

Review Article

The integration and sequencing of scapular-focused and eccentric exercises in shoulder rehabilitation: a scoping review of combined protocols for RCRSP

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ABSTRACT

Rotator cuff related shoulder pain is a common musculoskeletal condition associated with pain, decreased shoulder function, and impaired quality of life. Eccentric exercise and scapula focused rehabilitation are frequently prescribed. However, their optimal integration and sequencing remain unexplored.

Evidence Acquisition: Systematic searches of PubMed, Scopus, Web of Science, CINAHL and PEDro (2015-2025) identified randomized controlled trials investigating eccentric exercise, scapular stabilization or combined rehabilitation approaches in individuals with RCRSP. Data were extracted on study characteristics, intervention protocols, outcome measures and key findings. Eight studies met the inclusion criteria, including randomized controlled trials and pilot randomized studies. Eccentric exercise interventions demonstrated improvements in pain, strength, tendon-related outcomes, and functional recovery. Scapular-focused programs showed significant benefits in pain reduction, shoulder function, neuromuscular control, scapular alignment, and movement mechanics. Multimodal approaches combining exercise with adjunct therapies also reported positive clinical outcomes. However, no included study explicitly investigated the combined sequencing of scapular stabilization and eccentric exercise within a single rehabilitation framework. Most studies evaluated these interventions in isolation or as comparative protocols. Both eccentric exercise and scapular-focused rehabilitation are effective in managing RCRSP. However, evidence regarding their optimal integration and sequencing is lacking. A biomechanically informed progression in which scapular stabilization precedes eccentric strengthening may be clinically reasonable, but this hypothesis requires confirmation through high-quality randomized controlled trials.

Keywords: Eccentric exercise, Rehabilitation, Rotator cuff injuries, Rotator cuff-related shoulder pain, rotator cuff tendinopathy, Scapular stabilization, Shoulder pain

INTRODUCTION

Shoulder pain is the third most common musculoskeletal condition experienced by 7% to 26% of the general causing significant pain and functional limitation in adults with women reporting it frequently than men.^{1,2} Among these, rotator cuff-related shoulder pain (RCRSP) account for 70% of shoulder pain cases.²

RCRSP comprises a spectrum of shoulder conditions including: subacromial pain (impingement) syndrome, rotator cuff tendinopathy, and symptomatic partial and full-thickness rotator cuff tears.³ RCRSP involves factors like age, loading history, biomechanics, psychology and overall health with symptoms including anterolateral shoulder pain, restricted abduction and rotation, and diminished strength that impacts function.⁴ The scapula provides a stable base for glenohumeral motion however

abnormal posture and movement (scapular dyskinesis), reduces subacromial clearance during elevation, disrupts scapulohumeral rhythm, and increases mechanical stress on the rotator cuff.⁵

Due to this biomechanical relationship, rehabilitation including scapular-focused interventions has shown benefits for RCRSP.⁶ In addition rotator cuff muscle strengthening is an important part in the conservative management of rotator cuff pathologies.^{7,8} Among various strengthening approaches eccentric training has been proven to be an effective treatment in terms of symptom reduction and improved function particularly in tendon-related pathologies due to its potential to stimulate tendon remodeling and improve load tolerance.^{8,9}

Despite the growing evidence supporting both scapular stabilization and eccentric strengthening exercises, the optimal integration and sequencing of these interventions during shoulder rehabilitation remain unclear. Therefore, the purpose of this scoping review is to map the available evidence regarding the integration and sequencing of scapular stabilization and eccentric strengthening exercises in the rehabilitation of RCRSP, and to identify evidence-based strategies that may guide clinical practice.

METHODS

Study design

This scoping review was conducted to map the existing literature on the integration and sequencing of scapular-focused and eccentric exercises in the rehabilitation of rotator cuff-related shoulder pain (RCRSP). The review followed the methodological framework proposed by Hilary Arksey and Lisa O'Malley, which includes five stages: identifying the research question, identifying relevant studies, study selection, charting the data, and collating, summarizing, and reporting the results. The reporting of this review adhered to the recommendations of the PRISMA-ScR checklist.

Research question

The research question guiding this review was: "What evidence exists regarding the integration and sequencing of scapular-focused and eccentric exercises in the rehabilitation of rotator cuff-related shoulder pain?"

Eligibility criteria

The eligibility criteria for study selection were developed using the Population–Concept–Context (PCC) framework recommended by the Joanna Briggs Institute.

Population

Studies involving participants diagnosed with rotator cuff-related shoulder pain, rotator cuff tendinopathy, partial

rotator cuff tears, or subacromial pain syndrome were included.

Concept

Studies that investigated scapular-focused exercises, eccentric strengthening exercises, or rehabilitation programs that integrated this exercise approaches were considered eligible. Context: Studies conducted in physiotherapy, sports rehabilitation, orthopedic clinics, or community rehabilitation settings were included.

Inclusion criteria

Studies were included if they investigated exercise-based rehabilitation for rotator cuff-related shoulder pain, included scapular stabilization or eccentric exercise interventions, were randomized controlled trials, quasi-experimental studies, cohort studies, or clinical trials, reported outcomes such as pain, shoulder function, strength, or range of motion, were published in peer-reviewed journals in English. Exclusion Criteria: Studies were excluded if they: Focused on post-operative shoulder rehabilitation, involved shoulder fractures, instability, or neurological disorders, were conference abstracts, editorials, commentaries, or narrative opinions, did not include exercise-based interventions

Literature search strategy

A comprehensive literature search was conducted in the following electronic databases: PubMed, Scopus, Web of Science, CINAHL, PEDro. The search strategy combines Medical Subject Headings (MeSH) and free-text keywords related to rotator cuff disorders, scapular exercises, and eccentric training. Boolean operators such as AND and OR were used to combine search terms. The search included keywords such as rotator cuff, rotator cuff-related shoulder pain, shoulder impingement, scapular stabilization, scapular exercises, eccentric exercise, and eccentric training.

Study selection

All identified studies were imported into reference management software, and duplicate records were removed. The study selection process was performed in two stages. First, titles and abstracts were screened to identify potentially relevant studies. Second, full-text articles of eligible studies were assessed according to the predefined inclusion and exclusion criteria. The screening process was conducted independently by two reviewers. Any disagreements were resolved through discussion until consensus was reached. The study selection process was documented using a PRISMA flow diagram.

RESULTS

Table 1 outlines the methodological and demographic profiles of 8 included studies published between 2017 and

2025, comprising randomized controlled trials and one pilot study conducted across multiple countries like Spain, Egypt, Netherlands, Brazil, China, USA, Mexico. Sample sizes ranged from 26 to 105 participants with various rotator cuff-related disorders. Interventions involved are

eccentric exercises, scapular stabilization, or their comparison with general or conventional or concentric exercises, with one study including invasive techniques. Duration of the interventions ranged from 4 to 12 weeks, with follow up periods up to 6 months.

Table 1: Study characteristics.

Author	Country	Study design	Sample size	Population	Intervention type	Duration
Jorge Gongora-Rodriguez et al¹⁵	Spain	Single blinded RCT	50	Adults (18–65 yrs) with supraspinatus tendinopathy	Electrolysis + PNS + eccentric exercise Vs TENS + US + Eccentric exercises	4 weeks intervention + follow-up at 4, 12, 24 weeks
Mina Magdy Wahba et al¹³	Egypt	Randomized comparative study	40	Patients with rheumatoid arthritis + rotator cuff tendinopathy	Eccentric vs concentric exercise	4 weeks
Beate Dejaco et al⁸	Netherlands	Single-blinded RCT	36	Individuals with Rotator cuff tendinopathy	Isolated Eccentric vs conventional exercise	12 weeks + follow-up (6, 12, 26 weeks)
Ibrahim Metwally Dewir et al¹⁹	Egypt	Triple blinded RCT	105	Individuals with Subacromial impingement syndrome ((Neer stage I & II))	Rigid taping vs scapular stabilizing exercises	6 weeks + 3-month follow-up
Cristina dos Santos et al⁶	Brazil	Randomized clinical trial	60	Individuals with Rotator cuff-related pain syndrome.	Scapular-focused exercise ± EMG biofeedback	6 weeks
Lan Tang et al²⁰	China	Randomized clinical trial	90	Patients with shoulder pain	Scapular stabilization vs conventional	6 weeks with 6 weeks follow-up
Eric J. Chaconas et al¹²	USA	Randomized controlled trial	48	Patients with Subacromial pain syndrome	Eccentric external rotator training vs general exercise	6 weeks & 6 month follow up
Salvador Israel Macias-Hernandez et al¹⁴	Mexico	Pilot randomized controlled study	26	Patients with Partial rotator cuff tear.	Eccentric strengthening vs concentric muscle strengthening	4 weeks

Table 2 shows the specific rehabilitation protocols including their dosing frequencies used in clinical trials.

The studies show variability in intervention design comprises of isolated eccentric exercise regimens and multitargeted scapular stabilization programs.

Table 2: Overview of eccentric strengthening and scapular stabilization interventions.

Author	Type of intervention	Components	Frequency	Duration
Jorge Gongora-Rodriguez et al¹⁵	Combined therapy	Percutaneous Electrolysis (PE) Percutaneous Peripheral Nerve Stimulation (PNS) Eccentric Exercise (EE)	PE & PNS: 1/week. Eccentric exercise: 2/day	4 weeks

Continued.

Author	Type of intervention	Components	Frequency	Duration
Mina Magdy Wahba et al¹³	Eccentric vs concentric exercise	Stretching (pectoralis minor + posterior capsule) Strengthening (IR/ER + abduction) Concentric OR Eccentric loading	3/week	12 sessions 4 weeks
Beate Dejaco et al⁸	Exercise based rehabilitation (Eccentric vs conventional)	EE group: 2 eccentric exercises, stretching CG group: Multiple strengthening exercises (concentric + eccentric), Stretching	Daily home program + supervised sessions EE: 2/day, CG: 1/day	12 weeks
Ibrahim Metwally Dewir et al¹⁹	Multimodal rehabilitation including Scapular stabilization	Stretching exercises (all groups) Strengthening exercises (all groups) Rigid scapular taping (RTG) Scapular stabilizing exercises (SSEG)	3/week	6 weeks
Cristina dos Santos et al⁶	Scapular-focused exercise	Scapular-focused exercise protocol EMG biofeedback (in one group) Control: manual therapy + shoulder rotation strengthening	Weekly sessions divided into 3 phases	6 weeks
Lan Tang et al²⁰	Scapular stabilization rehabilitation	Scapular stabilization group: Type I: PM stretching + serratus anterior strengthening + middle & lower trapezius strengthening Type II: Teres major stretching + serratus anterior + MT & LT + rhomboids strengthening Type III: PM stretching + upper trapezius stretching + levator scapulae stretching + MT & LT strengthening Control group: Pendulum exercises, Wall climbing, Stick exercises	Once daily	6 weeks
Eric J. Chaconas et al¹²	Eccentric strengthening program	Experimental: Eccentric external, rotator training, Scapular retraction exercises, Posterior shoulder stretching Control group: Active flexion, Abduction, Scapular retraction, Posterior stretching	4 supervised sessions over 6 weeks	6 weeks
Salvador Israel Macias-Hernandez et al¹⁴	eccentric vs. concentric muscle strengthening.	Experimental: Eccentric strengthening + standard physiotherapy (moist heat, massage, ROM, stretching) Control group: Concentric strengthening + same standard physiotherapy	5/week	4 weeks + home program up to 12 months

Eccentric exercise interventions

The 5 studies evaluated eccentric-based interventions, either in isolation or compared with conventional exercise or concentric exercises. These interventions commonly incorporated stretching and strengthening components and performed either daily or multiple times per week. Eccentric training significantly improved pain, muscle strength, tolerance and functional outcomes. Several studies also showed the superiority of eccentric exercise over concentric or general exercise for improving tendon healing, strength, and early functional recovery.

Scapular stabilization interventions

The 3 studies investigated scapular focused rehabilitation programs which emphasizing muscle activation, postural correction and neuromuscular control. These interventions were commonly performed over 6 weeks with structured progression. Scapular stabilization exercises showed significant improvements in pain, shoulder function, scapular alignment, and neuromuscular control. Additional benefits included improved muscle activation timing and reduction in scapular dyskinesis.

Multimodal and combined interventions

The 2 studies implemented multimodal approaches involving exercise with adjunct therapies such as electrolysis, peripheral nerve stimulation, Rigid taping, or biofeedback. These interventions proved enhanced clinical outcomes, including improved tendon structure, pain reduction, and overall functional recovery. Combined approaches showed greater overall effectiveness when compared to isolated interventions, particularly for promoting tendon healing and long-term improvements.

Outcome measures across studies

Table 3 outlines the clinical outcome domains and measurement tools evaluated across the studies. Pain

intensity and shoulder function are the primary endpoints across all eight trials, assessed using standard tools like Visual Analogue Scale (VAS), Numerical Pain Rating Scale (NPRS), Shoulder Pain and Disability Index (SPADI), Disability of the Arm Shoulder and Hand (DASH), Constant Murley Score (CMS). Biomechanical and structural changes are also assessed using handheld dynamometry for rotator cuff strength, goniometry for ROM and Ultrasound for muscle architecture and tendon thickness. Highly specialized assessments for investigating scapular stabilization are used in the trials like surface EMG for muscle activation timing, Lateral scapular sliding Test as well as Kinetic chain alterations are also assessed with tools like pectoralis Minor Index (PMI).

Table 3: Outcome measures and assessment tools.

Author	Outcome domains	Measurement tools
Jorge Gongora-Rodriguez et al¹⁵	Pain	NPRS (pain)
	Rotator cuff muscle strength	Portable Handheld dynamometer (Strength)
	Electromyographic activity	EMG (mDurance® device (muscle activity))
	Tendon structure (echogenicity, thickness and vascularization)	Ultrasound Mindray® DP30 (tendon structure)
	Shoulder function.	DASH and SPADI (function)
Mina Magdy Wahba et al¹³	Pain	SPADI (function)
	Function	VAS (pain)
	Tendon structure (Supraspinatus, Subscapularis)	MSUS (thickness, echo pixels)
	Disease activity	DAS-28-ESR (disease activity)
Beate Dejaco et al⁸	Pain	Constant-Murley Score (CM)
	Shoulder Function	VAS
	Range of Motion (ROM)	Goniometer (ROM)
	Strength	Handheld dynamometer (strength)
Ibrahim Metwally Dewir et al¹⁹	Pain	Visual Analog Scale (VAS)
	Functional disability	Shoulder Pain and Disability Index (SPADI)
Cristina dos Santos et al⁶	Pain	SPADI
	Function	NPRS
	Neuromuscular control	DASH
	Muscle activation timing	Surface EMG
	Scapular alignment	Clinical observation (scapular dyskinesis)
	ROM	Goniometer (ROM)
	Strength	Manual muscle testing
Lan Tang et al²⁰	Function	Constant-Murley Score (CMS)
	Pain	Numerical Rating Scale (NRS)
	ROM	Electronic goniometer (ROM)
	Scapular dyskinesis	Visual observation & palpation (SD type)
	Scapular stability	Lateral Scapular Sliding Test (LSST)
	Muscle tightness	Pectoralis Minor Index (PMI)
	Patient satisfaction	Scapular Index (SI)
		Satisfaction scale
Eric J. Chaconas et al¹²	Strength	Western Ontario Rotator Cuff Index (WORC)
	Pain	Numeric Pain Rating Scale (NPRS)
	ROM	Handheld dynamometer (strength)
	Functional performance	Goniometer (AROM)
		Upper Quarter Y Balance Test (UQYBT)

Continued.

Author	Outcome domains	Measurement tools
		Global Rating of Change (GROC)
Salvador Israel Macias-Hernandez et al¹⁴	Pain	Visual Analogue Scale (VAS)
	Function	Constant-Murley Scale
	Strength	Hand-held dynamometer
	Structure	
	Tolerance and compliance	

Table 4 explains the primary clinical findings and statistically significant outcomes across the included studies which gives a clear therapeutic trend for both mechanical frameworks. In all trials investigating tissue loading eccentric exercise shows superior clinical efficacy over concentric training and conventional models, demonstrating early improvements in rotator cuff strength, tendon healing, and functional performance. Similarly

targeted scapular stabilization exercise achieved better therapeutic outcomes compared to traditional rehabilitation methods while providing long lasting pain relief and functional improvements than rigid taping alone. In addition, the integration of these protocols yields notable biomechanical corrections, indicated by improvements in neuromuscular control, scapular alignment and the correction of scapular dyskinesis.

Table 4: Summary of key findings and significant outcomes across included studies.

Author	Intervention type	Key findings	Significant improvements
Jorge Gongora-Rodriguez et al¹⁵	Combined therapy	Combined approach with PE, PNS and EE improved tendon healing and functional recovery and it is an effective option in the clinical management of tendinopathies.	Significant reduction in pain, improved tendon structure, enhanced shoulder function
Mina Magdy Wahba et al¹³	Eccentric vs concentric	Eccentric exercises showed superior outcomes compared to concentric training.	Significant improvements in pain reduction, reduction in SPADI, and in eccentric group
Beate Dejaco et al⁸	Eccentric exercise vs Conventional exercise	The isolated eccentric training programme of the RC is beneficial for improving pain and function. Performing two eccentric exercises twice a day is as effective as performing six concentric/eccentric exercises once a day in patients with RC tendinopathy.	Significant improvement in pain and functional scores (CM score↑, VAS↓)
Ibrahim Metwally Dewir et al¹⁹	Scapular stabilization vs Rigid taping	Both Scapular stabilization exercise and rigid taping significantly improve pain and function. Scapular exercises yield a longer effect than taping.	Significant improvement in pain reduction and functional ability
Cristina dos Santos et al⁶	Scapular-focused exercise	Targeted scapular protocol improved symptoms and function	Pain & function improved significantly, Neuromuscular control (SSNC) & Scapular alignment also got improved.
Lan Tang et al²⁰	Scapular stabilization	Targeted Scapular stabilization exercise is superior to conventional therapy	Significant improvements in shoulder pain & function. CMS ↑, NRS↓, and significant improvement in LSST, PMI, SI, Scapular dyskinesis
Eric J. Chaconas et al¹²	Eccentric training	Eccentric external rotator training improved outcomes and is superior to general exercises	Significant improvements in strength, shoulder function and pain reduction.
Salvador Israel Macias-Hernandez et al¹⁴	Eccentric vs. concentric muscle strengthening	Both eccentric and concentric strengthening are effective and are well tolerated. Eccentric training showed greater early improvements in functionality, strength, and tendon healing compared to concentric training.	Significant improvements in pain, function, strength, and tendon structure and high tolerance.

DISCUSSION

The present scoping review synthesized current evidence of scapular stabilization and eccentric exercise in the management of RCRSP with particularly focus on their integration and sequencing. The findings indicate that both approaches are very effective in improving pain, strength, function and shoulder biomechanics. However, the evidence is mainly derived from studies on these interventions in isolation or as comparing with other approaches with no study clearly examining their combined sequencing within a structured rehabilitation protocol.

Eccentric exercise

Eccentric exercise showed consistent effectiveness across many studies, specifically in improving pain, muscle strength and tendon related outcomes. The role of eccentric loading in promoting tendon remodeling, enhancing tensile strength and facilitating mechanotransduction, all are contributing to these findings.^{10,11} Some studies demonstrated the superiority of eccentric training when compared to concentric training or general exercise, suggesting its importance in later stages of rehabilitation when the tissue loading becomes vital.

The study by Eric J chaconas et al demonstrated that external rotator eccentric training was superior to general exercise and showed greater improvements in shoulder functions, pain reduction and rotator cuff strength in both short term and long term follow up.¹² Similarly, Beate Dejado et al found that isolated eccentric program was effective as a conventional mixed exercise program for improving pain and functional outcomes, suggesting that simplified eccentric approach is clinically effective.⁸

Some comparative studies further supported the superiority of eccentric loading. Mina Magdy Wahba et al revealed that eccentric exercise resulted in greater reduction in pain and disability (SPADI Scores) compared to concentric training.¹³ In the same way Mecias Hernandez et al reported that even though both eccentric and concentric strengthening are effective and well tolerated, eccentric training showed greater early improvements in strength, function, and tendon healing.¹⁴ In a multimodal approach Gongora Rodriguez et al included eccentric exercise along with invasive therapies and found a significant improvement in pain, functional outcomes, and tendon structure which all indicating that eccentric loading plays a critical role even in combined rehabilitation strategies.¹⁵

Scapular stabilization exercise

Scapular stabilization exercises are mainly focused on neuromuscular control, muscle activation patterns and postural alignments.^{16,17} This intervention demonstrated a significant improvement in pain, functional outcomes and shoulder biomechanics. Reduction in Scapular dyskinesis

and improvements in the shoulder kinematics observed in many studies underlines the importance of proximal stability for optimal shoulder functions. Similarly, scapula plays an important role in maintaining scapulohumeral rhythm and provide a stable base for upper limb movements.^{17,18} All these findings support the inclusion of scapular stabilization exercise in shoulder rehabilitation protocols.

Ibrahim Metwally Dewir et al found that scapular stabilization exercises significantly improved pain and functional ability in individuals with subacromial impingement syndrome with long lasting effects compared with rigid taping.¹⁹ Likewise, Lan Tang et al showed that targeted scapular stabilization programs were superior to conventional exercise and also leading to significant improvements in shoulder pain, function, and scapular stability, along with reduction in scapular dyskinesis.²⁰

Moreover, Dos Santos et al demonstrated that scapular focused exercise program improved pain, functional outcomes, neuromuscular control, and scapular alignment. The inclusion of EMG biofeedback further enhanced muscle activation patterns, indicating the importance of motor control in scapular rehabilitation.⁶

Integrated approach

Despite the proven evidences on the effectiveness of both approaches the analysis showed a lack of clear evidences regarding their integration and sequencing which limiting the ability to determine how these approaches should be optimally combined in clinical practice. Rehabilitation models proposed by Ann M Cools, w Ben Kibler and Jeremy S Lewis are mainly focused on the importance of restoring scapular motor control before rotator cuff strengthening.²¹⁻²⁴ It is based on the concept that optimal scapular positioning is essential for maintaining subacromial space and reducing mechanical stress on the rotator cuff tendons.

From a biomechanical point of view a logical sequencing approach can be proposed. Scapular stabilization may serve as a base by restoring neuromuscular control, improving scapular alignment as well as optimizing force coupling around the shoulder complex.¹⁶ Inadequate scapular control during eccentric loading results in altered biomechanics, inappropriate force transmission and increased pressure on rotator cuff tendons.²⁵ Therefore, initiating the shoulder rehabilitation with scapular focused exercises followed by progressive eccentric strengthening may yield improved overall outcomes. This proposed proximal to distal progression is following the established principles of kinetic chain concepts where stability and motor control precede high load strengthening.²⁶

The findings of this review revealed an important gap in the literature. While most of the articles supporting the positive effects of both eccentric exercise and scapular stabilization exercise individually in the rehabilitation of

RCRSP there is no sufficient evidence to determine the optimal sequencing strategy. Future research should focus on well-designed randomized control trials to optimize rehabilitation outcomes.

Limitations

This scoping review has some limitations that should be considered while interpreting the findings. First, the studies included shows heterogeneity regarding the study design, population characteristics, intervention protocols and outcome measures which limits the direct comparison across studies. Second, most studies investigated eccentric exercise and scapular stabilization as isolated or comparative approaches and no study investigating their integrated sequencing. Therefore, no conclusions can be drawn about the optimal sequence.

CONCLUSION

Both eccentric and scapular-focused rehabilitation are effective for improving pain, shoulder function, strength and movement mechanics in individuals with rotator cuff-related shoulder pain. However, no included study examined their combined use, so no definitive recommendation on sequencing can be made. A progression in which scapular stabilization precedes eccentric strengthening is biomechanically plausible, but it requires validation through high-quality randomized controlled trials.

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