55 Postoperative Rehabilitation: Return to Sport in the Noncompetitive Athlete

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Rotator cuff disease is frequently tied to tissue degeneration related to advancing age, with a higher prevalence in individuals between 40 and 60 years [1].

The cause of rotator cuff tear is usually degenerative in elderly subjects and traumatic in younger patients [2]. Athletes are especially at risk, in particular those who practice overhead or forced overhead sports (tennis, golf, baseball, basketball) and contact sports (rugby, American football, ice hockey) [3].

When lesions are symptomatic, conservative treatment is typically recommended. In some cases, it is not possible to reduce symptoms and regain function without surgical treatment. The main goals of surgical procedures for rotator cuff repair (RCR) are to restore function and reduce pain.

The healing process of collagen tissues usually occurs between 1 and 60 days after injury, with final fiber maturation occurring up to 360 days. The initial phase is inflammation (1–3 days postoperatively), followed by proliferative or tissue repair phase (3–20 days). Fibroblasts initiate collagen synthesis in the repaired tissue, and this healing tissue begins to strengthen the sutured site. The healing tissue is remodeled through gentle stress. In the first 3 weeks after surgery, the suture performed can only withstand minimal stress due to the weakness of the healing tissue. The rehabilitation program in this initial stage of healing should be focused on pain relief, minimize inflammation, increase scapular control, and prevent postoperative complications. Between 21 and 60 days, the healing tissue becomes progressively stronger and more responsive to remodeling. Therefore, moderate stress should be applied to the joint. Peak remodeling should occur between 1 and 8 weeks [4, 5].

Physiotherapy after RCR plays a fundamental role, as it facilitates the recovery of strength and function. The great question regarding rehabilitation refers to the ideal moment to start rehabilitation that should initiate and develop the ROM (range of motion) gain and muscular strengthening of the cuff rotator, without disturbing the healing process. Re-tearing and stiffness are troubling complications and may be related to when the ROM gain begins [6–10]. The current literature suggests that early movement improves ROM after RCR but with a higher risk of re-tearing the rotator cuff [10, 11].

Patients with calcific tendonitis, adhesive capsulitis, partial articular supraspinatus tendon avulsion (PASTA)-type repair, concomitant labral repair, and single-tendon RCR are at the greatest risk for stiffness development [6].

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Parsons et al. evaluated 43 patients in these conditions and hypothesized that a later start to rehabilitation after RCR can contribute to stiffness of the shoulder. The sling was used for 6 weeks, and passive ROM exercises were performed between 6 and 12 weeks and active ROM exercises after 12 weeks. Patients who presented <100° of flexion and <30° of external rotation up to 8 weeks postoperative (PO) were considered at risk of stiffness (23% of total). However, after 1 year of surgery, there were no differences in ROM between the stiff and nonstiff groups. The authors believed that slowing ROM gain in the first few weeks after the operation does not encourage stiffness, even in those who exhibit some initial ROM resistance [12].

Restoring motion, strength, and function requires a proper rehabilitation program to maintain the integrity of the rotator cuff. A very slow physiotherapy program tends to promote stiffness, but an overly aggressive approach can result in recurrent rupture [13].

We believe that the best indicator for the initiation of ROM gain and strengthening of RCR is related partly to the size of the lesion, the tissue healing time, and mainly the stability of the tendons after surgery. The conditions of preexisting tissue and the stability reached after surgical repair are the main factors that guide physiotherapy. Lesions can eventually grow large, but when they reach satisfactory stability in surgery, early mobility can be achieved.

Some informations, which a physiotherapist should know before starting rehabilitation, can help during the onset and progression of physical therapy. One of the factors that guides the immobilization time is *the surgical approach*; in some cases, the sling is needed for a greater length of time, resulting in cicatrization of the subscapular tendon or the deltoid muscle (in open surgeries). Other examples include the *size of the tears*, *fixation method utilized* (more or less stable), *location of the lesion* (whether each tendinous region involved in the repair allows certain movements, as in the case of subscapular repair that requires caution in the gain of external rotation), the *timing of surgery* (related to the risk of joint stiffness), *surrounding tissue quality* (which will guide the volume and intensity of the exercises), and *individual characteristics* (age, health habits, lifestyle, activity level, type of professional activity, and type of recreational and/or sports activity because exercises should be customized to the personal function and activities of each patient) [14].

With this information in hand, the physiotherapist can start the treatment without risk of re-tearing. Close communication between the surgeon, the patient, and the physiotherapy team is important and should be maintained throughout the recovery process.

In Brazil, a variation of post-RCR physical therapy programs exist due to the immense size of the country, which sometimes hinders the exchange of information among professionals. Access to information and the personal experiences of surgeons and physiotherapists is not uniform in all states.

Tables 55.1 and 55.2 contain detailed information on our guidelines, which were developed based on scientific evidence, tissue healing time, and the professional experiences of surgeons and physiotherapists. Table 55.1 describes the guidelines for small and/or medium lesions with stable repair, and Table 55.2 describes guidelines for large and/or medium lesions with unstable repair.

These guidelines serve as a basis for conducting physiotherapy, but the individual characteristics of each patient should be respected, and the program should be personalized. Each phase covers patient guidance, period of initiation and progression of ROM gain, initiation of strengthening, and functional exercise activities for daily living and sports.

55.1 Specific Concepts of Rehabilitation

55.1.1 Guidance

Like other authors [15, 16] we believe patient orientation and adherence to treatment are the most important points in rehabilitation. Patients

Table 55.1 Rehabilitation guideline RCR for small or medium lesions (stable repair)

Phase	ROM	Active exercises	Strengthening	Functional exercises
Phase I (3–6 weeks)	Passive elevation 90° ER 45° (0° ABD)	Active exercises elbow, wrist (avoid elbow flexion, supination strength if biceps repair or tenodesis until 8 weeks) Scapulothoracic mobility Trigger points relief Hydrotherapy if available	NO	Functional activities/ ADL guidance
Phase II (7–10 weeks)	Elevação, flexion 130° (PROM, AAROM) Flexion AROM (8 weeks) ER (0° ABD) progressive ER 45° (45° ABD) IR abduction (8 weeks) IR hand on back (8 weeks)	Slide table ER with cane Flexion supine position (8 weeks) Scapular punched supine position (8 weeks)	Isometric, isotonic scapular for stability Isotonic biceps Isometric light RC, deltoids (0° ABD) 8 weeks Flexion side position (if possible) 8 weeks Extension prone position ER side position (if possible) 8 weeks	Proprioception at ranges below 60° if possible (8 weeks)
Phase III (11–14 weeks)	Progressive flexion, elevation ER progressive (45° de ABD) ER (90° de ABD) Extension progressive	Slide wall Flexion, elevation, ER active progressive	Isotonic light for all muscles (below 90°) Flexion standing light weight (below 90°) Scapular exercises progressive Press up wall	OKC, CKC (especially athletes) Functional activities emphasize on elderly
Phase IV (15–20 weeks or more)	ROM without restriction	Without restriction	Isotonic progressive all muscles Flexion standing progressive weight Push up, push up plus, hug dynamic (if necessary) Standing scapular punched ABD horizontal (if necessary)	OKC, OKC progressive Plyometric if necessary (16 weeks) Training motion sport (16 weeks) Return sport without throwing (20 weeks) Return sport (24 weeks)

ER external rotation, *ADL* activity of daily living, *PROM* passive range of motion, *AAROM* active-assisted range of motion, *AROM* active range of motion, *ABD* abduction, *IR* internal rotation, *OKC* open kinetic chain, *CKC* closed kinetic chain, *ROM* range of motion

must respect the use of the sling, perform home exercises and follow the guidelines for daily activities as prescribed by the multiprofessional team.

The patient's expectations are often unmet because he or she has not understood the information about the surgery and the postoperative plan. Poor patient satisfaction after RCR is related to persistence of pain and dysfunction, among other complaints [16]. These clarifications can easily be made before and after the procedure.

55.1.2 Pendulum Exercises

Pendulum exercises can be potentially dangerous after RCR if performed incorrectly. Poor performance of this exercise can cause more than

Table 55.2 Rehabilitation guideline RCR for large or medium lesions (unstable repair)

Phase	ROM	Active exercises	Strengthening	Functional exercises
Phase I (6–10 weeks)	Flexion, elevation PROM, AAROM 130° ER (0° ABD) progressive	Active exercises elbow, wrist (avoid elbow flexion, supination strength if biceps repair or tenodesis until 8 weeks) Trigger points relief Scapulothoracic mobility Slide table ER with cane Hydrotherapy if available	*No*	Functional activities/ADL guidance
Phase II (11–14 weeks)	ER (45° ABD) IR abduction IR hand on back Extension (12 weeks)	Slide table ER with cane Flexion active supine position Scapular punched supine position	Isometric scapular for stability Isotonic biceps Isometric light RC, deltoids (0° ABD) Flexion side position (if possible) ER side position (if possible) Extension prone position (if possible)	Proprioception at ranges below 60° (if possible) emphasize functional activities
Phase III (15–20 weeks)	ER progressive (45° ABD) ER (90° ABD) Progression of other movements	Slide wall Active ER, flexion, IR progressives	Isotonic progressive for all muscles Scapular exercises progressive Press up wall and floor (if necessary) Horizontal abduction (if necessary)	CKC, OKC progressive Functional activities emphasize on elderly
Phase IV (20–24 weeks)	ROM without restriction	Without restriction	Isotonic progressive all muscles Flexion standing progressive weight Push up, push up plus, hug dynamic (if necessary) Standing scapular punched ABD horizontal (if necessary)	OKC, OKC progressive Plyometric if necessary Training motion sport Return sport without throwing (24 weeks) Return sport with throwing (28 weeks)

AAROM active-assisted range of motion, *ER* external rotation, *ABD* abduction, *ADL* activity of daily living, *IR* internal rotation, *CKC* closed kinetic chain, *OKC* open kinetic chain

15% of maximal voluntary isometric contraction (MVIC) of the supraspinatus and infraspinatus muscles. Significant activation of these muscles occurs even when performed correctly [17]. Therefore, we do not recommend this exercise in our RCR guidelines.

55.1.3 Sling

The surgeon, who is knowledgeable of the tissue conditions during surgery and the level of stability during repair, should determine how long the patient should wear a sling. Vieira et al. asked

78 shoulder surgeon specialists in the Brazilian Congress of Shoulder and Elbow Surgery the following question: What is the recommended time of immobilization after arthroscopic shoulder surgery? 4.3% of participants indicated early mobilization, 8.7% indicated less than 3 weeks, 67.4% indicated between 3 and 6 weeks, and 19.6% answered that the onset of mobilization depends on the lesion found. We agree that the ideal immobilization time is approximately 3 weeks for small to medium lesions with stable repairs and 4–6 weeks for large to medium lesions with unstable repairs [1].

55.1.4 Modalities

We used cryotherapy three to four times a day in the first 2 weeks postoperation [18] and two to three times in the subsequent period until pain decreased. The application of neuromuscular electrical stimulation was used in cases of acute pain.

55.1.5 ROM and Strengthening

We based ROM gain on Edwards et al. study, which conducted a systematic review on the identification of which passive, active-assisted, active, and strengthening exercises required more or less involvement of the supraspinatus and infraspinatus muscles. Forty-three exercises were analyzed with EMG, which determined the MVIC of each of them. Exercises with a maximum MVIC of 15% were considered low demand; MVICs between 15% and 20% were low-moderate; MVICs between 21% and 40% were moderate; MVICs between 41% and 60% were high demand; and an MVIC of 60% or higher was very high demand. The studies included in the review were conducted with healthy individuals; we should not extrapolate the results to individuals with RCR, because details such as lesion size, quality and integrity of the tendon, type of surgery, repaired tissue conditions, stability achieved in repair, age, and health habits directly interfere with tendon resistance to muscle contractions [8]. However, we have not identified studies evaluating rotator cuff MVIC in RCR subjects. We believe that studies of this nature can serve as a guide in the establishment of these standards. Figures 55.1, 55.2, and 55.3 illustrate MVIC exercises below 15% and above 50% for the supraspinatus, infraspinatus, and subscapular muscles, respectively.

We orient the recovery of ROM in the abduction position with extension and especially with internal rotation (Fig. 55.4), after

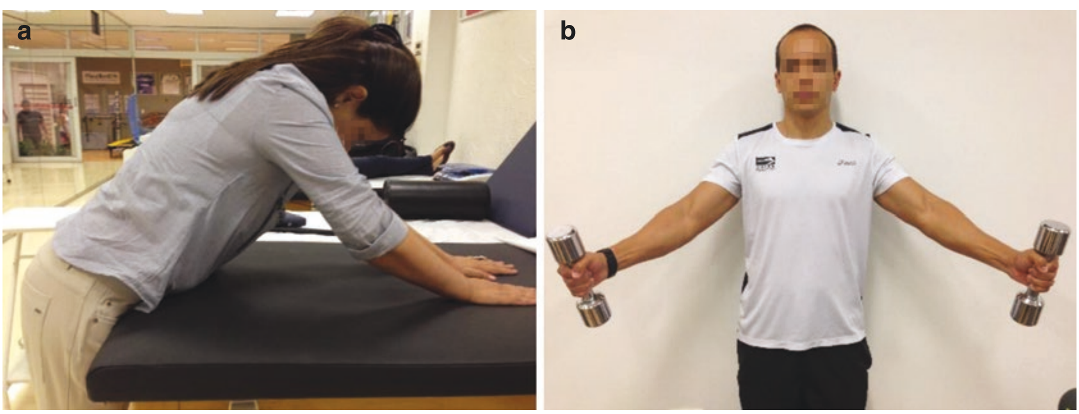

Fig. 55.1 (**a**) Slide table (MVIC <15% supraspinatus). (**b**) Full cam shoulder ABD (MVIC >50% supraspinatus)

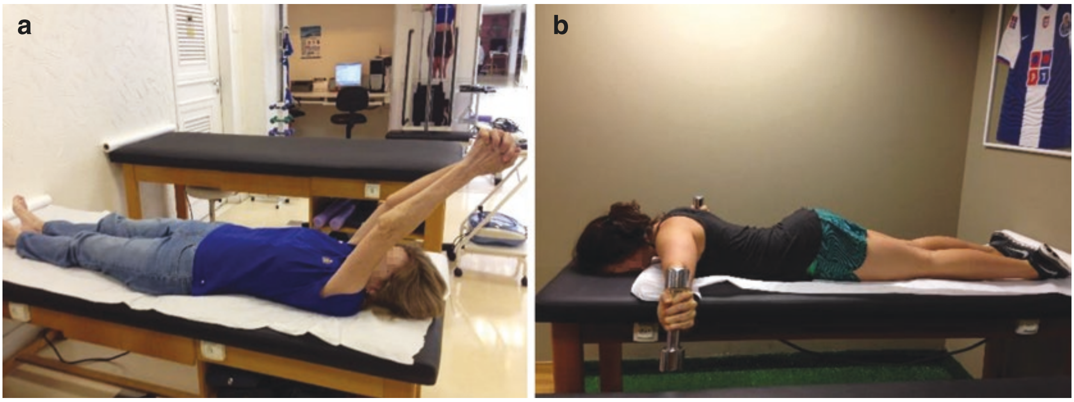

Fig. 55.2 (**a**) Supine self-assisted elevation (MVIC <15% infraspinatus). (**b**) Prone horizontal ABD 90° (MVIC >50% infraspinatus)

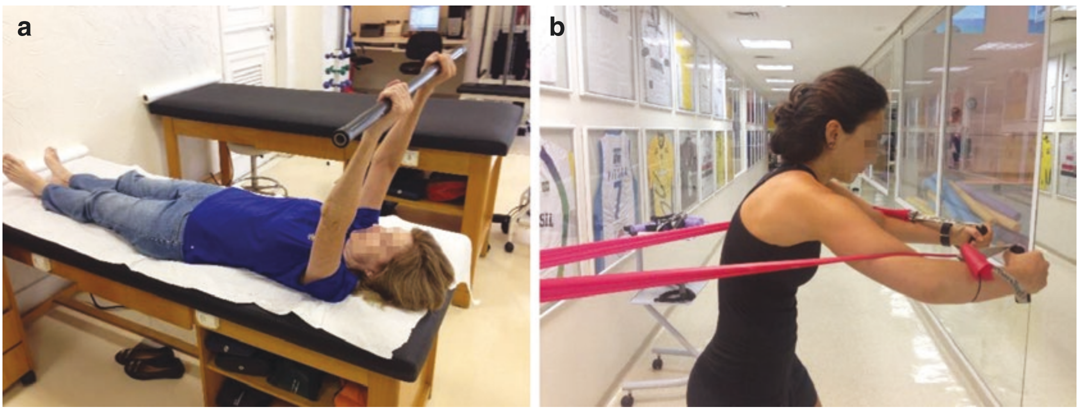

Fig. 55.3 (**a**) Pulley-assisted elevation (MVIC <15% subscapular). (**b**) Dynamic hug (>50% MVIC subscapular)

Fig. 55.4 Extension with abduction that promotes tension in the supraspinatus muscle

10–12 weeks of PO, because this position causes a significant increase in tension in the rotator cuff [9, 19].

55.1.6 Activation and Strengthening of the Scapular Muscles

The rotator cuff functions to promote co-contraction, to lower the humeral head, and to promote shoulder movements. These movements cannot occur if the scapula does not maintain the axis of rotation in the glenohumeral, allowing for optimal performance of the rotator cuff. When the scapula does not perform the support role for the movements of the humerus, the result is a condition defined as scapular dyskinesis [20]. In the presence of dyskinesis, the combination of anterior tilt, internal rotation, and upward rotation of the scapula is common during arm elevation, as opposed to the expected movement of posterior tilt, external rotation, and upward rotation [21]. The three-dimensional scapular movement is necessary to maintain the subacromial space throughout the movements.

Dyskinesis is a common condition observed in individuals with or without injury [22–24]. In postoperative situations, the shoulder is expected to present scapular activation deficits; these should be minimized until the treatment is completed. In our experience, even after 6 months of physical therapy, scapular dyskinesis is common even in patients who have performed well in the exercises. We argue that these individuals may have had some altered scapular patterns for chronic lesions or individual biomechanics, prior to the procedure.

Scapular performance is predictive of rotator cuff activity at various shoulder positions. For this reason, scapular training is considered one of the pillars of shoulder rehabilitation.

Activating the scapular muscles requires multiplane exercises, following an ascending order of difficulty and performance. Once the patient performs an exercise satisfactorily, the difficulty of training can progress. Strengthening the rotator cuff muscles requires good posture of the body and, consequently, of the scapula. This demonstrates that muscle groups are trained together rather than in isolation, even though some of them may be activated more easily in certain positions.

The important muscles that should be focused on are the anterior serratus and lower and medium trapezium to prevent the scapular dyskinesis (Figs. 55.5 and 55.6). The power of these muscles and superior trapezium keeps the correct scapulohumeral rhythm [25–28].

Fig. 55.5 Strengthening of the anterior serratus in closed kinetic chain

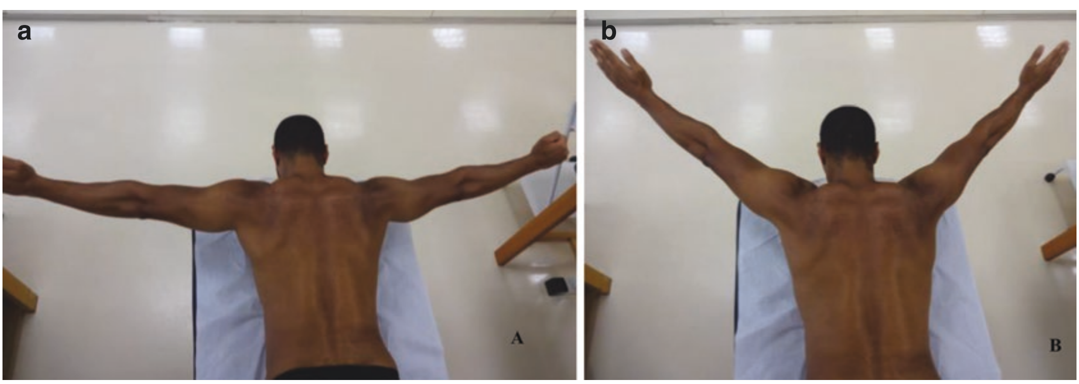

Fig. 55.6 Trapezium strengthening medium fibers (**a**) and lower fibers (**b**)

55.2 Sensory-Motor Training, Advanced Strength, and Return to Activity

After surgical intervention, the functional rehabilitation program is vital for the return of normal shoulder function. Regaining a joint's sense of position and neuromuscular control requires training. Functional rehabilitation is believed to increase sensitivity and facilitate the coactivation of the afferent responses of the capsuloligamentous and musculotendinous receptors, and reactive muscular contractions [29]. Functional exercises include open kinetic chain (OKC) and closed kinetic chain (CKC), allowing the reproduction of movements and postures from daily life as well as sports activities.

The final phase of rehabilitation consists of overhead strengthening, progressing endurance, advanced closed chain, proprioceptive, and plyometric exercises. Based on the functional status and strength achieved at this point postoperatively, patients may or may not be appropriate for this phase of rehabilitation. The physical therapist should focus on specific functional requirements based on strength deficits [30].

OKC exercises with ball-throwing movements are included, in addition to CKC exercises that simulate falls and movements on the ground. In both cases, the CORE activation is needed to maintain the correct muscular activation sequence and transfer and dissipate energy in the kinetic chain [31, 32].

The diagonal exercises are used to strengthen the muscles (Fig. 55.7). The diagonal D1 in the flexor pattern (acceleration) and extension (deceleration) activates the rotator cuff, scapular waist, and deltoid muscles, which is important to improve the coactivation of the intra-articular power couples [33, 34].

The sensory-motor training is an important part of the program. The lack of shoulder stability increases the need of the sensory-motor system for neuromuscular control. The feed forward and feedback mechanisms are considered as critical points of the kinetic chain, making their training extremely important for the prevention of lesions [35].

Fig. 55.7 Diagonal exercise (D1)

Plyometric training is also included, which facilitates the increase of excitability of the neural system and the reactive capacity of the neuromuscular system of healthy athletes shoulders (Figs. 55.8 and 55.9). This training includes the eccentric movement that produces elastic energy and transforms this accumulated energy into kinetic energy, which is transferred to the concentric phase using the shortening-strengthening cycle [36–38].

The return to the sport should be done gradually. The Advanced Throwers Ten Exercise Program [39] can be included. This program consists of exercises that restore muscle balance and symmetry in the overhead-throwing athlete, which is necessary for the symptom-free return to sports after lesion. Specific exercises for the sport of each patient can be used [40], as in the figures. The Brazilian shoulder surgeons agreed in relation to the time taken to return to sports (>6 months) [1].

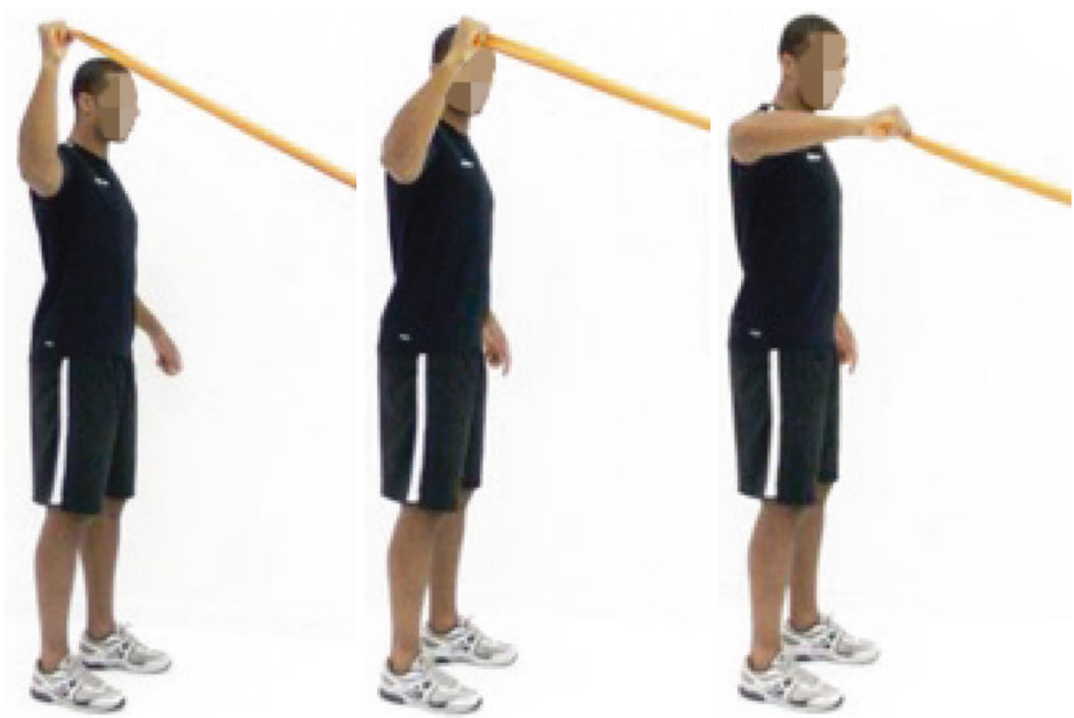

Fig. 55.8 Plyometric exercise in external rotation

Fig. 55.9 Plyometric exercise in internal rotation

55.3 Criteria to Return to Sports

Clinical decision-making for determining the successful completion of a rehabilitation program and thus safe return to activity can be challenging. There is no consensus on treatment or timing to return to play. Is a general practice, concurrent with most studies, athletes are allowed to return to play when they can demonstrate symmetric range of motion and strength and perform sport-specific exercises without pain and limitations.

Measures of strength, mobility, resistance, or pain do not necessarily translate into the patient's ability to perform a specific movement, such as the sporting gesture. However, these measures are used to as criteria of return to sport.

Clinicians have some instruments to assist them in making discharge and return to activity decisions, with most clinicians opting to use some variation of a strength measure as a means of determining cessation of treatment or activity readiness [41]. The strength test identifies possible deficiencies and assesses safe progress in rehabilitation.

Routinely, the manual muscle testing is applied during the rehabilitation to identify strength deficits and strength imbalances. In conditions where neurological integrity is compromised, manual muscle testing may have clinical value. However, manual muscle testing may not have robust value as an individual evaluation tool for musculoskeletal injury with an absence of nerve injury or neurological dysfunction [41].

Isokinetic evaluation of IR and ER strength can help determine a functional-strength profile in patients suffering from shoulder disorders to guide diagnosis, therapy, and rehabilitation [42].

Due to the absence of a gold standard of assessment for upper extremity physical performance [41], clinicians will often utilize some variation of strength testing because force is a basic component for the execution of fundamental physical tasks. Furthermore, strength testing is for identifying potential impairments and assessing progress in the secure rehabilitation setting; it has been recognized that single-component physiological measurements of strength, mobility, endurance, or pain do not necessarily translate to a patient's ability to perform a highly skilled dynamics task [43].

Evaluation tests of the upper limb are used in clinical and sports practices to provide important information about functional performance. Specifically, dynamic tests, whether in an OKC (pull-up, throwing test, and shot putting) or CKC (one-arm hop test, upper quarter Y-balance test, and the closed kinetic chain upper extremity stability test), enable not only the identification of possible deficits in strength and muscular power but also to evaluate proprioception and motor control [44–47].

These instruments have a low cost of application; are portable, easy, and quick to administer; and provide an immediate result which contributes to the use in clinical practice. However, the clinical measurement properties of these tests should be better evaluated for individuals with rotator cuff lesions.

55.4 Considerations

One of the main expectations of athletes, whatever their age or level of play, is to return to sports after treatment, if possible at the same level as before injury. This is especially true of professional and competitive athletes [48].

In their systematic literature review, Plate et al. [3] found 83.3% of the patients returning to competitive sports with a mean of 8.6 months after the intervention out of 124 recreational athletes (sports using the upper limb above the head) who underwent arthroscopic debridement or either arthroscopic or open cuff repair.

Klouche et al. [48] in their meta-analysis included 25 studies, with 859 patients (683 athletes) all treated surgically (arthroscopic debridements, arthroscopic repairs, repairs by minimally invasive approach, and open surgery). Although their results do not differentiate the type of treatment performed, it showed that the overall rate of return to sports was 84.7% with 65.9% of participants returning to play at the same level after between 4 and 17 months. However, if considering only professional and competitive athletes, the returned to play at the same level as before their injury was 49.9%.

Vives et al. [49] found 89.7% of patients who underwent open acromioplasty and rotator cuff repair and arthroscopic acromioplasty and mini-open repair returning to nonprofessional golf at the same level as their pre-lesion level, but with a weekly intensity significantly reduced.

Sonnery-Cottet et al. [50] evaluated 51 amateur tennis players with rotator cuff repair (open repair and arthroscopic debridement), found 78.4% of the patients returning to sport at a mean 9.8 months after surgery at an identical or better level at the last follow-up in 77.5% of the cases, and not found difference in the ability to return to tennis between types of surgery.

Studies evaluated patients with arthroscopic rotator cuff repair who participating in a recreational sport soliciting the shoulder showed better results. Antoni et al. [51] found 88.6% of the returned to the same sport: 91.7% of the golfers, 88.9% of the tennis players, and 76.9% of the swimmers. Liem et al. [52] found better results in their study when they evaluated recreational athletes who undergone arthroscopic repair with 100% of the patients returning to sports at a weekly frequency and duration identical to their preoperative activity.

Bathia et al. [53] assessed a series of 31 recreational sports patients over 70 years of age operated for arthroscopic rotator cuff repair, and they noted that 77% of these patients returned to their sport at the same level. However, older individuals have characteristics that can make rotator cuff repair more challenging and contribute to the worst outcomes after surgery: higher prevalence to massive rotator cuff tears compared with younger patients [54], decreased bone quality, lamellar dissection, and fatty infiltration are more common [55], and healing may be impaired by poor blood supply, as histologic examination of rotator cuff tendon tissue has shown decreased vascularity in older patients [56].

There is a contrast between the recreational and the professional athlete in the literature regarding treatment of complete rotator cuff tears. Return to sports has been far more difficult for professional overhead-throwing athletes. High-level athletes who experience rotator cuff tear have a dramatically inferior prognosis for returning to sports compared with recreational athletes.

This is an important information because it shows that a professional player cannot rely on surgical repair of the rotator cuff to return him to a sports career at the same level. Although many patients do not return to play at the same level, the results of the studies in terms of pain relief or range of motion are almost all very good [48].

One of the hypotheses to explain this is that psychological factors, such as fear of another injury or loss of confidence in the shoulder, are usually not evaluated even though they may influence the return to sports [48].

Analyzing failures of the rotator cuff repairs, studies have suggested risk factors for a poor functional outcome: degenerative origin [57], work-related injuries [58], full-thickness tears [49, 58–60], associated labral injuries [57, 61, 62], and late surgery [63]. According to the literature, the risk factors of returning to sports at a lower level of play are professional athletic status [60, 63] and a delayed return [50].

According to a systematic review published by Ejnisman et al. [64], no studies with a high level of evidence have demonstrated what the best approach should be, in dealing with rotator cuff injuries.

Several limitations can be observed in the studies related of the return to sport. The first is the low level of evidence of the studies. We were unable to look for risk factors of not returning to sports, because most of the authors proposed a hypothesis [48]. Most of the studies do not mention the postoperative treatment performed or cite poorly. There is little information about how the return to the sport was made and what criteria were used.

55.5 Conclusion

Our objective was to provide guidelines and instructions for rehabilitation teams to administer efficient treatments after RCR. These guidelines are not intended to replace decision-making with regard to clinical treatment or the progression of a patient's postoperative course. The rehabilitation program must be adapted to the particulars of the case and the reality of the service. We base our protocol on tissue healing time, surrounding tissue quality conditions, and repair stability at the same time that movement, strength, and function are reestablished.

The return to sports in the postoperative of the rotator cuff is still a challenge for clinicians. Decision-making involves several factors, from the type and extent of the injury, the type of surgery, and the rehabilitation process performed.

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