

Original article

Comparative Effectiveness of Physiotherapy in Improving Pain and Shoulder Mobility in Diabetic and Non-Diabetic Patients with Adhesive Capsulitis

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Abstract

Adhesive capsulitis (AC) leads to pain and restricted shoulder range of motion (ROM), with diabetes potentially influencing recovery. This study compared the early response to structured physical therapy in diabetic and non-diabetic patients with AC. Thirty patients aged 40–60 years with unilateral AC were randomly assigned to a diabetic group (n = 15) or a non-diabetic group (n = 15). All participants received daily 40-minute sessions for 10 days, including interferential therapy, graded joint mobilization (Maitland technique), and a standardized home exercise program. Pain intensity was assessed using a 10-cm visual analogue scale (VAS), while active shoulder abduction and external rotation were measured with a goniometer on days 1, 3, 5, 7, and 10. Data were analyzed using paired t-tests for within-group comparisons and unpaired t-tests for between-group comparisons, with significance set at $p < 0.05$. Baseline characteristics—including age, symptom duration, sex distribution, pain scores, and ROM—were comparable between groups ($p > 0.05$). Both diabetic and non-diabetic groups exhibited significant within-group reductions in pain over 10 days ($p < 0.05$ – 0.001). Shoulder abduction and external rotation improved significantly in both groups, with mean abduction gains of 20.33° (diabetic) and 13.16° (non-diabetic) and mean external rotation gains of 11.33° (diabetic) and 17.00° (non-diabetic) by day 10. Between-group comparisons revealed slightly greater ROM improvements in non-diabetic patients at days 7 and 10 ($p < 0.05$), while pain reduction was similar across groups ($p > 0.05$). Structured physical therapy yields significant early improvements in pain and shoulder mobility in patients with AC, regardless of diabetic status. Non-diabetic patients may experience slightly faster ROM recovery, suggesting a modest impact of diabetes on functional recovery. These findings support the use of early, standardized physiotherapy interventions for AC, with consideration for potential systemic factors in diabetic patients.

Keywords. Adhesive Capsulitis, Frozen Shoulder, Physiotherapy, Diabetic Patients.

Introduction

Adhesive capsulitis (AC), commonly referred to as frozen shoulder, shows a strong bidirectional association with diabetes mellitus (DM). Epidemiological data indicate that individuals with DM are approximately five times more likely to develop AC compared to non-diabetic individuals, with an overall prevalence of 13.4%. Conversely, the prevalence of DM among patients diagnosed with AC has been reported to reach 30%, underscoring the significant interrelationship between these two conditions [1].

Adhesive capsulitis primarily affects middle-aged adults and is closely associated with various endocrine disorders. Despite its clinical frequency, the underlying pathophysiological mechanisms remain incompletely understood, contributing to diagnostic challenges and often resulting in delayed intervention and prolonged functional impairment [2].

Therapeutic strategies for adhesive capsulitis encompass a broad range of conservative and surgical interventions. Pharmacological therapies, intra-articular corticosteroid injections, physiotherapy, hydrodistension, and manipulation under anesthesia represent the mainstays of conservative management. In refractory cases, arthroscopic or open capsular release procedures may be indicated. Although conservative treatments generally achieve satisfactory outcomes, persistent pain and restricted motion lasting beyond three to six months often necessitate surgical management [3].

The higher prevalence of shoulder capsulitis among diabetic patients has been attributed to vascular and metabolic alterations associated with diabetes. Atherosclerotic changes in small vessels may impair local blood flow, resulting in tissue hypoxia and altered tendon physiology that predispose patients to shoulder capsulitis [4,5].

Several risk factors have been identified in the development of adhesive capsulitis, including female gender, age greater than forty years, trauma, prolonged immobilization, diabetes mellitus, thyroid disease, stroke, myocardial infarction, autoimmune disorders, cervical spine pathology, and reflex sympathetic dystrophy [6]. Idiopathic, or primary, adhesive capsulitis is pathologically defined by capsular fibrosis that progressively restricts both active and passive range of motion. The disease typically evolves through three distinct stages: Stage I, the “painful” phase, lasting approximately two to nine months; Stage II, or the “frozen” phase, characterized by marked stiffness lasting four to twelve months; and Stage III, the “thawing” phase, during which pain subsides and gradual recovery of motion occurs [7].

Given the strong association between diabetes mellitus and shoulder stiffness, this randomized comparative clinical trial was designed to assess the early therapeutic response to physical therapy among diabetic and non-diabetic patients. The study specifically aimed to evaluate differences in pain reduction and improvement in shoulder range of motion between the two groups, providing insight into whether diabetes influences the short-term outcomes of rehabilitation interventions for adhesive capsulitis.

Methods

Study Design and Setting

This randomized comparative clinical trial was conducted at the Libyan Center for Physiotherapy, located behind Khadra Hospital in Tripoli, Libya. Written informed consent was obtained from all participants before study enrollment. The study included a total of 30 patients aged between 40 and 60 years, divided equally into two groups: a diabetic group (n = 15) consisting of patients diagnosed with type 2 diabetes mellitus (fasting blood glucose ≥ 127 mg/dL and 2-hour postprandial glucose ≥ 180 mg/dL), and a non-diabetic group (n = 15).

Inclusion and Exclusion Criteria

Eligible participants presented with unilateral adhesive capsulitis, defined as more than a 30% reduction in passive shoulder movement compared to the contralateral side in at least one of three movement directions—abduction in the frontal plane, forward flexion, or external rotation at 0° abduction. Additional inclusion criteria were a symptom duration of at least three months and a baseline pain score of ≥ 5 on the visual analogue scale (VAS).

Exclusion criteria included previous manipulation under anesthesia of the affected shoulder, rheumatoid arthritis, osteoarthritis, osteoporosis, neurological deficits, shoulder dislocation, and rotator cuff tears affecting daily functional activities. Patients with cervical or upper limb disorders, or who had received corticosteroid injections in the affected shoulder within the preceding four weeks, were also excluded.

Intervention Procedures

Interferential Therapy

All participants received interferential therapy using a triangular pulse mode delivered via bipolar electrodes. A frequency of 80–100 Hz was applied for patients classified as highly irritable, while those in the non-irritable group were treated with frequencies ranging from 100–150 Hz. Each session lasted approximately 10 minutes per participant.

Joint Mobilization Techniques

Joint mobilization techniques were performed according to the methods described by Maitland [8] and Vermeulen et al. [9]. Patients in the highly irritable group received low-grade mobilization techniques (Grades I–II), administered within a pain-free range to minimize discomfort. In contrast, non-irritable patients underwent high-grade mobilization techniques (Grades III–IV), applied at the end ranges of restricted shoulder motion to address capsular adhesions, reduce stiffness, and enhance joint mobility. The duration of sustained end-range stretching varied according to each patient's tolerance. Each treatment session lasted 40 minutes and was administered once daily over 10 days. Participants were encouraged to attend all sessions to ensure consistency of intervention.

Home Exercise Program

All participants were prescribed a standardized home exercise program consisting of active, pain-free shoulder exercises. Patients were instructed to perform all physiological shoulder movements within a pain-free range twice daily, completing 20 repetitions per movement to maintain or improve flexibility and joint mobility, completing 20 repetitions per movement, to maintain or improve flexibility and joint mobility.

Outcome Measures

Range of Motion Assessment

Active shoulder range of motion (ROM) in abduction and external rotation was measured using a standard plastic goniometer. During assessment, participants were positioned supine on a plinth with the thorax stabilized to prevent compensatory body movements.

- Abduction: The affected arm was moved in the coronal plane from 0° to 180°, within the patient's pain limit.
- External rotation: The arm was abducted to 90°, the elbow flexed to 90°, and the palm facing downward, allowing external rotation as tolerated.

Pain Assessment

Pain intensity was evaluated using a 10-cm visual analogue scale (VAS) with endpoints labeled “no pain”

on the left and “worst possible pain” on the right. Participants were instructed to mark their perceived pain level on the scale using a non-erasable marker.

Assessments of shoulder pain and active ROM (abduction and external rotation) were conducted on the 1st, 3rd, 5th, 7th, and 10th treatment days to determine early therapeutic response in both diabetic and non-diabetic patients.

Statistical Analysis

Data were expressed as mean $\pm$ standard deviation (SD). Normality of the data distribution was assessed prior to analysis. Within-group comparisons were analyzed using the paired t-test, while between-group comparisons were analyzed using the unpaired Student's t-test. A p-value of <0.05 was considered statistically significant.

Results

Table 1 presents the baseline demographic and clinical characteristics of the diabetic and non-diabetic groups, including age, sex distribution, duration of symptoms, pain intensity, and range of motion (ROM) measurements. The mean age of participants in the diabetic group was 53.6 ± 6.9 years, while the non-diabetic group had a slightly higher mean age of 58.4 ± 9.7 years; however, this difference was not statistically significant ($p = 0.1$). The mean duration of symptoms was 5.6 ± 3.9 months in the diabetic group compared to 7.6 ± 3.9 months in the non-diabetic group, also showing no significant difference ($p = 0.1$). Regarding sex distribution, females represented 60% and males 40% in the diabetic group, whereas the non-diabetic group included 73% females and 27% males; this variation was not statistically significant ($p = 0.4$). The mean Visual Analogue Scale (VAS) scores for pain were 7.41 ± 1.32 and 6.89 ± 2.24 in the diabetic and non-diabetic groups, respectively, indicating comparable pain intensity at baseline ($p = 0.63$). Similarly, no significant differences were observed in shoulder ROM between the two groups. Mean shoulder abduction was $116.0 \pm 25.6^\circ$ in the diabetic group and $114.8 \pm 22.3^\circ$ in the non-diabetic group ($p = 0.4$), while mean external rotation values were $36.3 \pm 16.5^\circ$ and $40.8 \pm 11.7^\circ$, respectively ($p = 0.8$).

Table 1. Demographic and Clinical Characteristics of Diabetic and Non-Diabetic Groups

Variable	Diabetic (n = 15)	Non-Diabetic (n = 15)	P-value	Significance
Age (years)	53.6 ± 6.9	58.4 ± 9.7	0.10	Not significant
Duration of symptoms (months)	5.6 ± 3.9	7.6 ± 3.9	0.10	Not significant
Sex (Female/Male, %)	60 / 40	73 / 27	0.40	Not significant
VAS (Pain Score)	7.41 ± 1.32	6.89 ± 2.24	0.63	Not significant
Abduction ($^\circ$)	116.0 ± 25.6	114.8 ± 22.3	0.40	Not significant
External Rotation ($^\circ$)	36.3 ± 16.5	40.8 ± 11.7	0.80	Not significant

Note: † $p > 0.05$ indicates non-significance.

In Table 2, within-group comparisons showed that diabetic patients experienced gradual pain reduction, with mean changes of 0.47 ± 0.74 , 1.00 ± 1.25 , 1.40 ± 0.99 , and 2.27 ± 1.22 at days 3, 5, 7, and 10, respectively. These improvements reached statistical significance, with t -values of 2.43, 3.09, 5.50, and 7.18, respectively ($p < 0.05$ to $p < 0.001$). Similarly, non-diabetic patients demonstrated comparable trends in pain reduction, with mean changes of 0.64 ± 1.25 , 1.32 ± 1.55 , 1.55 ± 1.32 , and 1.55 ± 0.99 across the same intervals, and corresponding t -values of 2.63, 1.71, 2.53, and 2.62, indicating statistically significant improvement over time. However, between-group comparisons showed no statistically significant differences in pain reduction at any of the measured intervals, with t -values of 0.48, 0.59, 0.35, and 1.83 (all $p > 0.05$). This suggests that both diabetic and non-diabetic patients responded similarly to the treatment in terms of pain relief, despite minor variations in the rate of improvement.

Table 2. Mean Changes in VAS Scores Within and Between Diabetic and Non-Diabetic Patients

Days	Diabetic (Mean $\pm$ SD)	t-value	Non-Diabetic (Mean $\pm$ SD)	t-value	Between-Group t-value	Significance
1-3	0.47 ± 0.74	2.43*	0.64 ± 1.25	2.63*	0.48†	Not significant
1-5	1.00 ± 1.25	3.09**	1.32 ± 1.55	1.71*	0.59†	Not significant
1-7	1.40 ± 0.99	5.50***	1.55 ± 1.32	2.53*	0.35†	Not significant
1-10	2.27 ± 1.22	7.18***	1.55 ± 0.99	2.62*	1.83†	Not significant

Significant ($p < 0.05$) ** Highly significant ($p < 0.01$) *** Very highly significant ($p < 0.001$) † non-significant ($p > 0.05$)

Table 3 shows in the diabetic group, mean increases in abduction ROM were $8.33 \pm 6.73^\circ$, $13.33 \pm 7.94^\circ$, $16.00 \pm 7.37^\circ$, and $20.33 \pm 8.96^\circ$ at days 3, 5, 7, and 10, respectively. These changes were statistically

significant at all intervals, with t -values of 4.80, 6.50, 8.41, and 8.79 ($p < 0.001$ to $p < 0.01$), indicating a consistent and marked improvement over time. In the non-diabetic group, abduction improvements were also evident, though slightly smaller in magnitude, with mean changes of $5.41 \pm 7.94^\circ$, $8.66 \pm 7.37^\circ$, $9.39 \pm 8.96^\circ$, and $13.16 \pm 9.39^\circ$ across the same intervals. The within-group t -values ranged from 0.33 (non-significant) to 4.46 ($p < 0.001$), showing that meaningful improvement became more pronounced in later measurements. Between-group comparisons revealed that differences in abduction gains between diabetic and non-diabetic patients were not statistically significant at days 3 and 5 ($t = 1.16, 1.66$; $p > 0.05$), but became significant at days 7 and 10 ($t = 2.15$; $p < 0.05$).

Table 3. Mean Changes in Abduction Range of Motion Within and Between Diabetic and Non-Diabetic Patients

Days	Diabetic (Mean $\pm$ SD)	t-value	Non-Diabetic (Mean $\pm$ SD)	t-value	Between-Group t-value
1-3	8.33 $\pm$ 6.73	4.80***	5.41 $\pm$ 7.94	0.33†	1.16†
1-5	13.33 $\pm$ 7.94	6.50**	8.66 $\pm$ 7.37	2.20*	1.66†
1-7	16.00 $\pm$ 7.37	8.41***	9.39 $\pm$ 8.96	4.00***	2.15*
1-10	20.33 $\pm$ 8.96	8.79***	13.16 $\pm$ 9.39	4.46***	2.15*

* Significant ($p < 0.05$); ** Highly significant ($p < 0.01$); *** Very highly significant ($p < 0.001$); † Non-significant ($p > 0.05$).

Table 4 displays the diabetic group; mean improvements in external rotation were $5.00 \pm 5.98^\circ$, $8.00 \pm 7.02^\circ$, $9.33 \pm 7.04^\circ$, and $11.33 \pm 7.19^\circ$ at days 3, 5, 7, and 10, respectively. These changes were statistically significant at all intervals, with t -values ranging from 3.24 to 6.11 ($p < 0.01$ to $p < 0.001$), indicating a steady enhancement in shoulder mobility. In the non-diabetic group, mean improvements were $6.00 \pm 5.41^\circ$, $10.33 \pm 7.19^\circ$, $15.00 \pm 7.79^\circ$, and $17.00 \pm 7.97^\circ$, all of which were highly significant ($t = 4.29$ – 8.06 ; $p < 0.001$). These results suggest that non-diabetic patients experienced slightly faster and greater improvements in external rotation compared with diabetic patients. Between-group comparisons showed no significant differences at days 3 and 5 ($t = 0.48, 0.90$; $p > 0.05$), whereas statistically significant differences emerged at days 7 and 10 ($t = 2.09, 2.04$; $p < 0.05$), supporting the non-diabetic group.

Table 4. The mean changes in external rotation range of motion within and between diabetic and non-diabetic patients.

Days	Diabetic	Non-Diabetic	t-value	t-value	
	Mean $\pm$ SD	t-value	Mean $\pm$ SD	t-value	
1-3	5 $\pm$ 5.98	3.24**	6 $\pm$ 5.41	4.29***	0.48†
1-5	8 $\pm$ 7.02	4.41**	10.33 $\pm$ 7.19	5.57***	0.9†
1-7	9.33 $\pm$ 7.04	5.14***	15 $\pm$ 7.79	7.46***	2.09*
1-10	11.33 $\pm$ 7.19	6.11***	17 $\pm$ 7.97	8.06***	2.04*

* Significance ($P < 0.05$) ** highly significance, ($P < 0.01$) *** Very highly significance ($P < 0.001$) † Non significance

Discussion

The present study evaluated the early response to physical therapy in diabetic and non-diabetic patients with adhesive capsulitis, focusing on pain reduction and improvements in shoulder range of motion (ROM). Both groups demonstrated significant within-group improvements in pain, abduction, and external rotation over a 10-day intervention period. While pain reduction was comparable between groups, non-diabetic patients exhibited slightly greater gains in ROM at later time points, suggesting that diabetes may moderately influence the rate of functional recovery.

These results are consistent with prior evidence indicating that structured physical therapy interventions, including manual therapy and exercise, can improve shoulder mobility and reduce pain in patients with adhesive capsulitis [10,11]. However, as Kirker et al. reported, variability in intervention techniques, dosing parameters, and duration of care limits the ability to determine an optimal regimen [10]. Our study supports the effectiveness of a structured program of interferential therapy, graded mobilization, and home exercise, while highlighting the potential influence of comorbid diabetes on rehabilitation outcomes.

The slightly slower improvements observed in diabetic patients may be explained by microvascular compromise, altered collagen metabolism, and low-grade systemic inflammation, which contribute to the higher prevalence and more recalcitrant course of adhesive capsulitis in this population [12,13]. Accurate assessment of ROM is essential for diagnosis and monitoring of treatment response, particularly in patients with metabolic comorbidities [14].

Adjunctive interventions, such as high-intensity home stretching devices, mobilization with movement (MWM), and hydrodilatation combined with corticosteroid injections, have demonstrated additional improvements in ROM and functional outcomes [12–15]. Our findings complement these observations, showing that even conservative clinic-based interventions can yield rapid early improvements, though

maximal recovery may require adjunctive or long-term strategies, particularly in diabetic patients. Electrotherapy modalities, including low-level laser therapy (LLLT) and pulsed electromagnetic field therapy (PEMF), have shown modest short-term benefits as adjuncts to exercise or manual therapy, although the overall quality of evidence remains low to moderate [16]. While our protocol included only interferential therapy, the results suggest that targeted physical therapy alone can produce clinically meaningful improvements in pain and ROM over a short-term period.

Conclusion

The outcomes of this study indicate that both diabetic and non-diabetic patients with adhesive capsulitis experienced significant early improvements in pain and shoulder range of motion following physical therapy. At baseline, there were no statistically significant differences between the groups in demographic characteristics, symptom duration, pain intensity, or shoulder mobility, suggesting that the two cohorts were comparable. Within-group analyses demonstrated gradual and significant reductions in pain scores for both diabetic and non-diabetic patients over the 10-day intervention period. Similarly, both groups exhibited marked improvements in shoulder abduction and external rotation. However, between-group comparisons revealed that non-diabetic patients experienced slightly greater gains in both abduction and external rotation at later time points (days 7 and 10), with statistically significant differences, suggesting a modestly faster recovery of shoulder mobility in this cohort. Overall, these results suggest that structured physical therapy is effective in producing early pain relief and functional improvement in patients with adhesive capsulitis, regardless of diabetic status. Although diabetic participants were identified based on glucose thresholds, the study did not assess HbA1c levels or diabetes duration, which may influence recovery. Future research should include these parameters to clarify their potential impact on physiotherapy outcomes.

Conflict of interest. Nil

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