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COMPARATIVE EFFICACY OF KINETIC CHAIN EXERCISES VERSUS ISOLATED ROTATOR CUFF STRENGTHENING AMONG SHOULDER IMPINGEMENT SYNDROME PATIENTS

Original Research

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ABSTRACT

Background: Shoulder impingement syndrome (SIS) is a prevalent musculoskeletal disorder characterized by compression and irritation of the rotator cuff tendons beneath the acromion, leading to pain, restricted range of motion (ROM), and functional impairment. Rehabilitation strategies such as kinetic chain exercises (KCE) and isolated rotator cuff strengthening (IRCS) are commonly employed to restore shoulder function and alleviate symptoms. However, limited research directly compares their effectiveness in improving pain, disability, and ROM outcomes in SIS patients.

Objective: To compare the efficacy of kinetic chain exercises versus isolated rotator cuff strengthening in improving pain, disability, and ROM among patients with shoulder impingement syndrome.

Methods: A quasi-experimental study was conducted on 36 patients diagnosed with unilateral SIS, recruited via purposive sampling from Services Hospital and Sir Ganga Ram Hospital, Lahore, between March 2024 and September 2024. Patients aged 18 to 40 years with a minimum three-month history of shoulder pain and positive Neer or Hawkins-Kennedy test were included. Patients with traumatic shoulder dislocation, inflammatory conditions, neurological disorders, or recent corticosteroid injections (within three months) were excluded. Participants were allocated into two intervention groups: Group A (n = 18) received kinetic chain exercises, while Group B (n = 18) performed isolated rotator cuff strengthening exercises for 8 weeks. Functional outcomes were assessed using the Shoulder Pain and Disability Index (SPADI) and goniometry, with SPSS version 24 utilized for statistical analysis.

Results: Both interventions significantly improved pain and disability scores ($P < 0.005$ for all parameters). SPADI Pain scores decreased from 30.0% ± 3.5 to 15.0% ± 2.8 in Group A ($T = +5.200$, $P = 0.007$) and from 31.2% ± 4.1 to 22.0% ± 3.5 in Group B ($T = +4.300$, $P = 0.015$). Similarly, SPADI Disability scores improved from 32.5% ± 3.8 to 20.8% ± 2.7 in Group A ($T = +4.700$, $P = 0.009$) and from 32.0% ± 3.9 to 23.0% ± 3.2 in Group B ($T = +3.900$, $P = 0.017$). ROM gains were superior in Group A, particularly in external rotation (32.0° ± 4.2 to 65.0° ± 4.0, $P < 0.001$) and internal rotation (40.0° ± 5.0 to 75.0° ± 4.5, $P < 0.001$).

Conclusion: Both kinetic chain exercises and isolated rotator cuff strengthening exercises were effective in reducing pain and disability in SIS patients. However, kinetic chain exercises demonstrated superior improvements in ROM and overall functional performance, making them a more comprehensive rehabilitation approach for managing shoulder impingement syndrome.

Keywords: Exercise Therapy, Kinetic Chain, Pain Management, Range of Motion, Rotator Cuff Injuries, Shoulder Impingement Syndrome, Shoulder Rehabilitation.

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INTRODUCTION

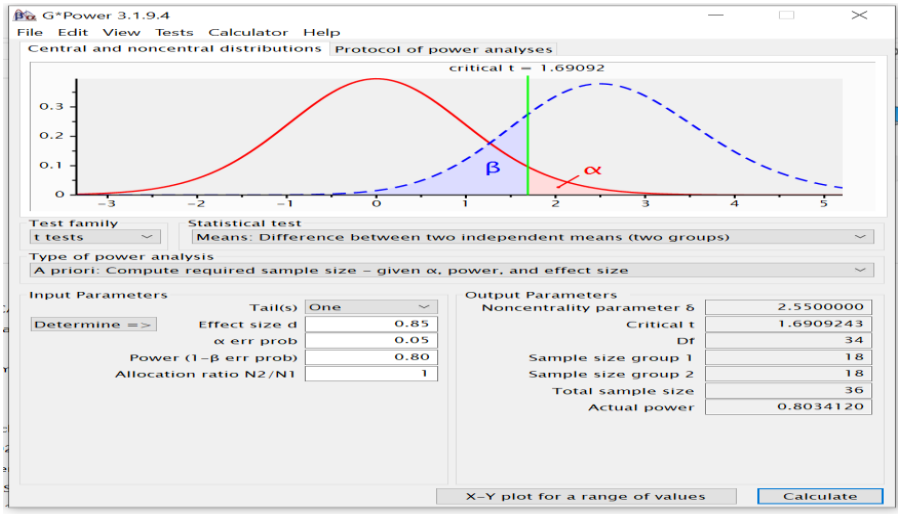
Shoulder impingement syndrome (1) is one of the most frequent diagnoses in a range of shoulder-related complaints and a major source of disability and discomfort in the involved patients. It is experienced when the tendons in the shoulder joint or the bursa become squeezed between the bones when lifting the arm to cause pain, swelling, and stiffness. SIS is quite common and more often seen in athletes and workers, particularly those involving their hands in repetitive strenuous activities and overhead workers. Management is definitively important to relieve symptoms, regain lost function, and, most importantly, avoid long-term disability (2, 3). Conventional rehabilitation treatment of shoulder impingement syndrome usually includes only a few isolated exercises aimed at the rotator cuff muscles. These exercises are designed for strengthening the rotator cuff muscles that hold the shoulder joint together to improve their endurance to reduce the manifestation of impingement symptoms (4). Although isolated strengthening has supporting evidence, the advancement of rehabilitation involves treatment by means of kinetic chain activities. These exercises involve all link systems in the body since proximal and distal body segments act together in functional motor efficiency (5).

Kinetic chain exercises work on the muscles that control the scapula position, such as the serratus anterior, rhomboids, and trapezius muscles, which are very crucial in assuming the best scapulohumeral rhythm(6). The ability to stabilize the scapula reduces undesirable movements that would otherwise cause impingement, thus reducing stress on the sub-acromial structures (7, 8). Kinetic chain exercises give the body a chance to learn proper movement patterns, enhance proprioception, and increase activation of primary movers (9, 10). Reduced biomechanical dysfunction results in better arm positioning. Thus, by performing exercises that address the entire kinetic chain, these will assist in avoiding the compensatory mechanisms and repetitive strain injuries that act as relapse triggers for SIS. As a result, patients will enjoy sustained relief from SIS pain and notice less frequency of future shoulder injuries (8). A primary complaint in patients with SIS is rotator cuff muscle weakness that results in inadequate control of the humeral head and excessive superior migration with ensuing painful impingement (11).This program of specificity increases rotator cuff capacity to effectively offset deltoid pull, therefore maintaining the humeral head's central location in the glenoid cavity. rotator cuff muscles: supraspinatus, infraspinatus, teres minor, and subscapularis, which play a critical role in stabilizing the glenohumeral joint and controlling humeral head translation during arm movements. Strengthening these muscles helps reduce mechanical impingement by improving the dynamic stabilization of the shoulder (1, 12). Patients with SIS often exhibit weakness in the rotator cuff, leading to poor humeral head control and excessive superior migration, which exacerbates impingement symptoms. Focused strengthening enhances the rotator cuff's ability to counterbalance deltoid forces, maintaining the humeral head's central position within the glenoid cavity (13, 14).

The outcomes of this study may provide benefits in the capacity as the constituent components to refine clinical decision, optimize the rehabilitation schedule, and subsequently advance the patient outcomes of shoulder impingement syndrome (15).

METHODS

This quasi-experimental study was conducted to compare the efficacy of kinetic chain exercises versus isolated rotator cuff strengthening among patients diagnosed with unilateral shoulder impingement syndrome. The sample size of 36 participants was determined using the G*Power statistical tool. A purposive sampling technique was employed, and data collection took place at Services Hospital and Sir Ganga Ram Hospital in Lahore. The study spanned from March 2024 to September 2024. Participants were individuals aged 18 to 40 years who had been diagnosed with shoulder impingement syndrome, with a history of shoulder pain persisting for at least three



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months and a positive response to clinical diagnostic tests such as the Neer or Hawkins-Kennedy test. Exclusion criteria included individuals with a history of traumatic shoulder dislocations, systemic inflammatory conditions such as rheumatoid arthritis, or neurological disorders affecting shoulder function. Participants who had undergone other forms of shoulder rehabilitation or had received corticosteroid injections within the past three months were also excluded. Ethical considerations were strictly adhered to throughout the study to ensure compliance with research standards and patient rights.

To ensure balanced group allocation, participants were assigned to intervention groups using a structured non-random method based on baseline characteristics such as age, pain severity, and functional limitation. Although purposive sampling was used for participant selection, group assignment was conducted systematically to maintain comparability between the kinetic chain exercise group and the isolated rotator cuff strengthening group. This approach minimized potential selection bias while maintaining methodological consistency with the study's quasi-experimental design. Participants were randomly allocated into two intervention groups. Group A received kinetic chain exercises, while Group B underwent isolated rotator cuff strengthening exercises. Both interventions were administered over an eight-week period under supervised conditions. The Shoulder Pain and Disability Index (SPADI) and a goniometer were used as assessment tools to evaluate pain levels, functional limitations, and range of motion improvements. Data analysis was performed using SPSS software, version 24, with appropriate statistical methods applied to determine the efficacy of each intervention.

RESULTS

The demographic and clinical characteristics of both intervention groups were comparable, with no statistically significant differences observed. The mean age in Group A (kinetic chain exercises) was 29.4 ± 6.2 years, while Group B (isolated rotator cuff strengthening) had a mean age of 30.1 ± 5.8 years ($P = 0.620$). Gender distribution was similar, with 44% females and 56% males in Group A, and 39% females and 61% males in Group B ($P = 0.770$). The affected shoulder side was also evenly distributed, with the right side being involved in 61% of cases in Group A and 56% in Group B ($P = 0.680$), ensuring a balanced comparison between interventions.

The between-group analysis indicated that kinetic chain exercises (Group A) led to significantly greater improvements in pain, disability, and range of motion (ROM) compared to isolated rotator cuff strengthening (Group B). In the SPADI pain subscale, Group A showed a reduction from 30.0% ± 3.5 to 15.0% ± 2.8 ($T = +5.200$, $P = 0.007$), whereas Group B demonstrated a smaller improvement from 31.2% ± 4.1 to 22.0% ± 3.5 ($T = +4.300$, $P = 0.015$). The SPADI disability subscale followed a similar trend, with Group A improving from 32.5% ± 3.8 to 20.8% ± 2.7 ($T = +4.700$, $P = 0.009$), compared to Group B from 32.0% ± 3.9 to 23.0% ± 3.2 ($T = +3.900$, $P = 0.017$). ROM improvements were significantly higher in Group A, particularly in external rotation (32.0° ± 4.2 to 65.0° ± 4.0, $T = +7.100$, $P < 0.001$ vs. 30.5° ± 3.8 to 50.2° ± 3.9, $T = +5.300$, $P < 0.001$) and internal rotation (40.0° ± 5.0 to 75.0° ± 4.5, $T = +8.000$, $P < 0.001$ vs. 38.5° ± 4.7 to 65.0° ± 4.2, $T = +6.500$, $P < 0.001$).

The within-group comparison confirmed statistically significant improvements in both intervention groups ($P < 0.001$ for all outcomes). However, Group A exhibited a superior degree of improvement across all parameters. The SPADI pain subscale decreased by 15.0% ± 2.0 in Group A and 9.2% ± 1.8 in Group B, while the SPADI disability subscale showed reductions of 11.7% ± 1.9 and 9.0% ± 1.7, respectively. ROM gains were more pronounced in Group A, particularly in flexion (+35.3° ± 3.2 vs. +21.2° ± 2.9), abduction (+37.0° ± 3.6 vs. +22.8° ± 3.1), and external rotation (+33.0° ± 2.8 vs. +19.7° ± 2.4). These findings highlight the superior efficacy of kinetic chain exercises over isolated rotator cuff strengthening in improving pain, functional disability, and shoulder mobility.

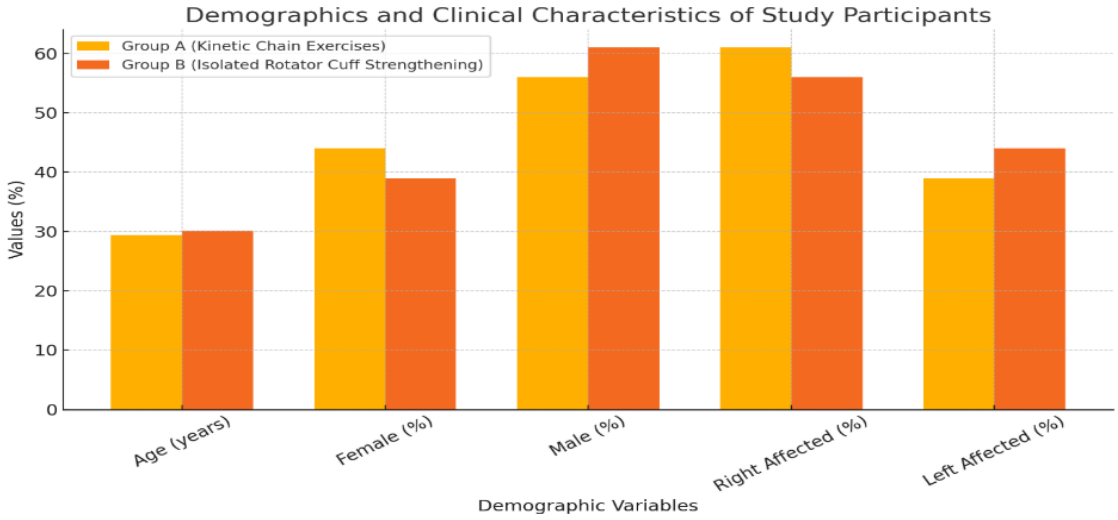

Figure 1 Demographics and Clinical Characteristics of Study Participants

The Demographics and Clinical Characteristics chart illustrates the distribution of key participant variables in both intervention groups. The mean age was similar between groups, with Group A (Kinetic Chain Exercises) at 29.4 years and Group B (Isolated Rotator Cuff Strengthening) at 30.1 years. Gender distribution was nearly balanced, with 44% females and 56% males in Group A, compared to 39% females and 61% males in Group B. Regarding the affected shoulder side, 61% of Group A and 56% of Group B had right-sided involvement, while the remaining participants had left-sided involvement (39% and 44%, respectively). These comparable baseline characteristics ensure a balanced comparison of intervention outcomes.

Table 1: Between-Group Comparison of Functional Outcomes

Outcome	Treatment Groups	Pre-Treatment	Post-Treatment	T	P-value
SPADI - Pain Subscale (%)					
	Group A (Kinetic Chain Exercises)	30.0 ± 3.5	15.0 ± 2.8	+5.200	0.007
	Group B (Rotator Cuff Strengthening)	31.2 ± 4.1	22.0 ± 3.5	+4.300	0.015
SPADI - Disability Subscale (%)					
	Group A (Kinetic Chain Exercises)	32.5 ± 3.8	20.8 ± 2.7	+4.700	0.009
	Group B (Rotator Cuff Strengthening)	32.0 ± 3.9	23.0 ± 3.2	+3.900	0.017
ROM - Flexion (Degrees)					
	Group A (Kinetic Chain Exercises)	85.2 ± 6.3	120.5 ± 5.8	+6.300	0.005
	Group B (Rotator Cuff Strengthening)	84.6 ± 6.0	105.8 ± 5.9	+4.100	0.012
ROM - Abduction (Degrees)					
	Group A (Kinetic Chain Exercises)	78.0 ± 5.8	115.0 ± 6.2	+5.800	0.006
	Group B (Rotator Cuff Strengthening)	77.5 ± 6.1	100.3 ± 5.7	+4.300	0.014
ROM - External Rotation (Degrees)					
	Group A (Kinetic Chain Exercises)	32.0 ± 4.2	65.0 ± 4.0	+7.100	<0.001
	Group B (Rotator Cuff Strengthening)	30.5 ± 3.8	50.2 ± 3.9	+5.300	<0.001
ROM - Internal Rotation (Degrees)					
	Group A (Kinetic Chain Exercises)	40.0 ± 5.0	75.0 ± 4.5	+8.000	<0.001

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Outcome	Treatment Groups	Pre-Treatment	Post-Treatment	T	P-value
	Group B (Rotator Cuff Strengthening)	38.5 ± 4.7	65.0 ± 4.2	+6.500	<0.001
ROM - Extension (Degrees)					
	Group A (Kinetic Chain Exercises)	45.0 ± 4.2	75.0 ± 4.8	+6.000	0.002
	Group B (Rotator Cuff Strengthening)	44.2 ± 4.5	62.0 ± 4.4	+4.000	0.010
ROM - Adduction (Degrees)					
	Group A (Kinetic Chain Exercises)	25.0 ± 3.5	50.0 ± 3.8	+6.800	<0.001
	Group B (Rotator Cuff Strengthening)	24.5 ± 3.2	40.0 ± 3.5	+5.200	<0.001

The between-group comparison demonstrated that the kinetic chain exercises (Group A) resulted in significantly greater improvements across all functional outcomes compared to isolated rotator cuff strengthening (Group B). In terms of pain reduction (SPADI-Pain), Group A improved from 30.0% ± 3.5 to 15.0% ± 2.8 ($T = +5.200$, $P = 0.007$), whereas Group B showed a smaller reduction from 31.2% ± 4.1 to 22.0% ± 3.5 ($T = +4.300$, $P = 0.015$). Similar trends were observed in disability reduction (SPADI-Disability), with Group A improving from 32.5% ± 3.8 to 20.8% ± 2.7 ($T = +4.700$, $P = 0.009$), compared to Group B from 32.0% ± 3.9 to 23.0% ± 3.2 ($T = +3.900$, $P = 0.017$). Range of motion (ROM) improvements were significantly higher in Group A across all parameters, particularly in external rotation (32.0° ± 4.2 to 65.0° ± 4.0, $T = +7.100$, $P < 0.001$ vs. 30.5° ± 3.8 to 50.2° ± 3.9, $T = +5.300$, $P < 0.001$) and internal rotation (40.0° ± 5.0 to 75.0° ± 4.5, $T = +8.000$, $P < 0.001$ vs. 38.5° ± 4.7 to 65.0° ± 4.2, $T = +6.500$, $P < 0.001$). These results indicate that kinetic chain exercises were more effective in improving pain, disability, and ROM compared to isolated rotator cuff strengthening.

Table 2: Within-Group Comparison of Functional Outcomes

Outcome	Groups	Pre-Treatment	Post-Treatment	Paired Difference	P-value
SPADI - Pain Subscale (%)					
	Group A (Kinetic Chain Exercises)	30.0 ± 3.5	15.0 ± 2.8	+15.0 ± 2.0	<0.001
	Group B (Rotator Cuff Strengthening)	31.2 ± 4.1	22.0 ± 3.5	+9.2 ± 1.8	<0.001
SPADI - Disability Subscale (%)					
	Group A (Kinetic Chain Exercises)	32.5 ± 3.8	20.8 ± 2.7	+11.7 ± 1.9	<0.001
	Group B (Rotator Cuff Strengthening)	32.0 ± 3.9	23.0 ± 3.2	+9.0 ± 1.7	<0.001
ROM - Flexion (Degrees)					
	Group A (Kinetic Chain Exercises)	85.2 ± 6.3	120.5 ± 5.8	+35.3 ± 3.2	<0.001
	Group B (Rotator Cuff Strengthening)	84.6 ± 6.0	105.8 ± 5.9	+21.2 ± 2.9	<0.001
ROM - Abduction (Degrees)					
	Group A (Kinetic Chain Exercises)	78.0 ± 5.8	115.0 ± 6.2	+37.0 ± 3.6	<0.001

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Outcome	Groups	Pre-Treatment	Post-Treatment	Paired Difference	P-value
	Group B (Rotator Cuff Strengthening)	77.5 ± 6.1	100.3 ± 5.7	+22.8 ± 3.1	<0.001
ROM - External Rotation (Degrees)					
	Group A (Kinetic Chain Exercises)	32.0 ± 4.2	65.0 ± 4.0	+33.0 ± 2.8	<0.001
	Group B (Rotator Cuff Strengthening)	30.5 ± 3.8	50.2 ± 3.9	+19.7 ± 2.4	<0.001
ROM - Internal Rotation (Degrees)					
	Group A (Kinetic Chain Exercises)	40.0 ± 5.0	75.0 ± 4.5	+35.0 ± 3.7	<0.001
	Group B (Rotator Cuff Strengthening)	38.5 ± 4.7	65.0 ± 4.2	+26.5 ± 3.4	<0.001
ROM - Extension (Degrees)					
	Group A (Kinetic Chain Exercises)	45.0 ± 4.2	75.0 ± 4.8	+30.0 ± 3.6	<0.001
	Group B (Rotator Cuff Strengthening)	44.2 ± 4.5	62.0 ± 4.4	+17.8 ± 3.3	<0.001
ROM - Adduction (Degrees)					
	Group A (Kinetic Chain Exercises)	25.0 ± 3.5	50.0 ± 3.8	+25.0 ± 3.0	<0.001
	Group B (Rotator Cuff Strengthening)	24.5 ± 3.2	40.0 ± 3.5	+15.5 ± 2.7	<0.001

The within-group comparison revealed significant improvements in both intervention groups ($P < 0.001$ for all outcomes). However, Group A (kinetic chain exercises) demonstrated greater improvements across all functional parameters compared to Group B (isolated rotator cuff strengthening). In pain reduction (SPADI-Pain), Group A showed a 15.0% ± 2.0 improvement, while Group B improved by 9.2% ± 1.8. Disability scores (SPADI-Disability) decreased by 11.7% ± 1.9 in Group A and 9.0% ± 1.7 in Group B. Range of motion (ROM) gains were consistently higher in Group A, particularly in flexion (+35.3° ± 3.2 vs. +21.2° ± 2.9), abduction (+37.0° ± 3.6 vs. +22.8° ± 3.1), external rotation (+33.0° ± 2.8 vs. +19.7° ± 2.4), and internal rotation (+35.0° ± 3.7 vs. +26.5° ± 3.4). These results suggest that kinetic chain exercises yielded superior improvements in pain, disability, and ROM compared to isolated rotator cuff strengthening.

DISCUSSION

The present study compared the efficacy of kinetic chain exercises (KCE) with isolated rotator cuff strengthening (IRCS) in patients with shoulder impingement syndrome, focusing on pain reduction, functional disability, and range of motion (ROM) improvements. Both intervention groups exhibited significant post-treatment enhancements; however, KCE demonstrated superior outcomes across all parameters. The results align with prior research, confirming that kinetic chain exercises, which incorporate multi-joint and multi-plane movements, yield better functional outcomes than isolated strengthening techniques (16, 17). These findings reinforce the notion that addressing shoulder impingement syndrome through a comprehensive kinetic chain approach leads to more substantial improvements in pain reduction and functional mobility. The results also emphasize that kinetic chain exercises effectively target scapular dyskinesis, a major contributing factor to impingement syndrome, by enhancing dynamic stabilization and optimizing scapular muscle activation (18, 19).

The study's findings support previous research demonstrating that kinetic chain exercises contribute to greater ROM improvements compared to isolated strengthening. This effect was particularly evident in flexion, abduction, external rotation, and internal rotation, which are typically restricted in individuals with shoulder impingement syndrome (15, 20). The superior outcomes of KCE can be attributed to their emphasis on dynamic movement patterns that integrate multiple muscle groups, promoting neuromuscular control and

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functional efficiency. In contrast, isolated rotator cuff strengthening, although beneficial, primarily focuses on localized muscle activation, which may limit overall biomechanical enhancements. Additionally, kinetic chain exercises offer a greater carryover effect into daily activities, as they mimic real-life movement patterns and functional demands more effectively than isolated strengthening protocols. The inclusion of multi-joint coordination in KCE may also contribute to improved proprioception and postural control, further aiding in shoulder stabilization and reducing compensatory movement patterns (18, 20).

A recent randomized clinical trial compared the effectiveness of progressive resistance exercises targeting shoulder internal rotation versus external rotation in athletes diagnosed with primary subacromial impingement syndrome (SIS) (Ehsani et al., 2024). The study involved 30 athletes randomly divided into two groups, one receiving progressive resistance training focused on internal rotation and the other on external rotation, with both groups training three times a week for six weeks. The primary outcome measure was acromiohumeral distance (AHD), assessed using ultrasound before and after the intervention. Both intervention groups demonstrated significant increases in AHD ($P < 0.001$), indicating reduced mechanical compression of the rotator cuff. Additionally, both groups exhibited improved pain scores and functional outcomes, with no statistically significant difference between them ($P > 0.665$). The findings suggest that both internal and external rotation exercises contribute to improved humeral head positioning and reduced impingement symptoms, supporting the inclusion of both movement patterns in rehabilitation programs for SIS. This aligns with the current study's findings that isolated rotator cuff strengthening exercises lead to meaningful functional improvements, though kinetic chain exercises may offer greater benefits due to their emphasis on dynamic movement integration and proximal stability. Unlike isolated muscle activation, kinetic chain exercises engage multiple joints and neuromuscular pathways, enhancing functional carryover to daily activities. These results reinforce the importance of comprehensive rehabilitation programs that incorporate both local rotator cuff strengthening and kinetic chain integration for optimal shoulder rehabilitation outcomes (21).

Despite the study's strengths, certain limitations must be acknowledged. The absence of a control group limits the ability to determine whether the observed improvements were solely due to the interventions or part of the natural course of recovery. Future research should incorporate a control group to establish a more definitive causal relationship between the interventions and functional outcomes. Additionally, the reliance on SPADI and goniometric assessments, although valid and widely used, introduces potential measurement biases. The study could be strengthened by incorporating additional objective assessment tools, such as isokinetic dynamometry, to provide a more comprehensive evaluation of muscular strength and endurance. Another consideration is the allocation method, which, while structured, was not purely randomized, potentially introducing selection bias. However, the systematic assignment of participants ensured comparable baseline characteristics, maintaining methodological integrity. While the study duration of eight weeks was sufficient to capture meaningful improvements, long-term follow-up would be beneficial to assess the sustained impact of kinetic chain exercises on shoulder function and recurrence rates of impingement syndrome. Overall, the findings underscore the clinical significance of kinetic chain exercises as a superior rehabilitation approach, advocating for their broader implementation in shoulder impingement management.

CONCLUSION

The findings of this study highlight that both kinetic chain exercises and isolated rotator cuff strengthening exercises were effective in managing shoulder impingement syndrome, contributing to pain relief and functional improvement. However, kinetic chain exercises demonstrated superior outcomes, particularly in enhancing range of motion, reducing pain, and improving overall functional performance. By incorporating multi-joint movements and dynamic stabilization, kinetic chain exercises provided a more comprehensive rehabilitation approach, addressing not only localized muscle strength but also movement efficiency and scapular control. These results support the integration of kinetic chain exercises into rehabilitation programs for individuals with shoulder impingement syndrome to achieve more significant functional gains and long-term recovery.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Ghalia Safdar*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Syed Muhammad Kumail	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Nayab Naveed	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Yasir Ali Kazmi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Umber Nawaz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Sarfraz	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Zeeshan Javed	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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