# Eccentric Exercise Training Combined with Conventional Physiotherapy for Rotator Cuff Tendinopathy Associated with Subacromial Pain: A Randomized Controlled Trial

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**Abstract**

**Background.** Rotator cuff tendinopathy associated with subacromial pain is a common cause of shoulder pain, restricted movement, and reduced muscle performance. Exercise-based rehabilitation is central to conservative management, although the additional benefit of eccentric loading when added to conventional physiotherapy requires further evaluation.

**Objective.** To compare the effects of eccentric exercise training combined with conventional physiotherapy and conventional physiotherapy alone on pain, shoulder range of motion, and muscle strength in adults with rotator cuff tendinopathy associated with subacromial impingement syndrome.

**Methods.** This randomized controlled trial included 52 participants aged 40–60 years, allocated to an experimental group (n=26) and control group (n=26). The experimental group received eccentric exercise training in addition to conventional physiotherapy; the control group received conventional physiotherapy alone. Both interventions were delivered over four weeks. Pain was assessed using the Visual Analogue Scale (VAS), active shoulder range of motion using a universal goniometer, and muscle performance using Manual Muscle Testing (MMT). Within-group changes were assessed using paired t-tests and between-group comparisons using independent-samples t-tests.

Results. Both groups improved in pain, shoulder range of motion, and MMT scores. VAS scores decreased from 7.35±0.83 to 2.00±0.69 in the experimental group and from 7.35±0.83 to 4.15±0.67 in the control group. Flexion increased from 116.38°±9.06° to 167.88°±6.89° in the experimental group and from 113.50°±9.62° to 145.38°±7.82° in the control group. MMT scores increased from 3.23±0.43 to 4.77±0.43 and from 3.15±0.37 to 4.15±0.37, respectively. Between-group comparisons showed statistically significant differences at post-intervention for each measured outcome ($p<0.001$).

**Conclusion.** In this sample, adding eccentric exercise training to conventional physiotherapy was associated with greater short-term improvements in pain, shoulder range of motion, and MMT scores than conventional physiotherapy alone.

**Keywords**: eccentric exercise; rotator cuff tendinopathy; subacromial pain; physiotherapy; shoulder range of motion; muscle strength; randomized controlled trial.

## Introduction

Rotator cuff tendinopathy is a frequent source of shoulder pain and activity limitation. The condition is multifactorial and may involve tendon-related changes, altered loading, age-related factors, and changes in shoulder muscle performance. Symptoms commonly include pain during elevation and overhead activity, reduced shoulder mobility, and difficulty performing occupational and daily tasks [1,2].

The term subacromial impingement syndrome has traditionally been used to describe shoulder pain associated with elevation of the arm. Contemporary approaches increasingly emphasize subacromial or rotator cuff-related shoulder pain as a multifactorial clinical presentation rather than attributing symptoms solely to mechanical compression [1,2]. Clinical assessment therefore considers the symptom pattern, functional limitations, and findings from a cluster of examination procedures rather than relying on a single special test [3].

Exercise-based rehabilitation is a central component of conservative management for rotator cuff-related shoulder pain. Programs commonly include progressive resistance exercise, motor-control training, and exercises directed at the rotator cuff and scapular musculature [11-13]. Eccentric exercise has been investigated as one method of progressively loading the tendon and associated musculature. Early clinical studies reported improvements following eccentric-focused rehabilitation, although the protocols and populations differed across studies [4-6].

Comparative trials have not established that eccentric exercise is universally superior to other appropriately dosed strengthening approaches. Studies comparing eccentric and conventional exercise have reported improvements in both groups, with between-group differences varying by protocol and outcome [8-10]. Current clinical guidance supports individualized active rehabilitation and progressive resistance exercise, without identifying eccentric loading as the only preferred contraction mode [13].

The present trial compared eccentric exercise training combined with conventional physiotherapy against conventional physiotherapy alone in adults with rotator cuff tendinopathy associated with subacromial impingement syndrome. The outcomes were pain intensity, active shoulder range of motion, and shoulder muscle performance.

## Materials and Methods

**Study design and setting**

A two-arm, parallel-group randomized controlled trial was conducted across physiotherapy and tertiary-care clinical settings associated with Malla Reddy University, Hyderabad; MNR Hospital, Sangareddy; P. Rami Reddy Memorial College of Physiotherapy, Kadapa; and Rajiv Gandhi Institute of Medical Sciences, Kadapa, India. The study was conducted over approximately 14 months, including recruitment, intervention, data collection, and analysis. The intervention period for each participant was four weeks.

**Participants**

Fifty-two adults aged 40–60 years with a clinical diagnosis of rotator cuff tendinopathy associated with subacromial impingement syndrome were included. Eligibility required shoulder pain during overhead or functional movements, positive findings on shoulder impingement and rotator cuff clinical tests, symptoms persisting for at least four weeks, willingness to provide informed consent, and availability to attend the prescribed sessions.

Participants were excluded if they had a history of shoulder fracture, dislocation, or surgery; a complete rotator cuff tear requiring surgical management; cervical radiculopathy or another neurological condition affecting upper-limb function; rheumatoid arthritis, adhesive capsulitis, or another systemic inflammatory shoulder disorder; corticosteroid injection to the affected shoulder within the preceding three months; severe glenohumeral osteoarthritis; uncontrolled diabetes or another medical condition likely to interfere with rehabilitation; or inability or unwillingness to complete the intervention and assessments.

**Randomization and group allocation**

The 52 participants were randomly allocated in a 1:1 ratio to the experimental group (Group A; n=26) and control group (Group B; n=26). Group A received eccentric exercise training in addition to conventional physiotherapy, whereas Group B received conventional physiotherapy alone.

**Outcome measures**

Pain intensity was assessed using a 10-cm Visual Analogue Scale, anchored by “no pain” and “worst imaginable pain.” Participants marked the point corresponding to their perceived shoulder pain, and the distance from the zero anchor was recorded [14].

Active shoulder range of motion was measured in degrees using a universal goniometer. Flexion, extension, abduction, external rotation, and internal rotation were assessed using the same measurement approach at baseline and after the four-week intervention. Goniometric measurement is commonly used in clinical shoulder assessment; measurement reliability depends on standardized positioning and examiner technique [15].

Shoulder muscle performance was assessed using Manual Muscle Testing. The recorded muscle groups included shoulder flexors, abductors, internal rotators, and external rotators. MMT grades were documented before and after the intervention. MMT is a clinical ordinal grading method and should not be interpreted as a direct measurement of force; objective dynamometry would provide a more precise strength estimate [16].

Neer impingement, Hawkins-Kennedy, Empty Can, and Drop Arm tests were recorded as part of the clinical screening process where applicable. These tests were considered alongside the participant’s symptoms and clinical assessment rather than as stand-alone diagnostic criteria [3].

**Interventions**

Both groups received supervised physiotherapy for four weeks. The intervention schedule was described as six sessions per week. The experimental group received the conventional physiotherapy program plus a progressive eccentric exercise program targeting the rotator cuff and scapular musculature. The control group received the conventional physiotherapy program alone.

**Experimental group: eccentric exercise plus conventional physiotherapy**

The eccentric program used a controlled lowering phase of approximately 3–5 seconds, with 60 seconds of rest between sets. Exercise-related pain up to 3/10 on the VAS was considered acceptable. Resistance was increased when the participant completed the prescribed repetitions without symptom aggravation.

**Table 1. Progressive eccentric exercise protocol administered to the experimental group.**

| Phase | Exercises and dosage reported in the study |
|---|---|
| Week 1: adaptation | Side-lying eccentric shoulder external rotation, 3×15 repetitions with 0.5–1 kg and a 5-second lowering phase; eccentric Empty Can exercise, 3×12–15 repetitions with light band or 0.5–1 kg; eccentric shoulder abduction, 3×15 repetitions. |
| Week 2: progressive loading | Eccentric external rotation, 3×15 with 1–2 kg and 4–5-second lowering; eccentric scaption, 3×15; eccentric internal rotation with resistance band, 3×15. |

| | |
|---|---|
| Week 3: strength development | High-load slow eccentric external rotation, 4×12 with moderate resistance and 5-second lowering; eccentric scaption, 4×12; prone eccentric horizontal abduction, 3×12. |
| Week 4: functional loading | Progressive eccentric external rotation, 4×10 using the highest tolerated resistance; eccentric abduction from 90° to 0°, 4×10; eccentric overhead control with resistance band, 3×10–12. |

**Control group: conventional physiotherapy**

The conventional program included posterior capsule, sleeper, and pectoralis minor stretching (30-second holds, five repetitions each); pendulum exercises for 3–5 minutes; wand-assisted flexion, abduction, and external rotation (3×10–15); isometric external and internal rotation (10-second holds, 10 contractions); progressive resistance-band external rotation, internal rotation, and shoulder extension (3×12–15); scapular retraction and serratus anterior punch (3×15 each); wall slides (3×10–15); prone Y and T exercises (3×10); chin tucks (10 repetitions with 10-second holds); and thoracic extension mobility exercises (3×15). Participants were advised to avoid repetitive overhead activity and movements that provoked substantial pain.

**Procedure**

After screening and written informed consent, demographic and clinical information was recorded. Baseline VAS, active shoulder range of motion, and MMT assessments were completed before group allocation and intervention. Following four weeks of supervised treatment, the same outcome measures were reassessed. Data were entered into a Microsoft Excel sheet and analyzed using statistical software (SPSS).

**Statistical analysis**

Continuous variables were summarized as means and standard deviations, and categorical variables as frequencies and percentages. Paired t-tests were used for within-group pre- to post-intervention comparisons, and independent-samples t-tests were used for between-group comparisons. Chi-square tests were used for categorical variables. Statistical significance was set at $p<0.05$. Between-group comparisons were performed using post-intervention values.

**Ethical considerations**

The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment.

# Results

The analysis included 52 participants, with 26 in each group. Baseline demographic and clinical characteristics were comparable between groups (Table 2).

**Baseline characteristics**

**Table 2. Baseline demographic and clinical characteristics of the participants.**

| Characteristic | Eccentric + conventional (n=26) | Conventional (n=26) | Between-group p |
|---|---|---|---|
| Age, years | 50.31 ± 5.48 | 50.73 ± 5.48 | 0.781 |
| Male, n (%) | 13 (50.0) | 13 (50.0) | 1.000 |
| Female, n (%) | 13 (50.0) | 13 (50.0) | 1.000 |
| Height, cm | 166.15 ± 6.84 | 166.62 ± 6.84 | 0.804 |
| Weight, kg | 70.62 ± 6.78 | 71.15 ± 7.58 | 0.789 |
| BMI, kg/m² | 25.52 ± 1.14 | 25.55 ± 1.21 | 0.928 |
| Symptom duration, months | 7.50 ± 2.47 | 8.00 ± 2.59 | 0.481 |
| Right shoulder, n (%) | 16 (61.54) | 16 (61.54) | 1.000 |
| Left shoulder, n (%) | 10 (38.46) | 10 (38.46) | 1.000 |

Values are mean ± SD.

**Pain, range of motion, and muscle performance**

**Table 3. Pre- and post-intervention pain, shoulder range of motion, and muscle performance.**

| Outcome | Eccentric + conventional: baseline | Eccentric + conventional: 4 weeks | Conventional: baseline | Conventional: 4 weeks | Between-group p at 4 weeks |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| VAS (0–10) | 7.35 ± 0.83 | 2.00 ± 0.69 | 7.35 ± 0.83 | 4.15 ± 0.67 | <0.001 |
| Flexion (°) | 116.38 ± 9.06 | 167.88 ± 6.89 | 113.50 ± 9.62 | 145.38 ± 7.82 | <0.001 |
| Extension (°) | 35.27 ± 4.37 | 55.00 ± 4.14 | 33.46 ± 4.42 | 46.23 ± 5.08 | <0.001 |
| Abduction (°) | 100.00 ± 8.87 | 163.12 ± 7.59 | 98.12 ± 9.48 | 138.88 ± 7.85 | <0.001 |
| External rotation (°) | 49.04 ± 5.85 | 82.00 ± 4.86 | 47.00 ± 6.05 | 67.00 ± 5.87 | <0.001 |
| Internal rotation (°) | 53.35 ± 5.33 | 83.65 ± 4.71 | 51.81 ± 5.71 | 69.58 ± 5.84 | <0.001 |
| MMT grade | 3.23 ± 0.43 | 4.77 ± 0.43 | 3.15 ± 0.37 | 4.15 ± 0.37 | <0.001 |

Within-group comparisons showed statistically significant improvements in all outcomes in both groups ($p<0.001$). Post-intervention between-group comparisons favored the eccentric exercise group for pain, all five shoulder range-of-motion directions, and MMT grade ($p<0.001$ for each comparison). The reported post-intervention mean VAS score was 2.15 points lower in the experimental group than in the control group. The corresponding between-group differences in post-intervention means were 22.50° for flexion, 8.77° for extension, 24.24° for abduction, 15.00° for external rotation, 14.07° for internal rotation, and 0.62 MMT grade points.

Values are presented as mean ± SD. Within-group comparisons were statistically significant for all outcomes in both groups ($p<0.001$). Between-group p values refer to post-intervention comparisons.

# Discussion

This randomized controlled trial compared eccentric exercise training combined with conventional physiotherapy against conventional physiotherapy alone in adults with rotator cuff tendinopathy associated with subacromial impingement syndrome. Both groups demonstrated improvement after four weeks. The reported post-intervention comparisons favored the combined intervention for pain, shoulder range of motion, and MMT grade.

**Pain**

Mean VAS scores decreased in both groups, with a larger reduction reported in the group receiving eccentric exercise in addition to conventional physiotherapy. This finding is consistent with clinical studies in which exercise-based rehabilitation, including eccentric-focused loading, was associated with reduced pain in people with subacromial or rotator cuff-related shoulder pain [4-7]. However, the evidence does not establish that eccentric contractions are consistently superior to other forms of progressive resistance exercise. Randomized comparisons have reported benefits from both eccentric and conventional strengthening approaches, with differences depending on the intervention and study population [8-10].

**Shoulder range of motion**

Improvements were reported in flexion, extension, abduction, external rotation, and internal rotation in both groups, with greater post-intervention means in the experimental group. Reduced pain and guarding may have contributed to increased active movement. Progressive exercise targeting the rotator cuff and scapular musculature may also have improved participants' capacity to control the arm during elevation and rotation. Exercise-based rehabilitation is supported in current evidence syntheses and clinical guidance for subacromial shoulder pain [11-13].

The magnitude of the reported changes, particularly the post-intervention flexion and abduction values, should be interpreted with consideration of measurement procedures. Goniometric measurements are influenced by positioning, stabilization, examiner technique, and whether active or passive range was assessed. Standardized procedures and assessor reliability are important when interpreting changes over time [15].

**Muscle performance**

MMT scores increased in both groups, with a larger mean increase in the eccentric exercise group. The intervention included progressive loading of external rotation, scaption, abduction, and internal rotation, which may have contributed to improved performance during manual resistance testing. Nevertheless, MMT is an ordinal clinical grading system and has limited ability to quantify small changes in force, particularly when grades approach the upper end of the scale. The strength findings should therefore be interpreted as changes in clinical muscle-test grades rather than precise changes in muscle force [16].

**Clinical interpretation**

The results suggest that adding a structured eccentric exercise component to conventional physiotherapy may provide additional short-term benefit in this sample. This interpretation is consistent with the broader recommendation to use individualized, progressive exercise as a central component of rotator cuff-related shoulder rehabilitation [11-13]. The findings do not establish that eccentric loading should replace other resistance-training approaches or that the observed benefits persist beyond the four-week intervention.

**Strengths and limitations**

The study included two intervention groups, a defined four-week treatment period, and assessment of pain, five directions of shoulder range of motion, and muscle performance. The inclusion of multiple clinical settings may broaden the range of participants represented.

Several limitations affect interpretation. The sample comprised 52 participants and the intervention lasted four weeks, with no longer-term follow-up. Functional disability and patient-reported activity outcomes were not measured. Muscle performance was assessed using MMT rather than dynamometry.

# Conclusion

In adults with rotator cuff tendinopathy associated with subacromial impingement syndrome, both conventional physiotherapy and eccentric exercise training combined with conventional physiotherapy were associated with improvements in pain, shoulder range of motion, and MMT scores over four weeks. The reported post-intervention comparisons favored the combined eccentric exercise intervention across all measured outcomes. These findings support further evaluation of eccentric loading as an adjunct to conventional physiotherapy.

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