Brief Report

Lateral meniscus allograft transplantation without bone plugs: technique and outcomes

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Abstract: Once considered a non-fundamental structure, the menisci are now known to provide several functions within the knee, including protection of articular cartilage, load-bearing, shock absorption, joint stability, joint lubrification and joint congruity functions. Meniscal tears are one of the most common lesions in knee orthopedics, and partial or total meniscectomies are commonly performed procedures in orthopedic surgery. Despite meniscectomy is well recognized to lead improvement in clinical outcomes, it has been related to early onset knee osteoarthritis and joint degeneration which are associated with pain and functional limitations. Meniscal allograft transplantation has become a viable option for patients under 55 years old that have undergone total or near total meniscectomy and are in a painful state. This procedure can be performed using bone plugs or without bone plugs. In the bone plugs free technique allograft will be presented as a lateral meniscus with a portion of tibial plateau and is then introduced into the joint through an arthroscopic portal and fixed to the capsule with all-inside stitches. The most important aspect required to obtain good clinical results are graft size, anatomic placement and fixation, because extrusion is the most common complication related to meniscal transplantation. Although a lack of long-term follow-up (FU) studies, it has been demonstrated that lateral meniscus transplantation without bone plugs is a minimal invasive surgical procedure that improves the knee function, increases patient physical activity and reduces pain.

Keywords: Lateral meniscus; allograft; transplantation; knee

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Introduction

Once considered a non-fundamental structure, the menisci are now known to provide several functions within the knee, including protection of articular cartilage, load-bearing, shock absorption, joint stability, joint lubrification and joint congruity functions (1,2).

Partial or total meniscectomy are commonly performed procedures. Despite providing an important role in pain relief, meniscectomies have been related to early onset of osteoarthritis due to an increase in tibiofemoral contact pressures. This phenomenon has been demonstrated to be true especially for active people (3,4). A meniscectomy will have several effects on the structure of the knee, it will be possible to observe narrowing of the joint space, flattening of femoral condyles and ridge formation. This change will lead to an alteration of the biomechanics of the knee joint and early degeneration of articular cartilage. This degeneration often manifests with pain and functional limitations, with an important impact in patient's quality of life (5).

For all the reasons mentioned above it is recommended to preserve as much of the meniscus as possible.

Meniscal allograft transplantation has become a viable option for patients that have undergone total or near total meniscectomy and are in a painful state. Because of its minimal immune response, the meniscus is an optimal tissue to transplant. Several studies have demonstrated that peripheral vascularization of menisci is able to produce a significant repair response, producing matter similar to connective tissue (6,7). This allows the integration of an allograft implant to the capsular red zone.

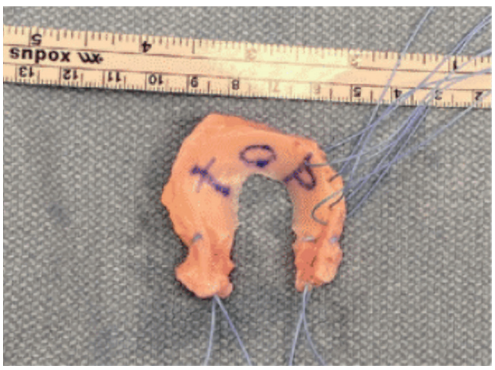

Figure 1 Suture fixation without bone plugs.

Figure 2 Lateral meniscal allograft.

The key to ensure a successful meniscal transplant includes patient selection and appropriate preoperative evaluation. The ideal candidate should be a young (<55 years) patient who has undergone a subtotal or total meniscectomy and develops knee pain and partial loss of function (8).

Previous infection in the knee, inflammatory arthritis, neuropathy, and evidence of osteonecrosis along with uncorrected malalignment or instability are considered contraindications to meniscal transplantation (9).

It is important to remember that each meniscal graft should be correctly sized based on the patient's knee, in order to reduce the contact pressure (10). An incorrectly sized graft will lead to uneven contact forces. An oversized lateral meniscus allografts will lead to greater forces across the articular cartilage, whereas an undersized one will lead to greater forces across the meniscus (11).

The transplantation can be performed using an open technique, an arthroscopically assisted procedures or a combination of these (12). The use of bone plugs is still controversial because of the fact that some studies support good clinical and biomechanical results (13), whereas other papers reported good clinical results with only suture fixation, without bone plugs (14,15). Even though it is not evident that fixation obtained using bone plugs versus sutures leads to improved outcomes, it must be taken into account that this technique requires a more exact size match between the graft and the host, henceforth increasing the risk of incorrect positioning that could lead to cartilage degeneration (16). Suture fixation without bone plugs (*Figure 1*), allows to reduce morbidity of the procedure and can be performed arthroscopically.

Surgical technique

The transplantation can be performed arthroscopically using a single tunnel. A standard diagnostic arthroscopic procedure is performed. The remnant of the native meniscus is removed to reach the meniscus-capsular zone. A bleeding bed is created at the periphery using a Steadman awl multiple times.

The appropriate size and direction of the graft should be confirmed before preparing the meniscal allograft through radiographic measurement and anthropometric parameters. The allograft will be presented as a meniscus with a portion of tibial plateau.

The first step is to remove all tissue ligaments from the periphery of the graft and bone plugs (*Figure 2*). Anterior and posterior horns are then fixed using a non-absorbable suture. The superior side of the meniscus is then marked to prevent mismatching during arthroscopic insertion.

A 3-mm drill is used to create a tibial tunnel using the outside-in guide needed to secure the suture which matches the posterior meniscal horn to the anterior tibial cortex. The posterior tibial tunnel is created to pull the graft into the joint. For lateral meniscal transplantation the tunnel is performed behind the anterior cruciate ligament (ACL) tibial insertion. The tibial entrance of the tunnel is created on the medial side of the tibia. Then a non-absorbable shuttle suture is passed through the tibial tunnel, it is tied to the posterior horn suture and it is then passed through the posterior tunnel, working as a transport suture from inside to outside (*Figure 3*).

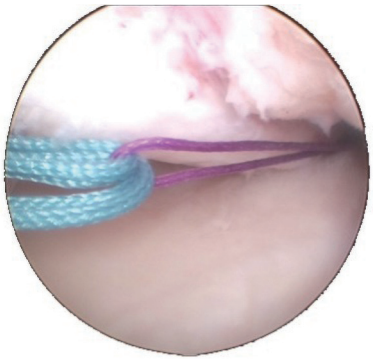

Figure 3 Nonabsorbable shuttle suture working as a transport suture.

Figure 4 Graft is introduced into the joint through the arthroscopic portal.

The graft is then introduced into the joint through the arthroscopic portal by pulling the suture fixed to the posterior meniscal horn (*Figure 4*). Ultimately the graft is fixed to the capsule with all-inside stitches, a mean of five stitches is used. Sometimes accessory portals could be required to place the stitches in the anterior third of the meniscus. Because of the fact that the load is shared between the sutures and the other all-inside stitches (8), there is only one suture required for each horn of the meniscus.

As a last step the transplanted meniscus is checked for stability and matching.

Outcomes

Results of meniscal allograft transplantation reported in the literature are difficult to interpret because of the small number of patients included in the studies, the heterogeneous population of patients studied, lack of outcome measures for evaluation of the allograft, and validity of methods used.

Meniscal extrusion is one of the most common problems that can effect both normal and osteoarthritic knee (17). Verdonk *et al.* (18) reported 70% partial extruded graft after a minimum follow up (FU) of 10 years, Lee *et al.* (19) fund 40% extruded grafts, but they also reported that the extruded allografts tend to stabilize in the long term.

Extrusion could be caused by several reasons, such as preoperative size mismatch, over-tensioning of the meniscal suture (20), loss of fixation of meniscal horns or insertion of the graft in an incorrect site. However is described in literature that there is no correlation between extrusion and clinical outcomes (18,21), but it can compromise long-term outcomes. Wang *et al.* (22) found that the possibility of meniscal extrusion increases in subchondral bone lesions and tibial plateau bone expansion in patients with knee osteoarthritis.

The most important aspect required to obtain good clinical results are graft size, anatomic placement and fixation (23). Alhalki *et al.* (24) demonstrated superiority of graft fixation with bone plug versus without plug *in vitro*, but the study doesn't consider the biological healing capacity of the allograft to the meniscal rim and bone tunnels (8). Rodeo *et al.* (25) showed higher histological score in meniscal allografts transplanted without bone plug versus with bone plug. In addition, the presence of bone plug rises the immunological risk and incorrect graft-positioning risk, which could lead to cartilage damage (26). Despite using the bone plug or not, Wirth *et al.* (27) and van Arkel *et al.* (28) described good results both in pain relief and increased knee functionality. Long-term chondroprotective effect of meniscal allograft transplantation techniques are still not well known (29).

Complication

Complication rate associated with lateral meniscal transplantation ranges from to 10% to 50% in the literature. Graft tearing is the most common complication. Tears of meniscal allograft are treated the same way as tears of native meniscus, including meniscal repair or partial meniscectomy. Infection and immune reactions are uncommon complications following meniscal transplantation. No report of human immunodeficiency virus transmission has been described in the literature from the use of allografts. Other complications that may occur with meniscal transplantation includes loss of graft fixation,

hemarthrosis, synovitis, and arthrofibrosis.

Our experience (8,30,31)

In our experience, lateral meniscus transplantation demonstrated significantly reduced pain, improved knee function, and increased patient physical activity: 94% of the patients benefited from this procedure at a minimum 3-year FU, representing an effective treatment for those patients treated with partial or total meniscectomy.

The results obtained confirm the success of meniscal transplantation procedure as a minimally invasive arthroscopic technique and graft fixation without bone blocks, although long-term reports are scarce. Among our studies, a significant improvement was reported in 10-year FU after transplantation with better post-operative clinical scores compared to the pre-operative scores, and highly satisfaction of the patients with good percentage of them (around 75%) involved in sports activity after surgery.

It is possible combining lateral meniscus transplantation with other surgical procedure without affecting long-terms outcomes; in the senior author experience, a closing wedge lateral high tibial osteotomy in case of varus deformity and a medial closing wedge distal femoral osteotomy in case of valgus deformity can be performed in the same surgical stage within the allograft transplantation as correction of deformity and resolution of post-meniscectomy syndrome. It could be associated with other procedures as ACL or posterior cruciate ligament (PCL) reconstruction, microfractures, osteochondral scaffolds, with good surgical and clinical results.

It still remains a surgical procedure with inferior surgical results and worse clinical outcomes compared to the medial meniscus transplantation in which the posterior tunnel was placed behind the medial tibial spine and in front of the PCL tibial insertion site (8), with a higher percentage of failure.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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