# NEW APPROACHES TO MENISCAL SURGERY

## MENISCAL SUBSTITUTION AND TRANSPLANTATION

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Meniscal tears are the most common knee injuries, especially in young active people[1]. Due to symptoms like pain, swelling and sudden knee blocks (especially in the case of displaced 'bucket handle' tears), 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'[2]. This led to the misconception that removing meniscal tissue would not raise any tissue loss concerns.

Today the meniscal integrity is well-known to be crucial in the knee health[3,4]. The main role of the menisci is to weight bear, absorbing the pressure that otherwise would charge the soft articular cartilage, 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 menisci also contribute to cartilage nutrition and lubrication.

It appears obvious that the knee joint cannot work correctly without such irreplaceable structures. In fact, many studies outline that even partial meniscal removal triggers the start of degenerative changes that can lead to the development of knee osteoarthritis[5] after 10 or more years. The risk is estimated at about 20% after medial meniscectomy and 40% 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 meniscectomy 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[6].

Following a meniscectomy, some patients experience symptoms such as knee pain, swelling and reduced knee function for several months or years after the surgery. This is caused by an altered biomechanical environment established after the removal that will lead to damage of the articular cartilage and, eventually, to osteoarthritis.

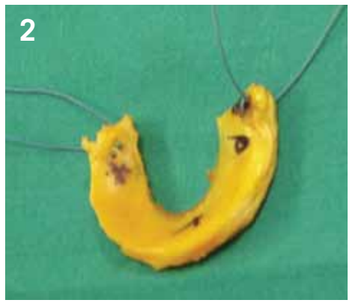
In order to stop or at least slow down this degenerative process, meniscal substitutes have been proposed.

In 1984 Milachowsky performed the first Meniscal Allograft Transplantation (MAT)[7]. The aim of this intervention was to replace the whole meniscal structure in the symptomatic patient following a total meniscectomy. This practice consists of the transplantation of an entire meniscus graft (Figure 2), harvested from a human donor and processed in order to reduce immunological and infective risks.


**Figure 1:** Knee anteroposterior radiograph before (a) and 10 years after a subtotal medial meniscectomy (b). Medial joint space narrowing is evident in picture b.

**Figure 2:** Meniscus allograft transplant prepared before implantation.

**Figure 3:** Collagen meniscal implant. The device can be measured and adapted to fill partial meniscal defects.





A decade later, Stone, Rodkey and Steadman introduced the first effective meniscal prosthesis (a scaffold composed by bovine collagen fibres) (Figure 3) arthroscopically implantable and adaptable to fill partial meniscal defects[8-10]. Recently, new effective synthetic meniscal scaffolds (composed of modified polyurethane) have been introduced in the clinical practice[11].

### 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.

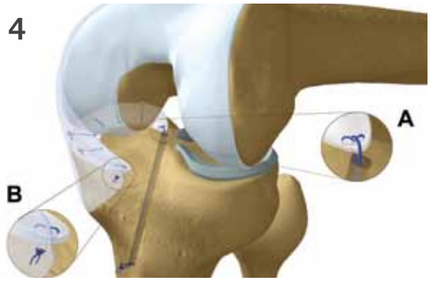
MS are reserved for patients with partial meniscal defect, while MAT is performed on with total or subtotal defect.

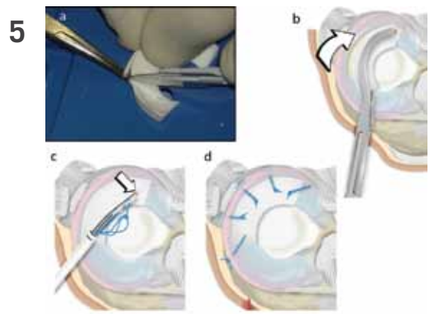
### HOW TO PERFORM THE SURGERY

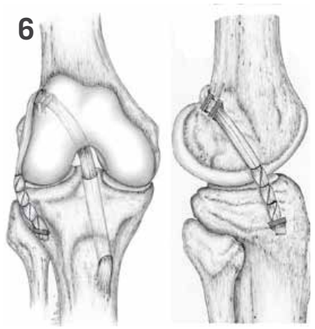
Since their development, surgical techniques for MS implantation and MAT have improved immensely, allowing the surgeon to perform these procedures completely arthroscopically. This requires a lot of training in arthroscopic knee surgery and sports medicine: only an expert knee surgeon is able to perform these complex biological substituting techniques.

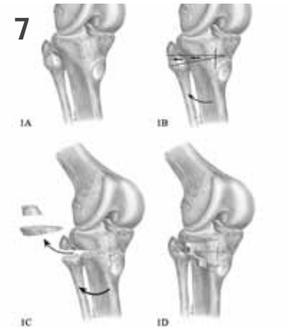
> ***meniscal scaffolds are reserved to patients with partial meniscal defect, while MAT to patients with total or subtotal defect***

As MAT involves the substitution of the entire meniscus, the technique is obviously more demanding when compared to a MS implantation. The first authors performing MAT described open techniques that kept two bone blocks anchored to the tibia in order fix them on the native meniscal insertion[7].





These days, we have developed an original, minimally-invasive bone-plug-free MAT technique[12] that allows us to execute this kind of surgery completely arthroscopically (Figure 4).

MS implantation technique appears easier when compared to MAT as no horn fixation is required. However, it requires dedicated instrumentation. After the removal of the damaged meniscus, the defect is regularised and arthroscopically measured with a dedicated instrument. Therefore the MS is trimmed according to the defect size, inserted into the joint through the arthroscopic accesses and sutured to the meniscal wall[10] (Figure 5).

When performing concomitant surgeries, the timing and the techniques are dictated by the single case indication. We usually perform ACL reconstruction with autologous hamstrings[13] (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[14] in the case of small defects or a novel bioengineered three-layered synthetic scaffold[15] for bigger lesions (Figure 8).

ARE THERE POSITIVE RESULTS?

Data regarding more than 1000 MAT, with follow-up from 8 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[16]. The mean failure rate is reported to be 21% at 4.6-year 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.

> ***timing and the techniques are dictated by the single case indication***

**Figure 4:** Meniscal allograft transplantation arthroscopic technique. The body of the graft is sutured to the capsule with all-inside suture (reprinted from reference 12).

**Figure 5:** Collagen meniscal implant arthroscopic technique. The device is sutured to the native meniscal remnant with all-inside vestical stitches (modified from reference 19).

**Figure 6:** Anterior cruciate ligament reconstruction with single-bundle plus extra-articular tenodesis autologous hamstrings technique (reprinted from reference 13).

**Figure 7:** Closing wedge high tibial osteotomy is performed to correct varus knee (1A). A wedge of bone (1B) is removed from the lateral side of the tibia (1C) and the two sides of the osteotomy are closed and fixed with a Krakow staple (1D) (reprinted from reference 20).

**Figure 8:** The bioengineered three-layered synthetic scaffold can be sized and adapted to match the osteochondral defect.



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[12].

MS is demonstrated to improve the clinical outcome at mid- to long-term follow-up, compared to partial medial 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 collagen implants at 10 weeks follow-up. The MRI evaluation showed integration of the scaffold, production of fibro-cartilaginous tissue and no progression of cartilage narrowing[9,10,17]. We also performed MS on a professional soccer player who returned to sport activity after a failed partial lateral meniscectomy[18].

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.

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