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Original Article

Effects of Abdominal Drawing-In Maneuver with Cross-Pattern Limb Exercises on Pain and Disability in Shoulder Impingement Syndrome: A Randomized Controlled Trial

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ABSTRACT

Background: Shoulder impingement syndrome is a common cause of shoulder pain and functional limitation, often associated with altered scapulohumeral mechanics, rotator cuff dysfunction, and impaired kinetic-chain control. Objective: To determine the effects of abdominal drawing-in maneuver with cross-pattern limb exercises on pain and disability in patients with shoulder impingement syndrome. Methods: This randomized controlled trial was conducted at Akhtar Saeed Trust Hospital, EME, over six months. Forty-two eligible patients aged 30–50 years with clinical signs of shoulder impingement syndrome were randomly allocated to conventional physiotherapy or conventional physiotherapy plus abdominal drawing-in maneuver with cross-pattern limb exercises. Treatment was delivered for six weeks, three sessions per week. Pain and disability were assessed using the Shoulder Pain and Disability Index before and after intervention. Data were analyzed using SPSS version 27, with independent-samples and paired-samples t-tests applied at $p < 0.05$. Results: Thirty-eight participants completed follow-up analysis. Baseline SPADI scores were comparable between groups ($p = 0.385$). After six weeks, the experimental group showed significantly lower SPADI scores than the control group (16.73 ± 3.15 vs. 47.21 ± 15.25; mean difference = 30.47; 95% CI: 23.00–37.94; $p < 0.001$). Within-group improvement was significant in both groups, but greater in the experimental group. Conclusion: Adding abdominal drawing-in maneuver with cross-pattern limb exercises to conventional physiotherapy produced greater improvement in shoulder pain and disability than conventional therapy alone. Keywords: Shoulder Impingement Syndrome; Abdominal Drawing-In Maneuver; Core Stability; Cross-Pattern Exercises; SPADI; Randomized Controlled Trial.

INTRODUCTION

Shoulder impingement syndrome is one of the most common causes of shoulder pain and functional limitation among peripheral joint disorders, and it is generally characterized by progressive pain, restricted movement, and difficulty during overhead or resisted shoulder activities (1). Subacromial impingement involves mechanical compression and irritation of the rotator cuff tendons, subacromial bursa, coracoacromial ligament, and adjacent structures beneath the anterior acromion, with clinical manifestations frequently including painful arc, positive Neer's sign, positive Hawkins-Kennedy test, pain during resisted abduction, and functional disability during daily activities (2). Because subacromial impingement syndrome contributes substantially to shoulder-related morbidity and has a variable prognosis with recurrent symptoms in a considerable proportion of patients, effective conservative rehabilitation strategies remain clinically important (3,4).

The pathophysiology of shoulder impingement syndrome is multifactorial and includes inflammation, degenerative changes in subacromial tissues, altered glenohumeral and scapulohumeral kinematics, rotator cuff dysfunction, and impaired scapular muscle performance (5,6). These impairments can reduce shoulder mobility, disturb force transmission across the upper quadrant, and negatively affect quality of life (7). Conventional physiotherapy commonly includes range-of-motion exercises, stretching, strengthening, pendulum exercises, soft-tissue techniques, and mobilization procedures to reduce pain and improve shoulder function (8,9). However, shoulder movement does not occur in isolation, and rehabilitation approaches limited only to local shoulder exercises may insufficiently address proximal neuromuscular control deficits that influence upper-limb loading and movement efficiency.

The trunk and lumbopelvic region provide a biomechanical foundation for upper-limb movement by contributing to postural control, load transfer, and kinetic chain efficiency (10). Core musculature plays an important role in generating and transferring force from the trunk to the shoulder and distal upper limb, particularly during functional reaching, lifting, and overhead activity (11). Reduced core stability may increase mechanical demand at the shoulder, while improved trunk control may enhance scapular positioning, neuromuscular coordination, and force distribution across the upper kinetic chain. Therefore, trunk stabilization has been increasingly considered relevant in shoulder rehabilitation, especially where pain and disability are influenced by impaired proximal control (12–14).

The abdominal drawing-in maneuver is a core stabilization technique designed to activate deep stabilizing muscles of the trunk and improve lumbopelvic control during limb movement (15). When combined with cross-pattern limb exercises, it may facilitate coordinated activation between trunk, scapular, and shoulder musculature, thereby improving upper-limb function through kinetic chain integration (16–18). Although previous studies support the role of core stabilization in shoulder function and rehabilitation, limited randomized evidence has specifically examined the added effect of abdominal drawing-in maneuver with cross-pattern limb exercises in patients with shoulder impingement syndrome. Therefore, this study was conducted to determine whether adding abdominal drawing-in maneuver with cross-pattern limb exercises to conventional shoulder rehabilitation produces greater improvement in pain and disability than conventional treatment alone in patients with shoulder impingement syndrome.

MATERIALS AND METHODS

This randomized controlled trial was conducted at Akhtar Saeed Trust Hospital, EME, over a period of six months to compare the effects of conventional shoulder rehabilitation alone with conventional rehabilitation plus abdominal drawing-in maneuver and cross-pattern limb exercises in patients with shoulder impingement syndrome. Participants were recruited using non-probability convenience sampling and were screened according to predefined eligibility criteria. Adults aged 30–50 years of either sex were considered eligible if they had clinical features consistent with shoulder impingement syndrome, including positive Neer's sign, positive Hawkins-Kennedy sign, painful arc, and pain during resisted isometric abduction (19). Patients were excluded if they had a history of shoulder dislocation, previous shoulder surgery, upper-limb fracture, current cervical spine-related symptoms, acromioclavicular joint pain, low back pain, or corticosteroid injection into the shoulder joint during the preceding 12 months (20).

A total of 50 patients were initially screened, of whom 42 fulfilled the eligibility criteria and were enrolled in the trial. The sample size was calculated using values from a previous study, with mean ± standard deviation values of 68.67 ± 11.06 and 56.96 ± 13.36, an estimated mean difference of 11.71, pooled standard deviation of 12.27, 95% confidence level, 80% statistical power, and two-tailed significance level of 0.05. The required sample size was 38 participants, and after adjustment for an anticipated 10% attrition rate, the final target sample size was increased to 42 participants. After baseline assessment, participants were randomly allocated into two equal groups using the lottery method. Four

participants did not complete follow-up assessment, leaving 38 participants for final analysis, with 19 participants in each group.

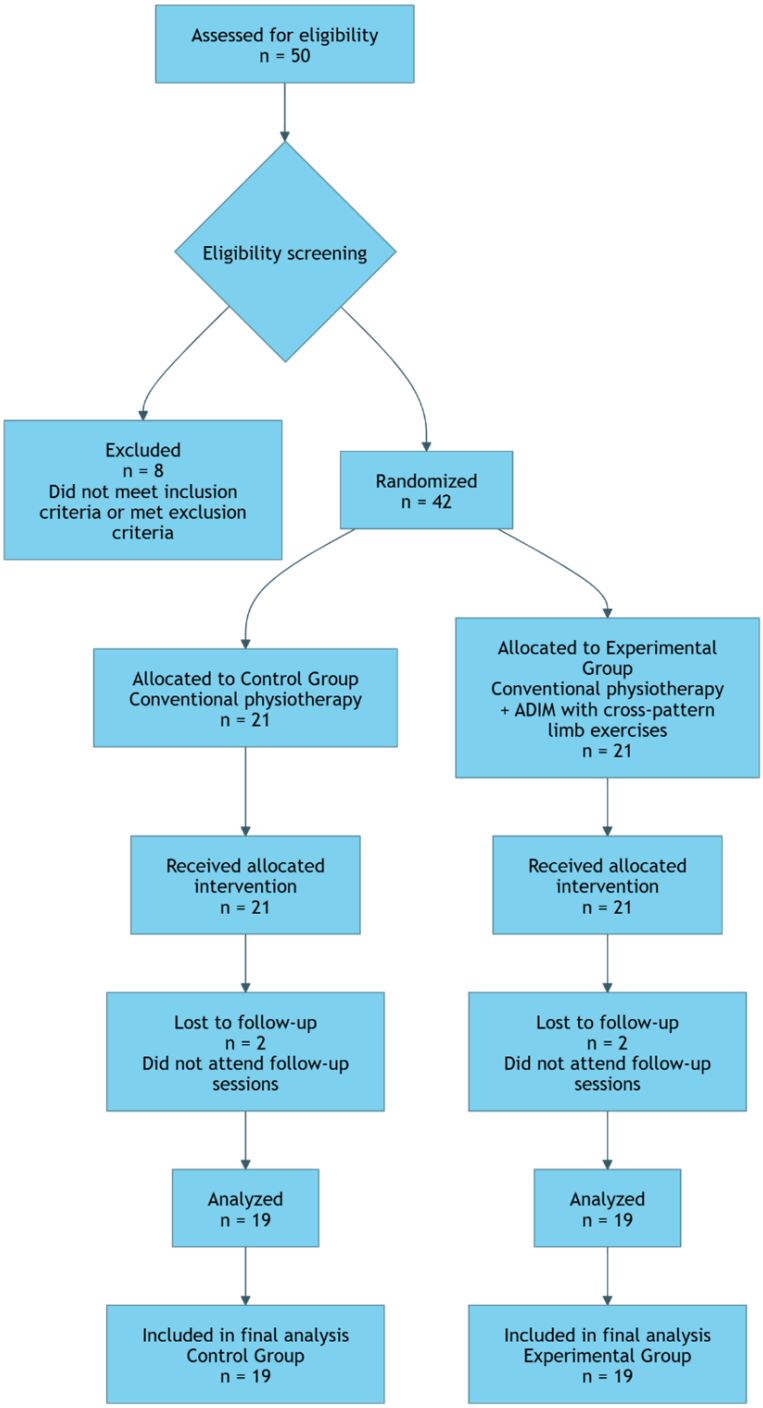

Figure 1 CONSORT Flowchart

The control group received conventional physiotherapy consisting of wall climbing, wand exercises, shoulder range-of-motion exercises, prone arm elevation, cross-chest stretch, and pendulum exercises. Each exercise was performed in three sets of 10 repetitions. The experimental group received the same conventional physiotherapy protocol with the addition of abdominal drawing-in maneuver and cross-pattern limb exercises, including abdominal drawing-in with alternating upper-extremity movement, abdominal drawing-in with alternating lower-extremity movement, abdominal drawing-in with alternating upper- and lower-extremity movement, opposite arm–leg raises in prone position, and bridge exercises. Participants in both groups received treatment for six weeks, three sessions per week, with one supervised treatment session per day.

Pain and disability were assessed using the Shoulder Pain and Disability Index before the start of treatment and after six weeks of intervention. The primary outcome was change in total SPADI score from baseline to post-treatment assessment. Baseline comparability between groups was assessed using pre-treatment SPADI scores, while within-group change was evaluated by comparing pre- and post-treatment SPADI scores in each group. Data were entered and analyzed using SPSS version 27. Quantitative variables were summarized using mean, standard deviation, range, and graphical assessment where appropriate. Normality was assessed using the Shapiro-Wilk test. Independent-samples t-test was used to compare between-group differences, while paired-samples t-test was used to evaluate within-group changes from baseline to post-treatment. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 38 participants completed the study and were included in the final analysis, with 19 participants in the control group and 19 in the experimental group. Baseline SPADI scores were comparable between groups, with the control group showing a mean score of 89.00 ± 16.44 and the experimental group showing a mean score of 84.42 ± 15.66. The baseline between-group difference was not statistically significant (mean difference = 4.57, 95% CI: −5.98 to 15.14; $p = 0.385$), indicating adequate comparability before intervention. After six weeks, the control group improved to 47.21 ± 15.25, whereas the experimental group improved to 16.73 ± 3.15. The post-treatment between-group difference was statistically significant in favor of the experimental group (mean difference = 30.47, 95% CI: 23.00 to 37.94; $p < 0.001$), with a large standardized effect.

Table 1. Between-Group Comparison of SPADI Scores Before and After Treatment

Measurement	Control Mean ± SD	Experimental Mean ± SD	Mean Difference	95% CI	t	df	p-value	Cohen's d
SPADI Pre-Treatment	89.00 ± 16.44	84.42 ± 15.66	4.57	−5.98 to 15.14	0.879	36	0.385	0.29
SPADI Post-Treatment	47.21 ± 15.25	16.73 ± 3.15	30.47	23.00 to 37.94	8.526	19.541	<0.001	2.77

Within-group analysis showed statistically significant improvement in both groups. The control group demonstrated a mean SPADI reduction of 41.78 points, corresponding to a 46.9% improvement from baseline. The experimental group demonstrated a greater mean reduction of 67.68 points, corresponding to an 80.2% improvement from baseline. The between-group difference in mean improvement was 25.90 points, indicating a clinically substantial added benefit of abdominal drawing-in maneuver with cross-pattern limb exercises.

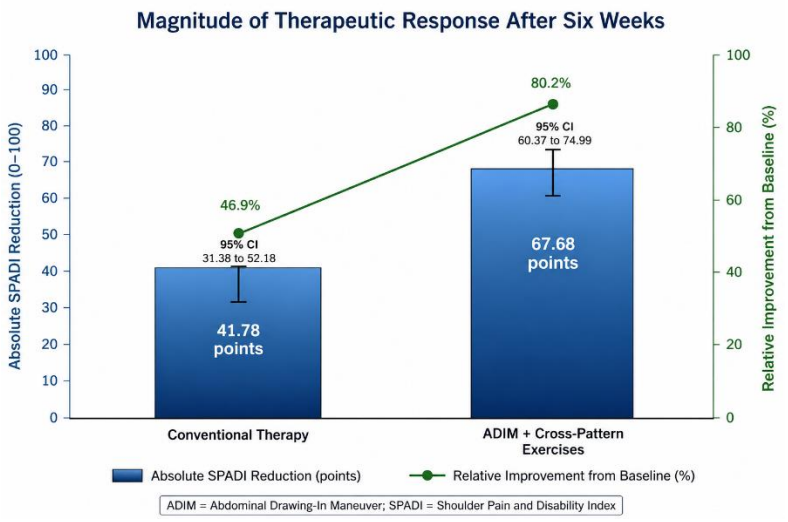

Figure 2. Magnitude of Therapeutic Response After Six Weeks

Table 2. Within-Group Change in SPADI Scores

Group	Pre-Treatment Mean ± SD	Post-Treatment Mean ± SD	Mean Reduction	95% CI for Reduction	% Improvement	t	df	p-value
Control Group	89.00 ± 16.44	47.21 ± 15.25	41.78	31.38 to 52.18	46.9%	8.44	18	<0.001
Experimental Group	84.42 ± 15.66	16.73 ± 3.15	67.68	60.37 to 74.99	80.2%	19.44	18	<0.001

Overall, both interventions reduced shoulder pain and disability, but the experimental protocol produced markedly greater improvement. The magnitude of post-treatment difference and the larger percentage reduction in SPADI scores support the added clinical value of integrating trunk stabilization and kinetic-chain-based exercises into shoulder impingement rehabilitation.

Figure 2 showed that the experimental group achieved a 67.68-point reduction in SPADI score compared with 41.78 points in the control group, representing relative improvements of 80.2% and 46.9%, respectively. This 25.90-point greater reduction demonstrates a clinically meaningful response gradient favoring abdominal drawing-in maneuver with cross-pattern limb exercises as an adjunct to conventional therapy.

DISCUSSION

The present randomized controlled trial demonstrated that both conventional physiotherapy and conventional physiotherapy combined with abdominal drawing-in maneuver and cross-pattern limb exercises significantly reduced pain and disability in patients with shoulder impingement syndrome. However, the experimental group showed a substantially greater reduction in SPADI score than the control group, with mean improvement of 67.68 points compared with 41.78 points after six weeks. The post-treatment between-group difference of 30.47 points, with a large standardized effect, indicates that adding trunk stabilization and cross-pattern limb activation produced clinically meaningful benefits beyond conventional shoulder exercises alone.

These findings support the concept that shoulder rehabilitation should not be limited to local glenohumeral and scapular exercises, because upper-limb function depends on coordinated force transfer through the trunk and proximal kinetic chain. The abdominal drawing-in maneuver may improve deep trunk muscle activation and lumbopelvic control, while cross-pattern limb exercises may enhance neuromuscular coordination between the trunk, scapula, and shoulder complex. This mechanism is consistent with previous evidence suggesting that core stability training can influence shoulder pain, posture, disability, rotator cuff strength, and upper-extremity performance (21–29). Although El-Nashar et al. reported limited influence of trunk stability training on upper-limb function in chronic stroke patients, that population differs substantially from patients with shoulder impingement syndrome because neurological impairment, motor control deficits, and post-stroke upper-limb dysfunction may alter responsiveness to kinetic-chain training (21). In contrast, studies involving musculoskeletal shoulder dysfunction, athletic upper-limb performance, and rotator cuff-related conditions more closely support the present findings (22–29).

The greater response observed in the experimental group may be explained by improved proximal stability, reduced compensatory shoulder loading, and more efficient distribution of mechanical stress during upper-limb movement. Patients with shoulder impingement often demonstrate altered scapular mechanics, reduced rotator cuff efficiency, and pain-related movement avoidance. When trunk control is improved, the shoulder may operate from a more stable base, allowing better scapulohumeral coordination and reducing excessive demand on symptomatic subacromial structures. The magnitude of improvement in the experimental group suggests that abdominal drawing-in maneuver with cross-pattern limb exercises may be useful as an adjunctive strategy in rehabilitation protocols for shoulder impingement syndrome rather than as an isolated replacement for conventional treatment.

Despite these promising findings, several limitations should be considered. Participants' posture, occupational load, home exercise compliance, and daily activity exposure were not strictly monitored, which may have influenced treatment response. The study was conducted at a single clinical setting,

limiting generalizability to other rehabilitation environments. The absence of long-term follow-up prevents conclusions about maintenance of improvement after completion of supervised treatment. In addition, the study primarily used SPADI as the outcome measure; future trials should include objective strength testing, scapular kinematic assessment, muscle activation analysis, quality-of-life measures, and longer follow-up intervals. Multicenter randomized trials with allocation concealment, assessor blinding, intention-to-treat analysis, and predefined adherence monitoring would strengthen the evidence base for kinetic-chain-based rehabilitation in shoulder impingement syndrome.

CONCLUSION

The study concluded that adding abdominal drawing-in maneuver with cross-pattern limb exercises to conventional physiotherapy produced greater improvement in pain and disability than conventional therapy alone in patients with shoulder impingement syndrome. The experimental intervention resulted in a larger reduction in SPADI scores after six weeks, supporting the clinical value of incorporating trunk stabilization and kinetic-chain-based exercises into shoulder rehabilitation programs.

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