Meniscal tears are the most common knee injuries, especially in young active people. Due to symptoms like pain, swelling and sudden knee blocks (especially in the case of a ‘locking’ ‘‘latch’’), it is quite impossible for those suffering a meniscal tear to perform any sport activity. For many years, the standard treatment of a meniscal tear was only meniscectomy, performed by removing the damaged meniscal tissue. This surgery is simple and allows the patient to return to sport in a few weeks when executed arthroscopically.

However, in the last decade, the approach to meniscal lesions has moved towards more conservative strategies such as meniscal suture, meniscal prosthesis and meniscal allograft transplantation. This approach aims to preserve as much meniscal tissue as possible.

WHY PRESERVE THE MENISCUS?

The menisci are two knee structures, interposed between the articular surfaces of femur and tibia. Historically they were thought to be ‘functionless’. It appears obvious that the knee joint cartilage, which is not structured to otherwise would charge the soft articular cartilage, is which is not structured to be loaded by the entire body-weight. Moreover, the menisci increase the congruence of the two articular ends, improving the stability of the joint. In addition to those important mechanical functions, the meniscus also contribute to cartilage nutrition and lubrication.

It is obvious that the knee joint cannot work correctly without such irreplaceable structures. In fact, many studies outline that even partial meniscal changes that can lead to the development of knee osteoarthritis after 10 or more years. The risk is estimated at about 50% after lateral meniscectomy (Figure 1). The higher risk associated with lateral meniscectomy is due to the different coverage area, shape, mechanical load and mobility of the two menisci. For the aforementioned reasons, particular care should be used when treating lesions of the lateral meniscus.

WHAT ARE THE OPTIONS?

In the case of meniscal lesion, suture should be attempted in order to allow the meniscus to heal and to preserve its structure. Unfortunately, due to its scarce vascular supply not all lesions are suitable for suture, particularly those far from the articular capsule. In those cases, a meniscus is required.

Depending on the location, type and extent of the lesion, different approaches are available:

1. A partial meniscectomy is performed when <50% of the meniscal surface is removed.
2. A subtotal/total meniscectomy is performed when almost the entire meniscal structure is removed.

A decade later, Stone, Rodney and Steinbuk introduced the first effective meniscal prostheses (a scaffold composed of bovine collagen fibres) (Figure 3). Artistically implantable and adaptable to fill partial meniscal defects. Recently, new effective synthetic meniscal scaffolds (composed of modified polyurethane) have been introduced in the clinical practice.

WHEN TO SUBSTITUTE THE MENISCUS?

Both meniscal scaffolds (MS) and MAT are basically indicated in symptomatic patients after meniscectomy who usually present a knee with pain, swelling and reduction in function. This treatment requires a stable knee, normal alignment (not varus or valgus alignment) of the lower limb and a low grade of cartilage degeneration (less than grade III in Outerbridge scale). These indications are not strict, as knee laxity, malalignment or cartilage defect can be addressed with anterior cruciate ligament (ACL) reconstruction, osteotomy or cartilage treatment at the same time as the meniscal substitution.

MS are reserved for patients with partial meniscal defect, while MAT is performed on with total or subtotal defect.

HOW TO PERFORM THE SURGERY

Since their development, surgical techniques for MS implantation and MAT have improved immensely, allowing the surgeon to perform these procedures completely arthroscopically. This requires a lot of training in arthroscopic knee surgery and sports medicine: only an expert knee surgeon is able to perform these complex biological substituting techniques.
These days, we have developed an original, minimally invasiva bone-plug-free MAT technique\(^2\) that allows us to execute this kind of surgery completely arthroscopically (Figure 4).

MS implantation technique appears easier when compared to MAT, as no bone fixation is required. However, it requires dedicated instrumentation. After the removal of the damaged meniscus, the defect is regularised and arthroscopically to be relieved by the single case indication. We usually currently use osteochondral arthroscopic transplantation arthroscopic technique. the device is adapted to match the osteochondral defect.

When performing concomitant surgeries, the timing and the techniques are dictated by the single case indication. We usually perform ACL reconstruction with autologous hamstring\(^3\) (Figure 6) and we correct inferior limb malalignment by means of closing-wedge osteotomies around the knee (Figure 7). Regarding cartilage treatment, we currently use osteochondral arthroscopic autografts\(^4\) in the case of small defects or a novel bioengineered three-layered synthetic scaffold\(^5\) for bigger lesions (Figure 8).

**ARE THERE POSITIVE RESULTS?**

Data regarding more than 1000 MAT with follow-up from 6 months to 20 years shows a general improvement of Tegner and Lysholm clinical scores and the decrease of pain score. The improvement appears to decrease over time, although in the most recent follow-up, 84% of knees are classified as ‘normal’ or ‘nearly normal’ according to the International Knee Documentation Committee subjective score, and 89% of patients were satisfied with their outcome\(^6\). The mean failure rate is reported to be 21% at 4.6 years mean follow-up. Radiological evaluation of MAT showed slight or no loss of the joint space in the majority of patients, even in the long term.

**Evaluating our personal case series of MAT, we also found improvement in all clinical scores at 3-year minimum follow-up, and an interesting improvement of cartilage status evaluated with MRI\(^7\). MS is demonstrated to improve the clinical outcome at midterm to long-term follow-up, compared to partial meniscectomy in particular in chronic (with prior meniscectomy) rather than acute (with meniscal lesion) patients, with smaller reduction of medial joint space narrowing. Lysholm score is reported to be good or excellent in nearly 80% of medial meniscectomy patients at 10 weeks follow-up. The MRI evaluation showed integration of the scaffold, production of fibrocartilaginous tissue and no progression of cartilage narrowing\(^8\)\(^9\). We also performed MS on a professional soccer player who returned to sport activity after a failed partial lateral meniscectomy\(^10\). MAT and MS are reported to be safe and successful solutions to replace meniscal deficiencies, ensuring good results in approximately 80 to 90% of patients.

**CONCLUSIONS**

Treatment of meniscal lesion and defects is a crucial issue in knee joint surgery. Poor management of these conditions can lead to the destruction of the joint. At this point in time, an expert surgeon is able to partially or entirely replace the meniscal tissue with promising results. In fact, the use of biological solutions such as MS or MAT could bridge the gap until a symptomatic patient receives a prosthetic replacement after meniscectomy.

**References**

21. Stefano Zaffagnini, Alberto Grasso, Giulio Maria Marchiagnani Muccioli, Tiziano Bonazangi, Maurizio Marasci Clownico Ortopedica e Traumatologia III – Lab II Biomeccanica e Innovazione Tecnologica, Istituto Ortopedico Rizzoli Bologna, Italy Contact: stefano.zaffagnini@biomec.or.it