

MENISCUS ALLOGRAFT

HOW GOOD IS THIS OPTION?

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OVERVIEW

The importance of the menisci in distributing load forces between the femoral and tibial bone, supporting the joint biomechanics as knee joint stabilizers while promoting synovial fluid distribution and cartilage nutrition, is well known to most orthopedic surgeons.

But still, in the USA alone, meniscectomy is estimated to be practiced on 850'000 patients yearly.

Meniscal tears are one of the most common injuries of the knee joint and result in significant loss of function. When they become symptomatic and irreparable, a partial meniscectomy is required.

Unfortunately, the functional loss of meniscus tissue as a result of tear, damage or surgery is proportional with the elevation of contact stresses on the cartilage surface, hereby risking early onset of cartilage damage. Hence, surgical removal of functional meniscus tissue should be limited.

The loss of functional joint tissue has irreversible consequences on knee homeostasis, especially in patients with already some degree of pre-existing osteoarthritis. The increased intra-articular contact stresses within the knee after meniscectomy resulting in 'overload' of the articular cartilage, ending with early articular cartilage degeneration, pain and

functional limitations, that define the post-meniscectomy syndrome¹.

As a solution, surgical replacement techniques such as meniscal allograft transplantations (MAT) or the use of biodegradable scaffolds were introduced²⁻³.

Meniscal allograft transplantation has evolved since the 1980s aiming to limit or even prevent the negative effects of meniscus loss. It is a possible treatment option for the patients with pain after meniscectomy, that have failed non-operative management. It has been shown to provide predictable symptomatic relief and a return to sporting activity with good long-term survival, and long term results continue to improve as surgical indications and techniques are evolving.

INDICATIONS

Correct patient selection is fundamental for successful meniscal transplantation surgery.

Appropriate candidates are young (typically less than 50-55 years old), healthy and active patients that are symptomatic after undergoing a prior meniscectomy and have failed further non operative management. A second indication is the patient with ACL instability in combination with a large meniscectomy, as the additional stabilizing role of the meniscus to the ACL has been well recognized.

The knee joint should be stable and limbs normal aligned. Grade I or II cartilage lesions are well tolerated, but any grade III or IV focal lesions might require concomitant treatment, whilst diffuse osteoarthritis (OA), squaring or flattening of the femoral condyle, and significant osteophytes formation are clear contraindications.

Other contraindications include inflammatory diseases, previous infections, skeletally immature patients and marked obesity.

Varus/valgus malalignment or knee joint instability are relative contraindications and a two staged or concurrent surgery can be considered to ensure that all joint pathology is addressed.

Each patient should undertake radiographs of the knee including: antero-posterior and lateral weight bearing views, Rosenberg views and merchant (axial view of the patello-femoral joint) to exclude OA, and full length weight bearing x-rays to assess mechanical axis and a potential need for realignment. An MRI should also be obtained to evaluate the remaining meniscus, and most importantly to assess the cartilage and ligamentous status⁴ (Table 1).

GRAFT SELECTION AND SIZING

A number of measurements techniques for the meniscus have been described

TABLE 1

<i>Indications</i>	<i>Contraindications</i>
<i>Age < 50-55 y</i>	<i>Age > 55 y</i>
<i>Persistent unicompartmental pain, failure of non-operative treatments</i>	<i>Knee instability</i>
<i>Previous total or subtotal meniscectomy</i>	<i>Generalized/grade-IV degenerative compartmental cartilage changes</i>
<i>Outerbridge grade < 3 articular changes</i>	<i>Marked radiographic changes such as femoral condyle flattening and osteophyte formation</i>
<i>Correct alignment</i>	<i>Varus/valgus malalignment</i>
<i>No ligament laxity</i>	<i>Synovial disease Inflammatory arthritis Obesity</i>

Table 1: Indications and contraindications to MAT.

based on plain radiographs, 3D computed tomography, magnetic resonance imaging and anthropometric data.

To date, the most used technique is the meniscal measurement obtained on a plain antero-posterior and lateral radiograph, as proposed by Pollard et al. On anteroposterior films two vertical lines are drawn perpendicular to the joint line and are used to measure meniscal width. In a medial meniscus, the first line is tangential to the medial tibial metaphyseal margin and the second is through the peak of the medial tibial eminence. For a lateral meniscus, the first line is tangential to the lateral tibial margin and the second is through the peak of lateral tibial eminence. The distance between these two lines is said to be meniscal width. Meniscal length is then measured in a similar manner on lateral radiographs. The first line is drawn at the anterior tibial surface above the tuberosity and the second is a parallel line tangent to the posterior margin of the tibial plateau⁵.

For what concerns graft preservation, non-irradiated deep-frozen or fresh frozen, is one of the most common conservation methods used in orthopaedics. It can be stored at -80°C for up to 5 years. This method is technically simple and minimally immunogenic. The menisci, harvested under

sterile conditions, are put into physiological solution with an antibiotic agent, followed by rapid freezing. Although donor fibrochondrocytes may be destroyed by the freezing process, it is hypothesized that the same process results in denaturation of the histocompatibility antigens and thus decreases immunogenicity within fresh frozen menisci. A further advantage is the maintenance of the mechanical properties of the meniscal allograft.

SURGICAL TECHNIQUE

Meniscal allograft transplantation (MAT) may be performed using either open or arthroscopically assisted techniques, or a combination of these, with a mini-arthrotomy to insert the graft and arthroscopic preparation and fixation.

Arthroscopically assisted techniques are obviously much more technically demanding, requiring a considerable learning curve⁵⁻⁶.

The three main fixation methods that can be used to fix a MAT are: suture-only transosseus fixation, bone plugs fixation and the bone bridge technique. The first one consists of fixing soft tissue graft only using sutures through the body and meniscal horns, while the meniscal roots are fixed using a transtibial suture technique, similar to root lesion repairs.

The bone plugs and keyhole techniques are different types of bone fixation. The double plug technique consists in bony fixation to the tibia of the meniscal horns, which are left attached to the allograft bone, and capsular fixation of the peripheral margin of the allograft. In the bone bridge technique, the grafts contain a common bone bridge attached to both anterior and posterior horns. This bone bridge is then inserted into a similarly shaped slot in the recipient tibia. It has been recommended that this technique should be used with implantation of a lateral meniscus because the distance between the horns is only 1 cm or less. Both osseous techniques require the preparation of osseous beds in the receptor knee, so the plugs or bridge can fit in it.

CONCOMITANT PROCEDURES

Meniscus allograft transplantation (MAT) has a significant role in the treatment of the symptomatic post-meniscectomized patient. However, the overall rules of surgical engagement include that in the presence of malalignment or ACL instability, a corrective osteotomy or an ACL reconstruction should be the first procedure, respectively, followed by MAT and ultimately cartilage repair. MAT or cartilage repair have little sense in the malaligned or unstable lower limb.

These concomitant procedures include a high tibial or distal femoral osteotomies when a malalignment is present, ligamentous reconstructions for unstable knees, and any cartilage procedure, such as microfractures, osteochondral allograft or scaffold implantation for focal cartilage defects. They should be performed at the time of the transplant, or via staged procedure, before the meniscal surgery⁷.

Many studies evaluate the outcomes of meniscal allograft in conjunction with concomitant procedures, reporting no significant influence of these procedures on postoperative patient reported outcomes, failure rates and graft survivorship.

MAT AND SPORTS

The treatment of young, active patients with chronic pain after total meniscectomy remains clinically challenging.

Meniscus allograft transplantation results in athletes are good, with some authors reporting up to 70% of patients returning to the same level of sporting

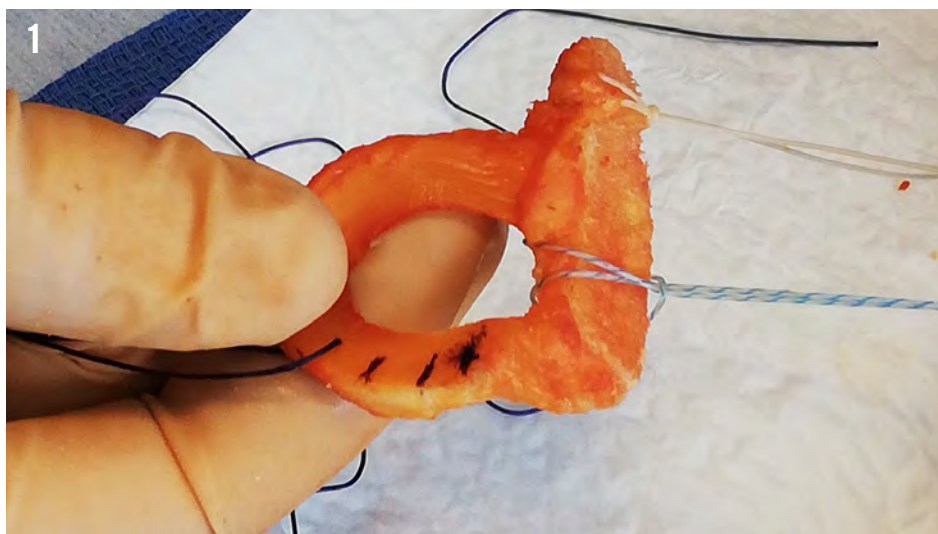


Figure 1: Lateral meniscus allograft with bone bridge connecting the anterior and posterior horn.

Figure 2: Medial meniscus allograft prepared for all soft tissue transosseus fixation using bony tunnels and a posteromedial traction suture.

Figure 3: A typical lateral meniscus allograft patient presenting late. The lateral femoral and tibial articular cartilage already shows grade 4 cartilage defects. These cartilagenous defect are secondary to the loss of functional meniscus tissue. Earlier intervention with a lateral MAT could have avoided the advanced cartilage wear.

activities. But the most important aspect is the management of patients' expectations. The athletes undergoing this kind of surgery need to be informed that they will return to play in about 1.5 years. Moreover, they have to be aware that there is a possibility of progression of articular cartilage degeneration or of traumatic disruption of the meniscus implant. Despite these risks, MAT remains a moderately successful surgery in young sportive patients.

Higher-volume surgeons have significant lower rates of failure, so this athletic population should always be addressed to specialized surgeons⁸⁻⁹.

A frequent observation in athletes confronted by meniscus damage and progressive cartilage degeneration is that most of these athletes are only referred for MAT in the later stages of the osteoarthritic disease when the damage in the affected knee compartment becomes very challenging (Figure 3). The ideal timing for MAT however remains an individual decision based on numerous parameters.

REHABILITATION

Refer to the 'Rehabilitation' Table.

RECENT INSIGHTS AND UNDERSTANDING OF MENISCUS DAMAGE PATHOGENESIS

The understanding of the pathogenesis of meniscus damage and tears, and the occurrence of early symptoms after meniscectomy is evolving. Meniscus disease is often the first symptoms of the onset of knee osteoarthritis. This disease is not only driven by a genetic predisposition but also by the mechanical load in the affected compartment. Hence factors such as activity level, body weight and alignment are essential parameters and can be addressed when dealing with the post-meniscectomized patient.

Also a smaller size of the medial femoral condyle, and hence a smaller contact area and subsequently higher load, has been linked with early onset of meniscus tears and subsequent early onset of OA. Indeed, a recent study (submitted for publication) has observed that medial MAT patients have significantly smaller medial femoral condyles.

In addition, tobacco, smoking and shisha should be scrutinized as more studies have identified them as having a significant negative effect on healing of soft tissues.

REHABILITATION

Unloader brace	Used for the first 3 to 6 months during walking and standing activities
Weight bearing	Weight bearing is limited to touch weight bearing for 3 weeks. Weight bearing is then gradually increased until full weight-bearing is commenced at 6 weeks
Squatting and loading in deep flexion	To be avoided for 6 months
Isometric exercise	Isometric quads and straight leg raise exercises can commence immediately post operatively, with closed chain exercises introduced at 6 weeks
Cycling	By 3 months exercising on a bicycle can be introduced
Running	To be avoided up to 9-12 months

CONCLUSIONS

Meniscus transplantation is a reliable technique for younger patients exhibiting symptoms in their daily activities.

Long term results show improved knee function and pain relief in the majority of the patients up to ten years follow-up.

The results are believed to be more favourable when the operation is done before the onset of tibio-femoral arthritis. Again, well recognized indications and contraindications for meniscus transplantation have been previously described.

A correct surgical and fixation technique is crucial in order for the graft to provide load bearing function and possible chondroprotective effects. Minimizing extrusion of the graft, which supposedly puts it in a nonanatomic position leading to biomechanical disadvantages is important, even if studies have found no correlation between clinical scores and meniscal extrusion. A combined approach for lower limb malalignment and knee joint instability must be always taken into account.

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