

REHABILITACIJA NAKON REKONSTRUKCIJE TETIVA ROTATORNE MANŠETE



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Rupture tetiva rotatorne manšete česte su u odraslih osoba i broj ruptura povećava se s dobi. Simptomatske rupture javljaju se u 4–32% slučajeva i često nije potrebno operacijsko liječenje, s obzirom na dobre rezultate nakon rehabilitacijskih postupaka. Ipak, rekonstrukcija tetiva rotatorne manšete jedan je od najčešće izvedenih ortopedskih zahvata na ramenu, osobito u populaciji srednje dobi te u osoba koje se bave zahtjevnim fizičkim poslovima ili aktivnostima. Korištenjem artroskopije i suvremenih ortopedskih materijala znatno su poboljšani ishodi operacijskog liječenja, no i dalje je funkcionalni rezultat vezan uz optimalnu poslijeoperacijsku rehabilitaciju. Kao i uvijek, rehabilitacijski cilj je osigurati cijeljenje, spriječiti komplikacije, smanjiti bol te vratiti snagu, pokretljivost i funkciju ramenog zgloba. Rotatornu manšetu čine tetive četiri mišića: supraspinatusa, infraspinatusa, teres minora i supskapularisa, koji aktivno stabiliziraju glenohumeralni zglob. Oštećenja najčešće nastaju uslijed degenerativnih promjena koje kompromitiraju tetivnu strukturu, a u manjem broju kao posljedica traume. Javlja se bol, ograničenje pokreta i smanjenje funkcionalnosti. Bolesnici otežano podižu ruku, otežano se oblače, češljaju, nose teret i bol ih budi noću. Konzervativno liječenje bazira se na iskorištavanju preostalog potencijala edukacijom i modifikacijom aktivnosti i redovito provođenjem vježbi koje pospješuju mišićnu kontrolu, kako samih mišića rotatorne manšete tako i stabilizatora lopatice. Sam rehabilitacijski proces je dugotrajan i, ako ne dolazi do poboljšanja, u obzir dolazi operacijsko liječenje, najčešće artroskopska rekonstrukcija tetiva mišića rotatorne manšete. Cijeljenje tetiva rotatorne manšete nakon rekonstrukcije kompleksan je biološki i biomehanički proces; dolazi do formiranja fibroznog ožiljnog tkiva, čija su mehanička svojstva inferiornija u odnosu na izvorno hvatište. Sam proces cijeljenja odvija se kroz tri preklapajuće faze: upalnu, proliferativnu i fazu remodeliranja. U ranoj upalnoj fazi (prvih nekoliko tjedana) dominira infiltracija upalnih stanica, povećana vaskularna permeabilnost i oslobađanje citokina. U proliferativnoj fazi dolazi do migracije fibroblasta i sinteze kolagena tipa III, koji je slabije organiziran i manje otporan na mehanička opterećenja, a u fazi remodeliranja, koja može trajati mjesecima, kolagen tipa III postupno se zamjenjuje kolagenom tipa I. Biomehanički, rekonstruirana tetiva u više mjeseci ima smanjenu otpornost na tenziju. Neadekvatno dozirano opterećenje može dovesti do mikropukotina, elongacije tetive ili rerupture i produžuje rehabilitaciju. Stoga su ciljevi poslijeoperacijske rehabilitacije: kontrola boli i otekline, zaštita rekonstruirane tetive, očuvanje i postupno povećanje opsega pokreta, prevencija mišićne atrofije i skapularne diskinezije. Kao glavni cilj se postavlja restitucija funkcije

i povratak radnim i ostalim aktivnostima. Razvojem novih tehnologija u rehabilitaciju se uvode proširena ili virtualna stvarnost te različiti oblici povratne biološke sprege za koje se čini da pozitivno utječu na ishod liječenja. Kao i uvijek, rehabilitacijski protokol mora biti individualiziran, uzimajući u obzir veličinu rupture, kvalitetu tetivnog tkiva, kiruršku tehniku, dob bolesnika i komorbiditete. U prvoj fazi rehabilitacije (0-4/6 tjedana) naglasak je na zaštiti rekonstruirane tetive. Ruka se najčešće imobilizira u abdukcijskoj ortozi i aktivni pokreti u ramenom zglobu nisu dopušteni. Mogu se provoditi analgetski postupci, potpomognute vježbe te aktivne vježbe šake, ručnog zgloba i lakta uz vježbe za vratnu kralježnicu i posturalnu kontrolu. Uloga fizijatra u ovoj fazi je kontrola boli, praćenje cijeljenja te prevencija sekundarnih komplikacija poput povećanja otekline ili razvoja kompleksnog regionalnog bolnog sindroma. U drugoj fazi (4/6-8 tjedana) započinje postupno povećanje pasivnog, a zatim asistiranog aktivnog opsega pokreta. Cilj je poboljšanje mobilnosti bez ugrožavanja integriteta tetive. Rade se asistirane aktivne vježbe zatvorenog kinetičkog lanca i mobilizacija i stabilizacija lopatice. Potreban je oprez kod antigravitacijskih pokreta. Nakon postizanja zadovoljavajućeg pasivnog opsega pokreta u trećoj fazi (8-12/16 tjedana), uvode se aktivni pokreti bez i potom s otporom. Fokus je na neuromuskularnoj kontroli i jačanju stabilizatora ramena. Napretkom slijedi četvrta faza funkcionalnog oporavka (4-6 mjeseci i dalje), koja je usmjerena na povrat pune funkcije ramena, uključujući radne, sportske i rekreativne aktivnosti. Komplikacije su izazovi u rehabilitaciji i nerijetko se jave u poslijeoperacijskoj rehabilitaciji. Najčešće komplikacije uključuju kontrakturu ramena, perzistentnu bol, slabost mišića i rerupturu tetive. Dolazi do dodatnog pogoršanja i produženog i otežanog liječenja u slučaju razvoja smrznutog ramena i centralne senzitivizacije. Reruptura predstavlja jednu od najznačajnijih dugotrajnih komplikacija, s incidencijom koja ovisi o veličini početne ruptуре i kvaliteti tetivnog tkiva. Često je posljedica kombinacije slabog biološkog cijeljenja i prekomjernog mehaničkog opterećenja u ranoj fazi rehabilitacije. Klinički se može manifestirati perzistentnom boli, gubitkom snage i ograničenjem funkcije, ali u dijelu bolesnika ostaje supklinička. Rizični čimbenici su starija dob, velika početna ruptura, dijabetes melitus i slabija suradljivost bolesnika. Potrebna je pravovremena identifikacija problema i prilagodba rehabilitacijskog protokola kako bi se postigli optimalni rezultati. Poslijeoperacijska rehabilitacija nakon rekonstrukcije tetiva rotatorne manšete složen je i dugotrajan proces. Specijalist fizikalne medicine i rehabilitacije je nakon operacije koordinator rehabilitacijskog procesa. S obzirom na klinički i funkcionalni status indiciraju se rehabilitacijski postupci te se u skladu s njima mijenjaju. Multidisciplinarni pristup značajno poboljšava ishod liječenja.

Ključne riječi

rame, rehabilitacija, rekonstrukcija, rotatorna manšeta

ROTATOR CUFF REPAIR REHABILITATION

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Rotator cuff tendon tears are common in adults, and their incidence increases with age. Symptomatic tears occur in approximately 4-32% of cases, and surgical treatment is often not required given the favorable outcomes achieved with rehabilitation interventions. Nevertheless, rotator cuff tendon reconstruction remains one of the most frequently performed orthopedic procedures, particularly in middle-aged individuals and in patients engaged in physically demanding occupations or activities. The use of arthroscopic techniques and modern orthopedic materials has significantly improved surgical outcomes; however, functional results remain dependent on optimal postoperative rehabilitation. As always, the primary goals of rehabilitation are to ensure tendon healing, prevent complications, reduce pain, and restore the strength, mobility, and function of the shoulder joint. The rotator cuff consists of the tendons of four muscles; supraspinatus, infraspinatus, teres minor, and subscapularis, that actively stabilize the glenohumeral joint. Ruptures most commonly result from degenerative changes that compromise tendon structure, and less frequently as a result of the trauma. Clinical manifestations include pain, restricted range of motion, and reduced functional capacity. Patients experience difficulty lifting the arm, dressing, combing hair, carrying loads, and pain that frequently disrupts sleep. Conservative treatment is based on maximizing residual functional potential through patient education, activity modification, and regular exercise programs aimed at improving muscular control of both the rotator cuff muscles and the scapular stabilizers. The rehabilitation process itself is prolonged, and in cases where improvement is insufficient, surgical treatment is considered, most commonly arthroscopic rotator cuff tendon reconstruction. The healing of the rotator cuff tendons following reconstruction is a complex biological and biomechanical process, characterized by the formation of fibrous scar tissue whose mechanical properties are inferior to those of the native tendon-to-bone insertion. The healing process progresses through three overlapping phases: inflammatory, proliferative, and remodeling phases. During the early inflammatory phase (the first several weeks), infiltration of inflammatory cells, increased vascular permeability, and cytokine release predominate. In the proliferative phase, fibroblast migration and synthesis of type III collagen occur; this collagen being less organized and less resistant to mechanical loading. During the remodeling phase, which may last for several months, type III collagen is gradually replaced by type I collagen. Biomechanically, the reconstructed tendon demonstrates reduced tensile strength for several months. Inadequately dosed mechanical loading may lead to microtears, tendon elongation, or rerupture, thereby prolonging rehabilitation. Accordingly, the goals of postoperative rehabilitation include pain and edema/effusion control, protection of the reconstructed tendon, preservation and gradual restoration of range of motion, and prevention of muscle atrophy and scapular dyskinesis. The primary objective is the restoration of function and return to occupational and other activities. With the development of new technologies, rehabilitation

programs increasingly incorporate augmented or virtual reality and various forms of biofeedback, which appear to have a positive impact on treatment outcomes. As always, the rehabilitation protocol must be individualized, taking into account tear size, tendon tissue quality, surgical technique, patient age, and comorbidities. In the first phase of rehabilitation (0–4/6 weeks), the emphasis is on protecting the reconstructed tendon. The arm is most commonly immobilized in an abduction brace, and active movements of the shoulder joint are not permitted. Analgesic modalities, assisted exercises, and active exercises of the hand, wrist, and elbow may be performed, along with exercises for the cervical spine and postural control. The role of the physiatrist during this phase includes pain control, monitoring of tendon healing, and prevention of secondary complications such as increased swelling or the development of complex regional pain syndrome. In the second phase (4/6–8 weeks), gradual progression of passive and subsequently assisted active range of motion is initiated. The goal is to improve mobility without compromising tendon integrity. Assisted active exercises in a closed kinetic chain are introduced, as well as scapular mobilization and stabilization exercises. Caution is required with antigravity movements. After achieving an adequate passive range of motion, the third phase (8–12/16 weeks) involves the introduction of active movements, initially without resistance and subsequently with resistance. The focus is on neuromuscular control and strengthening of the shoulder stabilizers. With continued progression, the fourth phase of functional recovery (4–6 months and beyond) aims at restoring full shoulder function, including occupational, sports, and recreational activities. Complications represent significant challenges in postoperative rehabilitation and are not uncommon. The most frequent complications include shoulder contracture, persistent pain, muscle weakness, and tendon rerupture. Additional deterioration and prolonged, more difficult treatment may occur in cases of frozen shoulder and central sensitization. Rerupture is one of the most significant long-term complications, with incidence depending on the size of the initial tear and the quality of tendon tissue. It is often the result of a combination of poor biological healing and excessive mechanical loading in the early rehabilitation phase. Clinically, it may present with persistent pain, loss of strength, and functional limitation, although in some patients it remains subclinical. Risk factors include advanced age, large initial tear size, diabetes mellitus, and poor patient compliance. Timely identification of problems and appropriate modification of the rehabilitation protocol are essential to achieve optimal outcomes. Postoperative rehabilitation following rotator cuff tendon reconstruction is a complex and long-term process. After surgery, the specialist in physical and rehabilitation medicine acts as the coordinator of the rehabilitation process. Rehabilitation interventions are prescribed and modified according to the patient's clinical and functional status. A multidisciplinary approach significantly improves treatment outcomes.

Keywords

shoulder, rotator cuff, repair, rehabilitation

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