



“EFFECT OF HAND-GRIP STRENGTHENING EXERCISES ON SHOULDER PAIN, RANGE OF MOTION, FUNCTION AND GRIP STRENGTH IN PATIENTS WITH ROTATOR CUFF IMPINGEMENT. A RANDOMIZED CONTROLLED TRIAL”

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Abstract Background: Rotator cuff impingement syndrome is a common musculoskeletal disorder causing shoulder pain, restricted range of motion, reduced grip strength, and functional disability. Conventional physiotherapy improves symptoms, but the additional effect of handgrip strengthening exercises remains unclear. This study aimed to evaluate the effectiveness of handgrip strengthening exercises combined with conventional physiotherapy in patients with rotator cuff impingement syndrome. **Methodology:** A randomized controlled trial was conducted on 44 participants aged 18–50 years with rotator cuff impingement syndrome. Participants were randomly divided into two groups. Group A received conventional physiotherapy along with handgrip strengthening exercises, while Group B received only conventional physiotherapy. Outcome measures included Visual Analog Scale (VAS), shoulder range of motion (ROM), DASH score, and grip strength measured pre- and post-intervention. Data were analyzed using SPSS Version 25.0 with $p < 0.05$ considered significant. **Results:** Both groups showed significant improvement; however, Group A demonstrated significantly greater reduction in pain, improved ROM, better functional ability, and increased grip strength compared to Group B ($p < 0.001$). **Conclusion:** Handgrip strengthening exercises combined with conventional physiotherapy are more effective than conventional therapy alone in improving pain, shoulder mobility, function, and grip strength in patients with rotator cuff impingement syndrome. **Keywords:** Rotator cuff impingement syndrome, handgrip strengthening, shoulder pain, grip strength, physiotherapy, DASH score.

Introduction

The shoulder complex is one of the most anatomically intricate and biomechanically dynamic regions of the human body. It comprises the coordinated interaction of the glenohumeral joint, acromioclavicular joint, sternoclavicular joint, and scapulothoracic articulation. This complex arrangement allows remarkable mobility required for performing activities such as reaching, lifting, throwing, grooming, and other functional upper limb movements. However, this extensive mobility

compromises inherent stability, rendering the shoulder particularly susceptible to overuse injuries, degenerative conditions, and mechanical dysfunction.

Shoulder pain is therefore one of the most frequently reported musculoskeletal complaints in orthopedic and physiotherapy settings worldwide. In athletic populations, especially elite cricketers, research has demonstrated a high prevalence of shoulder injuries accompanied by altered scapular positioning.¹ Repetitive overhead activities generate substantial mechanical stress on the rotator cuff musculature and scapular stabilizers, predisposing individuals to impingement syndromes and tendon pathology.

Beyond sports populations, shoulder pain significantly affects the general community. Epidemiological studies conducted in tertiary care hospitals in South India have reported a considerable prevalence of chronic shoulder pain among adult patients.² Such findings confirm that shoulder disorders represent a major public health concern rather than a condition limited to athletes. Persistent shoulder pain affects work productivity, functional independence, and overall quality of life.

Among various etiologies of shoulder pain—including adhesive capsulitis, glenohumeral instability, osteoarthritis, labral lesions, and cervical radiculopathy—subacromial impingement syndrome remains one of the most commonly diagnosed conditions.³

Rotator cuff injuries frequently coexist with myofascial pain syndromes, which may negatively influence prognosis and delay rehabilitation outcomes.⁴ Rotator cuff pathology is not an isolated event but rather a progressive pathological continuum. In its early stages, repetitive mechanical compression within the subacromial space leads to inflammation of the rotator cuff tendons and subacromial bursa. If the mechanical imbalance persists, degenerative changes occur, characterized by collagen fiber disruption, reduced vascularity, and diminished tensile strength. Ultimately, partial or full-thickness tears may develop.

Systematic reviews evaluating risk factors for rotator cuff tears have identified advancing age, repetitive overhead movements, systemic metabolic disorders, and biomechanical abnormalities as major contributors.⁵ Occupational studies have further demonstrated that repetitive upper limb tasks, forceful exertion, and prolonged overhead activities significantly increase the risk of chronic tendinous shoulder pathology.⁶

Meta-analytical evidence supports the multifactorial nature of rotator cuff tendinopathy, with intrinsic factors such as aging and extrinsic factors including mechanical overload playing synergistic roles.⁷ Symptomatic rotator cuff tears are strongly associated with cumulative stress exposure and impaired vascular supply within the critical zone of the supraspinatus tendon.⁸ Degenerative changes often begin asymptotically and may become clinically evident only when substantial structural compromise has occurred.

In the Indian healthcare context, the burden of rotator cuff disorders is increasing. Rapid urbanization, technological advancements, sedentary lifestyles, and increasing participation in recreational gym-based activities contribute to shoulder overuse injuries.⁹ The aging population further adds to the incidence of degenerative tendon disorders. Overhead athletes, particularly throwers, experience high rotational forces that predispose them to impingement syndromes and rotator cuff dysfunction.⁹

Clinically, patients with rotator cuff impingement syndrome typically present with localized anterolateral shoulder pain, painful arc between 60° and 120° of abduction, night pain, weakness, and functional limitations. Pain may radiate to the lateral arm but rarely extends below the elbow. These symptoms interfere with daily activities such as dressing, combing hair, lifting objects, and performing occupational tasks.

Muscle weakness contributes significantly to the pathomechanics of impingement. Weakness of the rotator cuff muscles results in inadequate humeral head stabilization, leading to superior migration and increased subacromial compression. Conversely, persistent pain causes reflex inhibition of musculature, further perpetuating weakness. Therefore, accurate and objective assessment of muscle strength is essential in both diagnosis and rehabilitation.

A cross-sectional study examining the relationship between handgrip strength and rotator cuff muscle strength demonstrated a significant positive correlation between the two variables in individuals with shoulder pain.¹¹ This finding reinforces the principle of kinetic chain integration and proximal

stability facilitating distal mobility. The shoulder girdle provides a stable base for effective hand function; thus, shoulder dysfunction may manifest as reduced grip strength.

Emerging evidence suggests that handgrip strengthening exercises may positively influence shoulder muscle activation. A randomized study demonstrated that handgrip strengthening exercises significantly reduced pain and improved rotator cuff muscle strength in patients with primary subacromial impingement syndrome.¹² These findings support the concept of neuromuscular irradiation, whereby strong distal contraction enhances proximal muscle recruitment.

Exercise-based rehabilitation remains the cornerstone of conservative management for subacromial impingement syndrome. Randomized clinical trials comparing supervised specific exercise programs with home exercise protocols emphasize the importance of structured, progressive strengthening approaches.¹³ Scapular stabilization exercises, in particular, have been shown to improve scapular positioning, restore normal scapulohumeral rhythm, and reduce mechanical compression. A systematic review confirmed significant pain reduction and functional improvement with scapular-focused rehabilitation.¹⁴ Recent randomized controlled trials further demonstrated that targeted scapular stabilization exercises are superior to conventional exercise programs in improving shoulder pain and disability.¹⁵ These findings highlight the importance of integrating biomechanical correction into rehabilitation protocols.

Pain measurement plays a crucial role in monitoring clinical progress. The Numeric Pain Rating Scale (NPRS) has demonstrated responsiveness and reliability in patients with shoulder pain.¹⁶ Stretching interventions targeting rotator cuff musculature contribute to improved flexibility, reduced muscle tightness, and enhanced range of motion. Comparative analyses of various rotator cuff stretching techniques provide evidence-based guidance for clinical application.¹⁷

Prevalence studies conducted in tertiary care settings continue to report a substantial proportion of patients presenting with shoulder disorders, reinforcing the need for effective management strategies.¹⁸ Objective muscle strength assessment using hand-held dynamometry provides reliable quantification of internal and external rotator strength and allows identification of unilateral strength deficits.¹⁹

Additionally, research investigating the effect of handgrip contraction on supraspinatus muscle activity suggests that gripping may facilitate neuromuscular activation of the rotator cuff.²⁰ Such findings provide physiological justification for incorporating handgrip strengthening into shoulder rehabilitation programs.

Reliable outcome measures are essential for evaluating treatment effectiveness. The Visual Analog Scale (VAS) has demonstrated high reliability for measuring acute pain intensity.²¹ The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire is a validated and responsive tool for assessing upper limb functional disability.²² Technological advancements in dynamometry have further enhanced the reliability and validity of grip strength assessment tools, improving research reproducibility and clinical accuracy.²³

Despite substantial research on conventional rehabilitation techniques, limited evidence exists regarding the additive effect of structured handgrip strengthening protocols when combined with conventional physiotherapy in patients with rotator cuff impingement syndrome. Given the established association between grip strength and shoulder muscle performance, further investigation is warranted. Therefore, the present randomized controlled trial was undertaken to evaluate the effect of handgrip strengthening exercises on shoulder pain, range of motion, functional ability, and grip strength in patients with rotator cuff impingement syndrome. By integrating validated outcome measures and objective strength assessment tools, this study aims to contribute to evidence-based physiotherapy practice and optimize rehabilitation outcomes in individuals suffering from shoulder impingement.

MATERIALS AND METHODOLOGY

This study will be conducted as a randomized controlled trial in various clinical set-ups over a duration of 6 months. A total of 44 participants diagnosed with rotator cuff impingement syndrome will be selected using convenience sampling technique. The study aims to investigate the effect of handgrip strengthening exercises on reducing shoulder pain and improving range of motion, functional ability, and grip strength

in patients with rotator cuff impingement. The research question of the study is: “Is there any effect of handgrip strengthening exercises on reducing shoulder pain, improving range of motion, function, and grip strength in patients with rotator cuff impingement?”

Participants fulfilling the inclusion criteria will be recruited for the study. Both male and female participants aged between 18 to 50 years, having symptoms duration of more than 3 months and less than 1 year, with pain intensity ranging from 3 to 7 on the Visual Analogue Scale (VAS), and positive Neer Impingement Test or Hawkins-Kennedy Impingement Test will be included in the study. Participants with shoulder fracture, dislocation, osteophytes, labral tear, acute trauma, previous surgery, recent fracture of the affected shoulder, hand or forearm dysfunction, symptoms persisting for more than one year, and individuals with cardiac, neurological, musculoskeletal diseases, rheumatoid disease, or malignancy that may interfere with upper extremity exercise will be excluded from the study.

Prior to participation, the nature and purpose of the study will be explained to all participants, and written informed consent will be obtained. Baseline assessment will be performed using outcome measures including the Visual Analogue Scale (VAS) for pain assessment, DASH Scale for functional evaluation, goniometer for shoulder range of motion assessment, and dynamometer for grip strength measurement. The materials required for the study will include pen, pencil, data collection forms, consent forms, VAS scale, DASH scale, handgrip strengthening equipment (hand gripper), dynamometer, and goniometer.

OUTCOMES

1. **VISUAL ANALOG SCALE-** (Reliability - 0.97)²¹: The Visual Analog Scale (VAS) is a simple and widely used tool to measure a person's pain intensity 0 cm = No pain, 5 cm = Moderate pain, 10 cm = Worst imaginable pain.
2. **RANGE OF MOTION** - It is measured in degrees using a goniometer. It refers to the extent of movement a joint can perform in different directions.
3. **DASH scale** - (Reliability – 0.96, Validity - > 0.70)²²: With the help of The DASH (Disabilities of the Arm, Shoulder, and Hand) scale is a questionnaire used to measure a person's physical function and symptoms in the upper limb (arm, shoulder, and hand). It consists of 30 questions assessing the ability to perform daily activities, severity of pain, weakness, and stiffness. Each item is rated on a 1 to 5 scale, where higher scores indicate greater disability. The final score is calculated on a scale of 0 (no disability) to 100 (most severe disability).
4. **DYNAMOMETER-** (Reliability – 0.90, Validity -0.80)²³: It is commonly assessed using a hand dynamometer. Indicates overall muscle strength, especially in the upper limb.



Fig: Hand grip strengthening equipment
+ Dynamometer

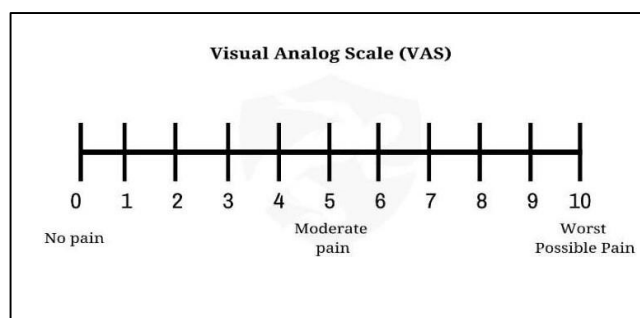


Fig: VAS scale

ETHICAL CONSIDERATION

After obtaining approval from the Institutional Ethical Committee, detailed instructions regarding the study procedure and its benefits were explained to all participants. Written informed consent was obtained from each participant prior to their inclusion in the study. Subjects were selected according to the predefined inclusion and exclusion criteria. The eligible participants were then randomly allocated into two groups using the chit method, while the patients were kept blinded to the group allocation. Before initiating the intervention, the procedure was thoroughly explained and demonstrated to each participant. Baseline assessment of pain intensity was carried out using the Visual Analogue Scale (VAS). Shoulder joint range of motion was assessed using a universal goniometer, with the participant positioned appropriately and the goniometer aligned according to the relevant anatomical landmarks for each specific movement. Grip strength was measured using a handheld dynamometer. Functional ability and symptoms related to the upper extremity were evaluated using the Disabilities of the Arm, Shoulder and Hand (DASH) scale.

INTERVENTION

Group A:

Conventional therapy and handgrip strengthening exercises:

Handgrip strengthening exercises: with hand-griper equipment

The patients were instructed to perform the exercises while standing with their back supported against a wall. The affected arm was positioned at either 30°, 60°, or 90° of shoulder abduction and maintained in 90° of external rotation as per the progression protocol.

In this position, patients were instructed to perform 3 sets of 10 repetitions, with each set lasting approximately one minute, once daily. The resistance of the hand-gripper was adjusted on a weekly basis according to the patient's tolerance and progression.

During the first week, the exercises were performed at 30° of shoulder abduction. In the second week, the abduction angle was progressed to 60°, followed by 90° of abduction in the third week. In the final week, the exercises were performed a 90° of abduction combined with 90° of external rotation.



30 Degrees of Shoulder Abduction



60 Degrees of Shoulder Abduction

**90 Degrees of Shoulder Abduction with external rotation**Group B: Conventional therapy**30 Degrees of Shoulder Abduction**

Exercise therapy - Scapular stability exercises ¹⁴, Rotator cuff strengthening, and Shoulder Flexibility exercises¹⁷.

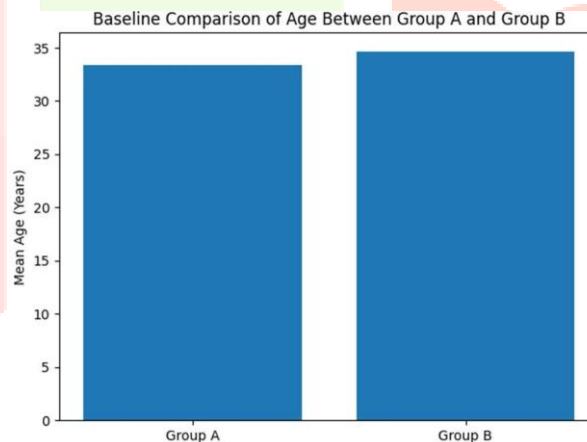
Scapular stability exercises ¹⁴	Rotator cuff strengthening exercises	Shoulder flexibility exercises ¹⁷
✓ Scapular clock exercise.	✓ External rotation exercises with theraband	✓ Capsular stretches
✓ Wall push up	✓ Internal rotation exercises with theraband	✓ Wand exercises
✓ Wall slide exercise.		✓ Cross body stretches
✓ Pendulum ¹⁵		

RESULTS AND DATA ANALYSIS

The data collected from all 44 participants were entered into Microsoft Excel and organized in a Master Chart with unique identification numbers assigned to maintain confidentiality. Variables such as age, gender, affected side, VAS score, shoulder range of motion, DASH score, and grip strength were coded and cross-checked for accuracy before analysis. The finalized data were imported into SPSS Version 25.0 for statistical analysis. Quantitative data were expressed as Mean $\pm$ Standard Deviation, while qualitative data were presented as frequency and percentage. Within-group and between-group comparisons were performed to determine treatment effectiveness, with a p-value < 0.05 considered statistically significant. The results were presented using tables, graphs, pie charts, and bar graphs for better understanding and interpretation.

TABLE 1. Age Distribution

Age	Group A	Group B
Mean	36.133	38.133
Standard Deviation	10.183	9.927

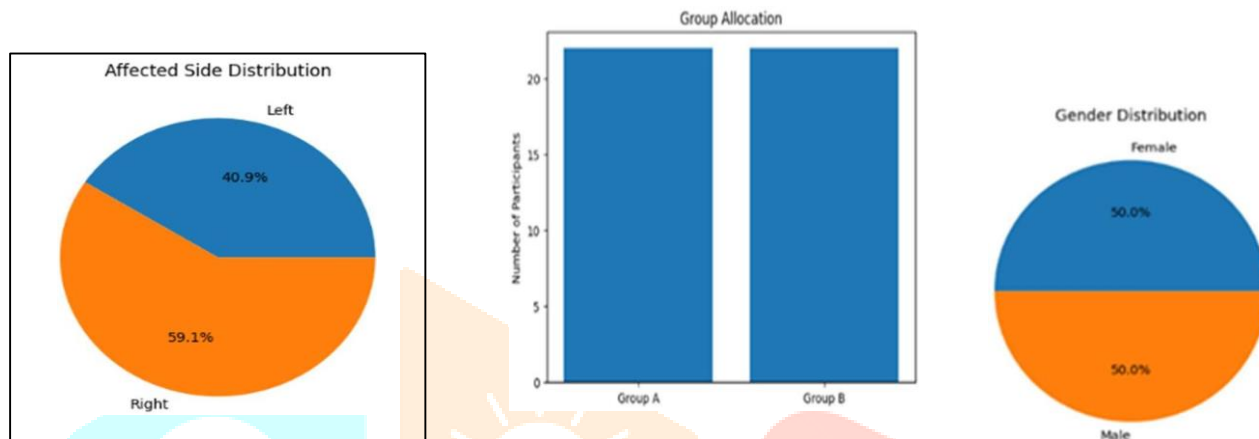


Group A and Group B were not statistically significantly different in terms of their mean baseline ages ($p = 0.48$). Therefore, each group contained similar ages pre-intervention and has maintained the same degree of homogeneity at baseline.

TABLE 2: Baseline Demographic and Clinical Characteristics

Variable	Group A (n = 22) Mean $\pm$ SD	Group B (n = 22) Mean $\pm$ SD	p-value
Age (years)	33.36 $\pm$ 6.31	34.68 $\pm$ 6.05	0.48

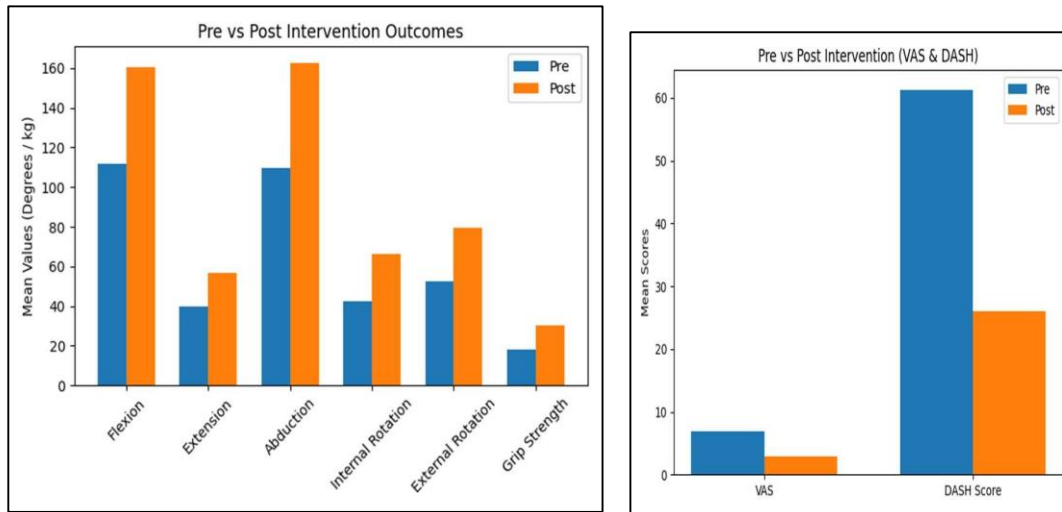
VAS (Pre)	6.86 ± 0.77	6.09 ± 1.41	.03*
Shoulder Flexion (°)	111.95 ± 14.44	114.14 ± 17.88	0.66
Shoulder Abduction (°)	109.45 ± 5.23	101.64 ± 11.77	.01*
DASH Score (Pre)	61.32 ± 4.08	60.23 ± 3.64	0.35
Grip Strength (kg)	18.27 ± 1.70	17.36 ± 0.90	.03*



At baseline, both groups were comparable for most variables. However, significant differences were observed for baseline VAS, shoulder abduction, and grip strength ($p < .05$), which justified the use of change-score (Post–Pre) analysis for between-group comparisons as per RCT standards.

TABLE 3. Within-Group Pre–Post Comparison: Group A (Handgrip Strengthening)

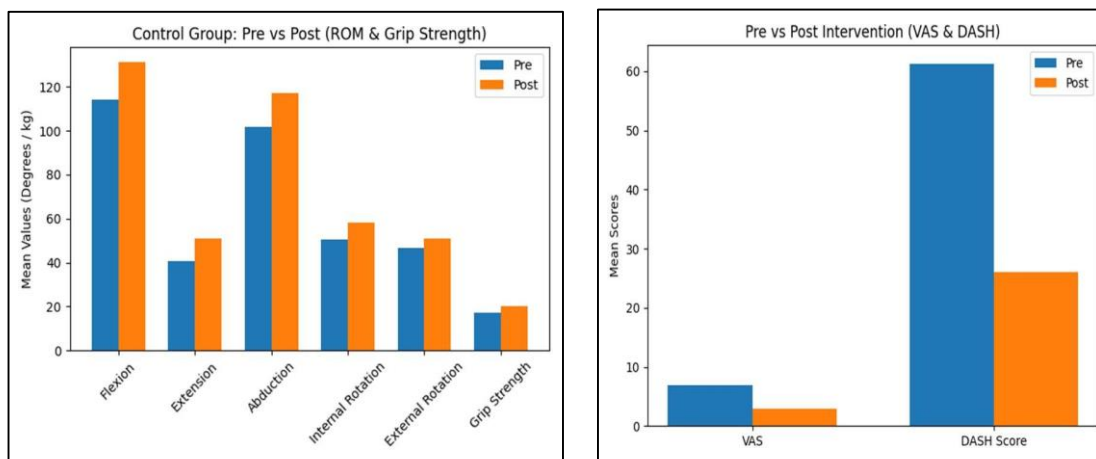
Outcome	Pre Mean ± SD	Post Mean ± SD	p-value	Effect Size
VAS	6.86 ± 0.77	2.86 ± 0.77	< .001*	$r = 1.00$
Flexion (°)	111.95 ± 14.44	160.68 ± 11.42	< .001*	$d = 3.28$
Extension (°)	39.59 ± 5.34	57.00 ± 5.85	< .001*	$d = 2.21$
Abduction (°)	109.45 ± 5.23	162.73 ± 5.05	< .001*	$d = 54.10$
Internal Rotation (°)	42.50 ± 6.63	66.36 ± 7.16	< .001*	$d = 28.63$
External Rotation (°)	52.50 ± 6.65	79.41 ± 7.08	< .001*	$d = 51.12$
DASH Score	61.32 ± 4.08	25.95 ± 3.93	< .001*	$d = 48.66$
Grip Strength (kg)	18.27 ± 1.70	30.27 ± 1.70	< .001*	$r = 1.00$



Group A demonstrated highly significant improvements ($p < .001$) across all outcome measures. The extremely large effect sizes indicate a strong clinical impact of handgrip strengthening exercises on pain reduction, shoulder mobility, functional ability, and grip strength.

TABLE 4. Within-Group Pre-Post Comparison: Group B (Control Group)

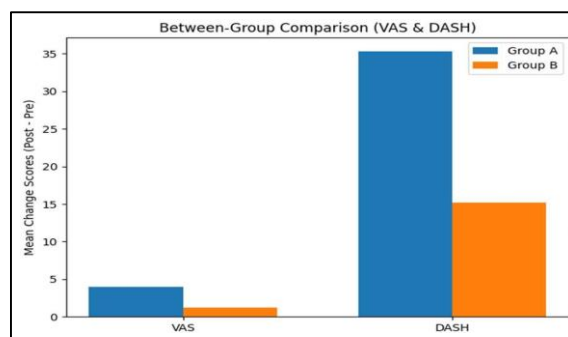
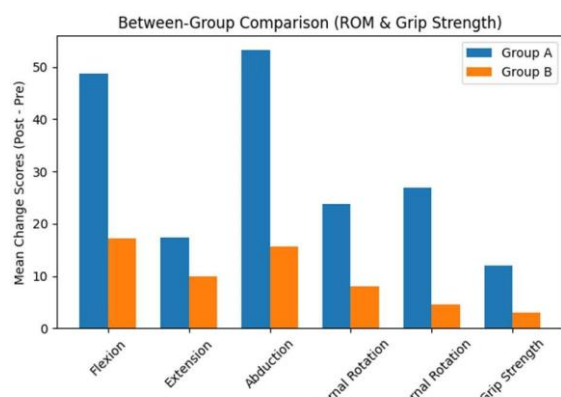
Outcome	Pre Mean $\pm$ SD	Post Mean $\pm$ SD	p-value	Effect Size
VAS	6.09 $\pm$ 1.41	4.86 $\pm$ 0.94	< .001*	r = 0.86
Flexion (°)	114.14 $\pm$ 17.88	131.32 $\pm$ 20.45	< .001*	r = 1.00
Extension (°)	40.77 $\pm$ 1.90	50.77 $\pm$ 1.90	< .001*	r = 1.00
Abduction (°)	101.64 $\pm$ 11.77	117.18 $\pm$ 20.66	< .001*	r = 1.00
Internal Rotation (°)	50.36 $\pm$ 10.57	58.32 $\pm$ 9.38	< .001*	r = 0.99
External Rotation (°)	46.50 $\pm$ 7.73	51.09 $\pm$ 7.26	< .001*	r = 1.00
DASH Score	60.23 $\pm$ 3.64	45.05 $\pm$ 3.00	< .001*	r = 1.00
Grip Strength (kg)	17.36 $\pm$ 0.90	20.32 $\pm$ 1.84	< .001*	r = 1.00



Group B showed statistically significant improvements; however, the magnitude of change was consistently smaller compared to Group A, indicating limited clinical effectiveness without targeted handgrip strengthening.

TABLE 5. Between group comparison of change scores (Post- Pre)

Outcome	Group A Mean $\pm$ SD	Group B Mean $\pm$ SD	p-value	Effect Size
VAS Change	4.00 $\pm$ 0.00	1.23 $\pm$ 1.07	< .001*	d = 3.68
Flexion Change (°)	48.73 $\pm$ 14.84	17.18 $\pm$ 16.81	< .001*	d = 1.99
Extension Change (°)	17.41 $\pm$ 7.87	10.00 $\pm$ 0.00	< .001*	d = 1.33
Abduction Change (°)	53.27 $\pm$ 0.99	15.55 $\pm$ 13.44	< .001*	d = 3.96
Internal Rotation Change (°)	23.86 $\pm$ 0.83	7.95 $\pm$ 4.32	< .001*	d = 5.12
External Rotation Change (°)	26.91 $\pm$ 0.53	4.59 $\pm$ 2.54	< .001*	d = 12.17
DASH Change	35.36 $\pm$ 0.73	15.18 $\pm$ 0.73	< .001*	d = 27.66
Grip Strength Change (kg)	12.00 $\pm$ 0.00	2.95 $\pm$ 1.62	< .001*	d = 7.91



Between-group analysis revealed statistically and clinically superior improvements in Group A across all outcomes ($p < .001$). These findings strongly support the effectiveness of handgrip strengthening exercises in managing pain, improving shoulder ROM, enhancing function, and increasing grip strength.

DISCUSSION

The present randomized controlled trial was conducted to evaluate the effect of handgrip strengthening exercises on shoulder pain, range of motion (ROM), functional ability, and grip strength in patients with rotator cuff impingement syndrome. Rotator cuff impingement is a common musculoskeletal disorder affecting functional capacity and quality of life^{1,2}. It is characterized by compression of the tendons in the subacromial space, leading to pain, restricted mobility, weakness, and reduced functional capacity^{3,4}. Several intrinsic and extrinsic risk factors contribute to rotator cuff pathology, including occupational and mechanical factors⁵⁻⁸. In India, the burden of rotator cuff disorders remains significant⁹. Effective rehabilitation therefore requires not only local strengthening but also improvement in neuromuscular control and dynamic shoulder stability^{10,14,15}.

In this study, 44 participants were randomly allocated into two groups. Group A received conventional physiotherapy combined with handgrip strengthening exercises, while Group B received only conventional physiotherapy. Both groups demonstrated statistically significant improvements following the intervention period, confirming the effectiveness of conventional management techniques such as scapular stabilization, rotator cuff strengthening, and flexibility exercises^{13-15,17}. These interventions help restore scapulohumeral rhythm, improve muscle balance, and reduce subacromial compression, thereby decreasing pain and enhancing mobility^{3,14}.

However, the experimental group showed significantly greater improvements across all outcome measures. Pain intensity measured by VAS was markedly reduced in Group A compared to Group B. The reliability and responsiveness of the VAS in shoulder pain assessment have been well established^{16,21}.

Improved muscular activation and joint stabilization likely reduced mechanical stress on subacromial structures, thereby decreasing nociceptive stimulation and inflammation^{3,5}.

Shoulder ROM improved in both groups, but the magnitude of improvement was substantially greater in the experimental group across flexion, extension, abduction, and rotational movements. The progressive handgrip protocol performed at different degrees of shoulder abduction may have enhanced dynamic stability and neuromuscular coordination. Improved humeral head control within the glenoid cavity likely reduced impingement during arm elevation, allowing smoother and less painful movement^{3,12,20}.

Functional ability, assessed using the DASH score, also showed greater reduction in disability in Group A. The DASH outcome measure has demonstrated strong validity and reliability in upper extremity conditions²². This suggests that the improvements were clinically meaningful and translated into better performance of daily activities¹².

Grip strength improved significantly in Group A compared to Group B. The relationship between handgrip strength and rotator cuff muscle strength has been previously established^{11,20}. Hand-held dynamometry is considered a reliable tool for measuring grip and shoulder muscle strength^{19,23}. Enhanced proximal control facilitates efficient force transmission through the kinetic chain, resulting in improved grip performance^{11,12}.

The additional improvements observed in the experimental group can be explained by the principle of neuromuscular irradiation. Strong handgrip contraction may increase neural drive to proximal muscles, particularly the rotator cuff and scapular stabilizers^{12,20}. This neural overflow effect enhances motor unit recruitment, contributing to improved dynamic stabilization and joint mechanics.

Between-group comparison of change scores confirmed statistically and clinically significant superiority of the combined intervention. These findings support the integration of kinetic chain principles into shoulder rehabilitation rather than focusing solely on the symptomatic joint¹².

In conclusion, this study demonstrates that adding handgrip strengthening exercises to conventional physiotherapy significantly enhances outcomes in patients with rotator cuff impingement syndrome. Addressing both distal and proximal components of the upper limb through neuromuscular facilitation appears to optimize pain reduction, mobility, function, and strength^{12,20}.

LIMITATIONS:

Although this randomized controlled trial demonstrated significant improvements with handgrip strengthening exercises in patients with rotator cuff impingement syndrome, certain limitations must be

considered. The sample size was relatively small ($n = 44$), which may limit the generalizability of the findings. Convenience sampling was used, which may introduce selection bias. The intervention period was limited, and no long-term follow-up was conducted to assess the sustainability of improvements. Additionally, some baseline differences were observed between groups (VAS, shoulder abduction, and grip strength), which required change-score analysis. The study relied mainly on clinical outcome measures without advanced objective tools such as EMG or imaging. Future studies with larger samples and longer follow-up are recommended.

SUGGESTIONS:

Future research should include larger sample sizes and multi-center trials to improve generalizability. Long-term follow-up studies are needed to determine whether the benefits of handgrip strengthening are sustained over time. Future studies should also use objective assessment tools such as EMG and imaging to better understand the underlying neuromuscular mechanisms. Additionally, different intensities and progression protocols of handgrip strengthening should be compared to establish optimal rehabilitation guidelines.

SUMMARY:

A randomized controlled trial was conducted to evaluate the effect of handgrip strengthening exercises in patients with rotator cuff impingement syndrome. The study included 44 participants aged 18–50 years who were divided into two groups: conventional physiotherapy alone and conventional physiotherapy combined with handgrip strengthening exercises. Results showed significant improvement in both groups; however, the experimental group demonstrated greater reduction in pain (VAS), marked improvement in shoulder range of motion, significant decrease in DASH score indicating better functional ability, and substantial increase in grip strength. Between-group comparison revealed statistically superior outcomes in the handgrip group ($p < 0.001$). The study suggests that incorporating handgrip strengthening exercises enhances rehabilitation outcomes by improving shoulder stability and neuromuscular activation. Early integration of this technique is recommended to achieve better clinical recovery in patients with rotator cuff impingement syndrome.

CONCLUSION:

This randomized controlled trial demonstrates that adding handgrip strengthening exercises to conventional physiotherapy significantly improves outcomes in patients with rotator cuff impingement syndrome. The experimental group showed greater reduction in pain, improved shoulder range of motion, better functional ability (DASH), and increased grip strength compared to conventional therapy alone ($p < 0.001$). The findings indicate that handgrip strengthening enhances neuromuscular activation and shoulder stability. Therefore, it can be effectively incorporated into routine rehabilitation programs to achieve superior clinical recovery.

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