

# Role And Outcomes of Conservative Treatment in Management of Rotator Cuff Tears: A Systematic Review of Randomised Controlled Trials

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## Abstract

Rotator cuff tears are known to result in significant societal burden. This review synthesises the evidence regarding the role and outcomes of conservatively managed rotator cuff tears. 17 prospective randomised controlled trials (RCTs) (Level 1 and 2 studies) were included in this systematic review. Modalities which were studied were classified into physical rehabilitative modalities, electrophysiological rehabilitative modalities, biological therapies, and pharmacologic therapies. Outcomes which were evaluated in the included RCTs comprised of clinical outcomes, functional outcomes, pain scores, quality of life scores, imaging based outcomes, and patient satisfaction scores. As the modalities and outcomes studied were varied, no quantitative analysis could be performed based on the primary data available. Nevertheless, most studies do suggest that conservative treatment remains beneficial for the management of rotator cuff tears. Based on these findings, an algorithm which proposes conservative therapy as the central mode of management for rotator cuff tear patients has been described. More high-quality studies are required in this area of study to allow for a quantitative review (meta-analysis and meta-regression) of the various non-surgical treatment modalities of rotator cuff tears.

**Keywords:** Rotator Cuff Tears; Conservative; Non-operative; Management; Randomised controlled trials; Review.

## Introduction

Rotator cuff tears are one of the most common shoulder disorders treated by orthopaedic surgeons, responsible in up to 85% of patients who present with shoulder pain [1]. Primarily a degenerative condition, it has a reported prevalence of around 10% in patients aged 50 to 59 years old, increasing to up to 80% in patients 80 and older [2–4]. Of these patients, up to two-thirds become symptomatic [2], resulting in pain and functional limitation. Moreover, unlike other degenerative conditions that predominantly affect older patients, societal burden of rotator cuff tears are significant, since more than two-thirds of such patients present during working age [5], especially in manual labourers [6].

Rotator cuff tears have a wide spectrum of severity, ranging from partial thickness tears of a single tendon to massive tears of two or more elements of the rotator cuff which can be treated operatively or nonoperatively [7, 8]. While surgical repair is widely accepted as the standard of care for acute or acute-on-chronic traumatic tears [9, 10], the management of chronic tears remains controversial [11]. Proponents of surgical repair in these patients have often cited benefits of a reduced risk of tear progression [12], reduced cost burden and recovery time [5] and with improvements that persist in the long-term [13]. However, unlike acute tears, chronic tears usually lead to fatty infiltration and rotator cuff atrophy, which have been found to be poorly

amenable to surgical repair and lead to poorer outcomes [14, 15]. Conversely, nonoperative therapies, primarily involving physical therapy and nonsteroidal anti-inflammatory drugs (NSAIDs), have been found to be effective in up to 75% of patients [16]. Systematic reviews evaluating outcomes between operative and nonoperative treatment have generally revealed mixed results, with some reviews failing to demonstrate a clear benefit to surgery [7, 17], while others have suggested surgery may be more effective than conservative treatment [18, 19] with a caveat of insufficient evidence.

Hence, the current literature recommends for rotator cuff tears to be managed with analgesia and physical therapy for a period before considering surgery. Despite increasing rates of shoulder surgery [20], less than 1 in 4 patients with rotator cuff tears eventually elect to undergo surgery [16]. Consequently, there is a need for effective adjuncts to physical therapy alone, especially for patients who are precluded from surgery due to personal, cost, or medical reasons. Recently, advances in technology in non-invasive therapies, such as the use of biologic therapies [21] and electrophysiological rehabilitation, have provided a greater diversity of nonsurgical options to patients.

This aim of this article is to summarize the various nonoperative modalities that can be offered to patients with atraumatic rotator cuff tears, and to evaluate how they compare with operative management.

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Submitted: 05 April 2021; Reviewed: 28 April 2021; Accepted: 10 May 2021; Published: 10 June 2021

Asian Journal of Arthroscopy | ISSN 2456-1169 | Available on [www.asianarthroscopy.com](http://www.asianarthroscopy.com) | DOI:10.13107/aja.2021.v06i01.024 |

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## Methodology

A systematic review was performed, identifying articles from PubMed and Embase. The following MeSH term was used to identify titles, abstracts and keywords relevant to the review: 'rotator cuff' AND ('treatment' OR 'therapy' OR 'management') AND 'trial'. Only articles from 1<sup>st</sup> January 2010 till the date of search (15<sup>th</sup> August 2020) were included.

All articles studying the outcomes of conservatively managed rotator cuff tears in the form of a prospective randomised controlled trial (RCT) were included in this review. Studies which were not related to this topic, not published in English, included other rotator cuff lesions in the analysis other than rotator cuff tears, or had no discussion on conservative treatment for rotator cuff tears were excluded from the study. Review articles, case reports, non-RCTs, basic science studies, animal studies and cadaveric studies were also excluded from this review. The elimination of studies were performed in a systematic fashion by a single author. The characteristics and findings from included studies were synthesised thereafter in the form of tables.

## Results

A total of 1172 articles were identified from the databases. After the removal of 259 duplicates, 913 articles remained for screening and elimination based on the exclusion criteria described above. 816 articles were eliminated based on the screening of titles. A further 70 articles were removed based on the screening of abstracts. After screening of full texts, 17 prospective randomised controlled trials were included within this review [22–37]. A summary of the elimination process can be found in Figure 1. The cumulative outcome of 1117 shoulders were included in the review.

Out of the 17 studies, 4 studies only included patients with full thickness rotator cuff tears. 4 studies focused on comparing the outcomes of conservatively managed and surgically managed rotator cuff tears revealing inconclusive results overall. Other studies compared the outcomes of various modalities, which can be classified into physical rehabilitative modalities (physiotherapy, occupational therapy and home based therapy), electrophysiological rehabilitative modalities (eg. Transcutaneous Electrical Nerve Stimulation (TENS) and Microcurrent Electrical Nerve Stimulation (MENS)), biologic therapies (PRP, BMAC and corticosteroids) and pharmacologic therapies (eg. injectable corticosteroids). A summary of study

characteristics and modalities studied can be found in Table 1. A variety of outcome variables were studied, mainly comprising of clinical outcomes (eg. active shoulder range of motion (ROM) and power), functional outcomes (eg. ASES, Constant and WORC scores), pain scores (eg. VSA score), quality of life scores (eg. SF-36 and EQ-5D scores), imaging based outcomes (utilising either ultrasound, MRI or MR arthrograms to assess tear recovery, progress and/or re-tear rates) as well as patient satisfaction scores. A summary of outcome variables assessed and study findings can be found in Table 2.

## Discussion

The spectrum of options for the non-surgical management of rotator cuff tears is wide. This systematic review has synthesised the evidence regarding non-surgical options studied in prospective randomised controlled trials. From these findings, we propose a treatment algorithm for rotator cuff tears, which we will describe below.

The majority of studies included within this review only studied partial rotator cuff tears. When surgical management was compared with non-surgical management for partial rotator cuff tears, there were conflicting conclusions on the differences in outcomes of both groups. Kukkonen et al [35] and Ranebo et al [32] revealed that there was no significant difference in functional outcomes and pain scores in both groups. However, Moosmayer et al [33] revealed that at 10 years follow-up, there was a difference in functional outcomes and pain scores for patients who underwent primary tendon repair when compared to patients who underwent physiotherapy with optional secondary repair. When surgical management was compared to non-surgical management of full thickness rotator cuff tears, there was some evidence that functional outcomes were superior for the surgical group as well. This review thus suggests that surgical treatment can be considered for rotator cuff tears. However, non-surgical management should always be considered as the primary and initial modality of treatment for rotator cuff tears, especially partial tears. For partial rotator cuff tears, surgery should only be considered when there is evidence of failure of non-surgical treatment.

## Indications for non-surgical treatment

Most, if not all, patients with suspected rotator cuff tears will receive a trial non-surgical treatment in the prelude to surgery, while the imaging is done to confirm the diagnosis. However, the conservative non-surgical treatment remains a trial, and is not the definitive treatment. Are there patients in whom the definitive treatment of choice is non-surgical? In our opinion, these patients can fall into one of these categories:

### 1. Patients who are not keen on surgery

Various reasons abound, patients may refuse surgery due to ignorance of the procedure, bias, fear and misunderstanding, and the costs of the surgery may be prohibitive.

### 2. Patients who are not fit for surgery

Patients requiring cuff surgery tend to be frail elderly individuals with pre-existing co-morbidities such as diabetes mellitus, ischemic heart disease and rheumatoid arthritis. Those who are ASA II and above and who are obese (BMI >35) are at risk. These effects might pose great challenges to the anesthetists in the conduct of anesthesia, airway management, and surgical positioning of patients.

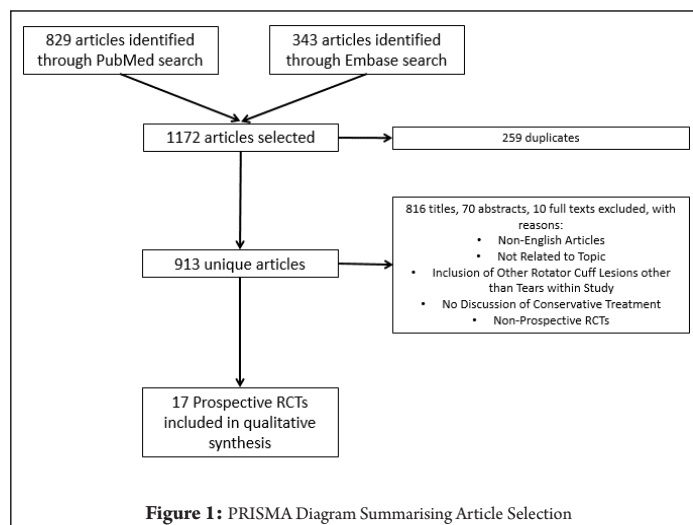


Table 1: Characteristics of Studies Included.

AUTHOR/ YEAR	COUNTRY	STUDY DESIGN/LEVEL OF EVIDENCE	COMPARISON	NO OF PATIENTS
Akan et al, 2019	Turkey	Prospective RCT, Level 1	Partial tear PRP vs Partial Tear Control vs Complete Tear PRP vs Complete Tear Control. All groups were given a home exercise programme 3 times weekly.	Total: 89 (Partial PRP Group: 30; Partial Control Group: 15; Full Thickness PRP Group: 29; Full Thickness Control Group: 15)
Cai et al, 2018	China	Prospective RCT, Level 1	Normal saline subacromial injection vs sodium hyaluronate subacromial injection vs PRP subacromial injection vs sodium hyaluronate + PRP subacromial injection	Total: 184 (Normal Saline Group: 47; SH Group: 44; PRP Group: 45; SH+PRP Group: 48)
Gialanella et al, 2013	Italy	Prospective RCT, Level 1	Control Group: Physiotherapy only, Group TA1: Physiotherapy and single intra-articular injection of 40mg triamcinolone acetonide, Group TA2: Physiotherapy and 2 doses of 40mg triamcinolone acetonide 21 days apart	Total: 60 (Group TA1: 20, Group TA2: 20, Control Group: 20)
Gialanella et al, 2018	Italy	Prospective RCT, Level 2	Cycloergometer (CYC) Group vs Control Group. CYC Group: patients received 15 mins training with an arm cycloergometer and were invited to use the cycloergometer at home 20mins/twice daily. Controls were invited to continue the standard exercises. During the 6 month study period, CYC Group received educational reinforcement monthly from the nurse of the telemedicine service. All patients also underwent a common outpatient rehabilitation exercise programme consisting of ten 30-min sessions (5 sessions/week).	Total: 38 (CYC Group: 19; Control Group: 19)
Heerspink et al, 2015	Netherlands	Prospective RCT, Level 2	Conservative treatment vs Surgical repair	Total: 45 (Conservative treatment: 25; Surgical repair: 20)
Hurd et al, 2020	USA	Prospective RCT, Level 1	Fresh, uncultured, unmodified, autologous adipose-derived regenerative cells (UA-ADRCs). Single injection of an average 11.4 x 10 <sup>6</sup> UA-ADRCs (in 5ml liquid; mean cell viability: 88%) vs single injection of 80mg of methylprednisolone (40mg/ml; 2ml) with 3ml of 0.25% Bupivacaine	Total: 16 (UA-ADRCs grp: 11; Corticosteroid grp: 5)
Kim et al, 2018	South Korea	Prospective RCT, Level 1	Group 1: Injection with BMAC-PRP at tear site under ultrasound guidance, Group 2: Rotator cuff exercises for 3 months	Total: 24 (Group 1: 12, Group 2: 12)
Kim et al, 2020	South Korea	Prospective RCT, Level 1	Group 1: Intratendinous injection with 0.5ml of type I atelocollagen; Group 2: Intratendinous injection with 1ml of type I atelocollagen; Group 3: no injection of type I atelocollagen	Total: 94 (Group 1: 32; Group 2: 30; Group 3: 32)
Krischak et al, 2015	Germany	Prospective RCT, Level 2	Occupational Therapy vs Independent Home-Based Exercises using a Booklet	Total: 38 (Occupational Therapy Group: 22; Independent Exercise Group: 16)
Kukkonen et al, 2015	Finland	Prospective RCT, Level 1	Group 1: Physiotherapy-only group; Group 2: Acromioplasty and physiotherapy group; Group 3: Rotator cuff repair, acromioplasty and physiotherapy group	Total: 160 (Group 1: 55; Group 2: 58; Group 3: 54)
Liu et al, 2019	Taiwan	Prospective RCT, Level 1	Group 1: Intra-substance injection into rupture area of supraspinatus with Diprosan 1cc (Betamethasone disodium phosphate 2mg and Betamethasone Dipropionate 5mg) and 1% xylocaine 1cc; Group 2: Injection with normal saline 1cc and 1% xylocaine 1cc.	Total: 24 (Group 1: 12, Group 2: 12)
Moosmayer et al, 2019	Norway	Prospective RCT, Level 1	Primary tendon repair vs Physiotherapy with optional secondary repair	Total: 91 (Primary tendon repair: 48; Physiotherapy with Optional Secondary Repair: 43)
Ranebo et al, 2020	Sweden	Prospective RCT, Level 1	Early surgical repair vs Physiotherapy	Total: 58 (Surgical Repair: 32; Physiotherapy: 26)

Table 2: Findings of Studies.

AUTHOR/ YEAR	PARAMETERS STUDIED	MINIMUM FOLLOW UP (MONTHS)	SIGNIFICANT FINDINGS
Akan et al, 2019	ROM, Quick DASH Score, SPADI Score, Constant Score, VAS Score	12	In all groups, statistically significant improvements were observed in ROM, Quick DASH, SPADI, Constant and VAS scores at 12 months ( $p<0.05$ ). More improvements in all these clinical parameters were observed in PRP groups than control groups ( $p<0.001$ ). Improvements seen after their first injection in PRP groups had persisted at 12 months. No significant difference in clinical parameter improvements between PRP groups.
Cai et al, 2018	Primary outcome: Constant score; Secondary outcomes: ASES Score, VAS Score, MRI	12	PRP Group and SH+PRP Group showed significantly higher Constant and ASES scores post-intervention. At 12 months, there were significant differences in Constant, VAS and ASES scores between SH+PRP Group when compared to SH and PRP groups. Tear size significantly decreased on MRI for both the PRP and SH+PRP groups.
Gialanella et al, 2013	ROM, Constant-Murley Scale, Pain score, Requests for NSAIDs	6	Groups TA1 and TA2 had less pain at night at 6 months ( $p=0.023$ ), better improvement in pain at night at 6 months ( $p<0.001$ ), better effectiveness in pain at night at 6 months ( $p<0.001$ ), better improvement in pain during activity at 6 months ( $p<0.001$ ), better effectiveness in pain during activity at 6 months ( $p<0.001$ )
Gialanella et al, 2018	VAS Score, Active ROM, Passive ROM, ROM-Pain, Revised Constant Score, HAQ Score	6	At 6 months, CYC Group showed significant improvement in all outcome measures ( $p<0.01$ ); At 6 months, compared to Control Group, CYC Group had lower pain scores during activities ( $p<0.01$ ), higher revised Constant total score ( $p<0.01$ ), better ROM-pain <sup>sum</sup> ( $p<0.05$ ) and active ROM <sup>sum</sup> ( $p<0.05$ ); At 6 months, home cycloergometer use was inversely associated with pain during activities ( $p<0.01$ ) and revised Constant total score ( $p<0.01$ )
Heerspink et al, 2015	CMS Score, VAS Pain Score, VAS Disability Score, MRI	12	At 12 months, VAS pain and VAS disability scores were significantly lower in the surgery group ( $p=0.04$ and $0.02$ respectively). No difference in mean CMS score in both groups at 12 months ( $p=0.08$ ). Subgroup analysis showed that postoperative CMS results were superior in surgically treated patients without a retear compared with conservatively treated patients.
Hurd et al, 2020	ASES Score, RAND SF-36 Score, VAS Score, MRI	12	Higher mean ASES score in UA-ADRCs group 52 weeks post injection ( $p<0.05$ )
Kim et al, 2018	VAS Score, MMT Score of SSP, ASES Score, tear size	3	At 3 months post-injection, Group 1 had superior improvement in VAS Score ( $p=0.039$ ), ASES Score ( $p=0.011$ ). Decrease in tear size also noted for participants in Group 1
Kim et al, 2020	ASES Score, Constant Score, VAS Score, active ROM, MRI (performed at least 6 months after injection)	12 (Mean: 24.7)	The functional and pain scores in Groups 1 and 2 significantly improved at final follow-up ( $p<0.05$ ). No significant improvement was seen in functional or pain scores for Group 3 ( $p>0.05$ ). Groups 1 and 2 had significantly better functional scores compared with Group 3 at final follow-up ( $p<0.05$ ). Group 1 (28.1%, $p=0.02$ ) and Group 2 (36.7%, $p=0.003$ ) had significantly higher proportion of patients with decreased size of tendon tear on follow-up MRI when compared to Group 3 (6.3%).
Krischak et al, 2015	VAS Score, CMS Score, Isokinetic strength testing in abduction and external rotation, functional limitation, clinical shoulder tests, EQ-5D VAS	2	A 2 months follow up, change in EQ-5D-VAS Score, abduction peak torque (60 degrees per second) and abduction peak torque (120 degrees per second) were greater for Independent Exercises Group ( $p=0.049$ , $0.01$ , $0.005$ respectively)
Kukkonen et al, 2015	Primary outcome: Constant Score; Secondary outcomes: VAS Score, Patient Satisfaction Score, Rotator Cuff Integrity in a control imaging investigation, cost of treatment	24	At 2 years, there was no significant differences in mean change in Constant Score, VAS Score, Patient Satisfaction Score between all 3 groups ( $p=0.38$ , $p=0.45$ , $p=0.28$ respectively). At 2 years, the mean sagittal site of tear was significantly smaller in Group 3 compared to Groups 1 and 2 ( $p<0.01$ ). Rotator cuff repair and acromioplasty were significantly more expensive than physiotherapy only ( $p<0.01$ ).
Liu et al, 2019	US Imaging, SPADI Score, VAS Score	6	At 6 months, superior improvement in VAS and SPADI Scores in Group 1 than Group 2. Therapeutic effect lasted for at least 6 months in both groups. Size of SSP rupture was not increased after injection in either group ( $p=0.066$ for Group 1, $p=0.073$ for Group 2).
Moosmayer et al, 2019	Constant Score, ASES Score, VAS Score, motion, strength, Patient Satisfaction Score	120	Post 10 years follow-up, primary tendon repair had superior outcomes compared to physiotherapy with optional secondary repair (Better Constant Score ( $p=0.002$ ), ASES Score ( $p<0.001$ ), 10cm Visual Analogue Scale for Pain ( $p<0.001$ ), pain-free abduction ( $p=0.007$ ), pain-free flexion ( $p=0.01$ ))
Ranebo et al, 2020	Primary outcome: CMS Score; Secondary outcomes: WORC Score, NRS Score, EQ-VAS score, MRI to assess retear rate, tear progression, fatty infiltration, atrophy	12	No difference in CMS Score ( $p=0.68$ ), WORC Score ( $p=0.62$ ), NRS Score and EQ-VAS Score ( $p=0.60$ ) at 12months. Retear rates for repaired patients: 6.5%, physiotherapy patients: 29.2%.
Schwitzgubel et al, 2019	Primary outcome: change in lesion volume (calculated on MR Arthrography) at 7 months; Secondary outcomes: improvement in shoulder pain and the Constant Score, ASES Score SANE Score at >12 months	12	At 7 months, no significant differences between PRP and control groups in change in lesion size ( $p=0.175$ ), change in VAS ( $p=0.586$ ), change in SANE Score ( $p=0.650$ ), change in Constant Score ( $p=0.596$ ), change in ASES Score ( $p=0.655$ ); At >12 months, no significant differences between PRP and control groups in change in VAS ( $p=0.087$ ), change in SANE Score ( $p=0.846$ ). At 19.5 +/- 5.3 months, the incidence of adverse effects (pain>48 hours, frozen shoulder, extension of lesion) was significantly higher in the PRP Group than the Control Group (54% v 26% respectively; $p=0.020$ )
Shams et al, 2016	ASES Score, CMS Score, SST Score, VAS Score, MRI (findings graded on scale of 0-5)	6	Both injection groups showed statistically significantly better clinical outcomes over time. Statistically significant difference between PRP Group and Corticosteroid Group 12 weeks after injection for VAS, ASES, CMS and SST Scores, favouring PRP Group. Non-significant improvement in MRI findings for both groups. No difference in outcomes for both groups at 6 months.
Turkmen et al, 2018	Active ROM, VAS Pain Score, DASH Score, ASES Score, SF-36 Score, Treatment Satisfaction Level	1.5	Statistically significant improvement in active ROM ( $p=0.001$ in both groups) and secondary outcomes ( $p<0.05$ in both groups); no statistically significant difference in all outcome measures between groups ( $p>0.05$ )
Vrouva et al, 2019	SPADI Score, NRS Score, EQ-5D	3	Significant improvement in pain scores, functionality and patients' quality of life ( $p<0.001$ ); no significant difference in treatment methods ( $p>0.05$ )

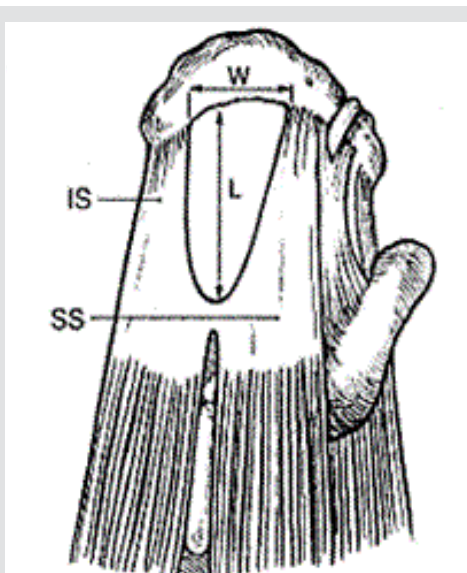


### 3. Patients who may not need surgery

These include those with partial thickness tears, and full thickness tears less than 10 mm in largest dimension. In our institution, these patients are treated conservatively first. They are usually handicapped mainly by pain and stiffness, both of which are amenable to physiotherapy. Outcomes with and without repair of such partial tears with stiffness are noted to be similar [38].

### 4. Patients whose surgery may be delayed

These are usually small to mid-sized full thickness tears which are well-balanced (Figure 2), often described as U-shaped. These patients tend to be relatively asymptomatic or tolerate the symptoms well when the tear is small, and hence present late with pain and weakness when the tear has become large or massive. In contrast, unbalanced or asymmetrical tears, often described as L-shaped or reverse L-shaped may present early with pain. These patients need surgery without delay. Patients with balanced tears can be treated with conservative treatment, albeit on a trial. In our survey of 38 patients with large tears [39], it was found that up to 24% had balanced tears and indeed, presented late after a long period of conservative treatment.



**Figure 2:** A balanced tear is one which involves largely the supraspinatus tendon with minimal or no tear noted in the subscapularis and infraspinatus.

### Nonoperative treatment modalities

#### Pharmacological therapy

Analgesic medications, such as paracetamol (acetaminophen) and NSAIDs are commonly prescribed to patients with painful rotator cuff syndromes. By blocking the inflammatory process, NSAIDs are thought to reduce pain and inflammation at the rotator cuff tear site. The excellent short-term effectiveness of NSAIDs in the management of rotator cuff syndromes has been well described in the literature [40, 41]. However, the gastrointestinal, cardiovascular, and renal adverse effects preclude long-term use for patients who have chronic pain. Furthermore, there has been debate on the role NSAIDs play in inhibiting rotator cuff healing. Studies in rats have demonstrated that NSAIDs result in impaired rotator cuff tendon [42] and tendon-to-bone [43] healing. However, the clinical impact of these inhibitory effects are less clear, with some reporting worse outcomes [15].

However, these studies investigate tendon healing after rotator cuff repair, while there is a paucity of evidence on the effect of NSAIDs on chronic rotator cuff tears. Hence, we commonly recommend NSAIDs for patients who have acute or acute-on-chronic flares of pain, while advising against long term NSAID use due to its side effect profile and potential adverse effects on tendon healing.

In patients with intractable acute pain not amenable to oral NSAID or paracetamol use, short course fixed dose opioid medications may be an option. However, its use should remain judicious, especially concerning its risks of respiratory depression and misuse.

#### Physical therapy

The main goal of physical therapy is to reduce pain and improve function via restoration of range of motion (ROM), shoulder strength, stability, and control. There are three distinct modalities, namely activity modification, stretching of the glenohumeral joint capsule and strengthening of the rotator cuff, scapular stabilizers, and deltoid muscles.

Firstly, patients should be educated to limit aggravating activities, such as overhead or reaching actions, to prevent further injury and pain. Next, patients should be placed on a comprehensive exercise and stretching program, with both physiotherapist lead sessions and home exercise program showing good results compared with placebo [44]. Patients can be initially started on passive pendulum exercises and progressed to active-assisted exercises using the other arm or a wall as tolerated. Special attention should be placed on anterior and posterior capsule stretching, to prevent adhesions and decrease impingement [45]. Targeted strengthening of the healthy rotator cuff muscles and scapular stabilizers should be performed in a progressive manner. The use of various adjuncts, such as elastic bands and weights, have been described [46] but individual specifics are beyond the scope of this review. Strengthening of these muscles helps in improving the stability of the glenohumeral joint and preventing superior migration of the humeral head and subsequent impingement [46].

While physical therapy is an essential component to the rehabilitative treatment for rotator cuff tears, to date there have been no randomized clinical trials that have evaluated its effectiveness. The ubiquity of physical therapy for patients with rotator cuff tears makes conducting such trials difficult. Goldberg et al [47] evaluated exercise therapy alone in an observational series of 46 patients with full thickness tears. The authors found that 27 patients (59%) of patients experienced improvement, 5 (11%) remained unchanged, while 14 (30%) of patients experienced worsening at a mean follow up of 2.5 years. Kukkonen et al [35] evaluated patients with non-traumatic rotator cuff tears at 1 year, who underwent (1) physical therapy alone, (2) physical therapy and acromioplasty, and (3) physical therapy, acromioplasty and rotator cuff repair, and found no clinical differences between all groups at 1 year. A systematic review on exercise therapy in the treatment of rotator cuff impingement found that exercise is generally an effective treatment for pain reduction [48], although the results between each study are not comparable due to the heterogeneity of the various exercise programs reported. However, despite consensus that physical therapy is beneficial, there has been some evidence that patients who remain symptomatic despite therapy continue to undergo anatomic deterioration, as compared to patients who remain asymptomatic [49]. Hence, in such patients, surgery should be considered before fatty degeneration and muscle atrophy worsen.

## Injections

Corticosteroid injections into the subacromial space have been shown to provide effective short-term relief of pain resulting from rotator cuff tears [7, 19, 45, 50–52]. Corticosteroids are commonly injected with a local anesthetic agent, such as lidocaine, to provide rapid pain relief, allowing patients to engage in physical therapy. By reducing the inflammatory process, corticosteroids are effective against acute tendinopathies and tears [45]. A systematic review on the effectiveness of such injections showed improved ROM of between 14 to 45 degrees, with most studies demonstrating statistically but not clinically significant improvements in the visual analog score for pain [53]. Such benefits were seen in patients regardless of the use of ultrasound guidance or anatomical approach. Regarding the longevity of pain relief, studies [52, 54] have reported that while there was effective pain relief at 1 month, such benefits were not seen at 3 months. Hence, given its short term effectiveness and recent concerns regarding corticosteroid mediated tendon necrosis [55], we recommend such injections to be given for a reduction of acute inflammation and resulting pain relief, in order for patients to embark on a course of physical therapy. We do not advise for repeat injections (e.g. more than once every sixth months) in view of its potentially detrimental effects on healthy tendons.

Recently, hyaluronic acid (HA) injections, while widely used for the treatment of osteoarthritis, have been gaining popularity in the treatment of tendinopathies such as rotator cuff tears. As a physiological component of synovial fluid, there has been some *in vivo* evidence on the efficacy of HA in treating tendinopathies. HA has been shown to suppress rotator cuff inflammation in a rat model [56], and reduced adhesions and improved tendon healing in Achilles tendon tears in a rabbits [57]. Whereas clinical evidence has been mixed, with some studies reporting improved pain and function [58], while others have reported inconclusive results [52]. In our view, more clinical trials are awaited before definite recommendations can be made on the use of HA for the treatment of rotator cuff tears.

## Biologic therapies

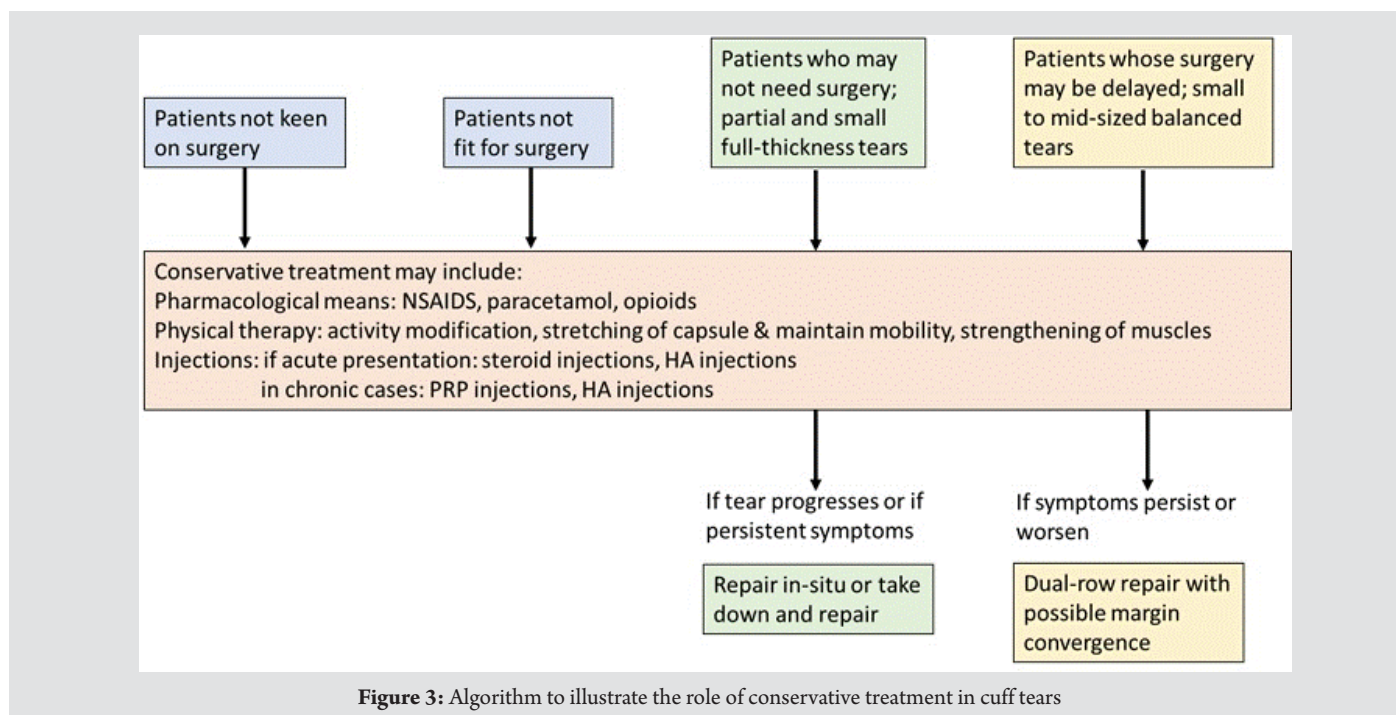
Biologic therapies, such as the use of platelet-rich plasma (PRP), have been advocated for the treatment of tendinopathies. PRP contains a mixture of host growth factors, which has *in vitro* evidence of improved tendon healing and remodeling [59]. It is thought that delivery of high concentrations of growth factors to injured tendons can augment the healing process. Its efficacy has been a topic of debate, with some reviews reporting long-term clinical effectiveness [52], while other reviews has demonstrating no significant long-term improvements [21]. As presented in our results, Akan et al [29] found that PRP benefitted patients with both complete and partial tears, with improvements lasting at least 12 months. Conversely, Schwitzgubel et al [31] and Shams et al [30] reported that PRP injection did not improve lesion size, pain or functional outcomes at 6 and 12 months respectively. One possible reason for the heterogeneity of the results seen in the literature may be the high inter-individual variation in the composition of PRP [60]. Recently, there has been new evidence that injection of bone marrow mesenchymal stem cells with PRP can improve tendon regeneration, reduced pain and improve function [61], however this remains a topic for future study.

## Algorithm

The central role of conservative treatment of cuff tears is illustrated in the algorithm in Figure 3. Conservative treatment may be the definitive treatment in some patients, in those who are not keen or not fit for surgery. Conservative treatment has a role to play for those who may not need surgery, like patients with small tears. In those with mid-sized but balanced tears, conservative treatment may be part of the treatment cascade.

## Limitations

This review only includes prospective randomised controlled trials (level 1 and 2) which have studied at least 1 non-surgical modality for the treatment of rotator cuff tears. However, the treatment modalities



available are extremely diverse, not allowing for a meaningful quantitative review of the topic. Furthermore, the way the treatment was delivered varied largely from study to study (for example dosages of pharmacologics and preparation techniques of biologics given via injections). The follow-up times varied between studies as well, ranging from 1.5 months to 10 years follow up. Moreover, expectedly, some of the studies were not able to blind participants and clinicians who provide the therapy for ethical reasons.

## Conclusion

There are a variety of non-surgical modalities available for the treatment of rotator cuff tears. These can be classified into pharmacologic therapies, injections, biologics, physical rehabilitation, and electrophysiological rehabilitation modalities. These non-surgical modalities should be considered as first line treatment in the management of rotator cuff tears, especially partial tears. More high-quality studies are required in this area of study to allow for a quantitative review (meta-analysis and meta-regression) of the various non-surgical treatment modalities of rotator cuff tears.

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**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

**Conflict of interest:** Nil **Source of support:** None

### How to Cite this Article

Sayampanathan AA, Tan MWP, Lie DTT | Role And Outcomes of Conservative Treatment in Management of Rotator Cuff Tears: A Systematic Review of Randomised Controlled Trial | Asian Journal of Arthroscopy | January-June 2021; 6(1): 39-47.