Rehabilitation Management of Rotator Cuff Injuries in the Master Athlete

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Abstract

Rotator cuff (RTC) injuries are common in master athletes, especially overhead athletes. Risk factors include aging and degeneration as nonmodifiable and volume of activity, muscle weakness, and loss of motion as modifiable. The clinical presentation involves limited range of motion (ROM), pain at rest and at night. Injury classification into traumatic versus nontraumatic and tendinopathy, partial or full-thickness tears helps to establish a treatment plan. RTC injury rehabilitation protocols are criteria-based, multimodal, and divided into four phases. The acute phase addresses pain, inflammation, ROM, and RTC protection. The recovery phase addresses kinetic chain abnormalities, flexibility, and strength, and the functional phase involves exercises directed toward specific sport activities. Return to sports is based on clinical recovery, kinetic chain principles, and adequate sports technique. Nonsurgical management is recommended in most cases, and surgical management is considered if symptoms progress, especially for full-thickness tears.

Introduction

Increased longevity has contributed to the rapid growth of the older population across the world. The 2016 American Community Survey estimated the number of people in the United States 65 years or older as 49.2 million. By 2030, it is expected that the older population will comprise about 12% of the projected total world population and will increase to 17% by 2050 (1). With this increase in the older population, the number of master athletes is increasing as well. Participation in master sports has been associated with multiple benefits including decreased smoking, less cardiac problems, improved sleeping, better medical check-ups, and better quality of life, but also has a high risk for injury, with >50% to 60% of master athletes suffering an injury that requires at least 1 wk of rest from training and competition (2,3).

Overhead athletes are perhaps the most susceptible to rotator cuff (RTC) injuries ranging from tendinopathy to partial or full-thickness tears. Although the epidemiology of RTC tears is not well established, its prevalence has been described to be between 7% and 30% (4). Zaremski et al. reports the highest shoulder injury rates among overhead throwing sports in baseball and RTC tendinopathy as the most frequent shoulder injury diagnosis (5).

Modifiable risk factors to be addressed in rehabilitation for RTC disease include tight posterior shoulder structures, tight pectoral muscles, glenohumeral internal rotation deficit (GIRD), weak RTC and scapular stabilizing muscles, weak and tight pelvic girdle muscles, high training volume, and increasing skill level (6). Nonmodifiable risk factors for RTC diseases affecting older athletes include age, tendon degenerative changes, mechanical overuse, and chronic diseases (*e.g.*, hyperlipidemia and diabetes mellitus) (7).

During the initial evaluation of a patient with shoulder pain, the injury should be classified as traumatic versus nontraumatic and whether the pathology is caused by factors extrinsic or intrinsic to the shoulder. Patients with RTC tendinopathy or tears will present with limited or painful arc of motion in shoulder elevation and abduction. Pain at rest or at night may suggest a RTC tear. Weakness in abduction and external rotation is common, although RTC weakness and atrophy will depend on the severity and number of tendons involved. Positive impingement signs can be present in tendinopathies or tears secondary to subacromial impingement (8,9).

In this population of athletes older than 50 years, the initial imaging for the painful shoulder should include standard radiographs to exclude degenerative changes and other causes of shoulder pain, particularly in the case of trauma. In the absence of trauma or after negative radiographs, ultrasound may be considered as the appropriate imaging study if RTC injury is suspected. In patient with traumatic injury, magnetic resonance imaging (MRI) is considered the best imaging study

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1537-890X/1809/330–337
Current Sports Medicine Reports

because it allows assessment of most soft-tissue injuries, including intra- and extra-articular structures. MRI is essential in cases requiring surgical evaluation to assess tissue quality, fatty infiltration, tendon retraction, muscle atrophy, and tear extension. MRI, magnetic resonance arthrogram (MRA) and ultrasonography (US) have similar high sensitivity and specificity in detection of full-thickness RTC tears but MRA is superior for partial thickness tears and labral tears (10,11). In the older athlete, it is important to correlate imaging findings with the clinical evaluation, as there is a high incidence of false positives, with imaging findings not necessarily representing the patient's source of pain (12).

The current literature provides limited guidelines regarding optimal treatment of RTC injuries in the master athlete. The purpose of this article is to review the rehabilitation management strategies for RTC tendinopathy and partial and full-thickness tears in the master athlete. We will be presenting principles of shoulder rehabilitation in older individuals and its application to the master athlete based on the available literature and the authors experience in clinical practice. The master athlete will be defined as active individuals 50 years or older, who exercise for general health, participate in sports, and look for optimal level of performance (8). We will include a discussion of rehabilitation protocols for patients treated conservatively and after surgical interventions. This article will not address calcific tendinopathy or adhesive capsulitis.

Literature Search

For this literature review we did an online search through different databases (PubMed, Medline, SportDiscus, CINAHL, and Chocrane) for peer-reviewed, full-text articles written in English and published from 1990 to September 2018. Search terms included ([rotator cuff] AND [master OR older OR aging] AND [rehabilitation OR therapy OR treatment]). We excluded articles not related to the RTC or any rehabilitation strategy and included some articles extracted from the references of reviewed articles. Other articles addressing specific topics, such as tennis, golf, racket sports, and baseball injuries were included. We accepted expert opinion articles and did not discard level four evidence articles. We ended up reviewing 82 articles. Although this article defines the master athlete as 50 years or older (8), we included some articles dealing with RTC rehabilitation in younger athletes, considering that many sports have master categories starting at a younger age and considering the limited literature available in master athletes.

Decision Making

Close monitoring of symptoms and function in patients with RTC tendinopathy and tears is important to decide which patients will be treated in a progressive rehabilitation program and who will be referred for surgical evaluation. Considering the limited capacity to heal of the RTC and the possibility of some tears to progress (13,14), advocates of early surgical management suggest that repair may prevent tear progression, tissue degeneration, significant retraction, atrophy, and fatty infiltration which make a tear irreparable and may result in RTC arthropathy (14,15). However, RTC repair should be considered carefully when treating master athletes since poorer surgical outcomes have been found in patients 63 years or older (16) and radiographic studies (US or MRI) have revealed a high retear rate (20% to 94%), significantly affected by age and original tear size (14,15).

Patients older than 65 years with full-thickness tears, or patients with large (>1–1.5 cm) or massive tears with chronic irreversible RTC should be treated nonsurgically due to compromised healing potential after surgical repair. Early surgical intervention should be considered for patients younger than 65 years with large full-thickness tears (either chronic or acute) based on their high risk of irreversible RTC changes (50% tear progression) and high likelihood of adequate healing after surgery (13,14). This should be followed by an appropriate postsurgical rehabilitation program.

RTC tendinopathies, partial and small (<1–1.5 cm) full-thickness tears have low risk of tear progression (25%) and limited risk of irreversible chronic changes; and therefore, should be treated with nonsurgical rehabilitation for at least 3 months and consider surgical evaluation if no improvement (13,14,17) (Figure).

A review article on non-operative management of RTC by Edwards and colleagues (14) included a case series by Bjornsson et al. who reported similar outcomes whether acute tears are fixed within 3 wk or 3 months. Therefore, initial non-operative treatment of at least 3 months seems a feasible alternative before considering surgery.

A randomized controlled trial with 187 patients older than 55 years with nontraumatic RTC tear revealed similar satisfaction levels and no clinical or significant difference in function between groups after 2-year follow-up after receiving, PT alone, PT and arthroscopy, or PT, arthroscopy, and repair. These results support that conservative management should be the primary initial treatment for nontraumatic, isolated, supraspinatus tear, since surgical repair, as the primary initial treatment, may increase health cost at no benefit over conservative treatment. It should be noted that this study was done

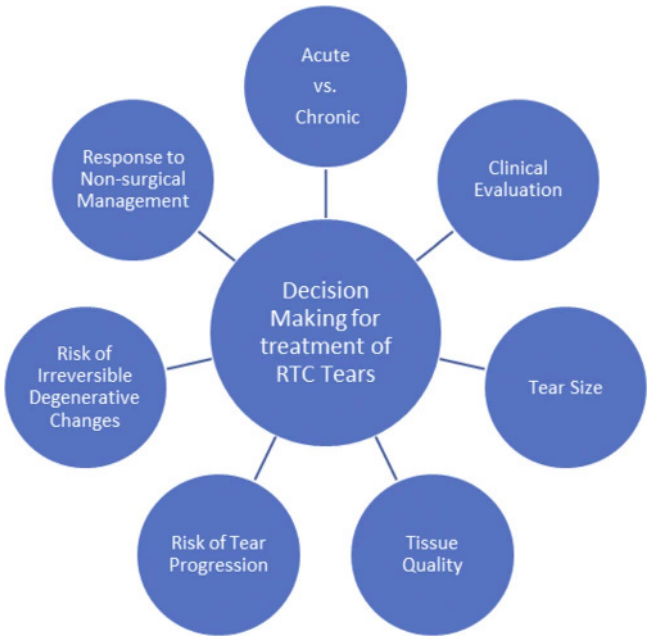

Figure: Considerations for RTC tears treatment decision making.

in nonathletic patients; therefore, the conclusions may not necessarily be extrapolated to master athletes (18).

Several interventions with regenerative potential have been studied in RTC injuries after failed nonsurgical rehabilitation before considering surgery. Platelet-rich plasma (PRP) has been suggested to enhance RTC healing in RTC tendinopathy and/or partial tears (19); however, most studies have investigated this technique as adjunct to RTC repair and its overall efficacy remains uncertain. Opinions in the literature are diverse but most of the current research does not support PRP for RTC tears (15,20). A recent study in patients with age ranging between 18 and 55 years evaluated the combined use of sodium hyaluronate and PRP subacromial injection in small to medium ($\leq$1 cm) partial thickness RTC tears, with promising results regarding pain, function, and tear size, but more investigation is warranted including long-term follow-up and older individuals (21). Extracorporeal shockwave therapy (ESWT) for RTC tendinopathy has been reported to result in pain relief and promote healing. Most evidence for this treatment deals with calcific tendinopathy, some recommend ESWT for athletes with refractory tendonitis of partial tears of the RTC before proceeding to a surgical intervention (20) (Table 1).

Nonsurgical Rehabilitation Considerations

The aim of nonsurgical rehabilitation is to improve pain and function as an alternative to surgical intervention (14). A multimodal approach, involving at least two therapeutic strategies, has been proposed for nonoperative management of RTC tendinopathy, tears, and nonspecific shoulder pain (22,23). Studies applying multimodal conservative treatment for RTC full-thickness tears in patients older than 60 years have reported good short- and long-term results in pain and function. These studies included programs with therapeutic strategies, such as activity modification, oral nonsteroidal anti-inflammatory medications (NSAID), therapeutic ultrasound, infrared radiation, transcutaneous electrical nerve stimulation (TENS), range of motion (ROM) and flexibility exercises, strengthening exercises, and manual therapy as needed and progressed to a home program when ready (23,24).

Rehabilitation protocols with greater success are organized in phases acknowledging the stages of tissue healing and the patient response to exercise (23). Three- and four-phase protocols have been proposed in the literature (14,23,25,26). We will discuss a four-phase protocol divided into acute, recovery, functional, and return to sports phases.

Nonsurgical Rehabilitation Protocol

Acute phase

This initial phase of RTC rehabilitation corresponds to the inflammatory phase of tissue healing. This phase is centered on reducing pain and inflammation and protecting the RTC from further damage. Athletes should be educated about activity modification to avoid provocative movements and postures, such as overhead activity (9). Physical modalities are widely used as part of nonoperative multimodal rehabilitation protocols to reduce pain and inflammation, but only low-level laser therapy, cryotherapy, and therapeutic heat have some evidence for soft tissue injuries, including the RTC, based on our literature review (26,27). Medications to modulate pain and inflammation are often needed in the acute phase to allow participation in rehabilitation protocols. Acetaminophen is the first-line medication for elderly, based on safety profile (26). NSAID are considered with caution, as second line, if there is poor response to acetaminophen (8). Although NSAID are the most commonly prescribed medication and have shown good short-term efficacy for painful shoulders, it is important to understand the potential benefits and recognize the common gastrointestinal, cardiac, and renal adverse effects, especially in older adults (26). In patients without absolute contraindications, it may be reasonable to consider a short course of 7 to 14 d of oral NSAID. Topical medications, such as cream, gels, or patches, also have been mentioned in the literature and used as part of nonoperative management of musculoskeletal injuries. Topical NSAID, capsaicin, and anesthetic agents have not been clinically studied to demonstrate effectiveness in RTC tears, but topical glyceryl trinitrate was found to improve pain, ROM, supraspinatus strength, and decrease shoulder impingement in patients with chronic supraspinatus tendinopathy. Common side effects for the latter included headache and dizziness and should be used with caution in patients with ischemic heart disease. Therefore, it is still unclear whether this might be an adequate adjunctive therapy for older athletes (26).

Subacromial (SA) corticosteroid injections (CSI) is another pharmacological treatment used in RTC rehabilitation to decrease pain associated with inflammation, improving ROM and may be useful in master athletes with RTC tendinopathy secondary to primary impingement (9,15,20). Advocates for

Table 1.
Treatment Decision Making for RTC Injuries in the Master Athlete.

Type of Injury	Considerations	Treatment
–RTC Tendinopathy –Partial-thickness RTC tears (except large bursal tear) –Small (< 1 cm) Full-thickness RTC tears	–Low risk of tear progression –Low risk of irreversible changes	Initial nonsurgical rehabilitation
–Acute full-thickness RTC tears (except small tears) –Chronic full-thickness tears in younger than 65 years patients (except small tears)	–High risk of irreversible changes –Adequate likelihood of postsurgical healing	Initial surgical treatment
–Chronic full-thickness tears in athletes older than 65 years –Irreparable tears (based on tear size, retraction, muscle quality, and migration)	–Compromised postsurgical healing	Initial nonsurgical rehabilitation

Modified from: Tashjian RZ. Epidemiology, natural history, and indications for treatment of rotator cuff tears. *Clin Sports Med.* 2012;31(4):589–604.

CSI cite positive findings in several small animal and human trials (28); however, there are some concerns and controversies regarding its effectiveness and safety (15,26,29). Some of these concerns include the potential deterioration of the tendons, the risk of postoperative infection, and inaccurate delivery of medications if not done with US guidance (28,30). Judicious use of CSI is recommended after PT and oral NSAID have been tried (15), considering possible adverse effects including increased risk of rupture, especially when treating aged and tendinopathic RTC. A limited number of patients may require CSI in the acute phase, particularly those who cannot sleep at night or cannot tolerate activity at rest. In most cases, CSI will be used at a later stage in patients who cannot progress in rehabilitation. The general recommendation is three CSI or less per year, considered safe for RTC tendons (15), although for RTC injuries in the elderly, some recommend one CSI or less every 6 months, limited to three injections total to avoid capsular atrophy (26).

Once pain is under control, stretching and strengthening exercises should start to retard atrophy, prevent contractures, and regain painless full ROM, especially internal and external rotation (15,25,26,31). Periscapular muscle strengthening, manual therapy, and scapular mobilization can be used to improve scapulohumeral rhythm, scapulothoracic motion, and thoracic kyphosis (9,23,32). Kinesiotaping may be a good alternative in the initial treatment for RTC injuries secondary to subacromial impingement (33) since it has been found to improve shoulder kinematics and enhance neuromuscular control of the scapular muscles (34). For patients with RTC tears, pain at rest, and limited active motion, it may be appropriate to begin with gentle passive ROM (PROM) and careful progression to active-assisted and active ROM, isometric, and closed kinetic chain exercises for the RTC muscles and scapular stabilizers. Dynamic pain-free exercises in protected ranges of motion and posterior capsule stretching for improvement of GIRD (*e.g.*, "cross body stretch" and "sleepers stretch") can be incorporated in this acute phase in patients with tendinopathy and no pain at rest (31). Cross-training, core strengthening, and cardiovascular exercises will help to maintain general and cardiovascular fitness during this shoulder-protection period (25,35,36).

Recovery phase

This second phase focuses on strengthening and correcting kinetic chain deficits and abnormal biomechanics, such as GIRD. It should begin after painless full ROM is achieved (15,23,25). The goals of this phase include restoration of normal strength, flexibility, and tolerance of functional activities. Resistance exercises with elastic bands, tubing, or hand weights are usually used and progressed as tolerated (15,25). Periscapular musculature strengthening restores normal scapulothoracic mechanics, minimizing dynamic impingement secondary to scapular dyskinesis (31).

Scapular stabilization should be achieved prior to starting aggressive RTC strengthening. Specific exercises for scapular stabilizers and dynamic scapular control include "low rows," "lawnmower," "robbery" exercises, prone scapular retraction ("scapular squeezes"), prone shoulder extension, bent over rows, supine scapular protraction, upright wall scapular protraction and retraction, wall pushups and quadruped scapula protraction (14,37). Strengthening of anterior deltoid, for humeral elevation, can be started with isometric shoulder contraction and progressed to supine, inverted, and standing shoulder flexion as tolerated (14). RTC strengthening should focus first on external rotation as internal rotators are stronger than external rotators (25). Exercises that promote middle and lower trapezius activation with minimal activation of the upper trapezius also should be incorporated. This can be achieved with side lying external rotation, side lying forward flexion, prone horizontal abduction with external rotation, and prone extensions, which also activate the infraspinatus and teres minor (38). Active internal and external rotations can be progressed to standing, starting in adduction and progressed with arm abducted if no pain (9,14). Finally, strengthening of latissimus dorsi, teres major, and pectoralis muscles to limit the superior migration of the humeral head, restoring force couples in the glenohumeral joint (31,39). In all these shoulder strengthening exercises, the eccentric component of the exercise must be emphasized.

Functional phase

Progression into this phase requires adequate strength with painless full ROM, since this phase incorporates advanced strengthening of scapular stabilizers and RTC with the introduction of sports specific exercises (14). Multi-angle dynamic, functional exercises can be incorporated as tolerated to simulate more sports specific movements. Resistive exercises with elastic bands and tubing for RTC and periscapular strengthening continue during this phase while resistive proprioceptive neuromuscular facilitation and closed kinetic chain exercises are incorporated to improve joint proprioception (23). Eccentric exercises can be incorporated for strengthening of the RTC muscles as they have shown good results for treatment of tendon disorders, increasing collagen production, and decreasing neovascularization (40). If appropriate progression is achieved with no pain, return to practice can be considered in this phase, including return to throwing, serving, or golf swing programs, emphasizing proper mechanics (41).

Return to sport phase

The aim of this phase is to promote the return to previous activity level (23), therefore, specific goals depend on the sport. The clinician's knowledge of the sport is very important as well as working closely with trainers and coaches (42). At present, return to full overhead activities is based on function and symptoms rather than on isokinetic testing. Athletes return to sports once full ROM and strength are restored (9). In the future, general recommendations for return to sports after shoulder injury may include the use of isokinetic testing with goals of obtaining 10% higher RTC strength on the dominant throwing side compared with the nondominant side, with external/internal rotation ratios from 65% isokinetic to 100% isometric (42). Functional testing for the shoulder is gaining interest but not fully explored in clinical practice, therefore, normative data and cutoff values for injury prevention and return to sports are lacking (42).

Once the patient returns to practice or competition, a sports injury prevention program should be integrated in the training addressing modifiable risk factors, neuromuscular deficits, and sports-specific techniques focusing in areas at risk or already injured in a specific sport. Components of this preventive program include stretching and strengthening exercises,

proprioceptive and balance exercises, continued scapular stabilization and eccentric RTC strength, plyometric exercises, and education about modifiable risk factors. Preventive programs can be part of preseason training or integrated as warm-up activities before the sport activity (5,43).

Surgical Treatment

SA decompression, RTC debridement, and RTC repair are common surgical interventions for RTC pathologies. SA decompression can be considered in athletes who fail conservative rehabilitation with RTC injuries secondary to primary impingement. RTC tendon debridement or repair can be recommended in some athletes with RTC tears who failed conservative treatment or as initial treatment for acute full-thickness tears in previously asymptomatic shoulders or in chronic full-thickness tears in those younger than 65 years (as detailed in Table 2) (9,14,15).

Arthroscopic tendon transfers can be considered for some irreparable RTC tears and reverse shoulder arthroplasty for those with massive chronic tears who have progressed to RTC arthropathy when there is no other viable alternative to improve pain and function (15).

Postoperative Rehabilitation Concepts

Strong scientific recommendations for a specific rehabilitation protocol after RTC surgery are lacking, therefore, an individualized approach considering the surgical findings, repaired tissue quality, risk of stiffness, and risk of retear should be considered. Therefore, good communication between the sports medicine physician, physiatrist, surgeon, and therapist is essential throughout the rehabilitation process. Patient education also is important for realistic expectations and compliance (44,45).

Postoperative Rehabilitation Protocol

The specifics of postoperative rehabilitation protocol will vary depending on the surgical procedure performed and the surgeon's recommendations. After a RTC repair the rehabilitation protocol is divided into four overlapping phases similar to the nonoperative rehabilitation protocol, with some important differences as presented in Table 3 (44,46). The main difference lies in the postoperative acute phase which usually begins with an initial 2-wk period of strict immobilization to facilitate the tendon-to-bone healing, followed by four additional weeks using a standard sling or abduction brace to complete 6 wk of RTC protection. Generally, PROM with pendulum exercises and passive flexion in the scapular plane are started 2 wk after surgery to prevent stiffness, as well as gentle isometric exercises of the scapular stabilizing muscles but avoiding activation of the RTC muscles (44,46). This phase should vary depending on the patient's risks of tendon retear (20% to 94%) (14,15) and postoperative stiffness (14%) (47). For patients with high risk of retear, such as those with larger tears, more than two tendons involved, poor postsurgical healing potential, older than 65 years, or if there are concerns regarding the quality of the repaired tissue, a conservative protocol is recommended with an initial period of strict immobilization of 4 to 6 wk, delaying passive external rotation until 6 wk postoperative and strengthening after 3 to 4 months (45,47). For patients at risk of postoperative stiffness, such as those with coexisting calcific tendinopathy, adhesive capsulitis, partial articular supraspinatus tendon avulsion type RTC repair, concomitant labral tear, and single tendon RTC repair, an accelerated rehabilitation protocol can be recommended (45). This accelerated protocol incorporates early mobilization in protected planes, such as table slide exercises, immediately after surgery. Physical modalities with some evidence in the postoperative acute phase include cryotherapy and TENS. Cryotherapy has resulted in decreased pain, reduced narcotics use, and improved sleep when used immediately after surgery, 4 to 6 times per day for short periods (46). TENS use also resulted in significant reduction in pain and opioid use when compared with placebo-TENS after shoulder RTC repair (48).

Table 2.
Nonsurgical Rehabilitation Protocol for RTC Injuries in the Master Athlete.

Phase	Goals	Rehabilitation Strategies
Acute	Reduce pain and inflammation Protection of RTC Painless full ROM	Activity modification Physical modalities Medications PROM→AAROM→AROM in scapular plane Periscapular muscle strengthening Cross-training Cardiovascular exercises Core strengthening
Recovery	Normal RTC strength Normal flexibility Correct KC abnormalities	Advanced periscapular muscle strengthening Stretching (posterior capsule, pectoral muscles) RTC strengthening exercises: –Isometrics →CKCE →OKCE →OKCME
Functional	Adequate KC function Return to sports-specific activities	Multiangle functional exercise Plyometric exercises Eccentric exercises Return to practice (sports-specific exercises and drills)
Return to Sports	Return to previous sport activity	Return to Throw/Swing/Serve program Injury Prevention Program

CK, kinetic chain; CKCE, closed kinetic chain exercises; OKCE, open kinetic chain exercises; OKCME, open kinetic chain multi-angle exercises.

Table 3.
Postsurgical Rehabilitation Protocol after RTC Repair in the Master Athlete.

Phase	Goals	Rehabilitation Strategies
Acute (weeks 0–6)	Reduce pain and inflammation Protection of repaired RTC Prevent stiffness Scapular stabilizing muscles activation	Strict shoulder immobilization for 2 wk (except if high risk of stiffness) Standard sling or abduction brace for 6 wk Physical Modalities Medications PROM (starting at week 2) Isometrics of scapular stabilizing muscles Cross-training Cardiovascular exercises Core strengthening
Recovery (weeks 6–12)	Normal ROM Normal scapular muscle strength RTC muscle activation	PROM → AAROM Scapular stabilizing muscle exercises Protected RTC AROM –Submaximal RTC isometrics (depending on patient's progression and retear risk)
Functional (week 12)	Normal RTC strength Correct KC abnormalities Return to sports-specific activities	Periscapular muscle strengthening RTC strengthening exercises –Isometrics → CKCE → OKCE → OKCME Multiangle functional exercise Plyometric exercises Eccentric exercises Return to practice (sports-specific exercises and drills)
Return to Sports	Return to previous sport activity	Return to Throw/Swing/Serve program Injury Prevention program

Modified from: Jung C, Tepohl L, Tholen R, *et al.* Rehabilitation following rotator cuff repair: A work of the Commission Rehabilitation of the German Society of Shoulder and Elbow Surgery e. V. (DVSE) in collaboration with the German Association for Physiotherapy (ZVK) e. V., the Association Physical Therapy, Association for Physical Professions (VPT) e. V. and the Section Rehabilitation-Physical Therapy of the German Society for Orthopaedics and Trauma e. V. (DGOU). Obere Extrem. [Internet]. 2018 [cited 2018 February 22];13(1):45–61. Available from: https://www.ncbi.nlm.nih.gov/pubmed/?term=PMID%3A+29527239 doi: 10.1007/s11678-018-0448-2.

The postoperative recovery phase begins 6 wk after surgery and focuses on restoration of normal ROM, scapular stabilizing muscle strength, and RTC muscles activation, incorporating active-assisted ROM (AAROM) exercises with a stick or pulley and progressing to protected active ROM (AROM) and submaximal RTC isometrics. In the case of large tears or questionable tendon integrity, AROM and isometrics might not begin until 8 to 10 wk after surgery (44,46). The postoperative functional phase focuses on restoring normal RTC and scapular muscle strength, functional restoration of AROM in multiple angles, and correcting kinetic chain abnormalities. It may begin 12 wk (3 to 4 months) after the surgery, once pain-free resisted arc of motion is achieved. Overhead RTC strengthening, closed and open kinetic-chain exercises, and proprioceptive and plyometric exercises can be added as tolerated (46). The return to sport phase usually begins 4 to 6 months after surgery, if normal strength and motion are present and is similar to the nonoperative protocol. Return to overhead sports or contact sports should be delayed until 6 months after surgery and only after consulting with the physician for appropriate clinical evaluation functional recovery (46).

Following arthroscopy in patients without RTC tear or capsular procedure, the patients are started also in a four-phase rehab program, beginning with immediate PROM for 6 wk and progressed to stretch and strengthening. Athletes are not allowed to do overhead activities for a minimum of 3 months. When full ROM and strength is achieved, the athlete could be started in a progressive return to sports program. A return to throwing, serving, or swinging program could be started around 6 to 8 months following surgery (25). After shoulder arthroplasty or reverse shoulder arthroplasty, a comprehensive rehabilitation protocol similar to the RTC repair postoperative program should be implemented with the same principles of protection, ROM, strengthening and functional training, and gradual return to sports, considering that master athletes could progress more slowly than younger athletes in the rehabilitation program (49). The physician members of the American Shoulder and Elbow Society suggest that the mean time for return to sports is 4.3 months after shoulder arthroplasty (50). This time may vary in patients after a reverse shoulder arthroplasty due to residual RTC weakness or limited motion.

CONCLUSIONS

RTC injuries in master athletes are common and expected to increase as the population ages. Modifiable risk factors to be addressed in the rehabilitation include tightness of the posterior capsule and pectoral muscles, GIRD, RTC weakness, scapular dyskinesis, weak and tight pelvic girdle muscles, inappropriate training volume, and mechanical overuse. Nonmodifiable risk factors associated with aging involve degenerative changes and chronic diseases. The clinical

presentation and evaluation help determine a treatment plan considering the history of trauma, tear size, tissue quality and repairability, and the postsurgical healing potential. Some RTC tears can progress if left unrepaired, but nonoperative rehabilitation should be considered in most cases (for at least 3 months), even in full-thickness tears. Nonoperative and postoperative rehabilitation protocols should be multimodal and are divided into four phases: acute, recovery, functional, and return to sport. The acute phase focuses on protection, ROM, and control of pain and inflammation. The recovery phase addresses flexibility, strength, and kinetic chain abnormalities, and the functional phase involves exercises directed toward specific sport activities. After RTC repair, immobilization for 2 wk is usually recommended with PROM starting 2 wk postoperative. Unless significant risk of stiffness in which immediate PROM is advised. AROM is started 6 wk postoperative and strengthening 3 months after surgery, except for high risk of retear in which case the progression is slower. Return to sport is considered if adequate strength and painless full arc of motion is achieved with a stepwise approach, based on clinical and functional criteria, focusing on proper mechanics, adequate sport technique, and kinetic chain principles.

The authors declare no conflict of interest and do not have any financial disclosures.

References

1. U.S. Census Bureau. *The Population 65 Years and Older in the United States: 2016*. Washington, DC: U.S. Census Bureau; 2018. 1 p. Available from: https://www.census.gov/content/dam/Census/library/publications/2018/acs/ACS-38.pdf.
2. Shephard RJ, Kavanagh T, Mertens DJ, *et al*. Personal health benefits of masters' athletics competition. *Br. J. Sports Med*. 1995; 29:35–40.
3. Galloway MT, Jokl P. Aging successfully: the importance of physical activity in maintaining health and function. *J. Am. Acad. Orthop. Surg*. 2000; 8:37–44.
4. Karas V, Cole BJ, Wang VM. Role of biomechanics in rotator cuff pathology: North American perspective. *Med. Sport Sci*. 2012; 57:18–26.
5. Zaremski JL, Wasser JG, Vincent HK. Mechanisms and treatments for shoulder injuries in overhead throwing athletes. *Curr. Sports Med. Rep*. 2017; 16: 179–88.
6. Changstrom B, Jayanthi N. Clinical evaluation of the adult recreational tennis player. *Curr. Sports Med. Rep*. 2016; 15:437–45.
7. Huang SW, Wang WT, Chou LC, *et al*. Diabetes mellitus increases the risk of rotator cuff tear repair surgery: a population-based cohort study. *J. Diabetes Complications*. 2016; 30:1473–7.
8. American Academy of Family Physicians; American Academy of Orthopaedic Surgeons; American College of Sports Medicine; American Medical Society for Sports Medicine; American Orthopaedic Society for Sports Medicine; American Osteopathic Academy of Sports Medicine, Kibler WB, Putukian M. Selected issues for the master athlete and the team physician: a consensus statement. *Med. Sci. Sports Exerc*. 2010; 42:820–33.
9. Blevins FT. Rotator cuff pathology in athletes. *Sports Med*. 1997; 24:205–20.
10. Nazarian LN, Jacobson JA, Benson CB, *et al*. Imaging algorithms for evaluating suspected rotator cuff disease: Society of Radiologists in Ultrasound Consensus Conference Statement. *Radiology*. 2013; 267:589–95.
11. Lenza M, Buchbinder R, Takwoingi Y, *et al*. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane Database Syst. Rev*. 2013; CD009020. Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD009020.pub2/full. doi: 10.1002/14651858.CD009020.pub2.
12. Kuhn JE. Nonoperative treatment of rotator cuff tears. *Am. J. Orthop*. 2016; 45: 66–7.
13. Tashjian RZ. Epidemiology, natural history, and indications for treatment of rotator cuff tears. *Clin. Sports Med*. 2012; 31:589–604.
14. Edwards P, Ebert J, Joss B, *et al*. Exercise rehabilitation in the non-operative management of rotator cuff tears: a review of the literature. *Int. J. Sports Phys. Ther*. 2016; 11:279–301.
15. Lansdown DA, Feeley BT. Evaluation and treatment of rotator cuff tears. *Phys. Sportsmed*. 2012; 40:73–86.
16. Merolla G, Paladini P, Saporito M, Porcellini G. Conservative management of rotator cuff tears: literature review and proposal for a prognostic. Prediction Score. *Muscles Ligaments Tendons J*. 2011; 1:12–9.
17. Wolff AB, Sethi P, Sutton KM, *et al*. Partial-thickness rotator cuff tears. *J. Am. Acad. Orthop. Surg*. 2006; 14:715–25.
18. Kukkonen J, Joukainen A, Lehtinen J, *et al*. Treatment of nontraumatic rotator cuff tears: a randomized controlled trial with two years of clinical and imaging follow-up. *J. Bone Joint Surg. Am*. 2015; 97:1729–37.
19. Petri M, Ettinger M, Brand S, *et al*. Non-operative management of rotator cuff tears. *Open Orthop. J*. 2016; 10:349–56. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5041208/. doi:10.2174/1874325001610010349.
20. Chou WY, Wang CJ, Wu KT, *et al*. Comparative outcomes of extracorporeal shockwave therapy for shoulder tendinitis or partial tears of the rotator cuff in athletes and non-athletes: retrospective study. *Int. J. Surg*. 2018; 51: 184–90.
21. Cai Y, Sun Z, Liao B, *et al*. Sodium hyaluronate and platelet-rich plasma for partial-thickness rotator cuff tears. *Med. Sci. Sports Exerc*. 2019 Feb; 51:227–33.
22. Goldgrub R, Côté P, Sutton D, *et al*. The effectiveness of multimodal care for the management of soft tissue injuries of the shoulder: a systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. *J. Manipulative Physiol. Ther*. 2016; 39:121–39.
23. Smith DS. Conservative rotator cuff treatment. *Top Geriatr Rehabil*. 2014; 30: 127–30.
24. Kuhn JE, Dunn WR, Sanders R, *et al*. MOON Shoulder Group. Effectiveness of physical therapy in treating atraumatic full-thickness rotator cuff tears: a multicenter prospective cohort study. *J. Shoulder Elbow Surg*. 2013; 22:1371–9.
25. Arroyo JS, Hershon SJ, Bigliani LU. Special considerations in the athletic throwing shoulder. *Orthop. Clin. North Am*. 1997; 28:69–78.
26. Lin JC, Weintraub N, Aragaki DR. Nonsurgical treatment for rotator cuff injury in the elderly. *J. Am. Med. Dir. Assoc*. 2008; 9:626–32.
27. Vecchio P, Cave M, King V, *et al*. A double-blind study of the effectiveness of low level laser treatment of rotator cuff tendinitis. *Br. J. Rheumatol*. 1993; 32: 740–2.
28. Alvarez CM, Litchfield R, Jackowski D, *et al*. A prospective, double-blind, randomized clinical trial comparing subacromial injection of betamethasone and xylocaine to xylocaine alone in chronic rotator cuff tendinosis. *Am. J. Sports Med*. 2005; 33:255–62.
29. Gialanella B, Prometti P. Effects of corticosteroids injection in rotator cuff tears. *Pain Med*. 2011; 12:1559–65.
30. Werner BC, Cancienne JM, Burrus MT, *et al*. The timing of elective shoulder surgery after shoulder injection affects postoperative infection risk in Medicare patients. *J. Shoulder Elbow Surg*. 2016; 25:390–7.
31. McConville OR, Iannotti JP. Partial-thickness tears of the rotator cuff: evaluation and management. *J. Am. Acad. Orthop. Surg*. 1999; 7:32–43.
32. Lenker C, Larocca N, Lee J, Tucker P. The use of thoracic mobilization with movement to treat shoulder impingement in older adults a case study. *Top Geriatr Rehabil*. 2012; 28:195–200.
33. de Oliveira FCL, de Fontenay BP, Bouyer LJ, *et al*. Effects of kinesiotaping added to a rehabilitation programme for patients with rotator cuff tendinopathy: protocol for a single-blind, randomised controlled trial addressing symptoms, functional limitations and underlying deficits. *BMJ Open*. 2017; 7:e017951. Available from: http://dx.doi.org/10.1136/bmjopen-2017-017951. doi: 10.1136/bmjopen-2017-017951.
34. Leong HT, Ng GY, Fu SN. Effects of scapular taping on the activity onset of scapular muscles and the scapular kinematics in volleyball players with rotator cuff tendinopathy. *J. Sci. Med. Sport*. 2017; 20:555–60.
35. Krabak BJ, Sugar R, McFarland EG. Practical nonoperative management of rotator cuff injuries. *Clin. J. Sport Med*. 2003; 13:102–5.
36. Sciascia A, Thigpen C, Namdari S, *et al*. Kinetic chain abnormalities in the athletic shoulder. *Sports Med. Arthrosc. Rev*. 2012; 20:16–21.
37. Kibler WB, Sciascia AD, Uhl TL, *et al*. Electromyographic analysis of specific exercises for scapular control in early phases of shoulder rehabilitation. *Am. J. Sports Med*. 2008; 36:1789–98.
38. Cools AM, Dewitte V, Lanszweert F, *et al*. Rehabilitation of scapular muscle balance: which exercises to prescribe? *Am. J. Sports Med*. 2007; 35:1744–51.
39. Jobe FW, Pink M. Classification and treatment of shoulder dysfunction in the overhead athlete. *J. Orthop. Sports Phys. Ther*. 1993; 18:427–32.

40. Maenhout AG, Mahieu NN, De Muynck M, *et al*. Does adding heavy load eccentric training to rehabilitation of patients with unilateral subacromial impingement result in better outcome? A randomized, clinical trial. *Knee Surg. Sports Traumatol. Arthrosc*. 2013; 21:1158–67.

41. Wilk KE, Arrigo CA, Hooks TR, Andrews JR. Rehabilitation of the overhead throwing athlete: there is more to it than just external rotation/internal rotation strengthening. *PM R*. 2016; 8(Suppl. 3):S78–90.

42. Ardern CL, Glasgow P, Schneiders A, *et al*. 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. *Br. J. Sports Med*. 2016; 50:853–64.

43. Micheo W, Baerga L, Miranda G. Basic principles regarding strength, flexibility, and stability exercises. *PM R*. 2012; 4:805–11.

44. Ratte-Larouche M, Szekeres M, Sadi J, Faber KJ. Rotator cuff tendon surgery and postoperative therapy. *J. Hand Ther*. 2017; 30:147–57.

45. Koo SS, Burkhart SS. Rehabilitation following arthroscopic rotator cuff repair. *Clin. Sports Med*. 2010; 29:203–11, vii.

46. Jung C, Tepohl L, Tholen R, *et al*. Rehabilitation following rotator cuff repair: A work of the Commission Rehabilitation of the German Society of Shoulder and Elbow Surgery e. V. (DVSE) in collaboration with the German Association for Physiotherapy (ZVK) e. V., the Association Physical Therapy, Association for Physical Professions (VPT) e. V. and the Section Rehabilitation-Physical Therapy of the German Society for Orthopaedics and Trauma e. V. (DGOU). *Obere Extrem*. 2018; 13:45–61. Available from: https://www.ncbi.nlm.nih.gov/pubmed/?term=PMID%3A+29527239. doi: 10.1007/s11678-018-0448-2.

47. Kim YS, Chung SW, Kim JY, *et al*. Is early passive motion exercise necessary after arthroscopic rotator cuff repair? *Am. J. Sports Med*. 2012; 40:815–21.

48. Mahure SA, Rokito AS, Kwon YW. Transcutaneous electrical nerve stimulation for postoperative pain relief after arthroscopic rotator cuff repair: a prospective double-blinded randomized trial. *J. Shoulder Elbow Surg*. 2017; 26:1508–13.

49. Brameier DT, Hirscht A, Kowalsky MS, Sethi PM. Rehabilitation strategies after shoulder arthroplasty in young and active patients. *Clin. Sports Med*. 2018; 37:569–83.

50. Brumitt J, Meira EP, En Gilpin H, Brunette M. Comprehensive strength training program for a recreational senior golfer 11-months after a rotator cuff repair. *Int. J. Sports Phys. Ther*. 2011; 6:343–56.