Journal of Pioneering Medical Sciences
Received: March 07, 2026 | Accepted: September 22, 2026 | Published: November 05, 2026
Volume 15, Issue 10, Pages 14-20
DOI https://doi.org/10.47310/jpms2026151002



Spencer Technique Versus Scapular Stabilization Exercises in Diabetic Adhesive Capsulitis: A Randomized Controlled Trial

Mahendran P[1], A Sam Thamburaj[2], Santhana Lakshmi S[3*], S. Mythili[4], Ajith Kumar G P[5], Iswarya Suresh[6], Shenbaga Sundaram Subramanian[7], Wasif Pasha[8], Baraa Alsulaimani[9], Nabeel Hamdan Alghamdi[10], Khalid Mohammed Yaseen[11], Riziq Allah Mustafa Gaowgzeh[12] and Khalid A. Alsayed[13]

[1,2]Vinayaka Mission's College of Physiotherapy, Vinayaka Missions Research Foundation (DU), Salem, Tamil Nadu, India
[3,6,7]Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences (SIMATS), Thandalam, Chennai, Tamil Nadu, 602105, India
[4]School of Allied Health Sciences, Sai University, OMR, Paiyanur, Chennai, Tamil Nadu, 603104, India
[5]College of Physiotherapy, Sri Venkateswaraa University, Nallur, Chennai, Tamil Nadu, India
[8]Acharya Institute of Health Sciences, Cholanagar, R.T. Nagar, Bangalore, Karnataka
[9-12]Department of Physical Therapy, Faculty of Medical Rehabilitation Sciences, King Abdulaziz University, Jeddah, Saudi Arabia
[13]Department of Prosthetics and Orthotics, Faculty of Medical Rehabilitation Sciences, King Abdulaziz University, Jeddah, Saudi Arabia

*Corresponding author: S. Santhana Lakshmi (e-mail: sandhiyasivakumar94@gmail.com).

©2026 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0

Abstract **Purpose:** To compare the effects of the Spencer technique and scapular stabilization exercises on shoulder pain and disability, upper-extremity function and shoulder range of motion in individuals with diabetes mellitus and Stage II adhesive capsulitis. **Methods:** This two-arm, parallel-group randomized controlled trial included 49 participants with diabetes mellitus and Stage II adhesive capsulitis. Participants were allocated to the Spencer technique group (Group A, n = 25) or the scapular stabilization exercise group (Group B, n = 24). Both groups received their assigned physiotherapy intervention for six weeks. SPADI and DASH raw item-sum totals were analysed as primary outcomes. We analysed active and passive shoulder abduction and external rotation, measured with a goniometer, as secondary outcomes. We compared groups using change scores, with the mean difference defined as the change in Group A minus the change in Group B. **Results:** Both groups showed reductions in SPADI and DASH raw total scores after six weeks. The mean SPADI reduction was 46.00 points in Group A and 49.75 points in Group B; the between-group mean difference was -3.75 points (95% CI, -9.50 to 2.00; p = 0.195). The mean DASH reduction was 50.12 points in Group A and 42.63 points in Group B, favouring Group A, with a between-group mean difference of 7.50 points (95% CI, 2.10 to 12.89; p = 0.007). The improvement in shoulder abduction was greater in Group A for active range of motion (between-group mean difference, 23.01°; 95% CI, 14.70 to 31.31; p<0.001) and passive range of motion (18.31°; 95% CI, 10.86 to 25.76; p<0.001). No statistically significant between-group differences were observed for active external rotation (1.12°; 95% CI, -3.07 to 5.31; p = 0.594) or passive external rotation (-0.37°; 95% CI, -2.98 to 2.25; p = 0.779). **Conclusion:** Both groups improved over six weeks. The change-score analysis favoured the Spencer technique for DASH raw total scores and shoulder abduction, while no statistically significant between-group differences were observed for SPADI or shoulder external rotation. These findings should be interpreted in the context of the raw-score method and differences in the intervention schedules.

Key Words Adhesive Capsulitis, Spencer Technique, Scapular Stabilization Exercises, Pain, ROM

INTRODUCTION

Adhesive capsulitis, commonly known as "frozen shoulder," is a painful musculoskeletal condition characterized by progressive shoulder pain, stiffness and restricted active and passive Range of Motion (ROM). The condition is particularly common among individuals with diabetes mellitus. It is associated with inflammatory and fibrotic changes in the joint capsule, leading to capsular thickening, reduced tissue elasticity and progressive restriction of shoulder movement [1,2].

Adhesive capsulitis is commonly categorized into four clinical stages. Stage I or the pre-freezing/painful stage, is characterized mainly by pain with an initial reduction in shoulder ROM. Stage II or the freezing stage, is

characterized by progressive pain and significant restriction of both active and passive ROM and may last approximately 3-9 months. Stage III or the frozen stage, is characterized by marked stiffness with pain mainly at end-range movement, while Stage IV or the thawing stage, is associated with a gradual reduction in pain and improved ROM [3].

Several factors may contribute to adhesive capsulitis, including diabetes mellitus, thyroid disorders, inflammatory conditions, prolonged immobilization, postsurgical conditions and age-related changes [4]. Adhesive capsulitis is more common in individuals with diabetes mellitus [5]. Individuals with adhesive capsulitis commonly experience pain during movement and sleep, followed by progressive stiffness and restricted ROM that may persist for an extended period and interfere with upper-limb function and daily activities [6].

However, different physiotherapy approaches target different components of shoulder dysfunction and evidence directly comparing the spencer technique with scapular stabilization exercises in individuals with diabetes mellitus and Stage II adhesive capsulitis remains limited. This provides a clinically relevant basis for comparing these two interventions using standardized measures of pain, shoulder ROM and upper-extremity function [7].

The spencer technique, also called the seven-stage technique, is an osteopathic manipulative approach involving slow, rhythmic, controlled passive movements of the glenohumeral joint. The technique includes shoulder flexion with elbow extension, shoulder extension with elbow flexion, shoulder abduction with internal and external rotation, shoulder circumduction with compression and traction and fluid-pumping movements. The spencer technique may be

particularly useful for addressing the restricted shoulder mobility that is characteristic of adhesive capsulitis. It may therefore reduce stiffness and improve functional shoulder movement in individuals with Stage II adhesive capsulitis [8,9].

Scapular stabilization exercises are therapeutic exercises designed to improve the strength, endurance and neuromuscular control of the muscles responsible for maintaining scapular stability. These exercises involve muscles such as the serratus anterior, middle and lower trapezius and rhomboids. Improved scapular control may contribute to better scapulohumeral rhythm, shoulder strength, movement efficiency and functional performance [10].

The effect of physiotherapy interventions in population with adhesive capsulitis can be assessed using validated patient-reported outcome measures and objective assessments of mobility of shoulder. The Shoulder Pain and Disability Index (SPADI) quantify shoulder pain and disability and has given a good reliability and validity in individuals with frozen shoulder [11]. The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire evaluates upper limb presentations and functional limitations, providing a shoulder-specific assessment similar to SPADI. Measuring shoulder range of motion (ROM), particularly flexion, abduction and internal and external rotation, provides objective evidence of mobility changes after rehabilitation [12].

Although both the spencer technique and scapular stabilization exercises are used in the rehabilitation of shoulder disorders, the comparative effectiveness of these interventions in individuals with both diabetes mellitus and Stage II adhesive capsulitis requires further investigation. Diabetes mellitus is associated with an increased risk of adhesive capsulitis and the resulting pain, restriction of shoulder movement and functional limitations may interfere with daily activities. The spencer technique uses a series of shoulder mobilization procedures, whereas scapular stabilization exercises aim to improve scapular control and shoulder girdle function. However, the available evidence directly comparing these two interventions in patients with diabetes mellitus and Stage II adhesive capsulitis is limited. Therefore, a direct comparison is warranted to determine their relative effects on shoulder pain and disability, upper-extremity function and shoulder range of motion.

The aim of this study was to compare the effects of the Spencer technique and scapular stabilization exercises in individuals with diabetes mellitus and Stage II adhesive capsulitis. We assessed shoulder pain and disability using the Shoulder Pain and Disability Index (SPADI) and upper-extremity functional disability using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. Secondary outcomes were shoulder range of motion, including active and passive abduction and external rotation, measured using a goniometer at baseline and after six weeks of intervention. We hypothesized that the two interventions would differ in their effects on shoulder pain and disability, upper-extremity function and shoulder range of motion.

METHODS

Study Design and Participants

Study Setting, Recruitment and Sample Size: This two-arm, parallel-group randomized controlled trial was conducted at the Department of Physiotherapy, Acharya Institute of Health Sciences, Bengaluru, Karnataka, India, between March and July 2026. A sample-size calculation was reported to have been performed using G*Power and estimates from previously published evidence. However, the supplied manuscript and master chart do not provide the calculation's primary outcome, expected between-group difference, variability estimate, significance level, statistical power or allowance for attrition. Fifty-eight individuals were screened for eligibility and 49 were ultimately randomized after nine exclusions., 25 to Group A, which received the Spencer technique and 24 to Group B, which received scapular stabilization exercises. Recruitment was conducted from the institution and the surrounding Bengaluru region. The study records document convenience sampling. The random allocation sequence was generated using a computer-generated method. The available study records do not specify a separate allocation-concealment procedure or identify the personnel responsible for sequence generation, participant enrolment and intervention assignment.

Participants aged 40-65 years with diabetes mellitus and unilateral shoulder pain and stiffness of approximately three months' duration were eligible for inclusion. The study criteria included restricted passive shoulder range of motion,

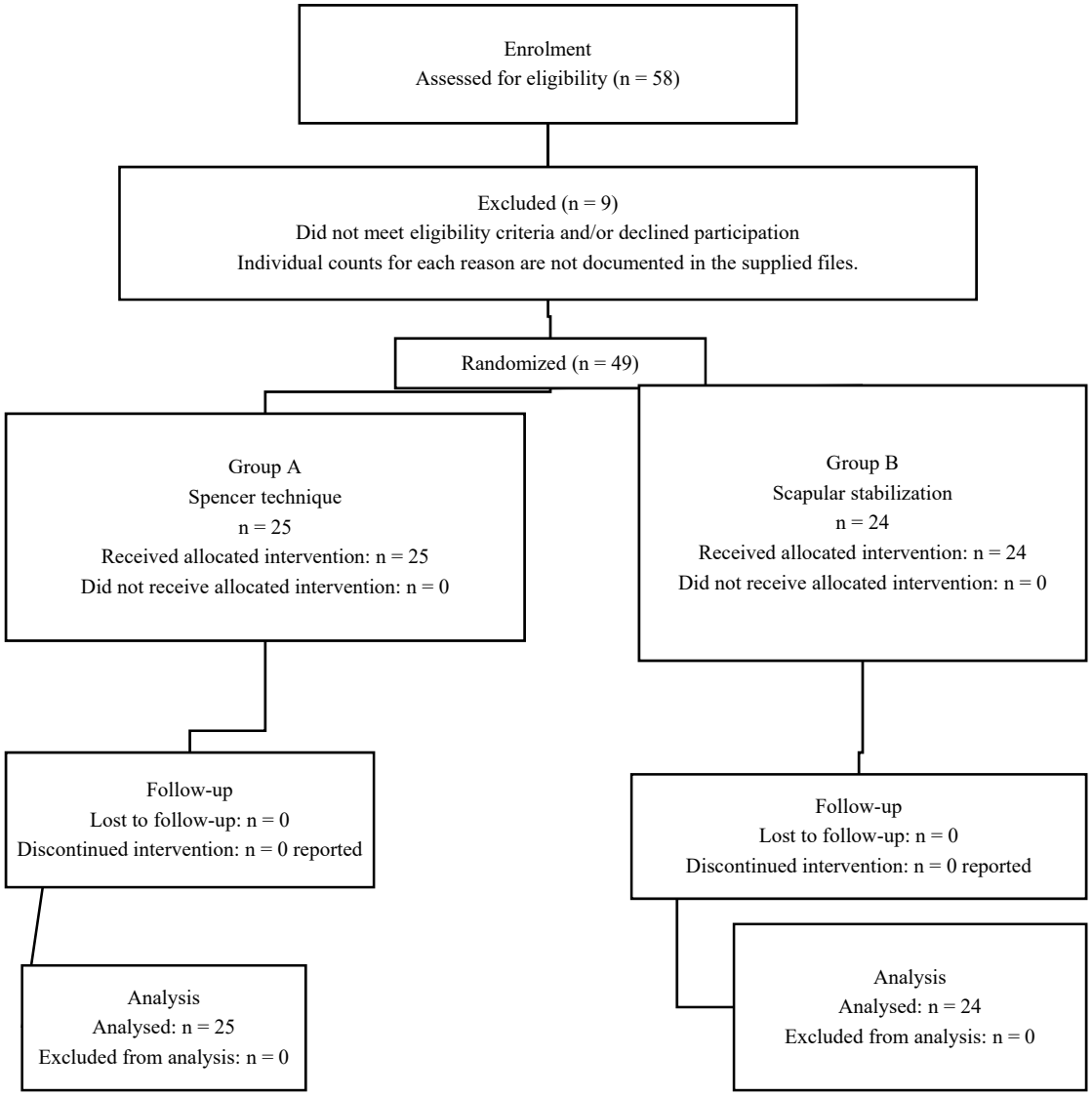


Figure 1: CONSORT Flow Diagram Showing Participant Screening, Randomization, Allocation, Follow-Up and Analysis

particularly in abduction and external rotation, consistent with the reported Stage II adhesive capsulitis presentation. Individuals with a history of trauma, congenital shoulder abnormalities, shoulder fracture or subluxation, rheumatoid arthritis, malignancy or tumour, previous shoulder surgery, Grade II or III rotator cuff tear, degenerative joint disease, stroke, use of analgesic medication, unwillingness to participate or inability to follow study instructions were excluded. Written informed consent was obtained before enrolment. Participants with diabetes mellitus and an HbA1c level greater than 7% were eligible for inclusion. The available study documentation does not specify how diabetes was verified, the rationale for selecting the HbA1c threshold or whether diabetes type, duration, medication use and other measures of glycaemic control were recorded.

After eligibility screening and baseline assessment, 49 participants were randomized using a computer-generated randomization sequence. Twenty-five participants were allocated to the Spencer technique group and 24 to the scapular stabilization exercise group. All randomized participants were included in the six-week follow-up and analysis. The study records provided for this revision indicate no loss to follow-up; however, the supplied master chart did not include detailed session attendance or protocol-deviation records (Figure 1).

Outcomes were assessed at baseline and after six weeks of intervention. We used the Shoulder Pain and Disability Index (SPADI) to assess shoulder pain and disability and the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire to assess upper-extremity functional disability. Shoulder range of motion was also assessed, including active and passive abduction and external rotation.

Intervention Protocol

The intervention period lasted six weeks. Group A (n = 25) received the Spencer technique three times per week,

Table 1: Intervention Schedule for the Spencer Technique Group, Including Adjunct Physiotherapy and Codman Pendulum Exercises

Intervention	Frequency	Intensity	Duration
Week 1: Moist heat therapy	Three times a week	10 repetitions, 1 set	20 minutes
Codman's pendulum exercises			10 minutes
Interferential therapy (IFT)		Comfortable sensory level	15 minutes
Spencer technique		1 set of 15 repetitions	15 minutes
Week 2-3: Moist heat therapy	Three times a week	15 repetitions, 2 set	20 minutes
Codman's pendulum exercises			10 minutes
Interferential therapy (IFT)		Comfortable sensory level	15 minutes
Spencer technique		3 set of 10 repetitions	15 minutes
Week 4-6: Moist heat therapy	Three times a week	10 repetitions, 3 sets	20 minutes
Codman's pendulum exercises			10 minutes
Interferential therapy (IFT)		Comfortable sensory level	15 minutes
Spencer technique		5 sets, 15 repetitions each with a two-minute rest period	15 minutes

Table 2: Intervention Schedule for the Scapular Stabilization Exercise Group, Including Adjunct Physiotherapy

Intervention	Frequency	Intensity	Duration
Week 1: Moist heat therapy	Five times a week	Comfortable sensory level	20 minutes
Interferential therapy (IFT)			15 minutes
Scapular stabilization exercises		2 sets, 10 repetitions each	20 minutes
Week 2-3: Moist heat therapy	Five times a week	Comfortable sensory level	20 minutes
Interferential therapy (IFT)			15 minutes
Scapular stabilization exercises		3 sets of 15 repetitions with two minutes rest period	20 minutes
Week 4-6: Moist heat therapy	Five times a week	Comfortable sensory level	20 minutes
Interferential therapy (IFT)			15 minutes
Scapular stabilization exercises		5 sets of 10 repetitions with two minutes rest period	20 minutes

together with moist heat therapy, interferential therapy (IFT) and Codman pendulum exercises as recorded in the intervention protocol. Group B (n = 24) received scapular stabilization exercises five days per week, together with moist heat therapy and IFT. Moist heat therapy was listed as 20 minutes and IFT as 15 minutes at a beat frequency of 100 Hz in both groups. The session duration and exercise dosage must be interpreted according to the intervention components and progression documented in Table 1 and 2.

Outcome Measures

The primary outcomes were shoulder pain and disability, assessed using the Shoulder Pain and Disability Index (SPADI) and upper-extremity functional disability, assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. Secondary outcomes were shoulder range of motion, measured using a goniometer, including active and passive shoulder abduction and external rotation. Outcomes were recorded at baseline and after six weeks of intervention.

The supplied master chart contains SPADI and DASH raw total values, with Group A labelled as SPADI total = 130 and DASH total = 150. The Group B chart reverses these labels. For consistency, the questionnaire totals are reported as raw item-sum scores rather than transformed 0-100 scores. Lower raw totals indicate fewer reported symptoms or functional limitations. The original item-level scoring records were not included in the supplied files; therefore, the use of the standard transformed scoring algorithm and the handling of missing questionnaire responses could not be independently verified.

Shoulder range of motion was recorded in degrees for active and passive abduction and external rotation. The supplied documentation does not specify the participant positioning, goniometric landmarks, number of repeated measurements, assessor training, assessor blinding or whether the assessor was independent of the treating therapist.

Statistical Analysis

Continuous variables are summarized as means and standard deviations and categorical variables as frequencies and percentages. Within-group changes from baseline to six weeks were assessed using paired-samples t-tests. Between-group comparisons were performed on change scores using independent-samples Welch t-tests. For SPADI and DASH, improvement was defined as baseline score minus post-intervention score; for shoulder range of motion, improvement was defined as post-intervention value minus baseline value. The between-group mean difference was calculated as the mean change in Group A minus the mean change in Group B. Two-sided 95% confidence intervals were calculated for the between-group mean differences and statistical significance was set at $p<0.05$. All 49 randomized participants were included in the supplied outcome dataset, with 25 in Group A and 24 in Group B. The supplied records do not identify the statistical software and version or document formal checks of normality and other test assumptions. No separate statistical analysis plan was available in the supplied documentation.

RESULTS

The study included 49 participants with Stage II adhesive capsulitis associated with diabetes mellitus, who were randomly allocated to two intervention groups. Group A, comprising 25 participants received the Spencer technique while Group B, comprising 24 participants, received scapular stabilization exercises. Baseline assessment was

Table 3: Baseline Demographic and Clinical Outcome Characteristics

Variable	Spencer technique (n = 25)	Scapular stabilization (n = 24)
Age (years, Mean±SD)	51.28±5.18	52.00±5.30
Male (n)	13	15
Female (n)	12	9
SPADI raw total (Mean±SD)	108.68±14.20	105.83±6.85
DASH raw total (Mean±SD)	107.92±10.48	110.88±7.31
Abduction AROM (degrees, Mean±SD)	83.56±10.72	94.04±12.15
Abduction PROM (degrees, Mean±SD)	100.08±12.19	109.83±11.34
External rotation AROM (degrees, Mean±SD)	48.68±7.98	43.33±6.27
External rotation PROM (degrees, Mean±SD)	65.12±7.21	57.25±6.52

Table 4: Within- and Between-Group Comparisons of Outcome Measures Before and After the Six-Week Intervention

Outcome	Group	Pre-intervention (Mean±SD)	Post-intervention (Mean±SD)	Within group (p-value)	Mean Change	Between-group (p-value)
SPADI	Spencer	108.68±14.20	62.68±12.61	<0.001	-46.00	0.187
	Scapular stabilization	105.83±6.85	56.08±6.12	<0.001	-49.75	
DASH	Spencer	107.92±10.48	57.80±3.57	<0.001	-50.12	0.004
	Scapular stabilization	110.88±7.31	68.25±8.53	<0.001	-42.63	
Abduction AROM	Spencer	83.56±10.72	144.36±12.78	<0.001	+60.80	<0.001
	Scapular stabilization	94.04±12.15	131.83±17.29	<0.001	+37.79	
External rotation AROM	Spencer	48.68±7.98	68.84±8.26	<0.001	+20.16	0.595
	Scapular stabilization	43.33±6.27	62.38±5.99	<0.001	+19.04	
Abduction PROM	Spencer	100.08±12.19	169.68±8.33	<0.001	+69.60	<0.001
	Scapular stabilization	109.83±11.34	161.13±13.80	<0.001	+51.29	
External rotation PROM	Spencer	65.12±7.21	81.88±6.31	<0.001	+16.76	0.778
	Scapular stabilization	57.25±6.52	74.38±6.78	<0.001	+17.13	

performed before commencement of the intervention and post-intervention assessment was conducted following the 6-week treatment period. Table 3 presents the baseline, between-group and within-group results (Table 4).

Baseline Characteristics

The master chart contained data for 49 participants: 25 in the Spencer technique group and 24 in the scapular stabilization exercise group. The mean age was 51.28±5.18 years in Group A and 52.00±5.30 years in Group B. Group A included 13 males and 12 females, while Group B included 15 males and 9 females. Baseline questionnaire and shoulder range-of-motion values are presented in Table 3.

Within-Group Changes in Outcome Measures

After six weeks, SPADI raw total scores decreased by a mean of 46.00 points in Group A and 49.75 points in Group B. DASH raw total scores decreased by 50.12 points in Group A and 42.63 points in Group B. Both groups showed statistically significant within-group reductions in SPADI and DASH scores (all $p<0.001$).

Active shoulder abduction increased by 60.80° in Group A and 37.79° in Group B. Passive shoulder abduction increased by 69.60° in Group A and 51.29° in Group B. Active external rotation increased by 20.16° in Group A and 19.04° in Group B. Passive external rotation increased by 16.76° in Group A and 17.12° in Group B. Within-group improvements in all four range-of-motion outcomes were statistically significant (all $p<0.001$).

Between-Group Comparison

Between-group comparisons of change scores showed a mean difference of -3.75 points for SPADI (95% CI, -9.50 to 2.00; $p = 0.195$), indicating a numerically greater reduction in Group B, though not statistically significant. For DASH, the mean difference was 7.50 points (95% CI, 2.10 to 12.89; $p = 0.007$), favouring Group A.

The mean between-group difference in improvement in active shoulder abduction was 23.01° (95% CI, 14.70 to 31.31; $p<0.001$) and the difference in passive shoulder abduction was 18.31° (95% CI, 10.86 to 25.76; $p<0.001$), both favouring Group A. No statistically significant between-group differences were observed for active external rotation (mean difference, 1.12°; 95% CI, -3.07 to 5.31; $p = 0.594$) or passive external rotation (mean difference, -0.37°; 95% CI, -2.98 to 2.25; $p = 0.779$). These comparisons indicate differences in change scores; they should not be interpreted as evidence of superiority across all outcomes.

DISCUSSION

The present randomized controlled trial compared the effects of the Spencer technique and scapular stabilization exercises in individuals with diabetes mellitus and Stage II adhesive capsulitis. The findings suggest that both interventions may support rehabilitation but the pattern and magnitude of improvement may differ across specific functional and mobility outcomes.

The improvement observed in both intervention groups aligns with prior evidence supporting exercise-based and physiotherapy interventions for adhesive capsulitis. Kim *et al.*, in a systematic review and meta-analysis, reported that exercise alone and exercise combined with joint mobilization can improve shoulder range of motion and subjective outcomes in individuals with adhesive capsulitis [1,15]. The improvements observed in the present study are therefore consistent with the broader evidence supporting structured exercise and mobilization as important components of conservative management of adhesive capsulitis.

A systematic review by Dennis *et al.* reported that individuals with diabetes may experience worse clinical outcomes, pain and shoulder range of motion than those without diabetes, although evidence certainty varied across outcome measures and was limited by methodological concerns in the included studies [2,16]. These findings highlight the clinical relevance of maintaining shoulder mobility and incorporating structured movement-based rehabilitation in individuals with diabetes mellitus who develop adhesive capsulitis.

Previous clinical research has reported improvements in pain, disability and shoulder range of motion after applying the Spencer technique in individuals with frozen shoulder. Furthermore, a systematic review and meta-analysis of randomized controlled trials reported beneficial effects of the Spencer technique on pain, disability and shoulder range of motion in individuals with frozen shoulder [5,17]. However, the review also indicated that the Spencer technique was not consistently superior to other manual therapy approaches. Thus, these findings support the Spencer technique's potential role in improving functional outcomes but its effects should be interpreted in relation to the specific outcome measure and comparator intervention [18,19].

Jain *et al.*, in a systematic review of mobilization techniques, reported beneficial effects of several mobilization approaches on pain and range of motion in adhesive capsulitis, with combined mobilization approaches demonstrating potential benefits for active shoulder movement [20]. A more recent systematic review and meta-analysis also identified differences among joint mobilization approaches for outcomes including shoulder abduction, external rotation, pain and disability, although the magnitude of benefit varied across technique [19]. These findings are consistent with previous evidence that mobilization-based interventions may be particularly relevant for improving restricted shoulder movement.

A systematic review and meta-analysis examining scapular mobilization in primary adhesive capsulitis found no significant superiority over other therapeutic interventions for shoulder disability, pain or external rotation [8]. This is consistent with the present findings, in which the scapular stabilization intervention produced significant improvements but did not demonstrate a significant between-group advantage for SPADI or external rotation.

An important finding of the present study was that statistically significant improvement within both groups did not necessarily translate into a significant between-group difference for every outcome. Both interventions significantly improved SPADI and external rotation but the between-group differences were not statistically significant for these outcomes.

Recent evidence also supports these findings regarding rehabilitation in diabetic adhesive capsulitis. Ali et al. reported that adding moderate physical activity to conventional physiotherapy produced greater improvements in pain, shoulder range of motion and DASH scores compared with conventional physiotherapy alone [22]. Therefore, the present study contributes to the evidence by directly comparing two physiotherapy approaches in individuals with diabetes mellitus and Stage II adhesive capsulitis.

The study had several strengths. The randomized controlled trial design enabled a structured comparison between two intervention approaches, with participants allocated using a computer-generated randomization sequence. Including individuals with diabetes mellitus and Stage II adhesive capsulitis addressed a clinically relevant population that may experience substantial shoulder restrictions. The six-week intervention period and predefined outcome assessment also provided a standardized framework for evaluating short-term treatment responses.

This study has several limitations. The sample was relatively small and recruited from a single clinical setting, which may limit the generalisability of the findings. Outcomes were assessed only at baseline and after six weeks; therefore, the persistence of treatment effects is unknown. Participants and treating therapists were unlikely to have been blinded to the intervention and the supplied records do not establish whether outcome assessors were blinded or independent of the treating therapists. The intervention schedules differed in weekly frequency and Codman pendulum exercises were listed for Group A but not Group B. Both groups also received moist heat therapy and interferential therapy, which limits attribution of the observed changes to the assigned intervention alone. The supplied master chart did not include detailed records of session attendance, treatment fidelity, therapist effects or diabetes-related clinical characteristics. In addition, the questionnaire data were provided as raw item-sum totals and the original item-level records were not available to verify the use of standard transformed scoring. These limitations should be considered when interpreting the between-group findings. The results apply to the study population and the six-week assessment period and should not be generalised directly to individuals without diabetes, other stages of adhesive capsulitis or settings with different rehabilitation protocols.

Future randomized controlled trials should include larger, more diverse samples, multicenter recruitment, more representative sampling methods and longer follow-up periods.

CONCLUSIONS

Both the Spencer technique and scapular stabilization exercises were associated with improvements in questionnaire raw total scores and shoulder range of motion over six weeks in individuals with diabetes mellitus and Stage II adhesive capsulitis. Between-group change-score comparisons favoured the Spencer technique for DASH raw total scores and active and passive shoulder abduction. No statistically significant between-group differences were observed for SPADI or active and passive external rotation. These findings indicate outcome-specific differences rather than consistent superiority of one intervention across all measured outcomes. Interpretation is limited by differences in intervention schedules and the need for clear

documentation of questionnaire scoring. Longer-term follow-up and more fully documented, reproducible intervention protocols are required to establish the durability and comparative clinical relevance of these findings.

Clinical Trial Registry

The study received approval from the Institutional Scientific Review Board of Acharya Institute of Health Sciences, Bengaluru, India (Approval No. AIHS/Ethical Review/5202/26). The trial was not registered in the Clinical Trials Registry-India (CTRI). The supplied study documentation did not include a separately accessible trial protocol or statistical analysis plan. Accordingly, prospective public registration and public availability of a protocol or statistical analysis plan cannot be reported.

Acknowledgement

The authors express sincere gratitude to the department and to all who supported and inspired them and laid the foundation for this research. We sincerely thank each participant in this study, whose participation made this project possible.

REFERENCES

[1] Nakandala, P. *et al.* "The Efficacy of Physiotherapy Interventions in the Treatment of Adhesive Capsulitis: A Systematic Review." *J. Back Musculoskeletal Rehabilitation*, vol. 34, 2021, pp. 195-205. https://doi.org/10.3233/bmr-200186.

[2] Tamai, K. *et al.* "Can Magnetic Resonance Imaging Distinguish Clinical Stages of Frozen Shoulder? A State-of-the-Art Review." *JSES Reviews, Reports and Techniques*, vol. 4, no. 3, August 2024, pp. 365-370.

[3] Vita, F. *et al.* "Adhesive Capsulitis: The Importance of Early Diagnosis and Treatment." *J. Ultrasound*, vol. 27, June 2024, pp. 579-587. https://doi.org/10.1007/s40477-024-00891-y.

[4] Sarasua, S.M. *et al.* "The Epidemiology and Etiology of Adhesive Capsulitis in the U.S. Medicare Population." *BMC Musculoskeletal Disorders*, vol. 22, September 2021. https://doi.org/10.1186/s12891-021-04704-9.

[5] Hill, J.L. "Evidence for Combining Conservative Treatments for Adhesive Capsulitis." *Ochsner Journal*, vol. 24, no. 1, March 2024, pp. 47-52. https://doi.org/10.31486/toj.23.0128.

[6] Picasso, R. *et al.* "Adhesive Capsulitis of the Shoulder: Current Concepts on the Diagnostic Work-Up and Evidence-Based Protocol for Radiological Evaluation." *Diagnostics*, vol. 13, no. 22, 2023. https://doi.org/10.3390/diagnostics13223410.

[7] Abrar, M. *et al.* "Comparative Effects of Gong's Versus Maitland Mobilization Combined with Spencer Technique on Pain, Range of Motion and Functional Outcomes in Patients with Adhesive Capsulitis." *HJPRS*, vol. 6, no. 2, April 2026, pp. 80-87. https://doi.org/10.55735/r898wx05.

[8] Phansopkar, P. "An Integrated Physical Therapy Using Spencer's Technique in the Rehabilitation of a Patient with a Frozen Shoulder: A Case Report." *Cureus*, vol. 15, no. 6, June 2023.

[9] Deepika, B. *et al.* "Effect of Spencer Muscle Energy Technique and Proprioceptive Neuromuscular Facilitation in Adhesive Capsulitis." *Indian Journal of Physiotherapy & Occupational Therapy*, vol. 18, no. 5, January 2024, pp. 447-452. https://doi.org/10.37506/0tb6dq69.

[10] Başkurt, Z. *et al.* "The Effectiveness of Scapular Stabilization Exercise in the Patients with Subacromial Impingement Syndrome." *J. Back Musculoskeletal Rehabil*, vol. 24, no. 3, 2011, pp. 173-179. https://doi.org/10.3233/bmr-2011-0291.

[11] Venturin, D. *et al.* "Reliability and Validity of the Shoulder Pain and Disability Index in a Sample of Patients with Frozen Shoulder." *BMC Musculoskeletal Disorders*, vol. 24, March 2023. https://doi.org/10.1186/s12891-023-06268-2.

[12] Staples, M.P. *et al.* "Shoulder-Specific Disability Measures Showed Acceptable Construct Validity and Responsiveness." *Journal of Clinical Epidemiology*, vol. 63, no. 2, 2010, pp. 163-170. https://doi.org/10.1016/j.jclinepi.2009.03.023.

[13] Phansopkar, P. and M.I. Qureshi. "Impact of Spencer Technique on Pain, Range of Motion and Functional Disability in Patients With Frozen Shoulder: A Pilot Study." *Cureus*, vol. 16, no. 1, January 2024.

[14] Aboelnour, N.H. *et al.* "Combined Effect of Graded Thera-Band and Scapular Stabilization Exercises on Shoulder Adhesive Capsulitis Postmastectomy." *Support Care Cancer*, vol. 31, 2023.

[15] Wajid, W. *et al.* "Comparative Effects of Mobilization with Movement Versus Spencer Technique Combined with Scapular Stabilization Exercises on Pain, Range of Motion and Functional Disability in Patients with Adhesive Capsulitis." *HJPRS*, vol. 6, no. 3, May 2026, pp. 170-176. https://doi.org/10.55735/cnbrd779.

[16] Lee, J.H. *et al.* "Effects of Exercise Intervention (With and Without Joint Mobilization) in Patients with Adhesive Capsulitis: A Systematic Review and Meta-Analysis." *Healthcare*, vol. 11, no. 10, May 2023. https://doi.org/10.3390/healthcare11101504.

[17] Dyer, B.P. *et al.* "Diabetes as a Prognostic Factor in Frozen Shoulder: A Systematic Review." *Archives of Rehabilitation Research and Clinical Translation*, vol. 3, no. 3, September 2021. https://doi.org/10.1016/j.arrct.2021.100141.

[18] Amin, A. *et al.* "Comparison of Spencer Muscle Energy Technique and Conventional Physiotherapy on Pain and Disability in Shoulder Adhesive Capsulitis: A Quasi-Experimental Study." *Bulletin of Faculty of Physical Therapy*, vol. 30, no. 1, June 2025. https://doi.org/10.1186/s43161-025-00297-9.

[19] Jivani, R.R. and D.N. Hingarajia. "Effect of Spencer Muscle Energy Technique Versus Maitland's Mobilization Technique on Pain, ROM and Disability in Patients with Frozen Shoulder: A Comparative Study." *Int. J. Physiother. Res.*, vol. 9, no. 4, August 2021, pp. 3928-3936. https://doi.org/10.16965/ijpr.2021.148.

[20] Phansopkar, P. "Impact of Spencer Technique on Pain, Range of Motion and Functional Disability in Patients with Frozen Shoulder: A Pilot Study." *Cureus*, vol. 16, no. 1, January 2024.

[21] Olguin-Huerta, C. *et al.* "Effectiveness of Scapular Mobilization in Patients with Primary Adhesive Capsulitis: A Systematic Review and Meta-Analysis." *Medicine*, vol. 102, no. 22, June 2023.

[22] Tang, S. and X. Tan. "Does the Intervention for Adhesive Capsulitis in Patients with Diabetes Differ from That for Patients without Diabetes? A Systematic Review." *Medicine*, vol. 103, no. 46, November 2024.

[23] Lo, C.S. *et al.* "Comparative Effectiveness of Combination Versus Single-Modality Physiotherapy for Rotator Cuff-Related Shoulder Pain: A Systematic Review and Network Meta-Analysis." *Journal of Clinical Medicine*, vol. 14, no. 13, July 2025. https://doi.org/10.3390/jcm14134765.