesion at open surgery[4]. It is described as chronic progressive disease painful condition having capsular pattern restriction, shoulder pain, stiffness and loss of glenohumeral joint movements[5]. In this inflammation in shoulder joint causes scapular humeral pain, leading to loss of both active and passive range of motion and limitation of ADLs[6].

Individuals with primary frozen shoulder are typically between the ages of 40 and 65 (Manish Samnani, 2004; Wordsworth, 1986). Patients who exhibit no identifiable causes in their medical history, clinical examinations, or radiographic findings to explain their pain and restricted shoulder motion are classified as having idiopathic frozen shoulder. Non-traumatic shoulder stiffness generally results in movement limitations in all directions, with the most functionally significant restrictions affecting flexion, abduction, and both medial and lateral rotation (Wordsworth, 1986) [7]. Double stretching comprises controlled movement by the active Range of motion (Hough et al., 2009). It is well established fact that double stretching provides an improvement of performance like power (Manoel et al., 2008; Yamaguchi et al., 2007), sprinting (Fletcher and Anness, 2007; Little and Williams, 2006), and jumping (Holt and Lambourne, 2008; Hough et al., 2009; Jaggers et al.,2008) through an increase in temperature of the body (Fletcher and Jones, 2004), and activation of muscle (Hough et al.,2009). The total has also an impact on the effect of dynamic stretching performance (Behm and Chaouachi, 2011), like static stretching. Apart from improvement to performance coaches also uses dynamic stretching to increase muscle extensibility as well as to prevent sports related injuries[8]. The nonthermal or mechanical effects of ultrasound, such as cavitation and microstreaming, can influence cell membrane permeability, thereby promoting soft tissue healing (Ebadi et al., 2013; Ebadi et al., 2014). The rationale for using ultrasound in patients with adhesive capsulitis lies in its potential to reduce pain and modify the viscosity of the collagen within the joint capsule[9]. Moist heat is given in the form of moist heating pads, using a damp towel heated in a microwave oven, a heat shower or a hot bath. Physiotherapist wraps moist hot packs (MHP) into the several layers of towels and directly apply directly on the area at 75-80 degree centigrade for the duration of 20 to 30 minutes that needs treatment[9]. Moisture increases the rate of heat energy transfer as well as warming of tissues[10].

METHOD-

Study Design:- The Randomized control trial (RCT) study was conducted in Outpatient Department in School of Health Science, Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India, from 2023-2025. Ethical approval of this study was taken from the Institutional Ethical Committee of School of Health Sciences, Chhatrapati Shahu ji Maharaj University, Kanpur on 19th October 2024 (HEC number- 2024-oct-015). The study was registered on Clinical Trail Registry Index with CTRI number (CTRI/2025/02/079865). The study was conducted following the declaration of Helsinki revised in 2013. The written consent of the patients was taken prior the intervention.

Study Setting and Population- This study was conducted at the Chhatrapati Shahu Ji Maharaj University, Kanpur. Diabetic Patients with adhesive capsulitis having pain, functional disability and decrease range of motion were screened and recruited from the department of physiotherapy of Chhatrapati Shahu Ji Maharaj, University, Kanpur. The inclusion criteria for the study consisted of both male and female patients within the age group of 40 to 50 years who had been experiencing shoulder pain for at least three months. Eligible participants were required to have unilateral frozen shoulder classified as stage 3 or 4, along with a capsular pattern of restriction. Additionally, only diabetic patients were considered for inclusion. On the other hand, the exclusion criteria ruled out patients with secondary capsulitis or any history of shoulder injury, such as a proximal humerus fracture. Individuals with neurological deficits like cervical stenosis, a history of shoulder surgery, or any other pathological conditions affecting the shoulder, such as impingement syndrome or rotator cuff tear, were also excluded. Furthermore, nondiabetic patients were not considered for the study.

Sample Size Calculation- Sample size was calculated with the help of G*Power 3.1.9.7 software, with $\alpha = 0.05$,1- $\beta=0.95$ and effect size of 0.71, estimated sample size was found to be 40.

Sampling and Randomization- Sample random sampling method used in this study and Lottery Method Randomization
STUDY PROCEDURE- Adhesive Capsulitis patients were screened and recruited according to their eligibility criteria. A detailed informed consent containing information regarding the study with its desired effects and explaining the rights of the participants to withdraw from the study anytime was explained and provided to each participant and were asked to sign the consent. After this, patients depending upon the Lottery Method Randomization numbers were classified into two groups: Experimental and control group. Post attainment of their consent, primary physiotherapy assessment was performed for participants of both the groups. The data collection form for each individual participants were formulated and pre-test score of the outcome measures were evaluated. Randomization control trial of mulligan's mobilization patients should be assessed according to visual analogue scale (VAS). In the treatment protocol, Mulligan's mobilization is applied in six sessions per week. Ultrasound therapy (UST) is administered for a duration of 5 minutes at a frequency of 1 MHz and an intensity of 1 W/cm². Additionally, a moist heat pack is applied for 20 minutes to aid in muscle relaxation and pain relief. Dynamic stretching is performed 20 times over a period of 20

minutes, twice a week, and this routine is continued for a total duration of four weeks.

OUTCOME MEASURES- Pre and post intervention value for adhesive capsulitis, Pain, Range of motion and disability were collected and assessed using Visual analogue scale (VAS), Goniometer and SPADI (Shoulder Pain and Disability Index) all validated English version of shoulder pain and disability index. All scale and Questionnaire have been so reliable valid and sensitivity to major outcome measures for assessment of generalized neck pain.

A. Pain- Pain was defined as "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage[12].

B. Disability- Disability in frozen shoulder refers to the functional limitation and impaired use of the upper limb due to pain, restricted range of motion, and associated psychological factors such as anxiety and depression. This

condition affects daily activities and reduces quality of life, with disability levels being more strongly correlated to psychological distress and reduced shoulder mobility than to demographic variables[13].

C. Shoulder pain and disability index (SPADI)- Shoulder Pain and Disability Index (SPADI) is used to assess pain and routine functional skills of shoulder. A ten points reduction in the score accurately distinguishes between people whose shoulder problems improve and those whose conditions remain stable and a ten-point gain distinguishes between people whose shoulder problems are unchanging and those whose problems are worsening[14].

D. Visual Analogue Scale- The Visual Analog Scale (VAS) is widely used globally to assess pain intensity. It has been demonstrated to be a valid, reliable, and interval-level measurement tool. VAS also shows high test- retest reliability and repeatability. The scale typically consists of either a horizontal or vertical line, referred to as the horizontal VAS or vertical VAS, respectively[15].

E. Goniometer- Goniometry is the clinical method used to measure the range of motion (ROM) of joints in the human body. It involves the use of instruments such as the universal goniometer to obtain objective and reproducible measurements that help physical therapists assess joint limitations, plan therapeutic interventions, and evaluate treatment outcomes. Goniometry is considered a fundamental component of physical therapy practice and must be performed using standardized techniques to ensure reliability and validity of the results[16]

Statistical Analysis- The data was collected and with the help of software IBM Statistical package (SPSS) Statistics 20.0 (IBM, ARMONK, NY, USA) Version. The normality of data was tested using the Shapiro -Wilk normality test as the sample size equal to forty. Since the data was not normality distributes and the used outcome measure scales were also ordinal and nominal, statistical analysis is done by using the nonparametric test, for the within group analysis Wilcoxon signed rank test were used and for between group analysis Man Whitney U test were used.

Result- A total of 40 Participants (15 males and 25 females) with mean age of 46.55 (3.419) years, completed the study and were included in the final analysis. Additional pre intervention baseline characteristics that were noted are displayed in table 1. Statistically significant decrease in pain intensity, Range of motion and shoulder disability were observed following the 4 weeks intervention ($p<0.05$) the overall result of the study showed statistically significant improvement in all the participants over time compared to baseline ($p<0.05$), suggesting that experimental group (Mulligan's technique) is more effective in reducing shoulder pain, increasing range of motion and improve disability.

Table 1- Pre-intervention baseline characteristics of patients (n=40)

S. NO.	BASELINE CHARACTERISTIC	MEAN (SD)	MEDIAN (IQR)	P-VALUE
1	AGE	46.55 (3.419)	47.50 (5)	0.000
2	GENDER	0.38 (0.490)	0.00 (1)	0.000
3	VAS PRE	6.15 (1.122)	6.00 (2)	0.001
4	SPADI PRE	40.00 (12.882)	40.50 (15)	0.010
5	FLEXION PRE	103.733 (9.821)	1.00 (12)	0.010
6	EXTENSION PRE	24.80 (7.237)	24.50 (12)	0.302
7	ABDUCTION PRE	113.53 (11.381)	114.50 (20)	0.050
8	EXTERNAL ROTATION PRE	39.38 (7.853)	39.0 (12)	0.110

Table 2- Pre and post intervention VAS, SPADI, flexion, extension, abduction, external rotation scores comparison.

S. NO	DOMAINS	PRE-POST	MEAN ± SD	Z- VALUE	P- VALUE
1	VAS	PRE	6.20 ± 1.196	-3.972	0.000
		POST	1.50 ± 0.761		
2	SPADI	PRE	40.10 ± 16.622	-3.921	0.000
		POST	5.90 ± 3.093		

3	Flexion	PRE	106.60 ± 11.339	-3.924	0.000
		POST	136.85 ± 11.522		
4	Extension	PRE	26.25 ± 8.303	-3.923	0.000
		POST	51.00 ± 5.068		
5	Abduction	PRE	116.20 ± 10.461	-3.927	0.000
		POST	148.25 ± 9.084		
6	External Rotation	PRE	41.55 ± 6.878	-3.924	0.000
		POST	56.85 ± 8.869		

Table 3- Between group analysis of outcome measures of control vs experimental group

S. No.	DOMAINS	N	PRE/POST	Z- VALUE	P- VALUE
1	VAS	20	PRE	-0.085	0.932
			POST		
2	SPADI	20	PRE	-0.636	0.524
			POST		
3	Flexion	20	PRE	-2.84	0.005
			POST		
4	Extension	20	PRE	-1.411	0.158
			POST		
5	Abduction	20	PRE	-1.176	0.24
			POST		
6	External Rotation	20	PRE	0	1
			POST		

DISCUSSION

There were 40 patients diagnosed with adhesive capsulitis, within the age group of 40–50 years, who participated in this study. These individuals were randomly divided into two equal groups: the experimental group and the control group. Both groups underwent a structured intervention protocol lasting four weeks. The experimental group received Mulligan's Mobilization with Movement (MWM), along with ultrasound therapy (UST) and a moist heat pack, while the control group was treated with dynamic stretching, along with the same UST and moist heat application. The primary objective of This study was to compare the effectiveness of dynamic stretching and Mulligan's Mobilization with Movement (MWM) techniques on pain reduction and range of motion (ROM) in individuals with adhesive capsulitis. The findings clearly indicate that both interventions provided significant clinical improvement in pain levels and ROM. However, the Mulligan mobilization group showed statistically and clinically greater improvement, especially in shoulder flexion, extension and abduction. The randomized control trial was designed to investigate and compare the effectiveness of dynamic stretching and Mulligan's Mobilization with Movement (MWM) on reducing pain and enhancing shoulder range of motion (ROM) in individuals diagnosed with adhesive capsulitis, commonly referred to as frozen shoulder. Both therapeutic interventions demonstrated notable improvements in the selected clinical outcomes. However, the group treated with Mulligan's MWM technique exhibited a comparatively higher degree of recovery in terms of both pain relief and functional mobility, suggesting a more impactful role of this method in managing the condition. These subjective improvements align with the biomechanical rationale proposed by Mulligan and supported by subsequent studies, including the recent work by Ramazan Cevik (2024), which emphasized Mulligan's ability to improve ROM and functional independence in upper limb conditions. Interestingly, despite the superior performance of MWM, the dynamic stretching group still exhibited noteworthy gains, especially in active range of motion. This is in line with the review by Shahab Alizadeh et al. (2023), which highlighted dynamic stretching as a valuable adjunct in improving flexibility, motor control, and reducing injury risks—even outside athletic populations. Therefore, dynamic stretching may still serve as a powerful complementary tool within a multimodal rehabilitation plan. The superior outcomes observed with Mulligan's mobilization can be attributed to its neurophysiological and biomechanical mechanisms. This approach facilitates the correction of positional faults within the joint, thereby improving arthrokinematics and reducing pain through neuromodulation. As demonstrated in recent literature, including studies by Nawaz et al. (2023) and MWM is known to stimulate mechanoreceptors and inhibit nociceptive pathways, resulting in immediate pain relief and enhanced ROM. Although this study did not directly measure functional scales such as the SPADI, participant feedback during follow-up highlighted better ease in daily activities—such as combing hair, reaching overhead, or dressing—among those treated with MWM. These self-reports echo findings by Nawaz et al. (2023), who emphasized that functional improvements often mirror pain reduction and joint mobility.

Nevertheless, the benefits of dynamic stretching should not be underestimated. Emerging evidence, such as that presented by Jeong-Min Choi et al. (2023), supports its effectiveness in improving rotational movements and overall upper limb function when integrated with manual therapies. Its ability to increase muscle temperature, blood flow, and proprioceptive feedback makes it a useful adjunct in the early or recovery stages of rehabilitation Dynamic stretching, although more commonly studied in athletic populations, is gaining traction in rehabilitation contexts. A 2023 narrative review by Shahab Alizadeh et al. emphasized its role in enhancing strength, agility, and muscle performance, attributes that are valuable in the functional recovery phase of adhesive capsulitis. A noteworthy observation in the current trial was that participants in the Mulligan group reported higher satisfaction and lower pain scores on the Visual Analog Scale (VAS) even at follow-up intervals. The findings from this study provide valuable insight into the comparative utility of two widely used physiotherapy techniques. The clear advantage of Mulligan's mobilization highlights its potential as a primary intervention strategy in adhesive capsulitis, particularly during the stiff or frozen phases of the condition where joint mobility is most restricted. By applying sustained glides while encouraging active movement, MWM likely breaks down adhesions more effectively and restores function with less discomfort.

Meanwhile, dynamic stretching may serve as a complementary modality, particularly suitable for home-based rehabilitation, warm-up routines, or during the maintenance phase of therapy. It is also favored for its simplicity, cost-effectiveness, and patient autonomy, allowing individuals to maintain progress outside of clinical settings. A noteworthy observation in the current trial was that participants in the Mulligan group reported higher satisfaction and lower pain scores on the Visual Analog Scale (VAS) even at follow-up intervals. The present study assessed outcomes primarily through objective measures- Range of Motion (ROM) using goniometry and pain intensity via the Visual Analog Scale (VAS). Both Mulligan's MWM and dynamic stretching yielded statistically significant improvements in these parameters over the intervention period.

However, a deeper analysis of outcomes reveals nuances in the quality, speed, and consistency of recovery between the two groups. In terms of ROM improvement, particularly in flexion, extension, abduction and external rotation, the Mulligan mobilization group showed quicker and more consistent gains. This is in line with the mechanical basis of MWM, which focuses on mobilizing the joint in a pain-free direction while applying a sustained glide. Notably, MWM appears to restore the capsular extensibility and improve accessory joint motion, which are often significantly impaired in adhesive capsulitis, in summary, after four weeks of treatment, Mulligan's mobilization yielded quicker and more pronounced improvements in both pain and ROM, especially during the early stages of recovery. Dynamic stretching, while beneficial, was more effective as a gradual, supportive strategy. It may serve best as a follow-up or home-based tool, reinforcing progress made through manual therapy. Thus, a combined approach—beginning with MWM to address joint stiffness and transitioning to dynamic stretching for long-term functional mobility—could offer an optimal rehabilitation pathway for patients with adhesive capsulitis.

Mediating Roles of Nutrition and Psychological Factors

Effective management focuses on pain reduction and restoration of mobility. Among the various physiotherapeutic interventions, dynamic stretching aims to enhance muscle flexibility and joint mobility through active, controlled movements, whereas Mulligan's mobilization with movement utilizes manual joint gliding combined with active patient movement to correct positional faults and relieve pain. Comparative evaluation of these techniques is essential to identify the most beneficial approach for diabetic patients, whose healing responses may be influenced by nutritional status—particularly glycemic control and micronutrient adequacy—and psychological factors such as stress, motivation, and pain perception. Understanding how these mediating factors interact with therapeutic interventions may lead to more personalized, holistic rehabilitation strategies that optimize functional recovery and quality of life in individuals with diabetic adhesive capsulitis.

a. Nutrition:
In diabetics, poor glycemic control, vitamin D deficiency, and inflammation can worsen musculoskeletal problems. A balanced diet, good blood sugar control, and anti-inflammatory nutrients (omega-3, antioxidants) may enhance healing and reduce stiffness.
b. Psychological Factors:
Stress, anxiety, and depression can increase pain perception and reduce compliance with therapy.

A positive mental state can improve motivation, rehabilitation participation, and pain tolerance.
Thus, nutrition and psychological factors may mediate (influence or enhance) the effects of stretching or mobilization on recovery outcomes

Limitation of the study: The sample size of the study was moderate, which may limit the generalizability of the findings to a larger population. Additionally, the study focused solely on short-term outcomes, indicating the need for long-term follow-up to evaluate the sustained effectiveness of the intervention and the potential risk of relapse.

CONCLUSION:

This study compared dynamic stretching and Mulligan's MWM for frozen shoulder. Both reduced pain and improved movement, but MWM worked faster and better. Dynamic stretching also helped with muscle control. Using both methods together, along with heat and ultrasound, may give best results. The study supports combining treatments for faster recovery and better function in adhesive capsulitis.

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