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Current Research on the Diagnosis Method of Meniscus Root Injury and its Healing

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Abstract. Currently, meniscus injury has become a common disease among sports and fitness enthusiasts in China, with root meniscus injury accounting for a larger proportion, which damage impairs load distribution throughout the knee joint, reducing the surface area to bear the load and making patients susceptible to early degenerative changes that alter their daily activities. This injury has been ignored for a long time, and in recent years people have begun to pay more attention to it. However, the diagnosis of root meniscus injury is difficult to detect, and the current mainstream method is MRI examination, combined with X-ray and arthroscope examination. However, with people's increasing emphasis on health, some may not accept surgical treatments such as meniscus repair or meniscectomy. Therefore, non-surgical treatments such as drug injection are gradually being used. In this paper, the literature on meniscus root injury in recent years was reviewed, and the anatomy, injury mechanism and intervention of meniscus root were reviewed, so as to further understand the current progress of injury.

Keywords: Meniscus injury; magnetic resonance imaging; meniscectomy.

1. Introduction

According to the "Healthy China 2030" plan, the number of people participating in sports and fitness activities in China is projected to continue growing in the coming years. However, this surge in the sports population is likely to be accompanied by an increase in the number of patients with meniscal injuries. The root of the meniscus has the ability to prevent axial stress from squeezing the meniscus around. The function of prolapse is to fix the meniscus and maintain its normal functionhas an important role [1]. Meniscus injury is one of the most common injuries of knee joint, accounting for 12% to 14% of orthopedic injuries of knee joint. At the same time, meniscus tear is also the most important and common injury of meniscus injury. In the general population, meniscus tears are reported to occur in an average of 154 per 100,000 people. The data in foreign countries. MR damage accounts for 12% to 14% of all meniscus injuries, with an incidence rate of 60-70 cases per 100,000 people. Additionally, it has been found that 7-8% of arthroscopic examination procedures involve the knee joint, with approximately two-thirds of the cases caused by root tear of the medial meniscus and approximately one-third of the injuries located at the root of the lateral meniscus [2]. Meniscus tears are also common in everyday activities, but athletes and some workers are at greatest risk, especially in postures that require knee rotation or drastic twisting. Frequent, widespread movements put a huge load on the knee's meniscus, and prolonged loading can lead to excessive fatigue and wear and tear of the meniscus. Meniscus injuries are very common among athletes and the general population. People with meniscus injuries may experience swelling, pain, or some mechanical symptoms, and usually require surgery to treat.

However, it is difficult to find the damage of meniscus root in meniscus injury. The cause of the injury is difficult to diagnose. The most effective way that can detect meniscus root damage is with magnetic resonance imaging (MRI). The treatment of meniscus cna also be divided into surgical and non-surgical parts. During surgery, 10%-20% of patients with meniscal root injury receive

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meniscectomy or repair. With the attention paid to sports and health, the prevalence of MRT may continue to increase. Also, some patients have resistance to surgical treatment and try non-surgical treatment. This kind of treatment generally does not completely remove or change the structure of the meniscus and the nature of the existence of the meniscus as surgery, non-surgical treatment is more like an anti-inflammatory pain relief process, but also use some auxiliary activities to enhance the performance of the meniscus. With the in-depth research in recent years, the understanding of the importance of meniscus root and the diagnosis and treatment of meniscus root injury have been further improved. This paper reviews the previous literature, summarizes and analyzes the anatomy, clinical diagnosis and comprehensive treatment of meniscus, and guides the further diagnosis and study of meniscus root.

2. Basic Anatomical Structure of Meniscus Root

The meniscus structure is divided into the medial meniscus and the lateral meniscus, with the medial meniscus looking more "C-shaped" and the lateral meniscus also usually looking more "U-shaped". However, whether it is the medial meniscus or the lateral meniscus, when we talk about the root of the meniscus, they are divided into internal roots and external roots, in general, there is not only one meniscus root, as shown in Figure 1.

The attachment of the posterior root of the medial meniscus (MPRA) is usually located at 9.6mm posteriorly behind the apex of the "mound" of the medial tibia and is about 0.7mm away from the lateral.

The e medial meniscus anterior root attachment (MARA) is usually located approximately 27.5 mm in front of the apex of the "hill of bones" raised on the medial tibia.

However, the central point of the lateral anterior meniscus attachment (LARA) is 5-7.5 mm anterolateral from the central point of the anterior cruciate ligament termination point of the tibia, and 13.4 mm in front of the most anterior edge of the lateral posterior root attachment [3].

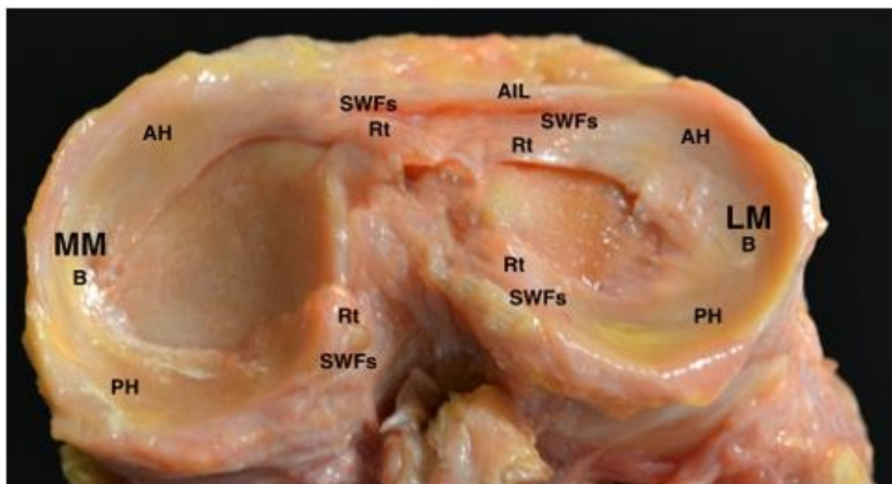

Figure 1. This is a rear view, this picture shows the stability and qualitative anatomical relationship between the two important parts of the meniscus, the fibrocartilage structure and the ligament, MM, the medial meniscus; LM, lateral meniscus; B) The body; AH, front corner; PH, rear Angle; Rt, root; swf, shiny and very smooth white fibers and anterior intermeniscal ligaments, this image helps us better understand the root of the meniscus and the structure of the meniscus.

3. Diagnosis of Meniscus Root Injury

There are three commonly used methods to diagnose meniscus root injury in clinic, which are X-ray examination, MRI and arthroscopy:

3.1. X-ray

X-ray examination is a kind of electromagnetic wave X-ray with a very short wavelength to carry out corresponding auxiliary examination, and X-ray can penetrate human tissue. While X-ray examination may cause physiological and biochemical changes in human body fluids and tissue cells, causing varying degrees of damage.

3.2. Magnetic Resonance Imaging (MRI)

MRI diagnosis of meniscus, with a sensitivity of 77% and specificity of 73%, The accuracy of damage can reach 80% to 100%, also known as spin imaging, is a faster and non-invasive method than X-ray examination [4,5]. MRI has a high soft tissue resolution and can accurately determine the location and morphological degree of knee joint injury. At present, MRI is the best examination method for determining knee meniscus injury [6]. MRI is used to diagnose meniscal injury. Classification criteria: Grade 0 is normal semilunar, The plate is a regular form of low signal; Grade I performance, Focal ellipses or circles that are not in contact with the articular surfaces of the meniscus High signal, is a kind of degenerative change; Level II is a horizontal linear shape of the medium and high signal, can Extending to the margin of the capsular joint of the meniscus but not reaching the meniscus Joint surface margin; Grade III was characterized by one high signal in the meniscus Or 2 articular surfaces, the high signal has reached the articular surface of the meniscus [7].

3.3. Arthroscopy

Arthroscopy can accurately locate the injury location of the meniscus of the knee joint, and can also grade the injury of the meniscus to different degrees. Compared with the first two types, it can not only inspect the damage of the patients with meniscus injury, but also do a minimally invasive surgery for the patients with meniscus injury [4].

According to the above content, MRI is the best method to detect meniscus injury at present. for the meniscus injury examination and meniscus root injury examination, the meniscus does not develop during X-ray examination, so there is no way to diagnose whether the meniscus root is damaged. Meanwhile, X-ray damage to the human body is mainly ionizing radiation, excessive and long-term exposure to X-ray radiation, may produce radioactive damage, resulting in cell damage. Although arthroscopy is the gold standard to detect meniscus injury, arthroscopy is invasive and may not be suitable for some patients who do not have knee tear [4]. However, in order to further determine whether the meniscus root injury is due to some routine physical examination, excluding height, weight, BMI, and activity, more attention should be paid to passive knee flexion pain, joint compression pain, and McMurray test positive, in certain cases, also during inversion pressure can be touched in the joint line [5].

4. Meniscus Root Injury Treatment

4.1. Non-operative treatment

Non-surgical treatments include medication, drug injection therapy (intra-articular injection), removal of knee braces, primarily for pain relief, and some treatments through changes in the patient's lifestyle and supervised exercise [8].This type of treatment is suitable for the following patients who are not suitable for surgical treatments: (1) People older than 40 to 45 years old are thought to have poor healing ability of their degraded meniscus tissue; (2) those with advanced knee osteoarthritis (Kellgren-Lawrence grade 3); (3) those with significant comorbidities; (4) those who do not have the will to adhere to a rigorous post-operative rehabilitation protocol [9,10].

Non-surgical treatment can improve the symptoms and function of meniscus root injury, but for the complete symptoms, the clinical effect is relatively short-term, and the lesions have not been solved accordingly, resulting in degenerative changes in the knee joint [11]. Although non-surgical treatment may lead to degenerative changes in the corresponding articular cartilage when relieving pain from

injury, studies have shown that the probability of degenerative changes is not higher with non-surgical treatment than with surgical treatment. The nam project team divided 255 middle-aged patients with meniscus root injury into two groups, 148 in the surgical treatment group and 107 in the conservative treatment group, excluding ligament or bone injury, lateral or anterior meniscus tear, meniscus repair, combined with high tibial osteotomy, structural varus alignment, and K-L classification of osteoarthritis > grade 3. A total of 109 patients were followed up for less than 2 years, and the remaining patients were divided into 90 patients in the surgical group and 56 patients in the non-surgical group [12]. Clinical manifestations at first visit and follow-up were assessed using the National Knee Documentation Committee (IKDC) Shooting Rating Scale, Visual Analogue Scale (VAS), Lysholm Knee Rating Scale, and Tegner Activity Scale. Result obtained, the overall Kaplan-Meier probability of survival after arthroscopic meniscectomy was 99% at 5years, 87%at10years, whereas that forconservativetreatment was 98%at 5years, 88%at 10years (p=0.8). The TKA, UKA or HTO conversion hazard was116% higher for the conservative group compared with the meniscectomy groupbut therewasno statistically sig nificantdifference (p=0.82) [12].

4.2. Meniscectomy

Meniscectomy can be used in patients who do not respond to nonsurgical treatment. Patients with intact footprints with partial tears may show good results in meniscectomy [10]. Compared with meniscus repair, the advantages of this treatment include short operation time, simple postoperative rehabilitation program, no strict weight restriction, short postoperative rehabilitation time, and faster return to activity. Although partial meniscectomy can relieve short-term symptoms in most patients, it cannot restore meniscal anatomy and function, or delay long-term articular cartilage degeneration and osteoarthritis progression.

4.3. Meniscus root repair

The repair methods for MMRT (posterior root tear of the medial meniscus) include two techniques: one uses a bone tunnel (transtibial pull-out repair), and the other uses a suture anchor repair, where a suture anchor is placed in the MMRT area to repair the posterior platform of the tibia above [7]. The advantages and disadvantages of the two procedures are different, the advantages of suture anchors are reduced bungee effect and the risk of suture material wear, but this procedure is very demanding in terms of technology. The other method is less difficult for the doctor to operate, but the wear degree of the suture material is higher [11]. The transtibial pullout technique facilitates anatomic reduction and fi xation of the meniscal [10]. Faucett et al. demonstrated that meniscus repair provided better treatment than meniscectomy or conservative treatment. Among 239 cases of meniscus root repair,171 cases were free of osteoarthritis within 5 years, and the rate was 19% and 24% in the meniscectomy group and the non-surgical group, respectively. As seen, meniscal repair is more effective than meniscectomy and replacement [9].

5. Postoperative Recovery

5.1. Conventional Rehabilitation

After meniscus tibial root pulling repair, the patient avoided bearing weight for 6 weeks to protect the root repair and avoid stress. When not undergoing physical therapy, the patient should wear a fully extended brace for 6 weeks. After physical therapy, exercise therapy should begin immediately with passive range of motion exercises four times a day. Knee movement is limited to 0-90 degrees for the first two weeks and then progresses to full knee movement depending on tolerance. Progressive progress to full weight-bearing should begin at week 6 and avoid varus squats greater than 70 degrees for at least four months after surgery. After six months of rehabilitation, the patient was allowed full freedom of movement [10].

5.2. Fast Rehabilitation

The patient used a knee fixator for 1 week to increase knee stability, and began ROM exercise and partial weight bearing 1 week after surgery. The range of activity is 30° in the first week, increasing to 90° in the third week and 120° in the fourth week. Partial weight bearing of 20 kg is allowed one week after surgery, with an increase of 20 kg per week, and the patient needs to be weighted according to the patient's body weight until the patient can fully carry the weight. This way of slowly increasing the weight and increasing the weight according to the patient's body weight can effectively promote the recovery of the meniscus and avoid secondary trauma to the meniscus root and meniscus. For patients with an average weight of about 60kg, full weight training is allowed 3 weeks after surgery. If the patient weighs more than 80 kg, full weight training is allowed 5 weeks after surgery. After starting with partial weight, the knee fixator can be removed during the day to allow the knee to recover naturally, and then worn at night until the patient is able to bend the knee to 90°. Patients should continue to follow this regimen for 2-3 months after surgery. In order to prevent the impact of the semilunar plate on the tibia and the medial condyle of the femur after surgical repair, it is recommended to permanently avoid hyperflexion of the knee joint when the patient is carrying weight, such as high-angle movements such as squatting [13].

6. Conclusion

Meniscal root injuries are often challenging to detect and are typically severe upon discovery. To address this issue, this article compiles and analyzes previous research on meniscal root injuries, presenting three different diagnostic methods. After considering various factors, MRI is currently the most appropriate diagnostic tool. For patients with varying conditions, both non-surgical and surgical treatment options are discussed. Among the two surgical treatment methods, posterior meniscal root repair is identified as the optimal approach. This article also proposes two rehabilitation methods for the postoperative recovery process. However, due to its recent introduction, the rapid rehabilitation protocol still lacks extensive clinical data to ensure its accuracy, and future postoperative rehabilitation may consider investigating the potential of home-based rehabilitation therapies. In addition, the mechanism of meniscus root injury, epidemiology, biomechanics and other basic researches have not been deeply understood, and relevant studies need to be further conducted, and current diagnosis and treatment methods need to be timely evaluated to continuously improve the level of diagnosis and treatment.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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