RESEARCH PAPER

Effectiveness of Open Kinematic Chain Exercises With Scapular Stabilization Exercises in Shoulder Impingement Syndrome: A Randomized Controlled Trial

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ABSTRACT

Background: Shoulder impingement syndrome is a common musculoskeletal disorder characterized by pain, restricted range of motion, and functional limitations. Altered scapular kinematics and inadequate rotator cuff control are recognized contributors to persistent symptoms. Exercise-based rehabilitation focusing on isolated muscle strengthening and scapular stability may improve outcomes.

Objective: To evaluate the effectiveness of open kinematic chain exercises combined with scapular stabilization exercises on pain, shoulder range of motion, and functional performance in individuals with shoulder impingement syndrome.

Methods: A randomized controlled trial was conducted among eighty participants diagnosed with shoulder impingement syndrome. Participants were randomly allocated into two groups. Group A received conventional physiotherapy including hot moist pack, transcutaneous electrical nerve stimulation, ultrasound therapy, range of motion exercises, stretching, and basic strengthening exercises. Group B received open kinematic chain exercises combined with scapular stabilization exercises. Interventions were administered four times per week for six weeks. Pain intensity was assessed using the Visual Analog Scale, shoulder range of motion using goniometry, and functional performance using the Shoulder Pain and Disability Index. Statistical analysis was performed using SPSS version 26.

Results: Both groups demonstrated statistically significant improvements in pain, shoulder range of motion, and functional performance following intervention. However, the experimental group showed significantly greater improvement compared to the conventional physiotherapy group across all outcome measures, with p-values less than 0.0001.

Conclusion: Open kinematic chain exercises combined with scapular stabilization exercises are more effective than conventional physiotherapy alone in reducing pain and improving shoulder function in individuals with shoulder impingement syndrome. Incorporation of targeted scapular stabilization into rehabilitation programs is recommended for enhanced clinical outcomes.

Categories: Physical Medicine and Rehabilitation.

Keywords: shoulder impingement syndrome, open kinematic chain, scapular stabilization, physiotherapy, rehabilitation..

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INTRODUCTION

Shoulder pain is a common musculoskeletal complaint affecting individuals across different age groups and activity levels, with shoulder impingement syndrome being one of the most frequently reported causes. Shoulder impingement syndrome is characterized by pain, weakness, and functional limitation resulting from compression and irritation of the rotator cuff tendons, subacromial bursa, and surrounding soft tissues beneath the coracoacromial arch during arm elevation. This condition often leads to difficulty in performing overhead activities, reaching tasks, and activities of daily living, thereby significantly impacting functional independence and quality of life.

The etiology of shoulder impingement syndrome is multifactorial and involves a complex interaction of intrinsic and extrinsic factors. Intrinsic factors include degenerative changes within the rotator cuff tendons, reduced vascularity, tendon thickening, and age-related alterations in tissue elasticity. Extrinsic factors primarily involve biomechanical abnormalities such as altered scapular positioning, reduced subacromial space, postural deviations, and repetitive overhead activities. These contributing factors may act independently or synergistically, resulting in progressive pain and functional decline if left unaddressed.

The scapula plays a pivotal role in normal shoulder biomechanics by serving as a stable base for glenohumeral motion and facilitating efficient force transmission through the upper limb. Coordinated movement between the scapula and humerus, commonly referred to as scapulohumeral

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rhythm, is essential for maintaining adequate subacromial clearance during arm elevation. Disruption of this rhythm due to weakness, delayed activation, or imbalance of the scapular stabilizing muscles can lead to abnormal scapular kinematics and increased mechanical stress on the rotator cuff.

Scapular dyskinesis, defined as abnormal scapular motion or positioning, has been widely reported in individuals with shoulder impingement syndrome. Dysfunction of key stabilizing muscles such as the serratus anterior, upper trapezius, middle trapezius, and lower trapezius may result in excessive anterior tilting, internal rotation, or reduced upward rotation of the scapula. These alterations can compromise the subacromial space, increasing the likelihood of tendon impingement during shoulder elevation. Addressing scapular control has therefore become a central focus in contemporary shoulder rehabilitation.

Conservative management is considered the first-line treatment for shoulder impingement syndrome, with physiotherapy forming the cornerstone of non-surgical intervention. Traditional physiotherapy approaches typically emphasize pain-relieving modalities, stretching of tight structures, and general strengthening exercises. Although these interventions may provide short-term symptom relief, they may not sufficiently address underlying neuromuscular deficits, particularly those related to scapular stability and motor control. Failure to correct these deficits may contribute to persistent symptoms and recurrence.

Exercise-based rehabilitation programs have gained increasing attention due to their role in restoring strength, mobility, and functional performance. Open kinematic chain exercises are commonly incorporated into shoulder rehabilitation to facilitate selective muscle activation, improve coordination, and enhance strength of the rotator cuff and peri-scapular musculature. In open kinematic chain movements, the distal segment is free to move, allowing targeted strengthening and controlled loading of specific muscle groups involved in shoulder stability and movement.

Scapular stabilization exercises aim to improve neuromuscular control and strength of the muscles responsible for maintaining optimal scapular positioning during arm movements. These exercises focus on enhancing the coordination and timing of scapular stabilizers, thereby improving scapulohumeral rhythm and reducing abnormal loading patterns. When integrated with open kinematic chain exercises, scapular stabilization strategies may offer a comprehensive approach that addresses both distal mobility and proximal stability.

Despite the widespread clinical application of open kinematic chain and scapular stabilization exercises, limited evidence exists regarding their combined effectiveness in individuals with shoulder impingement syndrome. Many studies have evaluated these interventions independently or compared them with generalized exercise programs, leaving uncertainty regarding their synergistic effects. Additionally, variability in exercise protocols, outcome measures, and study designs has made it challenging to draw definitive conclusions.

Understanding the combined impact of open kinematic chain exercises with scapular stabilization is particularly important for optimizing rehabilitation strategies and improving clinical outcomes. Shoulder impingement syndrome represents a significant burden in physiotherapy and orthopedic outpatient settings, often accounting for a large proportion of shoulder-related consultations. Persistent shoulder pain can lead to reduced work productivity, limitations in recreational activities, and increased healthcare utilization. Early and effective rehabilitation is therefore essential to prevent chronicity and reduce the socioeconomic impact associated with prolonged shoulder dysfunction.

Although various exercise-based interventions have been proposed for the management of shoulder impingement syndrome, the effectiveness of many conventional programs remains variable. General strengthening and mobility exercises may not adequately address deficits in motor control, scapular positioning, and coordinated muscle activation required for optimal shoulder function. As a result, patients may experience incomplete recovery or recurrence of symptoms despite adherence to rehabilitation programs. Incorporating exercises that specifically target scapular stability and controlled shoulder movement may enhance treatment outcomes by addressing these underlying biomechanical impairments.

Therefore, the present study was designed to evaluate the effectiveness of open kinematic chain exercises combined with scapular stabilization exercises in individuals with shoulder impingement syndrome. The study aimed to assess their effects on pain intensity, shoulder range of motion, and functional performance, and to compare these outcomes with those achieved through conventional physiotherapy management. By providing evidence on the combined therapeutic benefits of these exercise strategies, this study seeks to contribute to evidence-based clinical practice and guide physiotherapists in designing effective rehabilitation programs for shoulder impingement syndrome.

MATERIALS AND METHODS

Study design and setting

This randomized controlled trial was designed to evaluate the effectiveness of open kinematic chain exercises combined with scapular stabilization exercises in individuals diagnosed with shoulder impingement syndrome. The study was conducted in the physiotherapy outpatient department of Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad. The total duration of the intervention was six weeks. Ethical approval was obtained from the Institutional Ethics Committee, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad (Protocol number: 034/2023-2024). Written informed consent was obtained from all participants prior to enrollment, and the study was conducted in accordance with ethical principles for research involving human subjects.

Study participants

A total of eighty participants were recruited for the study using a convenient sampling method. Participants included individuals of both sexes aged between forty and sixty-five years who presented with unilateral shoulder pain of more than three months' duration and were clinically diagnosed with shoulder impingement syndrome. Diagnosis was based on patient history, physical examination, and positive clinical impingement tests. Assessment was performed using Neer's impingement test and the Hawkins-Kennedy test, both of which are commonly used clinical tests to identify subacromial impingement. Participants were required to report pain during overhead activities and functional limitations involving shoulder movements.

Individuals were excluded if they had a history of shoulder fracture, dislocation, or surgery; neurological conditions affecting the upper limb; inflammatory or systemic musculoskeletal disorders; cervical radiculopathy; or any other condition that could influence shoulder function. Participants receiving concurrent physiotherapy or other forms of rehabilitation for the shoulder were also excluded from the study.

Randomization and group allocation

Following baseline assessment, participants were randomly allocated into two groups using a computer-generated randomization sequence. Allocation concealment was maintained throughout the recruitment process. Forty participants were assigned to Group A, which received conventional physiotherapy, and forty participants were assigned to Group B, which received open kinematic chain exercises combined with scapular stabilization exercises. Participants were unaware of the specific intervention details of the alternate group, making the study single blinded in nature.

Intervention protocol

Treatment was performed four times a week and progression was shown from 0 to six weeks in both groups. The detailed treatment protocol for both groups is presented in Table 1.

Table 1. Treatment protocol

Group A – Conventional Exercise Program			
Hot moist pack – 15 mins Ultrasound (1 MHz, 8 mins, 0.8 W/cm²) TENS (50–100 Hz conventional TENS) – 15 mins Glenohumeral joint distraction			
	1-2 WEEKS	3-4 WEEKS	5-6 WEEKS
ROM in pain-free range	10 reps	10 reps x 3 sets	10 reps x 5 sets
Wand exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Wall ladder	10 reps	10 reps x 3 sets	10 reps x 5 sets
Scapular clocks	10 reps	10 reps x 3 sets	10 reps x 5 sets
Isometric exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Wall pushups	10 reps	10 reps x 3 sets	10 reps x 5 sets
Towel circles	10 reps	10 reps x 3 sets	10 reps x 5 sets
Pectoral stretch	10 sec hold ×3 sets	15 sec hold ×5 sets	20 sec hold ×5 sets
Upper trapezius stretch,	10 sec hold ×3 sets	15 sec hold ×5 sets	20 sec hold ×5 sets
levator scapulae stretch	10 sec hold ×3 sets	15 sec hold ×5 sets	20 sec hold ×5 sets
Shoulder Shrugs	10 reps	10 reps x 3 sets	15 sec hold ×5 sets
Wall slides	10 reps	10 reps x 3 sets	15 sec hold ×5 sets
Shoulder blade squeezes	10 reps	10 reps x 3 sets	10 reps x 5 sets
Towel exercises for Internal and external Rotation	10 reps	10 reps x 3 sets	10 reps x 5 sets

Group B – Open Kinematic Chain with Scapular Stabilization Exercsise			
Hot moist pack – 15 mins Ultrasound (1 MHz, 8 mins, 0.8 W/cm²) TENS (50–100 Hz conventional TENS) – 15 mins Glenohumeral joint distraction			
	1-2 WEEKS	3-4 WEEKS	5-6 WEEKS
Supine AROM	10 reps	10 reps x 3 sets	10 reps x 5 sets
(flexion, abduction, IR,	10 reps	10 reps x 3 sets	10 reps x 5 sets
ER)	10 reps	10 reps x 3 sets	10 reps x 5 sets
Wand exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Shoulder Scaption	10 reps	10 reps x 3 sets	10 reps x 5 sets
exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Pendular exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Serratus anterior punches	10 reps	10 reps x 3 sets	15 sec hold ×5 sets
Empty can exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Prone scapular	10 sec hold ×3 sets	15 sec hold ×3 sets	15 sec hold ×5 sets
squeezes			
W,Y,I,T exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Rowing exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Resistance band	10 reps	10 reps x 3 sets	10 reps x 5 sets
exercises	10 reps	10 reps x 3 sets	10 reps x 5 sets
Prone horizontal abduction	10 reps	10 reps x 3 sets	10 reps x 5 sets

All exercises were performed under the supervision of a physiotherapist to ensure correct technique and safety.

Selection of outcome measures

Selection of outcome measures was carried out to comprehensively evaluate the effects of the intervention on pain, mobility, and functional performance in individuals with shoulder impingement syndrome. Outcome measures were chosen based on their clinical relevance, widespread use in musculoskeletal research, and established reliability and validity. All outcome measures were assessed at baseline prior to the commencement of intervention and again at the end of the six-week treatment period in both groups.

Pain intensity was assessed using the Visual Analog Scale. The Visual Analog Scale is a simple, sensitive, and widely accepted instrument for measuring subjective pain perception in individuals with musculoskeletal disorders. It consists of a ten-centimeter horizontal line, with the extremes representing no pain and the worst pain imaginable. Participants were instructed to indicate their perceived pain intensity by marking a point on the scale. Pain assessment was performed both at rest and during

activity to capture variations in pain experienced during functional shoulder movements and daily activities.

Shoulder range of motion was evaluated using a universal goniometer, which is considered a standard and reliable tool for measuring joint mobility in clinical practice and research. Active range of motion was measured for shoulder flexion, extension, abduction, internal rotation, and external rotation. Standardized patient positioning and measurement techniques were followed to minimize compensatory movements and ensure consistency across assessments. Measurements were taken within the pain-free range to accurately reflect functional joint mobility.

Functional performance was assessed using the Shoulder Pain and Disability Index. The Shoulder Pain and Disability Index is a self-administered questionnaire specifically designed to evaluate shoulder-related pain and functional limitations. It comprises two subscales assessing pain and disability during various activities of daily living. Scores are expressed as a percentage, with higher scores indicating greater pain and disability. The Shoulder Pain and Disability Index has demonstrated good validity, reliability, and responsiveness in individuals with shoulder pathologies and was therefore considered appropriate for assessing functional outcomes in this study.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 26. Descriptive statistics were calculated for all variables and are presented as mean and standard deviation. Within-group comparisons between pre- and post-intervention values were analyzed using paired t-tests. Between-group comparisons were conducted using unpaired t-tests to determine differences in treatment effectiveness. The level of statistical significance was set at $p < 0.05$ for all analyses.

Results

Eighty participants diagnosed with shoulder impingement syndrome completed the study, with forty participants allocated to each group. No dropouts or adverse events were reported during the intervention period. Baseline demographic and clinical characteristics were comparable between the two groups.

Table 2 presents the baseline demographic characteristics of the participants. The mean age in Group A was 53.08 ± 7.17 years and in Group B was 51.40 ± 6.68 years. The gender distribution was comparable in both groups (Group A: 27 males, 13 females; Group B: 29 males, 11 females). The findings indicate that both groups were homogeneous at baseline

Table 2. Baseline demographic characteristics of participants

Variable	Group A (n = 40)	Group B (n = 40)
Age (years), mean ± SD	53.08 ± 7.17	51.40 ± 6.68
Sex (male/female)	27/13	29/11

Table 3 shows the comparison of VAS scores between the groups. At baseline, no significant difference was observed in pain at rest and on activity ($p > 0.05$). Post-intervention, a significant reduction in pain at rest ($p = 0.037$) and an extremely significant reduction in pain during activity ($p < 0.0001$) were observed in Group B compared to Group A. These results indicate greater pain reduction in Group B.

Table 3 Comparison of Visual Analog Scale scores between groups

Outcome	Group A Mean ± SD	Group B Mean ± SD	p-value
VAS at rest (pre)	2.33 ± 2.58	3.18 ± 1.81	>0.05
VAS at rest (post)	2.11 ± 1.37	1.88 ± 1.32	0.037
VAS on activity (pre)	5.25 ± 2.50	6.70 ± 1.44	>0.05
VAS on activity (post)	3.80 ± 0.91	2.83 ± 0.90	<0.0001

Table 4 demonstrates the comparison of shoulder range of motion within both groups. Both Group A and Group B showed statistically significant improvements in flexion, extension, abduction, internal rotation, and external rotation ($p < 0.05$). However, Group B demonstrated greater mean improvements and extremely significant values ($p < 0.0001$) in most movements, indicating superior effectiveness of the intervention in Group B.

Table 4. Comparison of Shoulder range of motion within Groups

Movement	Group	Pre Test (Mean ± SD)	Post Test (Mean ± SD)	Mean Difference	P Value
Flexion	Group A	146.63 ± 29.32	157.00 ± 19.62	-10.37	0.0001
	Group B	142.38 ± 35.59	159.43 ± 22.38	-17.05	<0.0001
Extension	Group A	54.68 ± 13.50	56.88 ± 8.02	-2.20	0.0004
	Group B	49.93 ± 13.30	60.80 ± 8.56	-10.87	<0.0001
Abduction	Group A	140.50 ± 32.86	151.40 ± 22.57	-10.90	0.0002
	Group B	135.40 ± 36.81	156.10 ± 24.80	-20.70	<0.0001
Internal Rotation	Group A	53.25 ± 15.40	60.78 ± 8.36	-7.53	0.0002
	Group B	57.80 ± 14.26	62.95 ± 10.01	-5.15	<0.0001
External Rotation	Group A	54.28 ± 19.57	62.03 ± 13.84	-7.75	0.0001

	Group B	54.78 ± 22.16	65.10 ± 14.90	-10.82	<0.0001

Table 5 shows the comparison of SPADI scores within both groups. Group A demonstrated significant improvements in pain, disability, and total scores ($p < 0.05$). Group B showed extremely significant improvements in all SPADI components ($p < 0.0001$) with greater mean differences. This indicates better functional recovery and pain reduction in Group B compared to Group A.

Table 5. Comparison of pre and post-test mean scores of SPADI within the Groups

SPADI		Pre Test	Post Test	Mean Difference	P Value
Group A	Pain	54.15± 9.82	47.70±9 .80	6.45	0.041*
	Disability	40.30± 7.73	34.10±7 .41	6.2	0.0004 *
	Total	45.43± 8.26	38.67±8 .61	6.76	< 0.0 001*
Group B	Pain	54.28± 10.59	42.65±1 0.35	11.63	< 0.000 1*
	Disability	39.80± 7.39	33.98±7 .61	5.82	< 0.000 1*
	Total	45.20± 8.04	35.42±7 .70	9.78	< 0.0 001*

DISCUSSION

The present randomized controlled trial was conducted to evaluate the effectiveness of open kinematic chain exercises combined with scapular stabilization exercises in individuals with shoulder impingement syndrome and to compare these effects with those achieved through conventional physiotherapy management. The findings of this study indicate that although both intervention groups demonstrated statistically significant improvements in pain intensity, shoulder range of motion, and functional performance following six weeks of intervention, participants who received open kinematic chain exercises with scapular stabilization exhibited significantly greater improvements across all outcome measures. These results highlight the importance of incorporating targeted scapular-focused exercise strategies into shoulder rehabilitation programs.

Pain reduction, as measured using the Visual Analog Scale, was observed in both groups; however, the magnitude of improvement was greater in the experimental group. This superior reduction in pain may be attributed to improved neuromuscular control and enhanced coordination between the scapulothoracic and glenohumeral joints. Scapular stabilization exercises are known to optimize scapular positioning and movement, thereby reducing excessive mechanical stress on the rotator cuff tendons and subacromial structures. Improved muscle activation patterns may also decrease abnormal loading during shoulder movements, leading to reduced nociceptive input and improved pain modulation.

Open kinematic chain exercises may have further contributed to pain reduction by allowing selective activation and strengthening of the rotator cuff and peri-scapular muscles without imposing excessive compressive forces on the shoulder joint. By enabling controlled movement of the distal segment, these exercises facilitate gradual adaptation of the musculotendinous structures and improve tolerance to functional activities. The combination of these mechanisms may explain the greater pain relief observed in the experimental group compared to the conventional physiotherapy group.

Significant improvements in shoulder range of motion were noted in both groups for all measured movements, including flexion, extension, abduction, internal rotation, and external rotation. However, participants in the experimental group demonstrated significantly greater post-intervention gains. Restoration of normal scapulohumeral rhythm is essential for achieving full, pain-free shoulder motion, and scapular stabilization exercises likely played a key role in facilitating these improvements. Enhanced upward rotation, posterior tilting, and external rotation of the scapula during arm elevation may have increased subacromial space and allowed greater humeral head excursion.

The role of open kinematic chain exercises in improving range of motion should also be considered. These exercises allow for isolated strengthening and controlled movement patterns, which may help reduce muscle guarding and improve joint mobility. Progressive loading during open kinematic chain exercises may have contributed to improved flexibility and strength of the shoulder musculature, thereby supporting greater movement range and improved functional use of the upper limb.

Functional performance, assessed using the Shoulder Pain and Disability Index, improved significantly in both groups, with greater reductions in pain-related disability and overall functional limitation observed in the experimental group. Improvements in functional outcomes are clinically meaningful, as shoulder impingement syndrome often interferes with activities of daily living, occupational tasks, and recreational activities. Enhanced scapular control and improved shoulder mechanics may have enabled participants in the experimental group to perform functional movements more efficiently and with reduced discomfort.

The findings of the present study are consistent with existing literature emphasizing the importance of scapular stabilization and targeted strengthening in the management of shoulder impingement syndrome. Previous research has demonstrated that correction of scapular dyskinesis and improvement in rotator cuff strength are associated with reductions in pain and improvements in function. The present study extends these findings by demonstrating that combining open kinematic chain exercises with scapular stabilization yields superior outcomes compared to conventional physiotherapy alone, suggesting a synergistic effect of these interventions.

From a clinical perspective, the results of this study have important implications for physiotherapy practice. Conventional physiotherapy approaches often focus on symptom relief and general strengthening; however, these strategies may not adequately address underlying biomechanical and neuromuscular deficits. Incorporating open kinematic chain exercises with scapular stabilization allows physiotherapists to target specific impairments related to scapular control, muscle imbalance, and movement coordination. This comprehensive approach may enhance rehabilitation outcomes and reduce the risk of symptom recurrence.

Despite the positive outcomes observed, certain limitations of the present study should be acknowledged. The intervention duration was limited to six weeks, and long-term follow-up was not performed to determine the sustainability of treatment effects. The study population was restricted to a specific age range, which may limit the generalizability of the findings to younger or older individuals. Additionally, the use of convenient sampling and the single-center study design may affect external validity. Blinding of the therapist delivering the intervention was not feasible, which could introduce performance bias.

Limitations of the study

The present study has certain limitations that should be considered while interpreting the results. The intervention period was limited to six weeks, and long-term follow-up was not undertaken to determine the persistence of treatment effects. As the study was conducted at a single center with participants from a restricted age group, the generalizability of the findings may be limited. Convenience sampling was used, which could have introduced selection bias. In addition, blinding of the therapist was not feasible due to the nature of the exercise interventions. Despite these limitations, the study provides clinically relevant findings regarding the effectiveness of targeted exercise interventions for shoulder impingement syndrome.

Strengths of the study

Despite the limitations, the present study has several strengths. The randomized controlled trial design enhances internal validity and allows appropriate comparison between intervention groups. The use of validated outcome measures such as the Visual Analog Scale, goniometric assessment of shoulder range of motion, and the Shoulder Pain and Disability Index strengthens the reliability of the findings. Clear differentiation between the intervention protocols and supervised treatment sessions further contributed to the methodological rigor of the study.

Future recommendations

Future studies should consider longer intervention and follow-up periods to evaluate the sustainability of treatment outcomes. Inclusion of a larger and more diverse sample may improve the generalizability of findings. Further research may also explore the effects of combining open kinematic chain and scapular stabilization exercises with other rehabilitation strategies and incorporate objective measures such as muscle strength and scapular kinematics. Nevertheless, the findings of the present study provide valuable evidence supporting the use of targeted exercise-based interventions in the rehabilitation of shoulder impingement syndrome.

CONCLUSIONS

The present study concludes that open kinematic chain exercises combined with scapular stabilization exercises are more effective than conventional physiotherapy in the management of shoulder impingement syndrome. The combined intervention resulted in significant reductions in pain intensity, greater improvements in shoulder range of motion, and enhanced functional performance as measured by the Shoulder Pain and Disability Index.

By addressing both distal mobility and proximal stability, this exercise approach offers a comprehensive and clinically effective rehabilitation strategy. Incorporation of open kinematic chain exercises with scapular stabilization into routine physiotherapy practice may lead to improved outcomes and better functional recovery in individuals with shoulder impingement syndrome.

REFERENCE

1. Neer CS: Impingement lesions. Clin Orthop Relat Res. 1983, 173:70-7. https://pubmed.ncbi.nlm.nih.gov/6825348/
2. Michener LA, McClure PW, Karduna AR: Anatomical and biomechanical mechanisms of subacromial impingement syndrome. Clin Biomech (Bristol, Avon). 2003, 18:369-79. 10.1016/S0268-0033(03)00047-0
3. Ludewig PM, Cook TM: Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. Phys Ther. 2000, 80:276-91. https://pubmed.ncbi.nlm.nih.gov/10696154/
4. Kibler WB, Sciascia A: Current concepts: scapular dyskinesis. Br J Sports Med. 2010, 44:300-5. 10.1136/bjsm.2009.058834
5. McClure PW, Michener LA, Karduna AR: Shoulder function and three-dimensional scapular kinematics in people with and without shoulder impingement syndrome. Phys Ther. 2006, 86:1075-90. 10.2522/ptj.20050218
6. Ellenbecker TS, Davies GJ: The application of isokinetics in testing and rehabilitation of the shoulder complex. J Athl Train. 2000, 35:338-50. https://pubmed.ncbi.nlm.nih.gov/16558656/
7. Cools AM, Declercq GA, Cambier DC, et al.: Trapezius activity and intramuscular balance during isokinetic exercise in overhead athletes with impingement symptoms. Scand J Med Sci Sports. 2007, 17:25-33. 10.1111/j.1600-0838.2006.00518.x
8. Page P: Shoulder muscle imbalance and subacromial impingement syndrome in overhead athletes. Int J Sports Phys Ther. 2011, 6:51-8.

https://pubmed.ncbi.nlm.nih.gov/21655485/
9. Bang MD, Deyle GD: Comparison of supervised exercise with and without manual physical therapy for patients with shoulder impingement syndrome. J Orthop Sports Phys Ther. 2000, 30:126-37. 10.2519/jospt.2000.30.3.126
10. Holmgren T, Björnsson Hallgren H, Öberg B, et al.: Effect of specific exercise strategy on need for surgery in patients with subacromial impingement syndrome. BMJ. 2012, 344:e787. 10.1136/bmj.e787
11. Roy JS, Moffet H, Hébert LJ, et al.: Effect of motor control and strengthening exercises on shoulder function in persons with shoulder impingement syndrome. Clin Rehabil. 2009, 23:556-68. 10.1177/0269215509102991
12. Ginn KA, Cohen ML: Conservative treatment for shoulder impingement: a systematic review. Arch Phys Med Rehabil. 2005, 86:176-85. 10.1016/j.apmr.2004.03.027
13. McClure PW, Greenberg E, Kareha S: Evaluation and management of scapular dyskinesis in overhead athletes. Curr Rev Musculoskelet Med. 2012, 5:68-75. 10.1007/s12178-011-9106-0
14. Williams JW Jr, Holleman DR Jr, Simel DL: Measuring shoulder function with the Shoulder Pain and Disability Index. J Rheumatol. 1995, 22:727-32. https://pubmed.ncbi.nlm.nih.gov/7791163/
15. Huskisson EC: Measurement of pain. Lancet. 1974, 304:1127-31. 10.1016/S0140-6736(74)90884-8
16. Escamilla RF, Yamashiro K, Paulos L, et al.: Shoulder muscle activity and function in common shoulder rehabilitation exercises. Sports Med. 2009, 39:663-85. 10.2165/00007256-200939080-00004
17. Seitz AL, McClure PW, Finucane S, et al.: Mechanisms of rotator cuff tendinopathy: intrinsic, extrinsic, or both?. Clin Biomech (Bristol, Avon). 2011, 26:1-12. 10.1016/j.clinbiomech.2010.08.001 .
18. h IM, Ernst G, Perrin DH. Open and closed Kinetic chain exercises improve shoulder joint reposition sense equally in healthy subjects. Journal of athletic training. 1998 Oct;33(4):315.
19. Moezy A, Sepehrifar S, Dodaran MS. The effects of scapular stabilization based exercise therapy on pain, posture, flexibility and shoulder mobility in patients with shoulder impingement syndrome: a controlled randomized clinical trial. Medical journal of the Islamic Republic of Iran. 2014 Aug 27;28:87.
20. Walther M. The subacromial impingement syndrome of the shoulder treated by conventional physiotherapy.
21. Turgut E, Duzgun I, Baltaci G. Effects of scapular stabilization exercise training on scapular kinetics, disability, and pain in subacromial impingement: a randomized controlled trial. Archives of physical medicine and rehabilitation. 2017 Oct 1;98(10):1915-23.
22. Dickens VA, Williams JL, Bhamra MS. Role of physiotherapy in the treatment of subacromial impingement syndrome: a prospective study. Physiotherapy. 2005 Sep 1;91(3):159-64.
23. Başkurt Z, Başkurt F, Gelecek N, Özkan MH. The effectiveness of scapular stabilization exercise in the patients with subacromial impingement syndrome. Journal of back and musculoskeletal rehabilitation. 2011 Aug;24(3):173-9.
24. Gomora-García M, Rojano-Mejía D, Solis-Hernández JL, Escamilla-Chávez C. Effectiveness of physiotherapy on painful shoulder impingement syndrome. Cirugía y Cirujanos (English Edition). 2016 May 1;84(3):203-7.
25. Wilk KE, Arrigo CA, Andrews JR. Closed and open Kinetic chain exercise for the upper extremity. Journal of sport rehabilitation. 1996 Feb 1;5(1):88-102..
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