Section A-Research paper

An Overview about Management Options of meniscal Root Injuries

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Abstract

Background: The fibrocartilaginous meniscus is essential for the musculoskeletal stability of the knee joint. Damage or loss of this vital structure can lead to significant articulatory morbidity and an accelerated course of osteoarthritis. Therefore, attempts should be made to preserve the meniscus. Treatment and management of meniscal tears are dictated by multiple factors which include age, complexity of the tear, tissue quality, the severity of symptoms, etiology (traumatic versus atraumatic tear), and quantified surgical risk. The integrity of the meniscal root insertions is fundamental to preserve correct knee kinematics and avoid degenerative changes of the knee. Injuries to the meniscal attachments can lead to meniscal extrusion, decreased contact surface, increased cartilage stress, and ultimately articular degeneration. Recent and well designed studies have clarified the anatomy and biomechanics of the medial and lateral meniscal roots. Although the treatment of meniscal root tears is still controversial, many different techniques have been described for root repair. The goal of this review is to summarize the existing knowledge regarding meniscal root tears management.

Keywords: meniscal Root Injuries, Management

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Introduction

The menisci are two fibrocartilaginous structures essential for correct knee function and joint preservation. About 40% to 70% of the load transmitted through the knee is borne by the menisci. [1]. The mechanical load absorption ability of the menisci is to convert axial load into circumferential *hoop stress*. [2]. The menisci also play a major role in maintaining knee stability. [3]. The integrity of the meniscal root insertions is fundamental to preserve correct knee kinematics and avoid degenerative changes of the joint. [3].
In 1991 Pagnani *et al*. [3]. first described meniscal root tears, and during the last 20 years the importance of meniscal root integrity became evident. An injury to the meniscal attachment, especially on the medial side, can lead to meniscal extrusion. Meniscal extrusion increases stress to the cartilage, by decreasing the contact surface. [4]. This causes impairment of hoop stress dissipation with accelerated articular degeneration. [5].

The fibrocartilaginous meniscus is essential for the musculoskeletal stability of the knee joint. Damage or loss of this vital structure can lead to significant articulatory morbidity and an accelerated course of osteoarthritis. Therefore, attempts should be made to preserve the meniscus. Treatment and management of meniscal tears are dictated by multiple factors which include age, complexity of the tear, tissue quality, the severity of symptoms, etiology (traumatic versus atraumatic tear), and quantified surgical risk [6].

For acutely painful and swollen knees with a suspected meniscal tear, the initial strategy is to follow the R.I.C.E. (rest, ice, compression, elevation) principle. Oral medication, such as acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs), can also be prescribed to reduce pain and swelling. For

degenerative tears and simple traumatic meniscal tears, additional conservative management involves the use of a knee brace, activity modification, physical therapy, and quadriceps strengthening exercises [7].

Physical therapy should be initiated early and should begin with pain-free range of motion exercises with progression to weight-bearing exercises as tolerated. Some activities like biking and swimming that decrease mechanical load across the knee should also be encouraged. In patients who refuse surgery or in whom chronic NSAID use/surgery is contraindicated, intra-articular steroid or hyaluronic injections may be provided every two to three months, for short term relief [8].

For simple traumatic/degenerative tears, it is reasonable to continue conservative management for about four to six weeks. A study found that quadriceps-strengthening exercises three times a week for 10 weeks have improved knee function by 35% in patients with osteoarthritis. However, if mechanical symptoms persist, are disabling, and significantly affect the quality of life, surgical intervention should be considered. Generally, surgery is favored if the case involves any of the following: (1) red zone tear, (2) complex and extensive meniscal rips > 1 cm, (3) young healthy candidates with age<40 years old, (4) acute tears that occurred <6 weeks, and (5) presence of recent ACL injury. The current surgical approaches are meniscectomy, meniscal repair, and meniscal reconstruction [9].

Meniscectomy:

Meniscectomy can be done completely or partially via an open or arthroscopic approach. In the current era, total meniscectomy is never performed due its side effects, most importantly early-onset osteoarthritis. Arthroscopic Partial Meniscectomy (APM) is more commonly performed as it is minimally invasive, has shorter recovery time, and lower morbidity. Indications for APM include radial white-white zone meniscal tears and degenerative meniscal injuries, not responding to conservative management. Advanced clinical research shows no significant long-term benefits of APM over non-operative management of traumatic and a traumatic meniscal tear. Factors associated with poor outcomes of APM are obesity, female gender, and advanced osteoarthritis. Therefore, per current guidelines, APM is no longer the first-line therapy and should be undertaken only in selective patients with non-repairable meniscal tears and those with persistent mechanical symptoms beyond 3 months [10-11].

Meniscal repair:

Meniscal repair like meniscectomy can be performed via an open surgical or arthroscopic approach which, predominates over open repair due to a lower risk of neural damage. Tear patterns and adequacy of vascularity should be accessed before proceeding with meniscal repair. Repair is most advantageous in 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. However, a repair can still be attempted with radial tears in partially perfused red-white zones [12-13].

Arthroscopic meniscus repair can be achieved via inside-out, outside-in, and all-inside techniques. The inside-out approach is associated with the greatest success rates and is the gold standard in meniscal repair. In this approach, the sutures are passed from inside the knee to an extra-capsular area through the extra-articular incision and a knot is then secured over the joint capsule. The inside-out technique is commonly used for posterior horn meniscal damage [14].

The outside-in technique is more commonly used for anterior horn tears. In this approach, the spinal needle is passed through the meniscal rip in an outside-in manner. The suture is passed through the arthroscopic portal once the tip of the needle is visible. The suture is pulled back after an interference knot is tied at the end [15].

The all-inside technique is most beneficial in case of extreme posterior meniscal rips. Instruments used for repair (such as screws, staples, etc.) are commonly made of bioabsorbable compounds like poly-L lactic acid. These implants are deformable and hence lowering the potential of chondral erosion during weight-bearing. Although arthroscopic techniques aim to lower the risk of neurovascular problems, inadvertent damage can still occur in all the above [16].

Meniscal reconstruction:

The least commonly performed is the meniscal reconstruction surgery, in which attempts are made to replace missing/resected components of the native meniscus with functional ones. The aim of this procedure is to re-establish the functionality of the knee joints and mitigate degenerative processes that would otherwise result from poor knee biomechanics. Reconstruction can be performed with the use of either meniscal scaffolds or via meniscal allograft transplantation (MAT). MAT involves the transplantation of preserved meniscus allograft. Meniscal scaffold surgery, on the other hand, uses synthetic biodegradable porous structures to fill meniscal defects. The high porosity of the scaffolds allows vascular tissue to grow within them which provides additional reinforcement [17].

Treatment of meniscal root tears

Treatment options for MMRTs include non-operative treatment, meniscectomy, surgical repair, and high tibial osteotomy. Although non-operative treatment and partial meniscectomy were the most commonly used treatment options for MMRTs until a decade ago, the frequency of surgical repair has increased as the biomechanical importance of the MMPR has been elucidated. Surgical repair is not appropriate for some cases of MMRTs, and non-operative treatment and meniscectomy remain available in some situations. However, based on the findings of numerous clinical studies, surgical repair has become the treatment of choice for MMRTs [18].

Meniscal root repair

The repair methods for MMRTs include two techniques: one uses a suture anchor (suture anchor repair), and the other uses a transosseous tunnel (transtibial pull-out repair). Suture anchor repair is performed by placing the suture anchor on the region of an MMRT above the posterior tibial plateau. This method has the advantage of reducing the risk of the bungee effect, micromotion between the meniscus-suture complex, and abrasion of the suture material, which may be found in long meniscus-suture constructs, resulting from transtibial pull-out repair. However, this surgical method is technically demanding and requires an additional high posteromedial working portal and specialized instruments. It also involves the risk of damaging the cartilage and neurovascular structures [19].

Transtibial pullout repair

The gold-standard for root repair is a transtibial pullout technique that involves passing sutures through the meniscal root, retrieving them through tunnels drilled in the proximal tibia, and subsequently tying the sutures over a button or a specific anchor or, less commonly, directly over the anterior tibial bone bridge. Use of a button for suture fixation is less invasive and reduces the risk of soft-tissue irritation in comparison with use of a screw [20]. Before the repair process, the medial joint space width is measured using a 5-mm hook on an arthroscopic probe. If the medial gap is narrow, a percutaneous pie-crusting release of the superficial medial collateral ligament is performed which reduces the risk of iatrogenic articular cartilage damage and facilitates the surgical procedure.

Figure 1: Transtibial pull-out repair of a medial meniscal posterior root tear in the knee [20].

As mentioned, this surgical method may have potential disadvantages, such as micromotion and suture abrasion. However, this method is technically less challenging and has a relatively low risk of damage to the vital structures of the knee joint. It also avoids potential complications caused by the loosening of the suture anchor. Therefore, most surgeons use transtibial pullout repair for MMRTs [21].

Single-tunnel and double-tunnel techniques have been described for attempting to reproduce the root's anatomic footprint and enhance biologic healing. Both methods begin by placing surgical arthroscopic incisions adjacent to the edges of the patellar tendon, both medially and laterally. A curette is then used to decorticate the site of planned root reattachment on the tibial plateau. An ACL or meniscal root guide is used to position a drill pin with a cannulated sleeve on the posterior aspect of the footprint. In the double-tunnel technique, a second drill hole with a cannula is placed approximately 5 mm anterior to the first hole. Once correct tunnel placement is verified, the drill pins are removed, and two simple sutures are passed, one anterior and one posterior, into the meniscal root. The sutures are then retrieved through the corresponding tunnels and are tied over a button, specific anchor, or anterior tibial bone bridge [20].

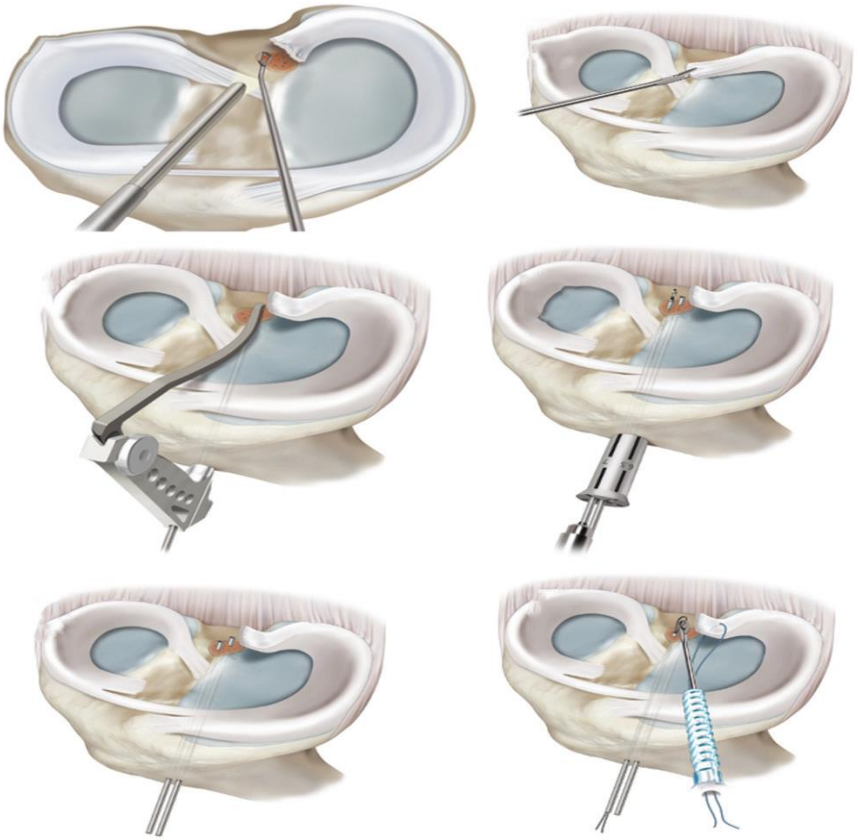

Figure 2: Illustration of an anatomic two-tunnel transtibial medial meniscus posterior root repair. (a) The torn attachment site is prepared to a bleeding bone bed using a curved curette. (b) Sutures are placed through the detached root of the meniscus (c) a cannulated guide is used to drill two transtibial tunnels from just adjacent to the ipsilateral side of the tibial tubercle to the anatomic attachment site of the root on the tibial plateau. (d) An offset is used to drill the tibial tunnels 5 mm apart. (e) The cannulas are left in place in the tibial tunnels to facilitate (f) passage of two simple sutures using suture pass [20].

In addition to these two representative techniques, various additional procedures have been used to minimize meniscal extrusion that may persist after surgical repair, including peripheral release, centralization suture, and whip-running suture. However, no well designed clinical study has demonstrated a method that reliably reduces residual meniscus extrusion [22].

High Tibial Osteotomy

High tibial osteotomy may be a treatment option for MMRTs. Because most MMRTs are degenerative in nature, it is common for them to be accompanied by cartilage lesions or varus deformities of the lower extremities. As high-grade cartilage lesions in the medial tibiofemoral joint and severe varus malalignment (more than 10 degrees) are poor prognostic factors for the surgical repair of MMRTs, high tibial osteotomy can be an alternative to the surgical repair of MMRTs for patients with medial compartment osteoarthritis in a varus knee by redistributing the load applied to the knee. High tibial osteotomy has been reported to show favorable clinical outcomes for patients regardless of the healing of MMRTs. Furthermore, although it would theoretically be ideal to perform concurrent surgical repair of MMRTs during high tibial osteotomy, it has been reported that there are no clinical benefits in combined surgical procedures compared to isolated high tibial osteotomy [23].

Approach strategy for the treatment of MMPRTs.

Due to many factors that alter the result of medial meniscus root repair. The significant factors were chronicity of tear, grading of osteoarthritis and mal-alignment (varus >5 degrees). We developed a strategic approach for the treatment of medial meniscus posterior root tear [24] .

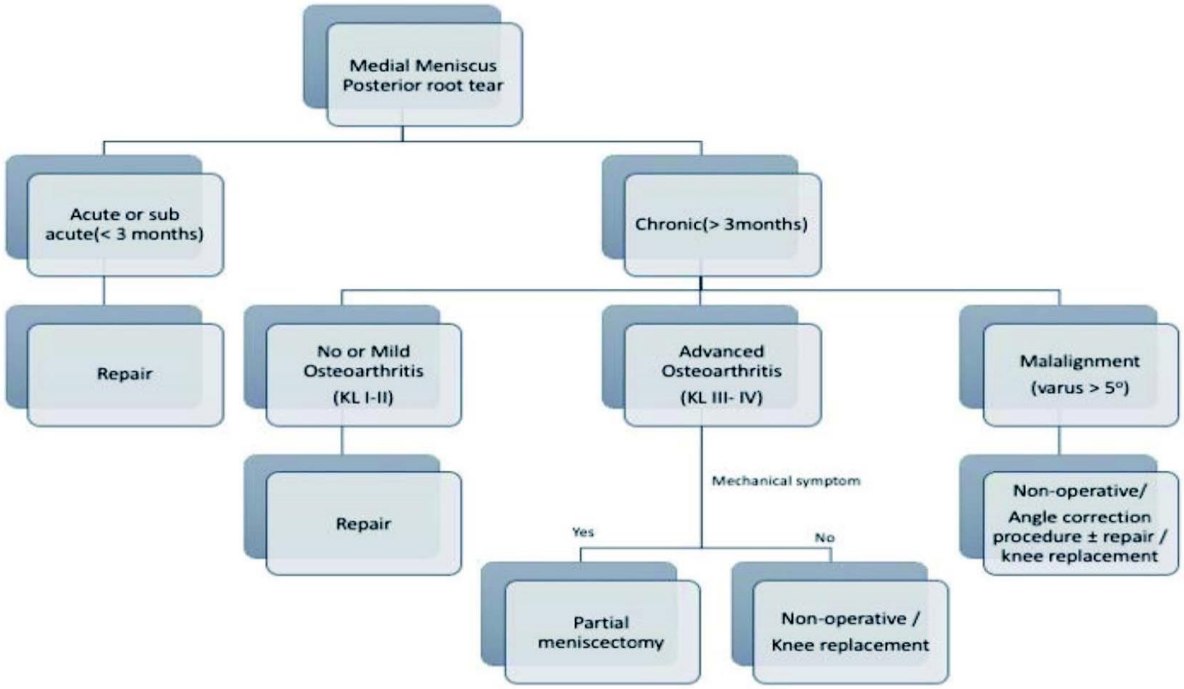

Figure 3: *Our strategic approach for symptomatic medial meniscus posterior root tear [21].*

Postoperative Rehabilitation

In immediate post-operative period, the goal was to reduce pain and swelling. In one study, the continue passive motion machine was used immediately after surgery but most of the studies would delay the motion after 4 weeks. Most of the repair protocol used cast or knee brace with locked flexion at first 4 weeks with the first 2 weeks in full extension and the other 2 weeks in 0-30 degrees to prevent femoral roll back and injury to the repair meniscus. Active range of motion exercise should be done after 4-6 weeks. Non-weight bearing or toe-touch weight bearing was used during the first 2 weeks after surgery. Then progressive weight bearing to full weight at 6-8 weeks after surgery. Isometric quadriceps exercise could start at the 1st post-operative day but active strengthening exercise should start at 8-12 weeks after surgery. In the majority of patients, full activity can be achieved by 4-6 months [25] .

Surgical Outcomes

Surgical repair of MMRTs provides both subjective and objective clinical benefits. The literature has consistently reported significant functional improvement, which could persist over the mid- to long-term after surgical repair of MMRTs. Although surgical repair cannot prevent degenerative changes in the knee joint, the progression of osteoarthritis is less severe compared to that in non-operative treatment or meniscectomy. Additionally, a paper reported that surgical repair is an economically superior treatment approach compared with other treatment modalities. Therefore, although further multidisciplinary studies are required, surgical repair should be recommended for MMRTs, rather than other treatment methods, unless contraindicated [99] rom a biomechanical point of view, meniscal root avulsions significantly alter the load transmission through the knee joint. The clinical implications of these biomechanical changes need to be determined with further Level I or II studies.

Some controversies exist regarding the optimal treatment of LMPRTs, when associated with ACL tears. The LMPRTs can be left untreated, with no significant clinical differences compared with arthroscopic repair at midterm follow-up (Grade of recommendation C). Further studies with longer follow up are needed to confirm this recommendation.

Repair of MMPRTs seems to result in better outcomes compared with partial meniscectomy, independently of the technique used (pull-out *vs* suture anchor) (Grade of recommendation C).

Despite good initial clinical outcomes, second look arthroscopies and post operative MRI showed high rates of non healing.

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