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# Meniscus Tears and Review of the Literature

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## Abstract

The knee joint is the largest and most complicated joint in the human body. Bone structures, capsules, menisci, and ligaments provide static stability in the knee joint and are responsible for dynamic stabilization of the muscles and tendons. Menisci are fibrocartilage structures that cover two-thirds of the tibial plateau joint surface. The main functions of the meniscus are load sharing and loading of the tibiofemoral joint, shock absorption, helping to feed the cartilage by facilitating dissociation of the joint fluid, and contributing to the joint fit by increasing joint stability and joint contact surface area. Menisci are frequently injured structures. The incidence of acute meniscal tears is 60 per 100,000. It is more common in males. Trauma-related tears are common in patients under 30 years of age, whereas degenerative complex tears increase in patients over 30 years of age. There may not be a significant trauma story, especially in degenerative meniscus tears. They are sports traumas that come to the fore in the etiology of meniscus tears. It is the football that has the greatest risk of creating a meniscus lesion, followed by athletics, American football, and skiing. There is an indication for repair in peripheral ruptures where blood flow is excessive. In the central rupture where blood is not present, the treatment is meniscectomy. In this review, we compiled the diagnosis, etiology, and treatment methods of the meniscal tears.

**Keywords:** meniscus tears, treatment, sports, trauma, literature, rehabilitation

## 1. Introduction

The knee is an open joint to frequent injuries in sports activities. Direct impacts, forced movements, or repetitive overloads can cause anatomical damage. Menisci are formed from fibrous cartilage. It has a shock-absorbing feature. The main tasks are providing load transfer, increasing joint surface contact area and joint stability, and contributing to proprioception [1, 2]. A total of 100,000 people per year are found to have meniscus rupture in 60–70 [3]. The most common pathology associated with meniscal tears is anterior cruciate ligament (ACL) ruptures [4].

Today, in addition to professional sportsmen, people participate in sports activities for hobby purposes [5]. Increasing interest in sports with high risk of injury, such as skiing, snowboarding, and mountain biking, has increased the frequency of traumatic meniscal tear [6, 7]. Decision-making process is difficult in professional sportsmen. Approximately 40% of all sports injuries involve the

knee joint. Meniscus injuries account for 14.5% of these injuries [6]. The most risky period in terms of age is between the ages of 20 and 29 [6]. Male to female ratio of meniscus proplemia in sports injuries is 2–4/1 [8, 9]. The medial-lateral meniscus injury rate for all age groups was reported as 3/1. However, lateral meniscus tears are more common in young professional athletes [6]. According to the age distribution, the medial meniscus tear is more likely to occur in the athletes who are under 30 years old and laterally in sportsmen over 30 years [10]. In an epidemiological study of National Basketball Association (NBA) basketball players, 87.8% of meniscal tears are isolated, and 12.2% are associated with ligament injuries, often ACL [10]. Acute ACL injuries are more common in lateral meniscus, and chronic ACL injuries are more common in medial meniscus tears [11]. Body mass index (BMI) is specified in professional basketball players as a risk factor. It has been reported that especially above 25, it increases the risk of rupture more in the lateral meniscus [12]. The high physical activity during play was more associated with the lateral meniscus [11]. In an epidemiological study of athletic knee injuries, the distribution of 836 medial meniscus injuries according to sports branches was examined. Soccer was 32.7%, skiing 22.4%, tennis 7.8%, handball 5.4%, and cycling 3.5%. In the distribution of 284 lateral meniscus injuries, 34.5% of football, 19% of skiing, 9.8% of handball, 6.6% of tennis, and 3.5% of cycling sources were stated. In gymnastics and dancers doing lateral, tennis, and jogging, the risk of medial meniscus injuries is greater [6]. Most of the injuries occur during the competition and are thought to be caused by faulty warming or overloading [6]. 10–19 years is the period when lateral meniscus injuries are seen in sportsmen at the second frequency [6]. It is thought that rapid and variable physiology of the age of growth has increased meniscus injuries in this age group [11]. Nowadays, with the understanding of biomechanics and functions of the meniscus, tissue preservation has become the mainstay of treatment [7]. Exposure to high physical activity levels and relatively early age causes injury to the athletes in terms of degenerative arthrosis [7].

The diagnosis of symptomatic meniscus rupture can be made during the anatomy of the patient. The common complaints of patients are pain during hanging and flexion, which starts after the knee swelling or excessive flexion. On physical examination, joint tenderness, McMurray test, and Apley test were described as the most commonly used tests [8]. Magnetic resonance imaging (MRI) can diagnose approximately 95% of cases. Because non-symptomatic individuals can also detect meniscal tears with MRI, treatment decisions should be made by combining them with the clinical findings of the patient, not just the MRI outcome [13]. Many features should be taken into account when deciding on surgical treatment of meniscus tears. Among the factors that are effective in deciding on surgical technique for menisci are patient complaints, age, rupture size, and additional pathologies associated with morphology [14].

Total meniscectomy has been used extensively in the pre-arthroscopic era and has caused many athletes to lose their sporting life [15]. It has been shown that partial meniscectomy causes irreversible damage to joint cartilage in the long term [16]. Since the 1980s, the development of arthroscopic techniques and the ability to repair the menstrual blood, and thus the healing possibilities, have led to the repair of suitable tears. Longitudinal tears, usually in the peripheral 25% area, are suitable for repairs in young and sporty people. With the understanding that menisci are indispensable for knee health today, indications for repair especially in lateral meniscus tears have been expanded.

In the beginning, conventional sewing techniques have been described as repairs from the inside to the outside and from the outside [17]. With a variety of meniscal fixators (meniscus fixation materials), the possibility of vascular nerve injury with

complete internal repair has been reduced, and operation times have been shortened [18].

In comparison with biomechanical stitches, conventional stitches have shown remarkably superior durability than meniscal fixators in many studies [19].

When performing arthroscopic surgery, care should first be taken to protect the meniscus tissue. Accompanying lesions should be evaluated carefully, especially with frequent ACL problems. All problems should be solved together by following a holistic approach in treatment. These injuries cause serious morbidity in the short term when not properly treated. In the long term, it may also lead to degenerative changes in the knee joint resulting in osteoarthritis.

Therefore, the treatment of meniscus injuries is very important. Today, it is understood that meniscus is protected as much as possible. Current treatment methods are being implemented and developed on the basis of this principle [20].

In this article, we aim to present the latest developments in diagnosis, treatment, and follow-up of meniscus injuries in the light of the literature.

## **2. Meniscus tear**

Meniscus tears are the result of traumatic, degenerative, or congenital pathologies. Loads exceeding the normal endurance limit may result in a tear. In degenerative menisci, ruptures may also occur at normal loads. Traumatic tears usually occur in active people, aged between 10 and 40 years [10]. Degenerative tears are generally over 40 years of age. Such tears are often associated with other degenerative changes in the cartilage and bone tissues of the knee.

## **3. Management of treatment**

Accelerating degenerative changes in the meniscus-deficient knees and the menisci played a key role in the functioning of the meniscus leading us to focus on the protection of the meniscus. In early 1948, Fairbank showed that total meniscectomy accelerated the radiological change in the knee [21]. This was changed by partial meniscectomy [22].

There is no randomized controlled trial showing that arthroscopic meniscus repair has a long-term benefit for joint protection. However, good results to date suggest that this may reduce the incidence of early degenerative changes [23].

According to De Haven, all meniscus tears would not cause clinical symptoms [24]. It has been shown that the tibial asymptomatic meniscus tears, which are intact and have biomechanical function, can recover spontaneously.

The results of not treating meniscus tears are not very clear. Experimental animal studies have shown that meniscal tears may result in chondropathy and osteoarthritis [25, 26].

Clinical studies could not explain whether meniscal injury or articular cartilage damage developed first [27]. A recent study by Christoforakis evaluated 497 consecutive knee arthroscopies in patients with meniscal tear [28]. These complex and horizontal tears were found to be statistically increased in outerbridge [29] grade III or IV joint cartilage damage. Moreover, complex and horizontal tears had excessive joint damage compared to other types of tears. Nevertheless, the result does not answer which of the meniscus tears or articular degeneration occurred first.

The general approach is to actively treat the young patients with clinical and radiological examinations including X-ray and MRI. If there is a tear or is very suspicious, arthroscopy and meniscus protection surgery are recommended.

Non-operative treatment option is used in patients with suspected degenerative tears. The debridement of the degenerated meniscus is well documented that it cannot always result in long-term relief [30].

### **3.1 Non-operative treatment**

Small peripheral tears in young patients can be treated without surgery. The difficulty is to decide whether the tear is stable or not. Weiss et al. retrospectively reviewed 3612 arthroscopic procedures for meniscus lesions [31]. They found 80 (2.2%) meniscus tears which were considered stable. They were not treated. Six patients presented for arthroscopy again due to meniscus symptoms. The authors suggest that stable vertical peripheral tears have a high healing potential [31].

Physiotherapy has been shown to be beneficial to patients with degenerative meniscus tears. In a recent published randomized control study, patients who underwent surgical debridement with physiotherapy showed no better results than those who received only physiotherapy [32].

Some patients with degenerative meniscal tears recover after a single corticosteroid injection into the knee. Corticosteroids are the first-line treatment for degenerative meniscus in the absence of locking symptoms.

Because of the high functional expectations and the need for early return to sports, it is still preferred in selected cases [33].

In the red-red zone, stable, incomplete longitudinal tears with a size below 1 cm may be suitable for conservative treatment [7]. Bucket handle, radial, parrot beak, oblique tears, and degenerative and complex tears are not suitable for conservative methods [34]. Conservative treatment can be used as a temporary treatment method in athletes, who are frequently asymptomatic in the season [33].

Selection should be made when deciding on conservative treatment. Abnormal stresses should be avoided in the early period of rupture. The development of cartilage lesions after aggressive rehabilitation of a young professional athlete with lateral meniscus radial rupture to return to early sports shows that this treatment is not innocent [35]. It should be kept in mind that meniscus tears, which cannot be repaired, may cause cartilage lesions due to mechanical problems that occur even if they are not symptomatic in athletes. Surgical treatment should be prioritized especially in athletes [5].

### **3.2 Operative management**

#### *3.2.1 Total meniscectomy*

With the development of arthroscopic techniques and understanding of biomechanics, the importance of meniscus has increased. Treatment led to a shift toward the protection of the meniscus tissue. Total meniscectomy treatment is rarely practiced today.

#### *3.2.2 Open repair*

It was one of the first ways to repair meniscus tears [36]. It is now used to fix the meniscus as part of the management of tibial plateau fractures.

#### *3.2.3 Arthroscopic repair*

The high expectations and career concerns of the athletes have made the meniscus repairs even more important. Red-red zone often provides successful repairs



due to the potential for cannulation. Discussions on repairs to the red-white zone are still ongoing. In a study, midterm and long-term acceptable results after repair of red-white zone tears of 22 athletes are promising [37].

When deciding on the repair of meniscus in professional athletes, it is necessary to take into account the possibility of the meniscus recovery and to target 90% success. Considering the possible risks, the athletes should be careful to repair the tears in the red-white zone. White-white zone is considered to be the indication of repair today. But athletes should not consider arthroscopic repair [5].

Meniscus tear is present in 60% of ACL-ruptured patients [38]. When the ligament is not repaired, the meniscus is becoming more complicated as it is not healed [39]. For this reason, repairs should be done in the early period and in the same session.

Although it is accepted that there is an improvement in the repair area in about 6–8 weeks, the process actually lasts longer, and the athletes cannot return to competitive activities before 3 months [7]. As stated by Forriol's study, the improvement in the repaired meniscus depends on two basic elements. The first one is the extrinsic blood circulation, and the other is the ability to repair synovial fluid and fibrocartilage intrinsically [40]. Histological studies after meniscus repair are based on animal experiments and cannot be fully adapted to human meniscus repair process [41]. Therefore, the relationship between healing in tissue and return to movement is mostly based on clinical observations.

The success rates after repair vary. Pujol et al. reported success rates between 5 and 43% of meniscus repair in basketball players [42]. According to Stein et al. in the 8-year follow-up, the rate of return to pre-traumatic activity in the group undergoing athletes was found to be 96.2%, and in the meniscectomy group, it was 50% [43]. Paxton et al. found failure after meniscectomy was 3.7% and in repair group 20.7% [44]. In this article, better long-term clinical results have been reported in meniscus repairs despite high reoperation rates [44].

It is reported that repair is better characterized by better functional scores and lower failure rates in the current meta-analysis of meniscectomy and repair [45]. Reoperation depends not only on the technique but on the skill of the orthopedist, the tear itself, the age of the athlete, the level of activity, and the rehabilitation program applied [44]. In a study evaluating the results of repair in athletes, failure in the medial meniscus was reported as 36.4%, and failure in the lateral meniscus was reported to be 5.6%.

Reoperation rates are high in medial meniscus repairs. This is due to the less mobility of the medial meniscus and to the greater load on the medial compartment [46]. Late repair of medial tears has also been implicated as the cause of this failure [47].

Forty-two elite athletes and meniscus repair aggressively recommend the study, after the repair reported 24% failure. Of the cases, 67% had medial meniscus, and 33% had lateral meniscus tears and a mean follow-up of 8.5 years [47].

The success of repair in the complete radial tears of the lateral meniscus is low [48]. However, in the studies of Haklar et al., successful results are obtained in approximately half of the patients, and return to sports is provided [48]. Nevertheless, these patients should be shared with the athlete who may be a candidate for meniscus transplant in the future.

The surgeon must also make efforts to repair the medial or lateral meniscus radial root tears in athletes. If the circumferential fibers are completely ruptured when the repair is not performed, the meniscus becomes functional. Therefore, primary repair of complete radial tears should be the first aim, especially in young athletes.

Radial tears in the posterior meniscus posterior are more promising because of the region's blood supply [49].

Failure to achieve successful results with today's repair techniques leads to new searches. The success of repair in meniscus tears combined with ACL reconstruction is thought to be the effect of growth factors and multipotent cells from the bone marrow [50]. Similarly, synovial abrasion, trephination, mechanical stimulation, fibrin clot, or platelet-rich plasma (PRP) applications are always aimed for the same purpose [51].

The growth factors released after mechanical stimulation and trephination contribute positively to meniscus healing. Ochi et al. showed that the mediators increased to the highest level in the joint after 14 days of mechanical stimulation [52].

Trephination can be used successfully in the complete tears of the lateral meniscus posterior or in complete longitudinal tears less than 1 cm. Successful results of vertical, peripheral, and non-degenerative tears in trephination are seen in the literature [53].

In a recent study on the effect of PRP on meniscus repairs, no significant difference was found in functional scores [51]. Rights et al. used microfracture to create an effect similar to ACL reconstruction, and this would also contribute positively to recovery in the repair area of multipotent cells.

Studies have shown that smoking has a negative effect on the results of meniscus repair [54].

For successful results, it is important to remember the importance of combining vertical mattress sutures from the inside to the outside as far as possible, with the microfracture method [54].

The presence of opposing views in the literature shows that there is still no consensus on rehabilitation and return to sports after repair [55]. In the conservative approach, the return to sports takes a long period such as 3–6 months, while the aggressive approach is as short as 10 weeks [56]. While limited conservative rehabilitation is recommended initially until the meniscus is healed [57], recent biomechanical studies report that early burden is not inconvenient [58]. Even in animal experiments, it has been shown that blood flow to the repair site increases with mobilization [59].

In a randomized controlled trial by Lind et al., the functional scores with MRI and arthroscopy are evaluated. The rate of failure was found to be 28% in the limited rehabilitation group and 36% in the nonrestricted rehabilitation group [60].

As a result, we can say that the trend toward accelerated rehabilitation in the current studies is promising. In practice, the location of the tear, its size, the quality of the meniscus, and the stability of the repair affect the rehabilitation to be applied to the athlete [5]. Neuromuscular control is very important in current rehabilitation [56]. The individual needs and sports-specific approaches of the athlete should not be ignored in rehabilitation [61].

Meniscal tears in young athletes have great challenges for orthopedists. High activity-level, long career expectancy requires all conditions to be repaired [46]. The high potential of recovery according to adults is an important advantage [11].

Athletes may be asked to be guided by the orthopedist athlete or club when planning treatment. Often, the athlete's desire to return to sports early can create pressure on the physician. The rehabilitation process following the treatment of accompanying ligamentous injuries gives the physician the time required for recovery after meniscus repair [62]. However, the expectation of early sports return to isolated meniscus tears may force the physician to perform meniscectomy. Taking into account the expectations of the athlete and the situation in which he/she is not affected from the orthopedic pressures, it is to make the right decision to give priority to anatomical and functional meniscus repair.

#### *3.2.4 Meniscal rasping*

Meniscal rasping is used to clean the torn edges of the meniscus to stimulate bleeding. It is indicated in patients with stable, longitudinal tears in the vascular

region of the meniscus. In the case of unstable knee or avascular region ruptures, this treatment is not appropriate.

### *3.2.5 Meniscal suturing*

Red-red zone or red-white zone tears can be repaired. Traditionally, longitudinal tears are most suitable for suturing and healing. The most important condition for a good recovery is a stable knee. Repair of meniscus in unstable knees results in failure of treatment.

However, a stable knee with normal kinematics does not apply unnecessary shear force on the meniscus repair. Recently, positive results have been obtained regarding the repair of full-thickness radial tears [59]. The results of the repair were not reported in randomized controlled trials. However, case reports seem to be positive. Repairs in the avascular region are at risk of failure. Meniscus repair, with ACL reconstruction, showed better recovery rates than ACL stable knees [63].

### *3.2.6 Meniscal suturing techniques*

Various techniques for the repair of meniscus have been described.

#### *3.2.6.1 Outside-in meniscal suturing techniques*

It was the first arthroscopic node technique. It is now the least used method. Suitable for tears in the middle and anterior 1/3 section of the meniscus. Posterior 1/3 cut is not possible with this technique.

The most important advantages of the outside-in repair method are that it is very easy to reach the anterior 1/3 region ruptures which are difficult to reach by other methods and it does not require additional posteromedial or posterolateral cuts to protect the vascular nerve pack. The most important disadvantage of this method is the difficulty in reaching tears extending to the posterior 1/3.

#### *3.2.6.2 Inside-out meniscal suturing techniques*

Single- or double-lumen, special-inclined cannula through the needles passed through the repair. It can be applied to tears in every region, but it is more suitable for tears in the rear and middle 1/3 section. With this method, which is accepted as the gold standard in meniscus repair, the desired number and type of stitches can be placed easily in each region of the meniscus.

The most important disadvantage of the method is the need for a second incision in the posteromedial or posterolateral to prevent the needles from the capsule from causing vascular nerve injury, requiring an experienced assistant and special instrumentation.

The repair of tears near the posterior insertion of the meniscus is difficult and dangerous with the inside-out technique. In this type of tear, Morgan described the whole technique of sewing inside [64].

## **4. Meniscus fixators**

Implants called “meniscus fixators” have been developed due to the difficulties of sewing techniques, in some cases requiring additional incisions and vascular nerve complications. These implants manufactured as arrow, hook, anchor, screw, or staple are biodegradable or permanent.



The most important advantage of the fixators is that they are technically very easy. In addition, there are advantages such as very low vascular nerve complications, no need for additional incisions, meniscus tears in hard-to-reach areas, “all-in-one” repair, no assistant, and no need for arthroscopic nodes. Generally, there is no problem in the visualization of the lateral compartment. Medial repair on very narrow knees can be difficult [65].

However, the fixators have serious disadvantages. The mechanical forces are half or one-third of the vertical stitch [66].

Another problem with meniscus fixators is the risk of rigid implants to damage the articular cartilage [19]. This problem arises especially in puffy head implants, which are not fully embedded in the meniscus body.

## **5. Methods for improving the healing**

Methods for improving healing in tears extending to the nonvascular area have been described. Some authors recommend applying one or more of these methods in all isolated tears, regardless of the area in which they are located. These methods are described below.

### **5.1 Fibrin clot technique**

When the patient’s venous blood is mixed with a glass baguette, the paste-shaped clot is placed between the torn lips. Since Arnoczky showed the chemotactic and mitogenic factors involved in these dogs and showed that this clot had a positive effect on healing, this technique was also introduced in humans [67].

### **5.2 Trephination technique**

This method is based on the principle of opening radial tunnels in the meniscus body so that the peripheral vascular structures reach the avascular region. Zhang et al. showed that the trephination combined with the suture was more effective than the suture alone in avascular tears in the goat meniscus [68, 69].

### **5.3 Synovial abrasion**

It is based on the principle of a hemorrhage and infusion responses as a result of filing the synovial tissue around the rupture with the help of a curette and contributing to the healing process [70].

### **5.4 Synovial flap transfer**

It was shown that a better repair tissue was formed in the animal experiments with the interposition of a vascular tissue, a pedicled flap, in the tear area of the synovium [71]. However, this technique has not been widely used.

### **5.5 Texture adhesives**

An ideal tissue adhesive should include the following: tissue compatibility, biodegradable, good connect, minimal tissue reaction, and affordable [72].

Tissue adhesives currently used in clinical practice are limited because they contain all of these features.

## **5.6 Growth factors in meniscus repair**

It is known that fibrin clots placed in meniscus tears increase the healing potential of these lesions. It has been shown that meniscal fibrochondrocytes have the ability to make matrix and cell proliferation when they are associated with mitogenic and chemotactic factors in wound hematoma [73]. In fibrochondrocyte cell culture, platelet-derived growth factor (PDGF) has been shown to stimulate proliferation of these cells [74].

Researchers showed that PDGF alone could not initiate meniscus repair in the central region of the meniscus [74].

The effect of endothelial cell growth factor (ECGF) on the healing potential of meniscal injuries was investigated. It has been said that there is not much effect [72].

## **6. Rehabilitation in patients with meniscus repair**

The discussion in the literature is on rehabilitation protocols that should be applied after isolated meniscus repair [75]. There is no consensus on knee movement, weight-bearing, knee pad use, and return to sports. In more conservative protocols, there are 4–6 weeks of partial load, knee movements gradually increased in knee pad control, and 6 months of deep crouching and sports ban. In contrast, aggressive protocols recommend immediate burdening, unlimited knee movement, and return to sports when muscle strength is acquired, as long as the patient can tolerate it.

In 95 patients with aggressive and conservative protocols, there was no difference in failure rates [75]. This study yields full knee movement width and allows for return to sports when pain and effusion are lost. Since the only factor affecting the success of the repair is not rehabilitation, the results of various series are difficult to compare. The generally accepted opinion is that rehabilitation using only meniscus fixators is a little more conservative.

## **7. Scaffolds**

Scaffolds can be used as salvage interventions in meniscus ruptures with irreparable meniscus tears and athletes with segmental meniscectomy [7]. The porous and absorbable structure should provide a meniscus-like tissue formation, while the biomechanical strength of the joint should be adequate.

In a European-centered study, 52 partial meniscectomy patients underwent polyurethane scaffold. In the third month, 81.4% of the patients underwent MRI. In the 12th month of the arthroscopic evaluation, in 97.7% of the cases, scaffold integration was detected with real meniscus tissue [76]. Zaffagnini et al. 43 patients with lateral meniscectomy applied scaffold. At the sixth postoperative month, they showed functional improvement. At the 12th month, the knee swelling and fatigue decreased to the optimal level. At the 24-month follow-up, 58% of the cases had reached the pre-injury activity level, and 95% of the patients had patient satisfaction [77].

However, it is recommended not to give a full load for 6–8 weeks after meniscus scaffold applications. This causes muscle atrophy especially in athletes and is inadequate to prevent rehabilitation muscle atrophy [78].

Nowadays, cell scaffolds have been introduced. The benefit of cell-free scaffolds was questioned [40]. The factors affecting the success of the procedure were

indicated as chronicity of the injury, body mass index, and other accompanying knee problems [48]. Long-term studies on the results of scaffold applications, especially in athletes, are needed.

## **8. Meniscus transplantation**

Meniscus transplantation has been proposed to prevent the development of arthrosis in young patients whose meniscus is completely removed, without axial impairment and arthritic changes. The structures used for meniscus replacement in experimental and clinical studies are as follows: autografts, allografts, xenografts, synthetic polymer implants, carbon fiber and polyurethane implants [79].

It is doubtful that structures used as meniscus transplant may prevent the development of arthritis in the knee in the long term [79].

### **8.1 Allograft transplantation**

Subtotal or total meniscectomy after the functional deficiency and pain is applied in athletes [80]. After close meniscectomy, especially under the influence of abnormal load distribution in the lateral compartment, chondral lesions develop in the early period. The rehabilitation of an athlete who develops a chondral lesion is more difficult, and in the late period, arthrosis develops frequently [81]. For success in transplantation, it is important that the articular cartilage surface is smooth, stable, and normal or that BMI is below 30. In a recent meta-analysis, good and excellent results were reported in 84% of cases after transplantation.

Again in a recent study, posttransplantation in 12 professional footballers was performed in 92% of the cases. At the 36th month, 75% of the cases were reported to continue their professional sports lives [59].

Studies and discussions on transplantation still continue, with short-term to midterm results being positive [82]. There is a rare risk of infection [83]. The delay in returning to sports due to the long healing process is the biggest obstacle to the technique. Currently, randomized controlled long-term studies are needed [34].

It should be kept in mind that this intervention can be applied after the professionalism of the athletes who have undergone meniscectomy in their careers and who are symptomatic or postponed transplantation in their careers.

## **9. Conclusion**

Meniscus injuries constitute a large part of the studies performed by orthopedist surgeons. The current management has progressed toward the meniscus protection. Although there has been a lot of progress in meniscus transplantation, this has still not become a routine procedure.

Young athletes need to make more efforts to protect the meniscus, while long-term treatments in a professional athlete may be postponed at the end of their career. Radial tears of the lateral meniscus corpus and anterior junction are quite important in athletes. They need to be treated early. In the case of complete radial tears, the rate of recovery after repair should be tried, but it should be noted that these patients may be transplant candidates in the later period.

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## References

- [1] Kılıç B. Six year follow-up after arthroscopic meniscectomy. *Advances in Environmental Biology*. 2015;**9**(2):50-53
- [2] Indelli PF, Szivek JA, Schnepf AS, Grana AW. Load bearing at the meniscomfemoral joint. *The Duke Orthopaedic Journal*. 2010-2011;**1**(1):39-43
- [3] Alturfan AK, Kılıçoğlu Ö, Gür E. Menisküs sorunları. *Türkiye Klinikleri Ortopedi ve Travmatoloji Dergisi*. 2006;**39**:23-30
- [4] Kilcoyne KG, Dickens JF, Haniuk E, Cameron KL, Owens BD. Epidemiology of meniscal injury associated with ACL tears in young athletes. *Orthopedics*. 2012;**35**(3):208-212
- [5] Meniscus. TUSYAD. Educational Book Series. Chapter 21. 2016. pp. 57-59
- [6] Majewski M, Susanne H, Klaus S. Epidemiology of athletic knee injuries: A 10-year study. *The Knee*. 2006;**13**(3):184-188
- [7] Zedde P, Mela F, Del Prete F, Masia F, Manunta AF. *Joints*. 2015;**2**(4):192-196. eCollection Oct-Dec 2014
- [8] Greis PE, Bardana DD, Holmstrom MC, Burks RT. Meniscal injury: I. Basic science and evaluation. *The Journal of the American Academy of Orthopaedic Surgeons*. 2002;**10**(3):168-117
- [9] Baker BE, Peckham AC, Pupparo F, Sanborn JC. Review of meniscal injury and associated sports. *The American Journal of Sports Medicine*. 1985;**13**(1):1-4
- [10] Yeh PC, Starkey C, Lombardo S, Vitti G, Kharrazi FD. Epidemiology of isolated meniscal injury and its effect on performance in athletes from the National Basketball Association. *The American Journal of Sports Medicine*. 2012;**40**(3):589-594
- [11] Popkin CA, Murnaghan ML. Knee injuries in the growing athlete. *Orthopaedics and Traumatology*. 2012;**26**(1):12-19
- [12] Poulsen MR, Johnson DL. Meniscal injuries in the young, athletically active patient. *The Physician and Sportsmedicine*. 2011;**39**(1):123-130
- [13] LaPrade RF, Burnett QM II, Veenstra MA, Hodgman CG. The prevalence of abnormal magnetic resonance imaging findings in asymptomatic knees: With correlation of magnetic resonance imaging to arthroscopic findings in symptomatic knees. *The American Journal of Sports Medicine*. 1994;**22**:739-745
- [14] Metcalf RW, Burks RT, Metcalf MS, McGinty JB. Arthroscopic meniscectomy. In: McGinty JB, Caspari RB, Jackson RW, Poehling GG, editors. *Operative Arthroscopy*. 2nd ed. Philadelphia, PA: Lippincott-Raven; 1996. pp. 263-297
- [15] Bonneux I, Vandekerckhove B. Arthroscopic partial lateral meniscectomy long-term results in athletes. *Acta Orthopaedica Belgica*. 2002;**68**:356-361
- [16] Jaureguito JW, Elliot JS, Lietner T, Dixon LB, Reider B. The effects of arthroscopic partial lateral meniscectomy in an otherwise normal knee: A retrospective review of functional, clinical, and radiographic results. *Arthroscopy*. 1995;**11**(1):29-36
- [17] Cannon WD Jr, Morgan CD. Meniscal repair: Arthroscopic repair techniques. *Instructional Course Lectures*. 1994;**43**:77-96
- [18] Lozano J, Ma CB, Cannon WD. All inside meniscus repair. *Clinical*

Orthopaedics and Related Research. 2006;**455**:134-141

[19] Barber FA, Herbert MA. Meniscal repair devices. *Arthroscopy*. 2000;**16**(6):613-618

[20] Fox AJ, Bedi A, Rodeo SA. The basic science of human knee menisci: Structure, composition, and function. *Sports Health*. 2012;**4**(4):340-351

[21] Fairbank TJ. Knee joint changes after meniscectomy. *The Journal of Bone and Joint Surgery. American Volume*. 1948;**30B**(4):664-670

[22] Hulet CH, Locker BG, Schiltz D, Texier A, Tallier E, Vielpeau CH. Arthroscopic medial meniscectomy on stable knees. *Journal of Bone and Joint Surgery. British Volume (London)*. 2001;**83**(1):29-32

[23] Sohn DH, Moorman CT. Meniscal debridement: Current concepts. *The Journal of Knee Surgery*. 2008;**21**(2):145-153

[24] De Haven KE. Decision-making factors in the treatment of meniscus lesions. *Clinical Orthopaedics*. 1990;**252**:49-54

[25] Appleyard RC, Burkhardt D, Ghosh P, Read R, Cake M, Swain MV, et al. Topographical analysis of the structural, biochemical and dynamic biomechanical properties of cartilage in an ovine model of osteoarthritis. *Osteoarthritis and Cartilage*. 2003;**11**(1):65-77

[26] Janusz MJ, Bendele AM, Brown KK, Taiwo YO, Hsieh L, Heitmeyer SA. Induction of osteoarthritis in the rat by surgical tear of the meniscus: Inhibition of joint damage by a matrix metalloproteinase inhibitor. *Osteoarthritis and Cartilage*. 2002;**10**(10):785-791

[27] Fahmy NR, Williams EA, Noble J. Meniscal pathology and osteoarthritis

of the knee. *Journal of Bone and Joint Surgery. British Volume (London)*. 1983;**65**(1):24-28

[28] Christoforakis J, Pradhan R, Sanchez-Ballester J, Hunt N, Strachan RK. Is there an association between articular cartilage changes and degenerative meniscus tears? *Arthroscopy*. 2005;**21**(11):1366-1369

[29] Outerbridge RE. The etiology of chondromalacia patellae. *Journal of Bone and Joint Surgery. British Volume (London)*. 1961;**43-B**:752-757

[30] Matsusue Y, Thomson NL. Arthroscopic partial medial meniscectomy in patients over 40 years old: A 5- to 11 year follow-up study. *Arthroscopy*. 1996;**12**(1):39-44

[31] Weiss CB, Lundberg M, Hamberg P, DeHaven KE, Gillquist J. Non-operative treatment of meniscal tears. *The Journal of Bone and Joint Surgery. American Volume*. 1989;**71**(6):811-822

[32] Herrlin S, Hallander M, Wange P, Weidenhielm L, Werner S. Arthroscopic or conservative treatment of degenerative medial meniscal tears: A prospective randomised trial. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2007;**15**(4):393-401

[33] Bizzini M, Gorelick M, Drobny T. Lateral meniscus repair in a professional ice hockey goaltender: A case report with a 5-year follow-up. *The Journal of Orthopaedic and Sports Physical Therapy*. 2006;**36**(2):89-100

[34] Giuliani JR, Burns TC, Svoboda SJ, Cameron KL, Owens BD. Treatment of meniscal injuries in young athletes. *The Journal of Knee Surgery*. 2011;**24**(2):93-100

[35] Thaunat M, Archbold P, Conteduca J, Chatellard R, Sonnery-Cottet B. Rapid chondrolysis following an unoperated lateral meniscus tear in a young

- professional rugby player. *Orthopaedics & Traumatology, Surgery & Research*. 2014;**100**(4):445-448
- [36] De Haven KE, Sebastianelli WJ. Open meniscus repair. Indications, technique, and results. *Clinics in Sports Medicine*. 1990;**9**(3):577-587
- [37] Noyes FR, Chen RC, Barber-Westin SD, Potter HG. Greater than 10-year results of red-white longitudinal meniscal repairs in patients 20 years of age or younger. *The American Journal of Sports Medicine*. 2011;**39**:1008-1017
- [38] Landreau P, Christel P, Djian P. *Pathologie ligamentaire du genou*. Springer; 2004. XV, 650p
- [39] Anderson AF, Anderson CN. Correlation of meniscal and articular cartilage injuries in children and adolescents with timing of anterior cruciate ligament reconstruction. *The American Journal of Sports Medicine*. 2015;**43**(2):275-281
- [40] De Albornoz PM, Forriol F. The meniscal healing process. *Muscles, Ligaments and Tendons Journal*. 2012;**2**(1):10-18. Print Jan 2012
- [41] Chevrier A, Nelea M, Hurtig MB, Hoemann CD, Buschmann MD. Meniscus structure in human, sheep, and rabbit for animal models of meniscus repair. *Journal of Orthopaedic Research*. 2009;**27**(9):1197-1203
- [42] Pujol N, Barbier O, Boisrenoult P, et al. Amount of meniscal resection after failed meniscal repair. *The American Journal of Sports Medicine*. 2011;**39**:1648-1652
- [43] Stein T, Mehling AP, Welsch F, et al. Long-term outcome after arthroscopic meniscal repair versus arthroscopic partial meniscectomy for traumatic meniscal tears. *The American Journal of Sports Medicine*. 2010;**38**:1542-1548
- [44] Paxton ES, Stock MV, Brophy RH. Meniscal repair versus partial meniscectomy: A systematic review comparing reoperation rates and clinical outcomes. *Arthroscopy*. 2011;**27**:1275-1288
- [45] Xu C, Zhao J. A meta-analysis comparing meniscal repair with meniscectomy in the treatment of meniscal tears: The more meniscus, the better outcome? *Knee Surgery, Sports Traumatology, Arthroscopy*. 2015;**23**(1):164-170
- [46] Logan M, Watts M, Owen J, Myers P. Meniscal repair in the elite athlete: Results of 45 repairs with a minimum 5-year follow-up. *The American Journal of Sports Medicine*. 2009;**37**(6):1131-1134
- [47] Buseck MS, Noyes FR. Arthroscopic evaluation of meniscal repairs after anterior cruciate ligament reconstruction and immediate motion. *The American Journal of Sports Medicine*. 1991;**19**:489-494
- [48] Haklar U, Kocaoglu B, Nalbantoglu U, Tuzuner T, Guven O. Arthroscopic repair of radial lateral meniscus tear by double horizontal sutures with inside-outside technique. *The Knee*. 2008;**15**(5):355-359
- [49] Arnoczky SP, Warren RF, McDevitt CA. Meniscal replacement using a cryopreserved allograft. An experimental study in the dog. *Clinical Orthopaedics and Related Research*. 1990;**252**:121-128
- [50] De Girolamo L, Galliera E, Volpi P, Denti M, Dogliotti G, Quaglia A, et al. Why menisci show higher healing rate when repaired during ACL reconstruction? Growth factors release can be the explanation. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2015;**23**:90-96
- [51] Griffin JW, Hadeed MM, Werner BC, Diduch DR, Carson EW,

Miller MD. Platelet-rich plasma in meniscal repair: Does augmentation improve surgical outcomes? *Clinical Orthopaedics and Related Research*. 2015;**473**(5):1665-1672

[52] Ochi M, Uchio Y, Okuda K, et al. Expression of cytokines after meniscal rasping to promote meniscal healing. *Arthroscopy*. 2001;**17**:724-731

[53] Shelbourne KD, Gray T. Meniscus tears that can be left in situ, with or without trephination or synovial abrasion to stimulate healing. *Sports Medicine and Arthroscopy Review*. 2012;**20**:62-67

[54] Haklar U, Donmez F, Basaran SH, Canbora MK. Results of arthroscopic repair of partial- or full-thickness longitudinal medial meniscal tears by single or double vertical sutures using the inside-out technique. *The American Journal of Sports Medicine*. 2013;**41**(3):596-602

[55] Kozlowski EJ, Barcia AM, Tokish JM. Meniscus repair: The role of accelerated rehabilitation in return to sport. *Sports Medicine and Arthroscopy Review*. 2012;**20**:121-126

[56] Pabian P, Hanney WJ. Functional rehabilitation after medial meniscus repair in a high school football quarterback: A case report. *North American Journal of Sports Physical Therapy*. 2008;**3**(3):161-169

[57] Horibe S, Shino K, Nakata K, Maeda A, Nakamura N, Matsumoto N. Second look arthroscopy after meniscal repair. Review of 132 menisci repaired by an arthroscopic inside-out technique. *Journal of Bone and Joint Surgery. British Volume (London)*. 1995;**77**:245-249

[58] Becker R, Brettschneider O, Grobel KH, von Verson R, Starke C. Distraction forces on repaired bucket-handle lesions in the medial meniscus. *The*

*American Journal of Sports Medicine*. 2006;**34**:1941-1947

[59] Bray RC, Smith JA, Eng MK, Leonard CA, Sutherland CA, Salo PT. Vascular response of the meniscus to injury: Effects of immobilization. *Journal of Orthopaedic Research*. 2001;**19**:384-390

[60] Lind M, Nielsen T, Faunø P, Lund B, Christiansen SE. Free rehabilitation is safe after isolated meniscus repair: A prospective randomized trial comparing free with restricted rehabilitation regimens. *The American Journal of Sports Medicine*. 2013;**41**(12):2753-2758

[61] Frizziero A, Ferrari R, Giannotti E, Ferroni C, Poli P, Masiero S. The meniscus tear. State of the art of rehabilitation protocols related to surgical procedures. *Muscles, Ligaments and Tendons Journal*. 2013;**2**(4):295-301

[62] Kim SG, Nagao M, Kamata K, Maeda K, Nozawa M. Return to sport after arthroscopic meniscectomy on stable knees. *BMC Sports Science, Medicine and Rehabilitation*. 2013;**5**(1):23. DOI: 10.1186/2052-1847-5-23

[63] Boyd KT, Myers PT. Meniscus preservation; rationale, repair techniques and results. *The Knee*. 2003;**10**(1):1-11

[64] Turman KA, Diduch DR. Meniscal repair: Indications and techniques. *The Journal of Knee Surgery*. 2008;**21**(2):154-162

[65] Rodeo SA, Senevirante AM. Arthroscopic meniscal repair using outside-in technique: Indications technique and results. *Sports Medicine and Arthroscopy Review*. 1999;**7**(1):20-27

[66] Horibe S, Shino K, Nakata K, Maeda A, Nakamura N, Matsumoto N. Second-look arthroscopy after meniscal repair.



Review of 132 menisci repaired by an arthroscopic inside-out technique. *Journal of Bone and Joint Surgery*. 1995;77(2):245-249

[67] Arnoczky SP, Warren RF, Spivak JM. Meniscal repair using an exogenous fibrin clot: An experimental study in dogs. *The Journal of Bone and Joint Surgery. American Volume*. 1988;70:1209-1217

[68] Zhang Z, Arnold JA, Williams T, McCann B. Repairs by trephination and suturing of longitudinal injuries in the avascular area of the meniscus in goats. *The American Journal of Sports Medicine*. 1995

[69] Zhang Z, Arnold JA. Trephination and suturing of avascular meniscal tears. A clinical study of the trephination procedure. *Arthroscopy*. 1996;12:726-731

[70] Reha Tandoğan N. Menisküs Tamiri: Endikasyon ve Prensipler. *Turkish Society of Orthopaedics and Traumatology*. 2002;1(1)

[71] Kobuna Y, Shirakura K, Niiijima M. Meniscal repair using a flap of synovium. An experimental study in the dog. *The American Journal of Knee Surgery*. 1995;8(2):52-55

[72] Kollias SL, Fox JM. Meniscal repair: Where do we from here? *Clinics in Sports Medicine*. 1996;15(3):621-630

[73] Weber RJ, Harris M, Hough AJ. Cell culture of rabbit meniscal fibrochondrocytes: Proliferative and synthetic response to growth factors and ascorbate. *Journal of Orthopaedic Research*. 1985;3:36-42

[74] Spindler KP, Mayes CE, Miller RR. Regional mitogenic response of the meniscus to platelet-derived growth factor (PDGF-AB). *Journal of Orthopaedic Research*. 1995;13:201-207

[75] Barber FA. Meniscus repair aftercare. *Sports Medicine and Arthroscopy Review*. 1999;7(1):43-47

[76] Verdonk R, Verdonk P, Huysse W, Forsyth R, Heinrichs EL. Tissue ingrowth after implantation of a novel, biodegradable polyurethane scaffold for treatment of partial meniscal lesions. *The American Journal of Sports Medicine*. 2011;39(4):774-782

[77] Zaffagnini S, Grassi A, Marcheggiani Muccioli GM, Holsten D, Bulgheroni P, et al. Two-year clinical results of lateral collagen meniscus implant: A multicenter study. *Arthroscopy*. 2015;31(7):1269-1278

[78] Gentile NE, Stearns KM, Brown EH, Rubin JP, Boninger ML, Dearth CL, et al. Targeted rehabilitation after extracellular matrix scaffold transplantation for the treatment of volumetric muscle loss. *American Journal of Physical Medicine & Rehabilitation*. 2014;93(11 Suppl 3):S79-S87

[79] Gür S, Janousek AT, Fu FH. Allograft menisküs transplantasyonu. *Acta Orthopaedica et Traumatologica Turcica*. 1997;31:429-436

[80] Kim JM, Jeon BS, Lee CR, Lim SJ, Kim KA, Bin SI. Comparison of postoperative magnetic resonance imaging and second look arthroscopy for evaluating meniscal allograft transplantation. *Arthroscopy*. 2015;31(5):859-866

[81] Sonnery-Cottet B, Archbold P, Thaumat M, Carnesecchi O, Tostes M, Chabot P. Rapid chondrolysis of the knee after partial lateral meniscectomy in professional athletes. *The Knee*. 2014;21(2):504-508

[82] Lee DH, Kim SB, Kim TH, Cha EJ, Bin SI. Midterm outcomes after meniscal allograft transplantation:

Comparison of cases with extrusion  
versus without extrusion. The  
American Journal of Sports Medicine.  
2010;**38**:247-254

[83] Matava MJ. Meniscal allograft  
transplantation: A systematic review.  
Clinical Orthopaedics and Related  
Research. 2007;**455**:142-157