UNIVERSITY OF ZAGREB

SCHOOL OF MEDICINE

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Meniscus tears

Graduate thesis

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This graduate thesis was done at the Department of Orthopedic, University Hospital Center Zagreb, School of Medicine, Zagreb University, mentored by Associate Professor Mislav Jelic, MD, Ph.D.. It was submitted for evaluation in the academic year 2022/2023.

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1. Summary-

The meniscus is an important component of the knee joint. His function is to helps prevent articular cartilage degeneration and the onset of osteoarthritis.

It serves a unique role in load bearing, load transmission, shock absorption, lubrication, and nutrition of articular cartilage. It can bear various forces such as shear, tension, and compression.

Meniscus injury is a common knee injury which requiring proper diagnosis to diagnose the type of tear and its location for appropriate treatment. Diagnosis is usually made by clinical history, physical examination, and imaging studies, with all those sources the physician can chose the best treatment option based on the specific condition. Various repair techniques are available today, ranging from non-surgical to total meniscectomy, but most are only effective for lesions located in the peripheral vascularized region of the meniscus. The demanding mechanical environment can make healing lesions in the inner avascular region challenging. This challenge has spurred interest in biomaterials and bioengineering to address meniscal deterioration through tissue engineering.

This thesis paper aims to review the different types of meniscus tears, the diagnostic process with an explanation of the different clinical tests, and the range of possible treatment techniques.

2. Sažetak-

Menisk je esencijalna komponenta zgloba koljena koja prevenira degenerativne promjene hrskavice, te razvoj osteoartritisa.

Ima ključnu ulogu u prijenosu opterećenja, apsorpciji udaraca, lubrikaciji i prehrani hrskavice zgloba, kao i sposobnost podnošenja raznolikih opterećenja kao što su smicanje, pritisak i kompresija.

Ozljeda meniska je učestao oblik ozljede koljena koja zahtijeva ispravni dijagnostički postupak s ciljem određivanja vrste i lokacije ozlijede, kako bi se mogla odrediti ispravna terapija. Dijagnoza se postavlja na temelju anamneze, kliničkog pregleda i radiološke dijagnostike, a potom kliničar određuje najbolju metodu liječenja za karakteristični tip ozljede. Danas su dostupne mnoge metode popravka oštećenja, varirajući od neoperativnih metoda do kompletne meniscektomije. Unatoč tomu, metode su uglavnom djelotvorne samo za oštećenja locirana na perifernoj vaskulariziranoj regiji meniska. Liječenje ozljeda unutarnje, avaskularne regije je problematično zbog zahtjevnog mehaničkog okruženja. Navedeno je potaknulo interes za rješavanjem problema ozljeda meniska tkivnim injženjerstvom, pomoću biomaterijala i bioinjženjerstva.

Cilj ovog diplomskog rada je dati osvrt na različite ozljede meniska, dijagnostički postupak sa objašnjenjem postupaka kliničkih testova te osvrt na raspon dostupnih metoda liječenja.

3. Introduction-

3.1 Knee Anatomy-

The knee joint continues to be a focus of wide interest, by each of its constituents. Its components are four bones, femur, tibia, fibula, and patella.

These bones that compose the knee play a important role in the joint. The femur bone is a unique constituent and the strongest in human body. At the proximal end of the bone, it creates the head of the femur. It then joins with the acetabulum. The distal end of the femur is wide and form the two condyle that joins with the tibia and patella. The part in the joint of the tibia articulates with the femoral condyles, and the patella build the articulates in the intercondylar fossa.

The tibia bone located medial to the fibula bone and distal to the femur. His proximal part composes from the medial and lateral condyles. The intercondylar region, and the tibial tuberosity are also important parts of the bone. The tibia bone has a connects with the medial and lateral condyles of the femur.

Distally, the tibia bone connects directly to the ankle. Both bones: the distal and proximal ends of the tibia, articulate with the fibula. The tibia and fibula shafts are linked by an interosseous membrane to creates a syndesmosis joint.

If we compared the fibula bone to the femur and patella, the fibula does not connect with the knee joint, and it is not part of the weight transmission.

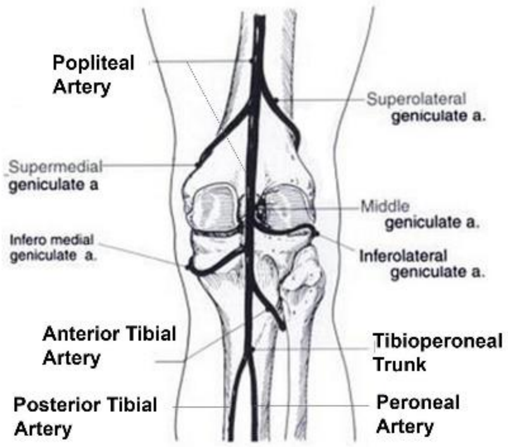
The patella varied in shape between each person. It is the widest sesamoid bone in the human body. The patella bone have a flat shape, proximally curved, and distally tapered. The posterior of the patella connects with the femur, and the apex is proximal to the knee joint line. The tendon of quadriceps femoris extend over the entire patella.

Vascular supply:

The arterial anastomosis that surrounds the knee joint is formed by several vessels. These vessels include the superior, inferior, and middle genicular branches of the popliteal artery. From the femoral artery, the descending genicular branch, and from the lateral circumflex femoral artery, the descending branch. The anastomosis supplies blood to the patella, the femoral and tibial condyles, bone marrow, the articular capsule, and the synovial membrane.

The popliteal artery is the primary artery that crosses the popliteal fossa at the posterior aspect of the knee. Due to its location, this artery is at risk of injury in knee injuries.

In terms of the venous system of the knee joint, it primarily comprises the popliteal and femoral veins. These veins parallel their respective arteries and collect deoxygenated blood from the arterial anastomosis. The popliteal veins contain 3-4 valves.



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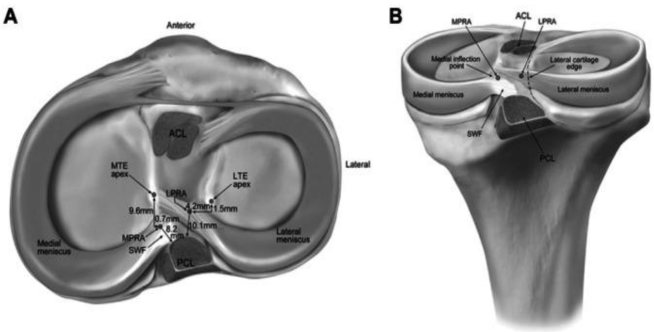
3.2 General information about Menisci

Anatomy-

The menisci are C-shaped fibrocartilage wedges located between the femoral condyles and tibial plateau. The larger semilunar-shaped medial meniscus is firmly attached, while the circular lateral meniscus is loosely fixed. Both menisci are attached to the tibial plateaus by their anterior and posterior horns. The transverse ligament connects the anterior horns of both menisci, while the meniscofemoral ligament stabilizes the posterior horn of the lateral meniscus with the femoral condyle. The coronary ligaments connect the peripheral rim of each meniscus to the tibia. The joint capsule attaches each meniscus but adheres more firmly to the medial meniscus. The lateral meniscus is not attached to the lateral collateral ligament (LCL) and has a popliteal hiatus that allows the popliteus tendon to pass through to its femoral attachment site. The popliteus contraction during knee flexion pulls the lateral meniscus posteriorly, avoiding entrapment within the joint space. The medial meniscus lacks a direct muscular connection. The medial meniscus may shift a few millimeters, while the less stable lateral meniscus may move up to 1 cm.



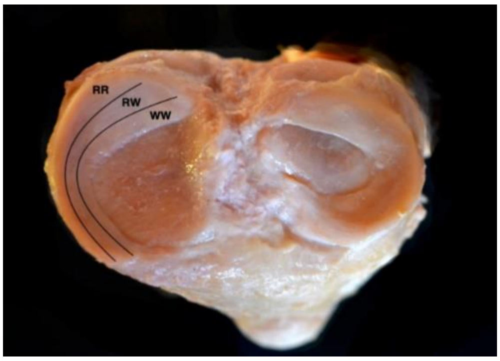
Published in American Journal of Sports Medicine 2019

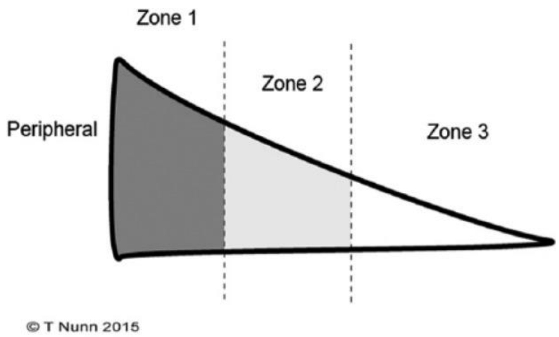
Histology-

The meniscus microstructure is a dense fibrocartilage that consist of cells and an extracellular. the extracellular matrix made up of a major network of collagen fibers. The cells there called fibrochondrocytes and they are a combination of fibroblasts and chondrocytes cells. These cells create constantly and maintain the fibrocartilaginous matrix at the extracellular space. The major component of the meniscus is collagen, accounting for 75%, primarily of type I collagen (>90%), with other types too, like II, III, V, and VI. The collagen fibers are primarily in a shape of longitudinally or circumferentially, with some interweaving radial and oblique fibers. The circumferential fibers are very important for the meniscus's functional ability to dissipate compressive loads, while other fibers primarily ties to get a better structural stability and prevent splitting, such as longitudinal splitting. Proteoglycans, glycoproteins, and elastin are also present in the extracellular matrix.

Blood supply-

The vascular supply to the menisci mainly comes from the medial, lateral superior, and inferior geniculate arteries via the perimeniscal capillary plexus. As the menisci age, they become increasingly avascular, with only the peripheral 10% to 25% of the tissue remaining perfused. This results in three distinct regions of the menisci: the red-red zone (Zone 1), which is a relatively vascularized peripheral region; the completely avascular inner zone known as the white-white zone (Zone 3); and the red-white zone (Zone 2), which is a transition zone between the two. The extent of vascularization is directly related to the tissue's healing capacity, which predisposes the white-white zone to permanent posttraumatic and degenerative lesions.





Banovetz MT, Roethke LC, Rodriguez AN, LaPrade RF. Meniscal Root Tears: A Decade of Research on Their Relevant Anatomy, Biomechanics, Diagnosis, and Treatment. Arch Bone Jt Surg. 2022

Biomechanics-

Axial load vector analysis of the knee demonstrates that force transmitted through the meniscotibial interface is always lower than that transmitted through the meniscofemoral interface. This difference in force transmission is due to the conversion of axial compressive loads into hoop stresses. Hoop stresses are radial tangential stresses that exert tensile stress on the circumferentially oriented collagen fibrils in the menisci. The menisci are fixed to the tibial plateau via their roots, which results in circular traction. This conversion of axial compressive loads into tensile hoop stresses reduces the compressive loads experienced by the chondral cartilage of the knee, and the menisci are commonly referred to as shock absorbers. The meniscal roots anchor the menisci to the tibial plateau and normalize load distribution across the knee joint by converting axial compressive loads into tensile hoop stresses. If the meniscal root attachment is compromised, as in the case of a meniscal root tear, axial compressive forces are no longer converted into tensile hoop stresses intrinsically within the meniscus. This requires anchoring the horns to the tibial plateau by their roots so that the meniscus can experience circular traction. The axial compressive forces result in the meniscus extrusion from the joint space. This pathologically alters the kinematic loading profile of the knee joint and renders it dysfunctional.

3.3 Meniscus injury:

As one of the most prevalent knee injuries, meniscal tears can be caused by Trauma or even a sudden twisting motion or repeated squatting. Injuries related to sports activities usually involve rotational force, where a flexed knee experiences a varus or valgus force. The medial meniscus may be torn if a valgus force is applied to a flexed knee when the femur is internally rotated. In contrast, a lateral meniscus lesion can be caused by a varus force over an externally rotated and flexed knee.

The pathoanatomy of meniscal tears can be described by their classification, which includes various types such as longitudinal, radial, parrot-beak, or oblique flap, horizontal, root, and complex tears that combine variations of the above. Longitudinal tears may assume a bucket-handle shape if displaced.

Lasanianos, N.G., Kanakaris, N.K. (2015). Meniscal Tears. In: Lasanianos, N., Kanakaris, N., Giannoudis, P. (eds) Trauma, and Orthopaedic Classifications. Springer, London

A traumatic tear of the meniscus defines as a meniscus injury that occurs due to a significant knee injury and results in sudden knee pain. This group mainly includes vertical tears like longitudinal (including bucket handle tears) and radial tears. Flap tears and primarily posterolateral root tears are also part of this group. Tears of the meniscus ramp are also regarded as traumatic tears, but there is still some debate over their definition. They are generally thought to happen at a ligamentous connection between the posterior horns of the meniscus and the tibial plateau. These tears frequently do not affect the actual meniscus tissue and are thus not considered true meniscus tears in this consensus. Usually, horizontal lesions are not classified as traumatic meniscus tears due to their degenerative nature, even in younger patients.

Traumatic meniscus tears have two different forms, it can be stable and unstable. If we diagnosed unstable meniscus tears, the central part of the torn meniscus can shift towards the joint space and the result will be locking and sudden pain. With the unstable meniscus, the fragment can get stuck between the tibia plateau and the MCL or it can be changed location up to 5 mm. Unstable meniscus tears examples are the longitudinal tears, which can progress to the tears of bucket handle, and flap tears that get stuck between the femoral condyle and tibial plateau.

In contrast, the stable tears are defined by doctors as tears that are not can be displace, with a probe, such as partial or short meniscus tears. Radial tears can be considered generally unstable. The classification for recognizing the location of a meniscus tear consist of dividing it into zones: circumferential and radial. The radial zones have been classified further based on vascularity as zones of red-red, red-white, and white-white. However, this approach is not highly recommended as vascularity can vary from patient to patient and may not be reliably to assessed during the surgery. Instead, a more objective method are prefer, and it is to divide the width of the meniscus into zones 0-3.

4. Diagnosis:

Ascertaining the presence and nature of a meniscal tear requires the orthopedic surgeon to integrate clinical data, imaging studies, and their own clinical experience to develop a personalized treatment plan. Interestingly, the intensity of the symptoms may not always correspond to the type or location of the tear. Although detailed history-taking and comprehensive clinical examinations may not be sufficient to establish the diagnosis, radiographic and arthroscopic evaluations are typically conducted for confirmation.

4.1 clinical tests

A number of clinical tests, such as the McMurray test, the Apley test, the Thessaly test, the bounce home test, the Finochietto test, and the Boehler test, can help identify meniscus injury. However, the accuracy and reliability of these tests remain limited.

McMurray test- to conduct the assessment, the joint line of the knee is grasped with one hand, while the other hand holds the sole of the foot to perform full flexion. The examiner subsequently extends the knee to a 90-degree flexion while internally rotating the leg. The presence of pain accompanied by a "thud" or "click" indicates a "positive McMurray test" for a tear in the lateral meniscus's posterior region. Similarly, testing the posterior part of the medial meniscus can be done by externally rotating the leg.

Apley test- To conduct the test, the patient assumes a prone (face-down) position on the examination table and flexes their knee to a 90-degree angle. The examiner places the knee on the posterior aspect of the patient's thigh and compresses the tibia onto the knee joint while externally rotating it. If the patient experiences pain during this maneuver, it indicates a "positive Apley test," suggesting meniscus damage. For medial implications, lateral rotation tests are performed during compression, and ligamentous tests are performed while distracting the tibia. Similarly, for lateral implications, medial rotation tests are conducted during compression, and ligamentous tests during tibial distraction. The posterior horn can be evaluated more effectively with knee flexion more significant than 90 degrees, the medial meniscus is evaluated at 90 degrees of knee flexion, and the anterior horn is tested closer to knee extension (less than 90 degrees of knee flexion).

<u>Thessaly test</u>- to conduct this test, the patient must stand on the affected leg, which is flexed to 20 degrees. The patient may hold onto the physician's arms for support. The tibia is then rotated three times on each side. If the patient experiences pain in the joint line during the rotations, the test is considered positive.

<u>Bounce home test</u>- with the patient lying on their back (supine), the therapist grasps the patient's foot heel with their hand and passively flexes the knee. The knee is then allowed to extend passively. The knee should fully extend with a sharp end feel, also referred to as "bounce home." If the knee does not fully extend or has a rubbery end feel, the test is considered positive, indicating the presence of a torn meniscus or other intra-articular pathology.

<u>Finochietto test</u>- To carry out the Finochietto Test or Jump Sign, the patient's knee is flexed to a range of 130-140 degrees, and the position is stabilized by the examiner. The examiner then pulls the tibia ventrally in a more forceful manner than with the anterior test.

If the examiner detects a "jump," wherein the torn posterior horn of the meniscus moves anterior to the tibiofemoral point of contact, the test is considered positive. The jump may not be visible or audible and does not necessarily cause pain.

<u>Boehler test</u>- The Boehler test involves applying a varus force to compress the medial meniscus or a valgus force to compress the lateral meniscus when the knee is nearly fully extended. Pain on the side of compression with this maneuver is considered a positive result and indicates meniscus injury, specifically in the anterior to the middle section of the meniscus.

Fig. 2.3 Positioning for Apley grind test

Fig. 2.2 Positioning for McMurray test

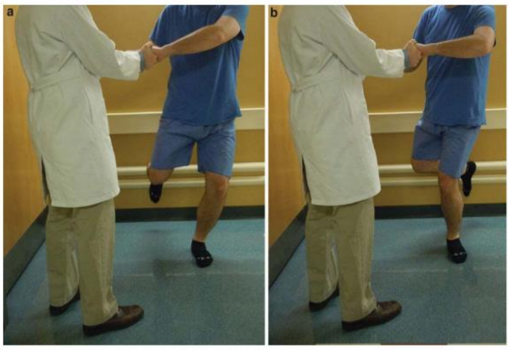


Fig. 2.4 Positioning for Thessaly test. (**a**) Thessaly test with external rotation of body. (**b**) Thessaly test with internal rotation of body

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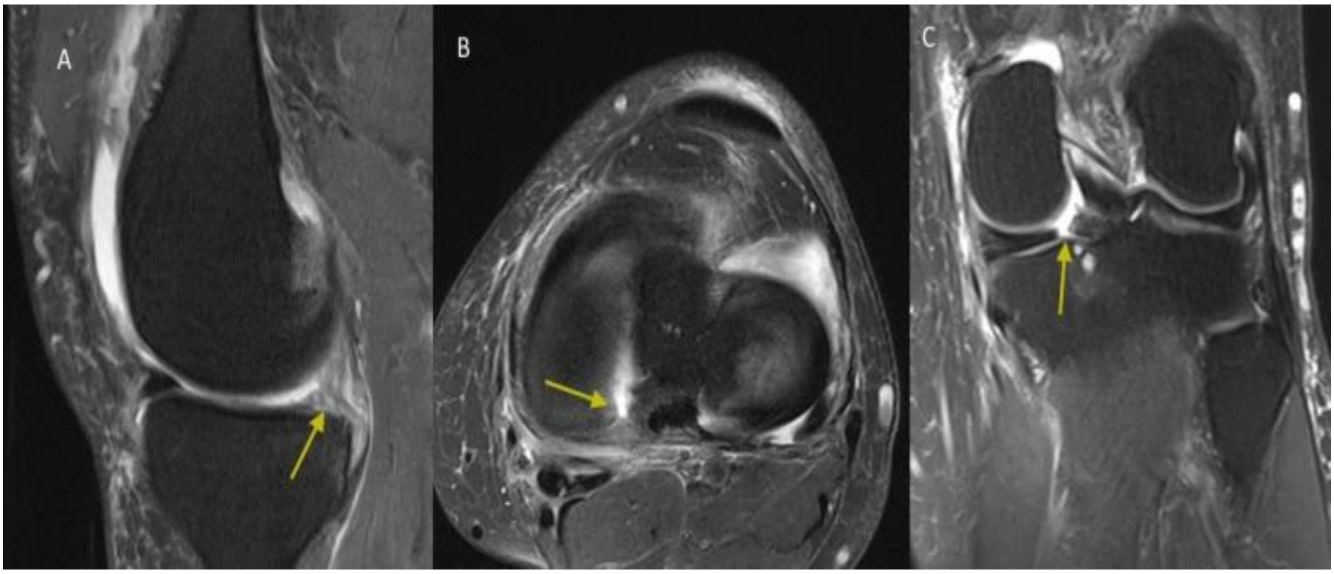
4.2 Imaging:

Routine use of plain radiographs is not recommended for the evaluation of meniscus tears, except in special conditions such as chondrocalcinosis. MRI remains the imaging modality of choice, with high sensitivity and specificity for diagnosing meniscal tears, reaching up to 93% and 88%, respectively. Meniscal tears can appear as a linear signal intensity on MRI that extends from the meniscal substance to a free edge. Diagnostic arthroscopy without therapeutic intervention is not advised. MRI is not always necessary before proceeding with arthroscopic surgery, but it can confirm the diagnosis and provide additional information about the ligaments and articular cartilage. Abnormal meniscal signals are categorized into Grade I, II, and III changes. Grades I and II changes are commonly seen in older patients and young patients due to normal aging and perforating vascular channels, respectively, and do not represent meniscal tears. However, grade III changes, which extend to the surface or edge of the meniscus, do represent meniscal tears. MRI has high sensitivity, specificity, and accuracy for evaluating menisci, with average sensitivity ranging from 81% to 95%, average specificity ranging from 88% to 96%, and average accuracy being 92% for both medial and lateral menisci. Meniscal root tears can be diagnosed via MRI by assessing the amount of meniscal extrusion, which is defined as at least 3 mm of coronal translation of the margin of the tibia.



Left knee MRI showing a medial meniscus posterior root tear (MPRT) (White arrow). A: Sagittal plane view. Ghost sign; B: Axial plane view; C: Coronal plane view -Pache S, Aman ZS, Kennedy M, Nakama GY, Moatshe G, Ziegler C, LaPrade RF. Meniscal Root Tears: Current Concepts Review. Arch Bone Jt Surg. 2018

5. Treatments

Determination of the treatment and management of meniscal tears are done by several factors, including age, tear complexity, etiology, tissue quality, symptom severity (traumatic versus non-traumatic), and surgical risk assessment. In cases of swollen and painful knees with suspected tear in the meniscus, the first approach involve is the R.I.C.E. principle, which stands for rest, ice, compression, and elevation. swelling and pain can be relieved with oral medication, such as acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs). For degenerative and simple traumatic meniscal tears, additional conservative management includes the use of knee braces, activity modification, physical therapy, and exercises that strengthen the quadriceps.

The earlier is the best to start with physical therapy, with range of pain-free motion of exercises and progression to weight-bearing exercises as tolerated. Endurance activities that reduce mechanical load across the knee joint, such as biking and swimming, should also be encouraged. In patients who cannot have surgery or refuse it or in whom chronic NSAID use, or surgery is contraindicated, intermittent intra-articular cortisone or hyaluronic injections can be provided for short-term relief every two to three months.

However, if mechanical symptoms persist, are disabling, and significantly affect the quality of life, surgical intervention should be considered. Surgery is generally preferred for red zone tears, complex and extensive meniscal tears greater than 1 cm, young, healthy candidates under 40 years old, acute tears that occurred within the past six weeks, or when there is a concurrent ACL injury. The current surgical approach to treating meniscal tears involves meniscectomy, meniscal repair, and meniscal reconstruction.

5.1 Meniscal Repair

As with meniscectomy, meniscal repair can be performed either via an open surgical or arthroscopic approach. Arthroscopic repair is the preferred method due to its lower risk of neural damage. Before proceeding with the meniscal repair, the tear patterns and adequacy of vascularity should be assessed. Meniscal repair is most beneficial in cases of acute traumatic meniscal tears within the well-perfused, peripheral red-red zones of the meniscus. Longitudinal/horizontal and vertical tears are more amenable to repair than radial tears, although a repair can still be attempted with radial tears in partially perfused red-white zones. Arthroscopic meniscus repair can be achieved via three techniques: inside-out, outside-in, and all-inside.

The inside-out technique known as the gold standard treatments in meniscal repair .it have the best success rates. This technique done by passing sutures from inside the knee to an extra-capsular area and through the extra-articular incision. Next the surgen will do securing a connection over the joint capsule. The inside-out technique is commonly used for posterior horn meniscal damage.

The outside-in technique is more commonly used for anterior horn tears. In this approach, a spinal needle is passed through the meniscal rip in an outside-in manner, and the suture is passed through the arthroscopic portal once the needle tip is visible. After tying an interference knot at the end, the suture is pulled back until the tear is stabilized.

The all-inside technique is most beneficial in cases of extreme posterior meniscal rips. Instruments used for repair, such as screws or staples, are typically made of bioabsorbable compounds like poly-L lactic acid. These implants are deformable and lower the potential for chondral erosion during weight-bearing. Despite the reduced risk of neurovascular problems with arthroscopic techniques, inadvertent damage can still occur with any of the above methods.

5.2 Meniscal Reconstruction

The least frequently performed procedure is meniscal reconstruction, which aims to replace damaged or resected portions of the native meniscus with functional ones. The primary goal of this surgery is to restore normal knee joint function and prevent degenerative changes resulting from poor knee biomechanics. Reconstruction can be achieved using either meniscal scaffolds or meniscal allograft transplantation (MAT). MAT involves the transplantation of a preserved meniscus allograft, while meniscal scaffold surgery involves using synthetic, biodegradable, porous structures to fill meniscal defects. The highly porous nature of the scaffolds enables vascular tissue growth, providing additional support. Finally, postoperative rehabilitation and gradual return to regular activity are recommended for all of these surgeries to optimize outcomes.

5.3 Cell-Based Tissue Engineering

Tissue engineering is a very advanced technology with a potential application in the treatment of meniscal tears. It focuses is on regenerating of the meniscus by stimulating cell differentiation to tissue which is closely resembles the native meniscus. This approach souled be used for the repair of meniscal tears or for the regeneration of a partial or complete meniscus following a partial, subtotal, or total meniscectomy.

The most commonly used cell types in meniscal tissue engineering are meniscal cells, articular cells, and mesenchymal stem cells (MSCs) derived from various sources such as embryonic, bone marrow, and synovium. These cells can differentiate into cartilaginous cells and deposit extracellular matrix (ECM) similar to that found in the native meniscus.

5.4 Total meniscectomy

As the standard approach for most of the 20th century, total meniscectomy has been reevaluated due to unfavorable long-term results documented in the literature. There are various reports on the biomechanics of the knee after this procedure. In 1923, McMurray suggested a relationship between secondary arthritis and pain affected by weather changes, indicating that meniscectomy could result in arthritis. The increased contact pressure after the procedure leads to an overload of articular cartilage, resulting in proteoglycan loss, disaggregation, and increased hydration. Articular cartilage dysfunction was confirmed with the naked eye or microscopically in animal models, indicating the influence of meniscectomy. These study results indicate that meniscectomy is not a harmless procedure. Thus, preserving the meniscus as much as possible during repair has been recommended as an alternative when the repair is not possible to avoid the complications of total meniscectomy.

5.5 Partial meniscectomy:

Meniscectomy is a common surgery that performed in elderly patients which suffering from knee pain because of meniscal problems. This procedure includes the insertion of a probe through the inferomedial portal for evaluation of the meniscus' condition. Then, the identification of the tear pattern occurs. Next, a meniscal biter instrument is introduced through the same portal to cut the rim of the torn meniscus to match the healthy portion. This promises a uniform rim that which can transmit knee forces adequately. After the damaged meniscus is properly resected, this meniscus part is replaced with an arthroscopic shaver, which is used to smooth out the meniscal rim while removing any remaining pieces of tissue from the joint. During the procedure, it is very important to minimize damage to the femur and tibia cartilage using arthroscopic instruments and cameras. Appropriate leg positioning helps in creating adequate joint gapping to minimize injury. Once the surgeon is satisfied with the result, the arthroscopic instruments are removed, and the excess saline and loose bodies are suctioned out. Finally, the two portal sites are closed with a 3-0 nylon suture, and the appropriate dressing is applied.

6. Postoperative rehabilitation

Post meniscectomy patient may experience a reduction in strength together with decrease in range of motion, changes in proprioception and abnormal gait patterns. All these symptoms can increase their risk of developing osteoarthritis. Fortunately, these issues can be addressed through a rehabilitation program which will be performed after the procedure and known as improving patient outcomes. Today, there low amount of evidence which support a rehabilitation program. This fact can explain the wide range of protocols that are used in practice. One of the common program include an 8–12-week program which compose of diverse of treatments such as electrotherapy, cryotherapy, and progressive resistance exercises. For athletes specific, an 8-week program is more recommended. At the beginning patients slowly propagate with exercises that control pain and improve range of motion. In the next step the athletes will practice gait training, balance exercises, stationary cycling, and strengthening exercises. Then they work to improve their gait and continue with more advanced strengthening and range of motion exercises. This program can be changed to fit the individual athlete's needs, mainly if they are in important period.

7. Conclusion-

The menisci are C-shaped fibrocartilage wedges located between the femoral condyles and tibial plateau. The larger semilunar-shaped medial meniscus is firmly attached, while the circular lateral meniscus is loosely fixed. The vascular supply to the menisci mainly comes from the medial, lateral, superior, and inferior geniculate arteries via the perimeniscal capillary plexus.

Meniscus tear known as prevalent knee injuries which can be caused by Trauma or a sudden twisting motion and repeated squatting. Traumatic meniscus tears have two different forms, it can be stable and unstable. In unstable meniscus tears, the central part of the torn meniscus can shift towards the joint space, causing locking and sudden pain. The unstable meniscus fragment can get stuck between the tibia plateau and the MCL or into the notch, or it can be displaced up to 5 mm.

The treatment and management of meniscal tears are chosen by several factors. Those factors are age, tear severity, tissue quality, symptom severity, etiology (traumatic versus non-traumatic), and surgical risk assessment.

Meniscal repair, meniscal reconstruction, meniscectomy, and cell-based tissue engineering are the common treatment approaches that were mentioned in my review.

The leading method for treatment is partial meniscectomy. Today we know that this procedure can result in the gradual development of osteoarthritis. This side effect lead to research search towards the fields of biomaterials and bioengineering, where it is hoped that meniscal deterioration can be tackled with the help of tissue engineering.

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10. Felix S Chew, MD, MBA, MEd Professor, Department of Radiology, University of Washington School of Medicine, Michael R Aiello, MD Locum Tenens Radiologist,2021, Meniscal Tears on MRI

10. Biography-

Stav David will soon be a medical doctor studying in her sixth and final year in the international medical program in the faculty of medicine, University of Zagreb, Croatia.

Stav was born on 18/12/1988 in Hadera, Israel.

During high school, her majors were Economy and psychology.

After completing her 4-years of obligatory military service in the Israeli defense force (IDF) as an officer, she traveled around the world for a few mounts. At that point in time, she decided to become a medical doctor.

After living for six years in Croatia and passing all her exams, she is ready to begin a new chapter in her medical future.