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CLINICAL ASSESSMENT, WORKUP AND TREATMENT OF MENISCUS TEARS: COMPARISON OF CONSERVATIVE AND SURGICAL APPROACH

KLINIČKA PROCJENA, OBRADA I LIJEČENJE OZLJEDA MENISKA: USPOREDBA KONZERVATIVNOG I OPERACIJSKOG PRISTUPA

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ABSTRACT

Introduction: Meniscus tears represent a significant challenge in orthopaedic practice, in which the selection of an optimal therapeutic approach often depends on multiple factors. *Materials and methods:* This paper provides a comprehensive review of meniscus tear treatment with a focus on comparing non-surgical and surgical approaches. The anatomy and physiology of the meniscus are analysed in detail, as well as diagnostic methods for injuries, such as magnetic resonance imaging and clinical examinations. The paper explains the difference between traumatic and degenerative meniscus tears, describing their characteristics and optimal therapeutic approaches. The treatment methods described in this paper are compared, and further divided into non-surgical and surgical treatments. *Results:* Non-surgical treatment, including physical therapy, use of nonsteroidal anti-inflammatory drugs (NSAIDs), and intra-articular injections, is compared to surgical methods such as arthroscopic partial meniscectomy (APM) and meniscal repair techniques. While non-surgical treatment is the first choice for degenerative tears, surgical treatment is more commonly used in traumatic tears, especially in the treatment of younger patients. Platelet-rich plasma (PRP) has shown the best results as a form of therapy used for reducing pain and improving joint function in traumatic tears. Surgical treatment, especially meniscal repair surgery, shows better long-term functional outcomes despite a higher reoperation rate (16.5%) compared to arthroscopic partial meniscectomy (1.4%). Meniscal repair, despite the higher reoperation rate, ensures better long-term functional results than meniscectomy. *Conclusion:* The importance of an individualized treatment approach is emphasized, taking into account factors such as patient age, type of injury, and long-term functional outcomes. Recent studies have further highlighted the cost-effectiveness of meniscal repair procedures when considering the reduced risk of osteoarthritis development and the potential need for future knee replacement surgery.

Keywords: meniscus, meniscus tear, arthroscopy, physical therapy, meniscal repair

SAŽETAK

Uvod: Ozljede meniska predstavljaju značajan izazov u ortopedskoj praksi, gdje odabir optimalnoga terapijskog pristupa često ovisi o više čimbenika. *Materijal i metode:* Ovaj rad pruža sveobuhvatan pregled liječenja ozljeda meniska s posebnom pozornošću na usporedbu neoperacijskih i operacijskih pristupa. Detaljno se analiziraju anatomija i fiziologija meniska, kao i dijagnostičke metode ozljeda poput magnetne rezonancije i kliničkih testova. Rad objašnjava razliku između traumatske i degenerativne ozljede meniska, opisujući njihove karakteristike i optimalne terapijske

pristupe. *Rezultati:* Kroz rad se uspoređuju metode liječenja s podjelom na neoperacijsko i operacijsko liječenje. Neoperacijsko liječenje, uključujući fizikalnu terapiju, primjenu nesteroidnih protuupalnih lijekova (engl. *nonsteroidal anti-inflammatory drugs*, u daljnjem tekstu NSAID) i intraartikularne injekcije uspoređuju se s operacijskim metodama poput artroskopske djelomične meniscektomije (u daljnjem tekstu ADM) i tehnikama šivanja meniska. Dok je neoperacijsko liječenje prvi izbor kod degenerativnih ozljeda, operacijsko liječenje češće se primjenjuje kod traumatskih ozljeda, posebno u mlađih pacijenata. Plazma bogata trombocitima (engl. *platelet riched plasma*, u daljnjem tekstu PRP) kao oblik terapije istaknula se najboljim rezultatima u smanjenju boli i poboljšanju funkcije zgloba kod traumatskih ozljeda. Operacijsko liječenje, osobito šivanje meniska, pokazuje bolje dugoročne funkcionalne ishode unatoč višoj stopi reoperacija (16,5%) u usporedbi s artroskopskom djelomičnom meniscektomijom (1,4%). Šivanje meniska, unatoč višoj stopi reoperacija, dugoročno osigurava bolje funkcionalne rezultate od meniscektomije. *Zaključak:* Potreban je individualiziran pristup liječenju, uzimajući u obzir čimbenike poput dobi pacijenta, vrste ozljede i dugoročnih funkcionalnih ishoda.

Ključne riječi: menisk, ozljeda meniska, artroskopija, fizikalna terapija, šivanje meniska

INTRODUCTION

The meniscus, as one of the key structures in the knee joint, has the primary role of distributing load between the articular surfaces, thereby protecting the cartilage (1). When a meniscus tear occurs, its ability to protect the cartilage is reduced, which can lead to the gradual development of degenerative changes in the knee known as osteoarthritis (1). Among knee injuries, meniscus tears are extremely common, with an estimated incidence of 60 to 70 cases per 100,000 knee injuries (1).

The menisci are crescent-shaped structures that play a key role in the biomechanics of the knee. Their specific structure allows for even load distribution and shock absorption, thus protecting the articular cartilage from excessive wear and tear. The diagnosis of meniscus tears has seen significant milestones throughout the history of medicine. An important breakthrough in diagnostics was made in 1928 by Thomas McMurray, a British orthopaedist, when he described the first specific clinical test for detecting meniscus tears (2). This test became the foundation for the later development of over twenty different clinical tests for the assessment of meniscus tears. A significant breakthrough in diagnostics also occurred in 1951, when Masaki Watanabe, a Japanese surgeon, constructed a prototype of a modern arthroscope (3). This invention enabled a direct visualization of the meniscus, thus significantly improving diagnostic capabilities. Although arthroscopy was initially used primarily for diagnostic purposes, today it is predominantly used as a therapeutic method. In the early 1970s, magnetic resonance imaging (MRI) was introduced, a non-invasive diagnostic method that allows for detailed visualization of the anatomical structures of the knee without the need for invasive procedures (3). The choice of treatment method for meniscus tears, which can be conservative or surgical, largely depends on the type of injury, i.e. whether it is traumatic or degenerative.

UVOD

Menisk, kao jedna od ključnih struktura u zglobu koljena, ima primarnu ulogu raspodjele opterećenja između zglobnih površina, čime štiti hrskavicu (1). Kada dođe do oštećenja meniska, njegova sposobnost zaštite hrskavice se smanjuje, što može dovesti do postupnog razvoja degenerativnih promjena u koljenu, osteoartritisa (1). Među ozljedama koljena, ozljede meniska su izuzetno učestale, s procijenjenom učestalošću od 60 do 70 slučajeva na 100.000 ozljeda koljena (1).

Menisci su polumjesečaste strukture koje imaju ključnu ulogu u biomehanici koljena. Njihova specifična građa omogućuje ravnomjernu raspodjelu opterećenja i apsorpciju udaraca, čime štite zglobnu hrskavicu od prekomjernog trošenja. Dijagnostika ozljeda meniska bilježi značajne prekretnice kroz povijest medicine. Važan iskorak u dijagnostici napravio je britanski ortoped Thomas McMurray 1928. godine, kada je opisao prvi specifični klinički test za detekciju ozljeda meniska (2). Ovaj je test postao temelj za kasniji razvoj više od dvadeset različitih kliničkih testova za procjenu ozljede meniska. Značajan pomak u dijagnostici dogodio se i 1951. godine, kada je japanski kirurg Masaki Watanabe konstruirao prototip modernog artroskopa (3). Ovaj je izum omogućio izravnu vizualizaciju meniska, značajno unaprijedivši dijagnostičke mogućnosti. Iako je artroskopija inicijalno korištena primarno u dijagnostičke svrhe, danas se pretežno primjenjuje kao terapijska metoda. Početkom 1970-ih godina uvedena je magnetska rezonancija (MR), neinvazivna dijagnostička metoda koja omogućuje detaljan prikaz anatomskih struktura koljena bez potrebe za invazivnim postupcima (3). Izbor metode liječenja ozljeda meniska, konzervativne ili kirurške, uvelike ovisi o vrsti ozljede, odnosno je li ona traumatska ili degenerativna.

Ovaj članak će se usredotočiti na različite pristupe liječenju, s naglaskom na usporedbu neoperacijskih i operacijskih metoda. Posebna pažnja bit će posvećena

This article will highlight different treatment approaches, putting an emphasis on comparing non-surgical and surgical methods. Special attention will be paid to differences in therapeutic approach depending on the nature of the meniscus tear.

ANATOMY

The menisci are connective cartilaginous tissues located between the condyles of the femur and tibia. Viewed from above, the menisci have a characteristic, crescent-like, C-shape, while in cross-section they are wedge-shaped (3). They do not cover the entire articular surface between the tibia and femur. The medial meniscus covers approximately 60% of the medial tibial plateau, while the lateral meniscus covers approximately 80% of that area. (4). Looking from front to back, the menisci can be divided into three equal sections. The front part of the meniscus is called the anterior horn, the back part is called the posterior horn, and the middle part is called the body of the meniscus. Their main functions include load transfer, knee stabilization, and shock absorption. Vascularization is ensured by the popliteal artery, and blood supply is divided into three zones: red, red-white and white (3). The outer part of the meniscus, known as the red zone, is located near the perimeniscal capillary plexus and is highly vascularized. On the other hand, the inner part of the meniscus forms the white zone, and is characterized by complete avascularity. Between these two zones there is a red-white zone that is partially vascularized. The peroneal nerve is responsible for innervation (2).

MENISCUS TEARS

The European Society of Sports Traumatology, Knee Surgery & Arthroscopy (hereinafter: ESSKA) has defined the characteristics of traumatic and degenerative lesions and issued guidelines for their treatment (5). A traumatic meniscus injury is defined as a 'meniscus tear', which is associated with a sufficient knee injury and a sudden onset of knee pain. Meanwhile, a 'meniscus lesion' is a degenerative meniscus tear marked by a slow progression of tissue degeneration without a history of an acute trauma. Meniscus tears are morphologically divided into horizontal tears, root tears, and vertical tears, which include longitudinal and radial tears (5). It is important to distinguish between traumatic and degenerative meniscus tears, given the fundamental differences in their optimal treatment.

Traumatic meniscus injury

Traumatic meniscus injury most often occurs in sports injuries, falls, or blows to the knee, which causes sudden rotation or hyperflexion in the knee joint (6). It can occur on its own, but is more often associated with

razlikama u terapijskom pristupu ovisno o prirodi ozljede meniska.

ANATOMIJA

Menisci su vezivno-hrskavične strukture koje su smještene između kondila femura i tibije. Gledani odozgo, menisci imaju karakterističan oblik slova C, dok su u poprečnom presjeku klinastog oblika (3). Ne prekrivaju cjelokupnu zglobnu površinu između tibije i femura; medijalni menisk pokriva otprilike 60% medijalnog platoa tibije, dok lateralni menisk pokriva otprilike 80% (4). Možemo ih podijeliti na tri jednaka dijela gledajući od sprijeda prema straga. Prednji dio meniska naziva se prednjim rogom, stražnji dio se naziva stražnjim rogom, a srednji dio se naziva tijelo meniska. Njihove glavne funkcije uključuju prijenos opterećenja, stabilizaciju koljena i apsorpciju šoka. Vaskularizaciju osigurava poplitealna arterija, a prokrvljenost se dijeli u tri zone: crvenu, crveno-bijelu i bijelu (3). Vanjski dio meniska, poznat kao crvena zona, nalazi se u blizini perimeniscealnog kapilarnog pleksusa te je bogato vaskulariziran. S druge strane, unutarnji dio meniska čini bijelu zonu, a karakterizira ga potpuna avaskularnost. Između tih dviju zona smještena je crveno-bijela zona koja je djelomično vaskularizirana. Za inervaciju je zadužen peronealni živac (2).

OZLJEDE MENISKA

Europsko društvo za sportsku traumatologiju, kirurgiju koljena i artroskopiju (engl. *European Society of Sports Traumatology, Knee Surgery & Arthroscopy*, u daljnjem tekstu ESSKA) definiralo je karakteristike traumatskih i degenerativnih ozljeda meniska te donijelo smjernice za njihovo liječenje (5). Traumatska ozljeda definira se kao „puknuće meniska" povezano s ozljedom koljena i naglim početkom boli. S druge strane, „lezija meniska" označava degenerativnu ozljedu meniska obilježenu sporom progresijom bez akutne traume. Pukotine meniska morfološki se dijele na horizontalne pukotine, ozljede korijena meniska i vertikalne pukotine koje obuhvaćaju longitudinalne i radijalne pukotine (5). Bitno je razlikovati traumatsku i degenerativnu ozljedu meniska, s obzirom na ključne razlike u načinu njihova optimalnog liječenja.

Traumatska ozljeda

Traumatska ozljeda najčešće nastaje kod sportskih ozljeda, padova ili udaraca u koljeno, što uzrokuje naglu rotaciju ili hiperfleksiju u zglobu koljena (6). Može se javiti samostalno, ali češće je udružena s ozljedama ligamenata koljena (5). Ozljede meniska uslijed traume učestalije su među populacijom mlađom od 30 godina, pri čemu su sportaši poput nogometaša, atletičara i skijaša pod znatno povećanim rizikom od ovog

knee ligament injuries (5). Trauma-related meniscus tears are more common among individuals under 30. Furthermore, athletes such as football players, track and field athletes, and skiers are at significantly increased risk of this type of injury (7). Trauma-related meniscus tears are manifested by a painful reaction and sensitivity along the joint line, as well as a skipping or locking sensation during an activity (8). Early and accurate diagnosis of these injuries through clinical examination and MRI is crucial for an adequate and successful treatment. Trauma-related meniscus tears usually result in vertical tears or meniscus root tears (5). Most often, these are radial tears that can significantly damage the meniscus, especially because they are often located in areas of the meniscus with poor blood supply, making spontaneous healing difficult (6). Longitudinal tears are characteristic in that they follow the natural curvature of the meniscus and are often associated with chronic ligament injuries.

Degenerative meniscus injury

The meniscus is subject to degenerative changes that occur over a long period of time due to wear and tear of the knee joint, and are often associated with chronic ligament injuries. These changes are common in the general population, and their incidence increases with age, thus they can be present in 50% of patients over the age of 70 (9). They can be seen as an indicator of increased risk for osteoarthritis or as part of the degenerative process in the knee itself. Degenerative meniscus tears usually manifest gradually, with characteristic horizontal or complex tears. It is important to note that most degenerative lesions do not cause symptoms, and even when symptoms are present, they may not necessarily be related to the lesion (9). Possible signs include knee pain, swelling, stiffness, and limited mobility (6). The diagnosis is made through a combination of clinical examination and X-ray imaging. A knee X-ray is always performed with the patient in a standing position, and is primarily used to assess the degree of osteoarthritis. MRI is not used as the first line of diagnosis in elderly people with knee pain. It is used only in specific cases with persistent symptoms or to plan surgical treatment (9).

DIAGNOSIS

The diagnosis of meniscus tears has evolved over time. Clinical examinations, such as the McMurray test that was first described in 1928, are still important for distinguishing meniscus tears from other knee injuries. Arthrography, which was a crucial procedure in the past, has been replaced by MRI, while arthroscopy, although considered the most accurate method, is currently used primarily for treatment, and in exceptional cases for diagnosis when clinical findings and MRI

tipa ozljede (7). Traumatske ozljede meniska očituju se bolnom reakcijom i osjetljivošću duž zglobnog prostora, kao i preskokom tijekom aktivnosti (8). Rana i precizna dijagnostika ovih ozljeda putem kliničkog pregleda i MR-a ključna je za adekvatno i uspješno liječenje. Traumatske ozljede meniska obično rezultiraju vertikalnim pukotinama ili oštećenjem korijena meniska (5). Najčešće su to radijalne pukotine koje mogu znatno oštetiti menisk, osobito zato jer se često nalaze u slabije prokrvljenim zonama meniska otežavajući spontano cijeljenje (6). Longitudinalne pukotine karakteristične su po tome što prate prirodnu zakrivljenost meniska i često su povezane s kroničnim ozljedama ligamenata.

Degenerativna ozljeda

Menisk podliježe degenerativnim promjenama koje nastaju tijekom duljeg vremena uslijed trošenja koljenskog zgloba. Ove promjene su česte u općoj populaciji, a njihova učestalost raste s godinama, dosežući čak 50% kod osoba u sedmom desetljeću života (9). Mogu se promatrati kao indikator povećanog rizika za osteoartritis ili kao dio samoga degenerativnog procesa u koljenu. Degenerativna oštećenja meniska obično se manifestiraju postupno, s karakterističnim horizontalnim ili kompleksnim pukotinama. Važno je napomenuti da većina degenerativnih lezija ne uzrokuje simptome, a čak i kada su simptomi prisutni, oni ne moraju nužno biti povezani s lezijom (9). Mogući znakovi uključuju bol u koljenu, oteklinu, ukočenost i ograničenu pokretljivost (6). Dijagnoza se postavlja kombinacijom kliničkog pregleda i rendgenskog snimanja. Rendgen koljena se obvezno izvodi u stojećem položaju pacijenta, a prvenstveno služi za procjenu stupnja osteoartritisa. MR se ne koristi kao prva linija dijagnostike kod starijih osoba s bolnim koljenom. MR se koristi samo kod specifičnih slučajeva s perzistentnim simptomima ili zbog potrebe planiranja operacijskog liječenja (9).

DIJAGNOSTIKA

Dijagnostika ozljeda meniska evoluirala je kroz vrijeme. Klinički testovi, poput McMurrayjevog iz 1928. godine, i dalje su važni za razlikovanje ozljeda meniska od drugih ozljeda koljena. Nekad ključna artrografija zamijenjena je MR-om, dok artroskopija, iako najpreciznija, danas služi prvenstveno za liječenje, a iznimno za dijagnostiku kada se klinički nalaz i nalaz MR-a ne podudaraju (2). Ultrazvuk, kao brza i dostupna dijagnostička metoda, također nalazi svoju primjenu u inicijalnoj procjeni ozljeda meniska.

Klinički pregled

Dijagnostika ozljede meniska započinje anamnezom i kliničkim pregledom. McMurrayev test, iako znača-

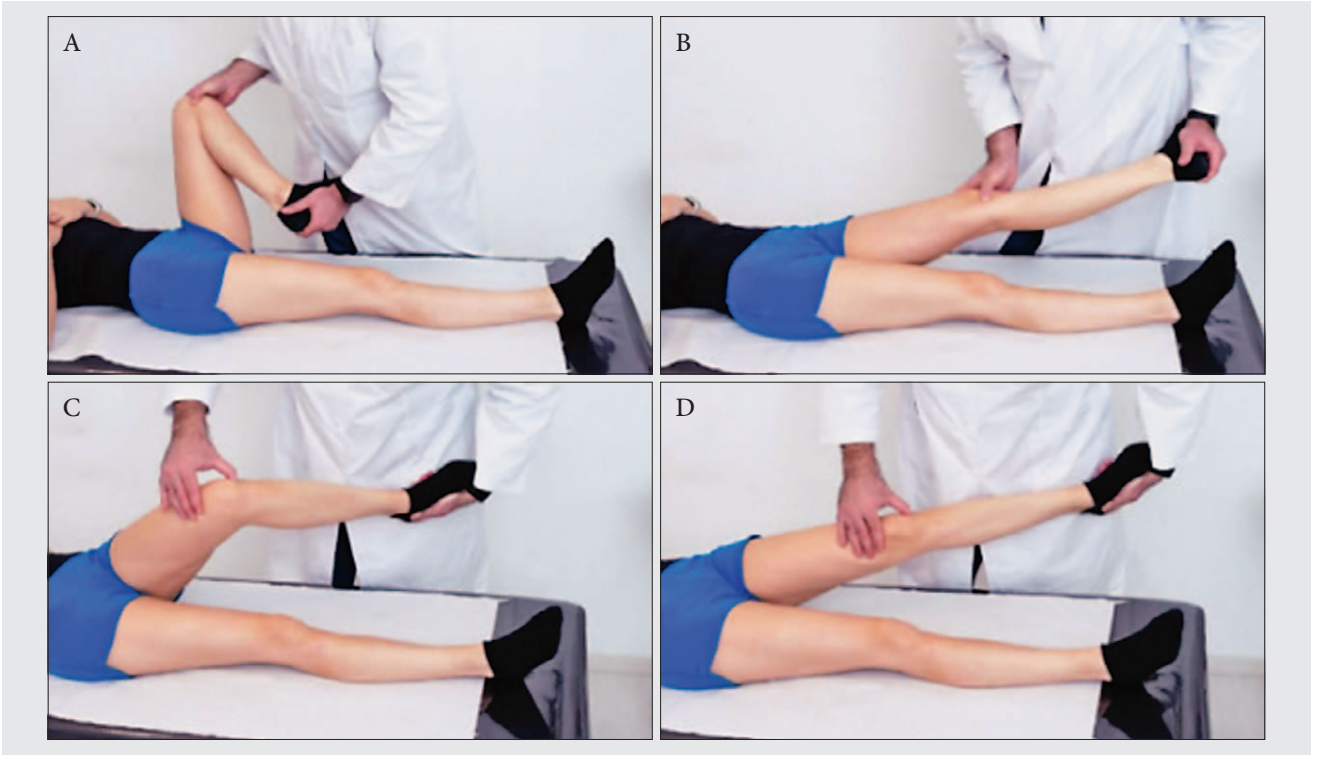


FIGURE 1. McMurray test; A – initial position of the patient during the medial meniscus tear test, leg in external rotation and flexion; B – final position of the patient during the medial meniscus tear test, leg in external rotation and extension; C – initial position of the patient during the lateral meniscus tear test, leg in internal rotation and flexion; D – final position of the patient during the lateral meniscus tear test, leg in internal rotation and extension

SLIKA 1. McMurrayev test; A – početni ležeći položaj pacijenta pri testiranju ozljede medijalnog meniska, noga u vanjskoj rotaciji i fleksiji; B – krajnji položaj pacijenta pri testiranju ozljede medijalnog meniska, noga u vanjskoj rotaciji i ekstenziji; C – početni položaj pacijenta pri testiranju ozljede lateralnog meniska, noga u unutarnjoj rotaciji i fleksiji; D – krajnji položaj pacijenta pri testiranju ozljede lateralnog meniska, noga u unutarnjoj rotaciji i ekstenziji

findings do not match (2). Ultrasound is also used in the initial assessment of meniscus tears due to its speed and availability.

Clinical examination

The diagnosis of a meniscus tear begins with a patient's medical history and clinical examination. The McMurray test, while significant, is not sufficient when used on its own. The modern practice relies on multiple tests, and recent research suggests that a combination of three specific tests (the Thessaly test, the McMurray test, and the joint line tenderness of the knee test) can provide results similar to MRI (10).

The McMurray test is performed while the patient is lying on their back. The examiner carefully manipulates the patient's leg, performing a combination of knee rotation and flexion (2). During this procedure, the joint space is simultaneously palpated, while the examiner attempts to detect any signs of meniscus damage (Figure 1). A positive McMurray test is indicated by pain or a noticeable popping sensation in the knee (2).

The Thessaly test is performed while the patient is in a standing position, standing on one leg, while the examiner holds their hands for support. The patient then rotates their body from one side to the other three times, first at 5° of knee flexion, then at 20° and finally at 45° (Figure 2). A positive test is indicated by pain or a sensation of locking in the knee (2).

Joint line tenderness is assessed by palpating the joint line with the patient lying on their back and the knee flexed at 90°. The examiner applies pressure to the joint line using their fingers, typically starting from the medial side and then moving to the lateral side. Pain or tenderness during palpation may indicate a meniscus tear (2).

Clinical examination, while important, is not always reliable on its own. Studies have shown that the accuracy of clinical tests can vary depending on the experience of the examiner and the specific characteristics of the tear. Therefore, clinical findings should be interpreted in conjunction with imaging studies, such as MRI, to confirm the diagnosis and guide treatment decisions (2).

Klinički pregled

Dijagnoza ozljede meniska započinje anamnezom i kliničkim pregledom. McMurrayev test, iako značajan, nije dovoljan sam po sebi. Moderna praksa oslanja se na više testova, a nedavno istraživanje sugerira da kombinacija triju specifičnih testova (Thessaly test, McMurrayev test i bolnost zglobne pukotine na palpaciju) može dati rezultate slične MR-u (10).

McMurrayev test izvodi se dok pacijent leži na leđima. Ispitivač pažljivo manipulira nogom pacijenta, izvodeći kombinaciju rotacije i fleksije koljena (2). Tijekom ovog postupka, istovremeno se i palpira zglobna pukotina, nastojeći otkriti eventualne znakove oštećenja meniska (slika 1). Pozitivan rezultat manifestira se bolom ili primjetnim preskokom u koljenu (2).

Thessaly test se izvodi u stojećem položaju: pacijent stoji na jednoj nozi, dok ispitivač pruža potporu držeći njegove ispružene ruke. Pacijent potom okreće svoje tijelo u jednu pa u drugu stranu tri puta i to prvo pri 5° fleksije u koljenu, a potom tri puta pri 20° fleksije (slika 2). Postupak je potrebno ponoviti na suprotnoj nozi. Nelagoda u zglobnoj pukotini tijekom rotacije upućuje na moguću ozljedu meniska (2).

Test bolnosti zglobne pukotine na palpaciju je test u kojem pacijent leži na stolu za pregled. Koljena su u fleksiji od 90°, a stopala na stolu (slika 3). Ispitivač vrši pritisak na zglobnu pukotinu koljena svojim pal-

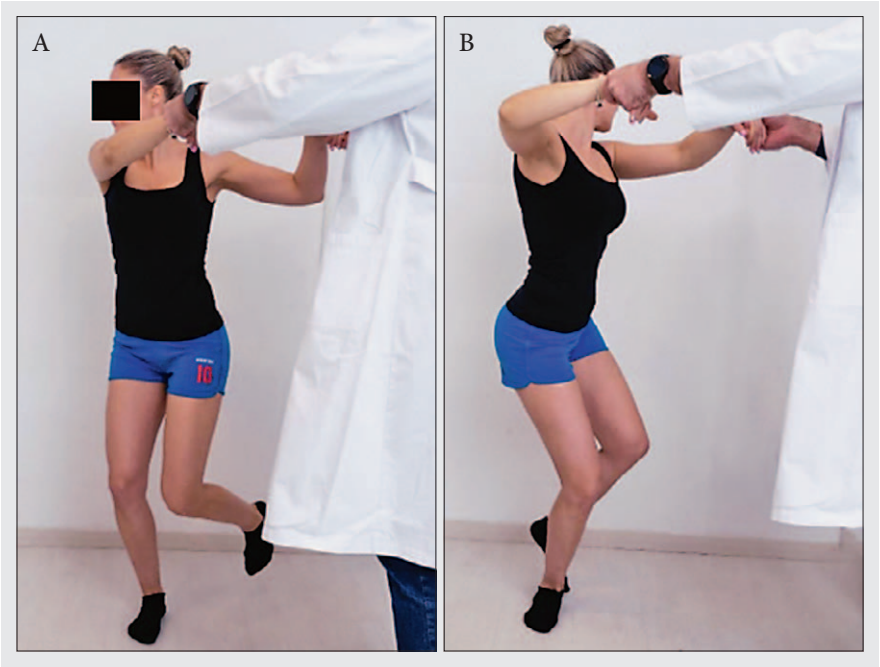


FIGURE 2. Thessaly test (A – rotation of the body into maximum external rotation around the tested leg to assess lateral meniscus tear; B – rotation of the body into maximum internal rotation around the tested leg to assess medial meniscus tear).
SLIKA 2. Thessaly test (A – okret tijela u maksimalnu vanjsku rotaciju oko noge koja se ispituje za procjenu ozljede lateralnog meniskusa; B – okret tijela u maksimalnu unutarnju rotaciju oko noge koja se ispituje za procjenu ozljede medijalnog meniskusa)

aminer provides support by holding their outstretched hands. The patient then turns their body from side to side three times, first maintaining the 5° knee flexion, and then three times at 20° flexion (Figure 2). The procedure must be repeated on the opposite leg. If the patient experiences discomfort in the joint space during rotation that indicates a possible meniscus tear (2).

The joint line tenderness (JLT) test is a physical exam that is performed while the patient is lying on their back. The patient's knees are flexed at 90° and their feet are on the table (Figure 3). The examiner palpates the joint line with their thumb and if the patient experiences pain, the test is considered positive (2).

Magnetic resonance imaging

MRI has become the leading method for imaging meniscus tears due to its non-invasiveness and ability to visualize other knee structures. However, this method also has its limitations. In addition to its high cost and limited availability, it presents several challenges: it is contraindicated in the presence of internal metallic objects and cardiac pacemakers, problematic for people with claustrophobia, and long examination times and waiting lists can delay timely treatment (11). MRI is used after a thorough clinical examination, especially in unclear cases. The MRI analysis of the meniscus includes assessment of its shape and signal intensity. Meniscus damage is classified into three grades: grade 0 indicates a normal, healthy meniscus, grades I and II indicate changes that do not extend to the meniscus surface, while grade III indicates a tear that passes through the meniscus surface (12). The diagnosis of a meniscus tear using MRI is based on two key signs:

cem; ako se pacijent požali na bol test se smatra pozitivnim (2).

Magnetna rezonancija

MR je postao vodeća metoda za prikaz ozljede meniska zbog svoje neinvazivnosti i mogućnosti prikaza ostalih struktura koljena. Međutim, ova metoda ima i svoja ograničenja. Uz visoku cijenu i ograničenu dostupnost predstavlja nekoliko izazova: kontraindicirana je kod metalnih implantata i srčanih elektrostimulatora, problematična za osobe s klaustrofobijom, a dugo trajanje pregleda i liste čekanja mogu odgoditi pravovremeno liječenje (11). MR se koristi nakon temeljitoga kliničkog pregleda, posebno kod nejasnih slučajeva. MR analiza meniska uključuje procjenu njegovog oblika i intenziteta signala. Oštećenja se klasificiraju u tri stupnja: stupanj 0 označava zdrav menisk, stupnjevi I i II pokazuju promjene koje ne dosežu površinu meniska, dok stupanj III ukazuje na pukotinu koja prolazi kroz površinu meniska (12). Dijagnoza puknuća meniska na MR-u temelji se na dva ključna znaka: prodor signala do površine meniska i promjena njegovog oblika (13). Prisutnost oba znaka snažno upućuje na puknuće. MR također pruža uvid u karakteristike puknuća, što je ključno za terapijski pristup (13).

Ultrazvuk

Posljednjih godina ultrazvuk koljena bilježi sve širu primjenu u brojnim medicinskim specijalizacijama, uključujući sportsku medicinu, reumatologiju i medicinu boli. Kao dijagnostička metoda, ultrazvuk nudi značajne prednosti: neinvazivan je, ekonomičan i brži od MR-a, uz mogućnost dijagnostike u stvarnom vremenu, što omogućuje rano liječenje (11). MRI se pokazao supe-

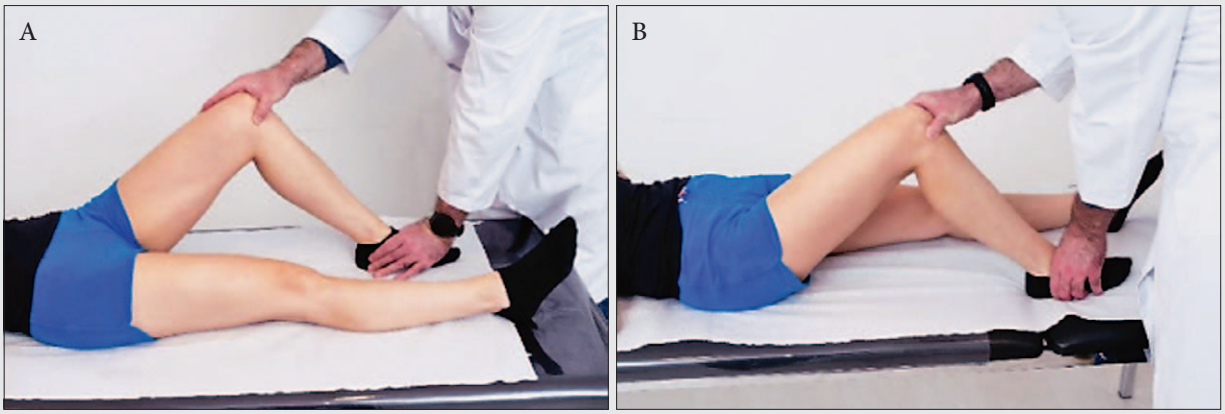


Figure 3. Joint line tenderness test (A – leg position during joint line tenderness test with the knee flexed at 90° and the examiner's thumb palpating the medial joint line during the medial meniscus tear test; B – leg position during the joint line tenderness test with the knee flexed at 90° and the examiner's thumb palpating the lateral joint line during the lateral meniscus tear test).

Slika 3. Test bolnosti zglobne pukotine na palpaciju (A – položaj noge pri izvođenju testa bolnosti zglobne pukotine na palpaciju u položaju od 90° fleksije koljena i s palcem ispitivača u medijalnoj zglobnoj pukotini pri testiranju ozljede medijalnog meniska; B – položaj noge pri izvođenju testa bolnosti zglobne pukotine na palpaciju u položaju od 90° fleksije koljena i s palcem ispitivača u lateralnoj zglobnoj pukotini pri testiranju ozljede lateralnog meniska)

increased signal intensity that extends to the surface of the meniscus and a change in the shape of the meniscus (13). The presence of both signs strongly suggests a tear. MRI also provides insight into the characteristics of a meniscus tear, which is crucial for the therapeutic approach (13).

Ultrasound

In recent years, knee ultrasound has seen increasing use in numerous medical specialties, including sports medicine, rheumatology, and pain medicine. As a diagnostic method, ultrasound offers significant advantages: it is non-invasive, economical and faster than MRI. It also has the ability of providing a real-time diagnosis, which enables early treatment (11). MRI has been shown to be superior in detecting meniscus tears. The MRI tests revealed a sensitivity of 94% and a specificity of 87.8% in identifying meniscus tears, which is significantly higher compared to ultrasound, especially for lateral meniscus tears (14). Its ability to provide detailed visualization of the medial and lateral meniscus allows for precise assessment of complex injuries, including ligament tears and joint effusions (15). Nevertheless, ultrasound diagnostics is also a cornerstone of clinical practice. Although the interpretation of findings is significantly dependent on the experience of the physician performing the examination, which can result in variability in results, ultrasound often serves as a valuable alternative in settings where MRI is not available or where its use is contraindicated (16). This is especially important in smaller healthcare facilities where it can serve as an effective tool for initial injury assessment.

riornijim u detekciji ozljeda meniska, sa senzitivnošću od 94% i specifičnošću od 87,8%, što značajno nadmašuje ultrazvuk, posebice kod ozljeda lateralnog meniska (14). Njegova sposobnost detaljnog prikaza medijalnog i lateralnog meniska omogućuje preciznu procjenu kompleksnih ozljeda, uključujući rupture ligamenata i zglobne izljeve (15). Međutim, ultrazvučna dijagnostika također ima svoje mjesto u kliničkoj praksi. Iako je interpretacija nalaza značajno ovisna o iskustvu liječnika koji izvodi pregled, što može rezultirati varijabilnošću u rezultatima, ultrazvuk često služi kao vrijedna alternativa u sredinama gdje MRI nije dostupan ili je kontraindiciran (16). Ovo je posebno važno u manjim zdravstvenim ustanovama gdje može poslužiti kao učinkovit alat za inicijalnu procjenu ozljeda.

LIJEČENJE

Pri odabiru terapije za ozljede meniska ključni su čimbenici vrsta ozljede i način nastanka. Traumatska oštećenja često zahtijevaju operaciju, dok se degenerativna oštećenja, po smjernicama ESSKA-e, uvijek prvo liječe konzervativno i to u trajanju od minimalno tri mjeseca. Kirurško liječenje kod degenerativnih ozljeda dolazi u obzir ako konzervativno liječenje nije dalo željene rezultate i uz uvjet da osoba nema izražene degenerativne promjene zgloba na rendgenu (17). Prognoza liječenja ovisi i o mjestu puknuća, s boljim izgledima za periferne ozljede u crvenoj zoni, gdje može doći i do cijeljenja meniska bez operacijskog liječenja (1).

Neoperacijsko liječenje

Neoperacijsko liječenje meniska obuhvaća fizikalnu terapiju, uporabu nesteroidnih protuupalnih lijekova

TREATMENT

The selection of appropriate treatment for meniscus tears depends on several crucial factors, such as the type of tear and its mechanism. Traumatic tears often require surgery, while degenerative tears, according to ESSKA guidelines, always require conservative treatment first, for a minimum of 3 months. Surgical treatment for degenerative tears is considered if conservative treatment has not yielded the desired results and provided that the person does not have pronounced degenerative changes in the joint on X-ray (17). The prognosis for treatment also depends on the location of the tear, with better prospects for peripheral injuries in the red zone, where meniscus healing may occur without surgical treatment (1).

Non-surgical treatment

Non-surgical treatment of the meniscus includes physical therapy, the use of nonsteroidal anti-inflammatory drugs (NSAIDs), and intra-articular injection (18). A conservative approach is the primary treatment choice for degenerative meniscus tears. Certain traumatic meniscus tears, such as minor vertical tears in childhood, can also be successfully treated with a conservative approach, including physical therapy and activity reduction, without the need for surgery (19).

Physical therapy is crucial in treating meniscus tears in the elderly. Studies indicate that up to 10 weeks of regular quadriceps strengthening exercises can improve knee function by up to 35% in patients with meniscus tears and knee osteoarthritis (20). Research indicates equal effectiveness of physical therapy and arthroscopic partial meniscectomy (APM) for degenerative meniscus tears in people over 45 (21). The goal of physical therapy is to improve the range of motion, stability, and functional ability of the knee, which ultimately contributes to the successful recovery of meniscus tears (21). Nonsteroidal anti-inflammatory drugs (NSAIDs) are used to reduce pain and inflammation in meniscus tears (21). Although they alleviate the symptoms, they do not cure the structural damage of the meniscus, and are therefore used as an addition to other conservative treatment methods. It is important to adhere to the prescribed doses and duration of therapy due to possible side effects. The main side effects include gastrointestinal problems, cardiovascular problems, and kidney damage (22). Patients with a history of gastrointestinal bleeding or high cardiovascular risk are at significant risk, and therefore the use of NSAIDs should be avoided in these patients (23).

Intra-articular drug administration involves direct injection of the drug into the joint, most commonly in patients with degenerative meniscus tears and osteoarthritis (24). Glucocorticoids, hyaluronic acid, PRP (engl. *nonsteroidal anti-inflammatory drugs*, u daljnjem tekstu NSAID) i intraartikularnu primjenu lijekova (18). Konzervativni pristup je primarni izbor liječenja za degenerativne ozljede meniska. Određene traumatske ozljede meniska, poput manjih vertikalnih puknuća u dječjoj dobi, također se mogu uspješno liječiti konzervativnim pristupom, uključujući fizikalnu terapiju i smanjenje aktivnosti, bez potrebe za operacijom (19).

Fizikalna terapija je ključna u liječenju puknuća meniska kod starijih osoba. Redovite vježbe jačanja kvadricepsa kroz deset tjedana mogu poboljšati funkciju koljena do 35% kod pacijenata s puknućem meniska i osteoartritisom koljena (20). Istraživanja ukazuju na jednaku učinkovitost fizikalne terapije i artroskopske djelomične meniscektomije (ADM) za degenerativne ozljede meniska kod osoba starijih od 45 godina (21). Cilj fizikalne terapije jest poboljšati opseg pokreta, stabilnost i funkcionalnu sposobnost koljena, što u konačnici doprinosi uspješnom oporavku ozljeda meniska (21). Nesteroidni antireumatici (NSAR) primjenjuju se za smanjenje boli i upale kod ozljeda meniska. Iako ublažavaju simptome, ne liječe strukturno oštećenje meniska te se zbog toga upotrebljavaju kao dodatak drugim konzervativnim metodama. Važno je pridržavati se propisanih doza i trajanja terapije zbog mogućih nuspojava. Glavne nuspojave su gastrointestinalni problemi, kardiovaskularni problemi i oštećenja bubrega (22). Poseban rizik imaju pacijenti s poviješću gastrointestinalnog krvarenja ili s kardiovaskularnim rizikom, zbog čega bi se kod njih trebala izbjegavati upotreba NSAR-a (23).

Intraartikularna primjena lijekova uključuje direktnu primjenu lijeka u zglob, najčešće kod pacijenata s degenerativnim puknućem meniska i osteoartritisom (24). Koriste se glukokortikoidi, hijaluronska kiselina, platelet rich plasma (PRP) i primjena mezenhimalnih matičnih stanica (22). Glukokortikoidi, poznati po svom imunomodulatornom učinku, koriste se za smanjenje upale i boli u zglobovima. Istraživanje provedeno 2019. godine, koje su proveli Wilderman i suradnici, pokazalo je da ultrazvučno vođene injekcije glukokortikoida u menisk pružaju značajno ublažavanje boli u trajanju od oko 5,68 tjedana (25). Osim toga, intraartikularna primjena hijaluronske kiseline poboljšava funkciju zgloba i dovodi do smanjenja boli kod pacijenata s degenerativnim oštećenjima meniska (24). PRP terapija koristi koncentriranu krv pacijenta za poticanje regeneracije tkiva (22). Bondariev i suradnici proveli su 2022. godine istraživanje koje je usporedilo učinkovitost PRP-a i NSAR-a s fizikalnom terapijom i ADM-om kod traumatskih ozljeda meniska (26). PRP se pokazao najučinkovitijim u smanjenju boli i poboljšanju funkcije zgloba, kako kratkoročno tako i dugoročno (26). NSAR i fizikalna terapija bili su najmanje

therapy, and the administration of mesenchymal stem cells are used (22). Glucocorticoids, known for their immunomodulatory effects, are used to reduce inflammation and joint pain (22). A 2019 study conducted by Wilderman et al. showed that ultrasound-guided meniscus-targeted glucocorticoid injections provided significant pain relief lasting approximately 5.68 weeks (25). In addition to that, it was demonstrated that intra-articular injection of hyaluronic acid improved joint function and reduced pain in patients with degenerative meniscus tears (24). PRP therapy utilizes the patient's concentrated blood to stimulate tissue regeneration (22). Bondariev et al. conducted a study in 2022 that compared the effectiveness of PRP, NSAIDs in combination with physical therapy, and arthroscopic partial meniscectomy (APM) in traumatic meniscus tears (26). PRP has emerged as the most effective treatment for reducing pain and improving joint function, both in the short and long term (26). NSAIDs and physical therapy were the least effective treatments, while APM showed initial improvement, but with worsening symptoms after the second year (26). A 2020 study conducted by Guenoun et al. showed promising results in the treatment of degenerative meniscus tears (27). Their study confirmed that PRP can be safely and effectively administered directly into the meniscal tissue (27). Patients who received this type of intrameniscal therapy showed significant improvement, with reduced pain and improved knee function (27). Research on intra-articular injection of mesenchymal stem cells in patients with meniscus tears is still in its early stages, and it is largely limited to in vitro studies and animal studies (28).

Surgical treatment

Studies conducted in the 1980s addressed the importance of the meniscus for knee stability, which prompted the development of methods for its preservation and repair (20). Surgical intervention is recommended in patients with meniscus tears in the vascularized, red zone, complex and larger lesions longer than 1 cm, acute injuries that occurred within the last 6 weeks, patients under 40, and in case of concomitant anterior cruciate ligament (ACL) tear (20).

Nowadays, meniscectomy is performed using open or arthroscopic approaches, and it can be partial or total (complete). Total meniscectomy is avoided because of the risk of early osteoarthritis (29). With the development of modern arthroscopic surgery, the open approach has become obsolete and is only used in exceptional situations when the meniscus is severely damaged and causes significant discomfort (30). This includes cases such as large radial meniscus tears or meniscus root tears, especially in knees already affected by osteoarthritis (30). APM is the preferred method

učinkoviti, dok je ADM pokazao početno poboljšanje, ali s pogoršanjem simptoma nakon druge godine (26). Istraživanje koje su proveli Guenoun i suradnici 2020. godine pokazalo je obećavajuće rezultate u liječenju degenerativnih ozljeda meniska (27). Njihova studija je potvrdila da se PRP može sigurno i učinkovito aplicirati direktno u meniskalno tkivo (27). Pacijenti koji su primili ovakvu intrameniskalnu terapiju pokazali su značajno poboljšanje, došlo je do smanjenja boli i unaprjeđenja funkcije koljena (27). Istraživanja o intraartikularnoj primjeni mezenhimalnih matičnih stanica kod pacijenata s puknućem meniska još su u početnim fazama, uglavnom ograničena na *in vitro* istraživanja i pokuse na životinjama (28).

Operacijsko liječenje

Istraživanja iz 1980-ih potvrdila su važnost meniska za stabilnost koljena, što je potaknulo razvoj metoda za njegovo očuvanje i popravak (20). Kirurška intervencija se preporučuje kod pacijenata s puknućima meniska u vaskulariziranoj, crvenoj zoni, kompleksnim i većim lezijama duljim od 1 cm, akutnim ozljedama koje su nastale unutar posljednjih šest tjedana, mlađih od 40 godina te u slučaju istodobne ozljede prednjega križnog ligamenta (20).

Meniscektomija se u današnje vrijeme izvodi otvoreno ili artroskopski, a može biti parcijalna (djelomična) ili totalna (potpuna). Totalna meniscektomija se izbjegava zbog rizika od ranog osteoartritisa (29). Razvojem moderne artroskopske kirurgije otvoreni pristup je postao zastario te se primjenjuje samo u iznimnim situacijama, kada je menisk teško oštećen i izaziva značajne tegobe (30). To uključuje slučajeve poput velikih radijalnih puknuća ili oštećenja korijena meniska, posebno kod koljena koja su već zahvaćena osteoartritisom (30). ADM je preferirana metoda zbog manje invazivnosti i bržeg oporavka. Preporučene indikacije za ADM su degenerativna oštećenja koja ne reagiraju na konzervativnu terapiju te radijalne pukotine smještene u avaskularnoj, bijeloj zoni meniska. Cilj ADM-a je ukloniti oštećeni dio meniska uz očuvanje perifernog ruba (32). ADM, iako minimalno invazivan, može ubrzati razvoj osteoartritisa zbog promijenjene biomehanike koljena (1). Klinička istraživanja ukazuju na lošije ishode i nižu razinu zadovoljstva kod pacijenata s degenerativnim puknućem meniska i osteoartritisom u usporedbi s traumatskim puknućima (31).

Artroskopsko šivanje meniska dijelimo na tri glavne tehnike: „iznutra – van" (engl. *inside-out*), „izvana – unutra" (engl. *outside-in*) te „sve iznutra" (engl. *all inside*) (29). Kod tehnike „iznutra – van" igle s koncima se provlače iz zgloba prema koži, potom se u području konaca čini rez kože, nakon čega se čvor fiksira preko zglobne kapsule (29). Ova metoda je primjenjiva za šivanje puknuća smještenih u središnjem dijelu meni-

because it is less invasive and enables faster recovery. The recommended indications for APM are degenerative lesions that do not respond to conservative therapy, and radial tears located in the avascular, white zone of the meniscus (31). The goal of APM is to remove the damaged portion of the meniscus while preserving the peripheral tissue (32). Although it is a common, minimally invasive procedure, APM may accelerate the development of osteoarthritis due to altered knee biomechanics (1). Clinical studies indicate poorer outcomes and lower levels of satisfaction in patients with degenerative meniscus tears and osteoarthritis compared to traumatic tears (31).

Arthroscopic meniscal repair (suturing) is divided into three main techniques: : *inside-out*, *outside-in* and *all-inside* (29). In the *inside-out* technique, needles with threads are passed from the joint to the skin, then a skin incision is made in the area of the threads, after which the knot is fixed over the joint capsule (29). This method is applicable for suturing tears located in the middle part of the meniscus, i.e. in the body of the meniscus (1). The *outside-in* technique uses threads that are passed through two pre-inserted needles from the skin towards the joint, crossing the meniscus tear (29). The ends of these sutures are then tied to the capsule as in the *inside-out* technique. The *all-inside* meniscal repair technique is performed completely intra-articularly without the need for additional skin incisions (1). This technique is particularly suitable for suturing posterior horn meniscus tears, but it is also the most expensive suturing method due to the use of specific implants. With every technique there is a risk of neurovascular complications. They are primarily used for acute traumatic injuries in the vascularized zone, but also for horizontal tears in athletes, meniscus root tears, and radial tears (29). In younger patients, meniscal repair is also recommended in the less vascularized red-white and white zones, with a high success rate of 75% (33). Meniscal repair surgeries show a higher reoperation rate compared to arthroscopic partial meniscectomy (APM). The results of a 2011 study conducted by Paxton et al. show that, in the short-term follow-up of patients (up to 4 years), the percentage of reoperations after meniscal repair is 16.5%, while after APM it is significantly lower, at only 1.4% (34). Reoperations are more common with meniscal repair due to the complexity of the injuries themselves, which are more difficult to operate on, as well as the healing process – if the meniscus does not heal properly, persistent pain and joint dysfunction often require reoperation (35). However, despite this difference in reoperation rates, meniscal repair provides superior long-term results (34). Patients undergoing meniscal repair surgery achieve better functional outcomes, maintain a higher level of physical activity, and have a lower likelihood of

ska, odnosno u tijelu meniska (1). Tehnika „izvana – unutra" koristi konce koji se provlače kroz dvije prethodno umetnute igle od kože prema zglobu, prelazeći preko pukotine meniska (29). Krajevi ovih šavova zatim se vežu za kapsulu kao i u tehnici „iznutra-van". „Sve iznutra" tehnika šivanja meniska izvodi se potpuno intraartikularno, bez potrebe za dodatnim kožnim rezovima (1). Ova tehnika je posebno prikladna za šivanje puknuća stražnjeg roga meniska, ali je također i najskuplja metoda šivanja zbog upotrebe specifičnih implantata. Svaka tehnika nosi rizik neurovaskularnih komplikacija. Primarno se koriste za akutne traumatske ozljede u vaskulariziranoj zoni, ali i za horizontalne pukotine kod sportaša, ozljede korijena meniska i radijalne pukotine (29). Također se kod mlađih pacijenata preporučuje šivanje meniska i u slabije vaskulariziranim crveno-bijelim i bijelim zonama, s visokom stopom uspjeha od 75% (33). Operacije šivanja meniska pokazuju višu stopu reoperacija u odnosu na ADM. Rezultati istraživanja Paxtona i suradnika provedenog 2011. godine pokazuju da je, u kratkoročnom praćenju pacijenata (do četiri godine), postotak reoperacija nakon šivanja meniska 16,5%, dok je nakon ADM-a značajno niži, samo 1,4% (34). Reoperacije su češće kod šivanja meniska zbog kompleksnosti samih ozljeda koje se teže operiraju, kao i zbog procesa cijeljenja – ako menisk ne zacijeli pravilno, perzistentna bol i disfunkcija zgloba često zahtijevaju ponovnu operaciju (35). Međutim, unatoč ovoj razlici u stopama reoperacija, šivanje meniska dugoročno pruža superiorne rezultate (34). Pacijenti podvrgnuti šivanju meniska postižu bolje funkcionalne ishode, održavaju višu razinu fizičke aktivnosti i imaju manju vjerojatnost dugoročnog neuspjeha zahvata u usporedbi s onima koji su prošli ADM (29). Ključna prednost leži u očuvanju tkiva meniska, koji ima esencijalnu ulogu u raspodjeli opterećenja i amortizaciji udara u koljenom zglobu. Kada se menisk uspješno zašije i očuva, pacijenti imaju bolju funkciju koljena i manji rizik od razvoja osteoartritisa u budućnosti (35).

ZAKLJUČAK

Ključ uspješnog liječenja ozljede meniska leži u individualiziranom pristupu koji uzima u obzir dob pacijenta, pridružene bolesti, simptome i karakteristike ozljede. Konzervativno liječenje pokazuje dobre rezultate, posebno kod degenerativnih ozljeda i starijih pacijenata. Operativni zahvati, poput ADM-a i šivanja meniska, imaju specifične indikacije i preferiraju se kod traumatskih ozljeda, pri čemu šivanje pruža bolje dugoročne funkcionalne ishode unatoč višoj stopi reoperacija.

Napredak u razumijevanju biomehanike koljena i razvoj novih terapijskih metoda kontinuirano unaprje-

long-term procedure failure compared with those who underwent APM (29). The key advantage lies in the preservation of the meniscus tissue, which plays an essential role in load distribution and shock absorption in the knee joint. When the meniscus is successfully sutured and preserved, patients have better knee function and a lower risk of developing osteoarthritis in the future (35).

CONCLUSION

The key to successful treatment of a meniscus tear lies in an individualized approach that takes into account the patient's age, comorbidities, symptoms, and characteristics of the injury. Conservative treatment shows good results, especially in degenerative injuries and elderly patients. Surgical procedures, such as APM and meniscal suturing or repair, have specific indications and are preferred in traumatic injuries, with suturing providing better long-term functional outcomes despite a higher rate of reoperation.

Advances in understanding knee biomechanics and the development of new therapeutic methods are continuously improving treatment approaches. In conclusion, successful treatment of meniscus tears requires careful assessment, an individualized approach, and balancing between conservative and surgical options, always keeping in mind the long-term health and functionality of the knee.

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đuju pristup liječenju. Zaključno, uspješno liječenje ozljeda meniska zahtijeva pažljivu procjenu, individualizirani pristup i balansiranje između konzervativnih i kirurških opcija, uvijek imajući na umu dugoročno zdravlje i funkcionalnost koljena.

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