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Meniscal allograft transplantation—*A case report*

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Introduction

The meniscus has several roles that are essential to normal knee function, including load transmission, shock absorption, joint stability, lubrication, and nutrition[1]. There is a severe compromise in these indispensable functions with even partial menisectomy, and this may predispose the knee to early degenerative joint disease[2,3]. Meniscal repair is the treatment of choice whenever possible, but this procedure is not suitable for many meniscal tears, and cannot be performed on previously menisectomised knee joints. Prosthetic replacements have been unsuccessful because of the inability to replicate the complex biomechanical properties of the normal meniscus[4]. Although methods such as tissue engineering show promise, they are as yet experimental. In this situation, meniscal allografts offer an attractive alternative and have been found to be a feasible meniscal replacement in young patients with irreparable meniscal tears and previously menisectomised knees[5]. Menisci are 'immune privileged' and basic science studies have found little evidence of rejection[6]. The grafts readily heal at the repair site, and biomechanical testing has found that the grafts reduce joint forces compared to menisectomy[7].

We report here our experience with lateral meniscus allograft transplantation in a previously menisectomised knee in a young football player. This is, to the best of our knowledge, the first reported meniscal allograft transplant from the Indian subcontinent.

Case report

A 37 year old man presented to us with persistent pain at the lateral aspect of the knee of 3 years duration. He had been a competitive football player and had represented his state in the sport for over 10 years. At the age of 29 years he had sustained a twisting injury to the knee while playing football and had undergone an open partial lateral menisectomy with lateral meniscal cyst excision via a posterolateral incision. He subsequently had a similar injury at the age of 34 years and underwent an arthroscopic lateral menisectomy. His surgical notes indicated that the remnant lateral meniscus had a complex tear and a subtotal menisectomy had to be performed. This second injury followed by surgery was career-ending and the post-menisectomy lateral compartment pain that resulted after the procedure prevented him from returning to sports.

On examination, the patient had lateral joint line tenderness with painful terminal flexion. There was no effusion, range was full and not associated with crepitus, axial alignment on standing was normal, and the knee demonstrated no instability.

Radiographs revealed a 2 mm loss of lateral compartment joint space, with no evidence of degenerative joint disease. MRI confirmed the absence of the entire lateral meniscus except for the anterior and posterior horns (Fig. 1). There was minimal chondral wear in the lateral compartment with the presence of a single subchondral cyst, however, there was no focal chondral defect.

After a detailed discussion regarding treatment options and the risks and implications of each, the patient opted for a

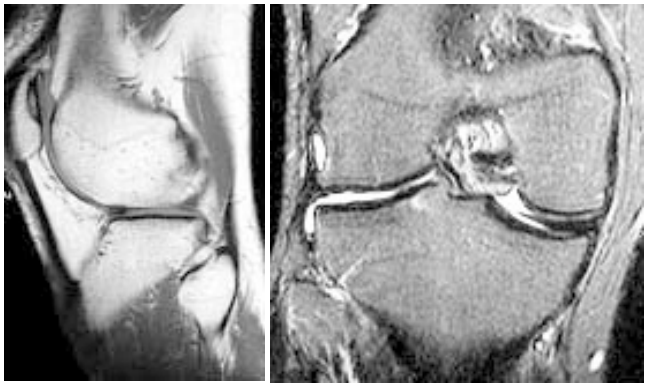

Fig. 1. ***Preoperative MRI showing lateral meniscus deficient knee.***

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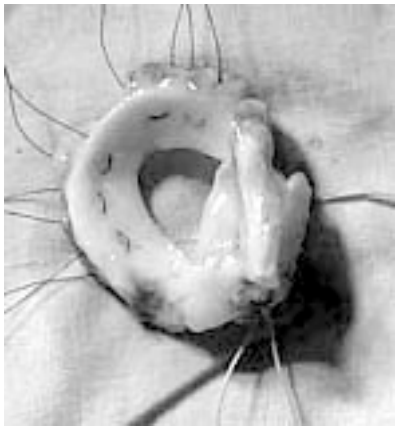

Fig. 2. ***Lateral meniscus allograft with a single rectangular bone block rigidly joining the anterior and posterior horns together in an anatomic relationship.***

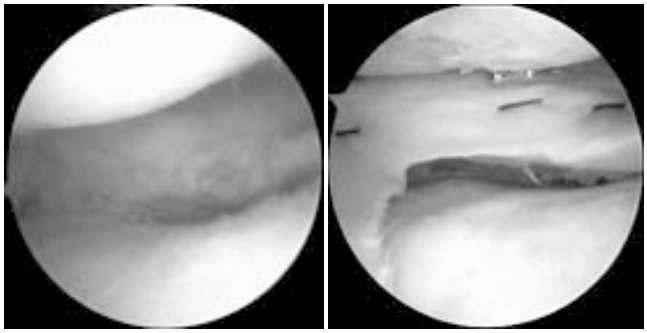

Fig. 3. (a) ***Arthroscopic image of lateral meniscus deficient compartment.*** **(b)** ***Arthroscopic image after lateral meniscus allograft transplantation.***

meniscal allograft transplantation. A CT scan was performed to determine exact recipient meniscal size, and the patient's name was entered into a register for patients awaiting allograft transplantation. We followed the recommendations of the American Association of Tissue Banks with regards screening of donors for blood borne diseases, harvest, preparation and storage of allograft tissue[8]. Allograft was stored at 4 degrees centigrade in cartilage culture medium containing antibiotic and antifungal powder, and was transplanted within 48 hours into the recipient. Donor and recipient are matched by size by using a measurement of tibial anteroposterior and mediolateral diameter 0.5 cm below the joint surface. We consider $\pm$ 4 mm an acceptable match.

Surgical technique:

Allograft preparation : The lateral meniscus allograft (Fig. 2) was prepared immediately prior to the surgical procedure, and involved sharp removal of all nonmeniscal soft tissue from the specimen, and fashioning of a single rectangular bone block that rigidly joined the anterior and posterior horns together in an anatomic relationship. The bone block was precisely debrided of excess bone until it fit within the 9 mm slot on a sizing block. A template was trimmed until it exactly matched the finished bone block. Multiple monofilament polypropylene (No. 2-0) sutures were preinserted into the meniscal edge, whereas two coated polyester (No. 2) sutures were inserted 10 mm apart through the common bone block.

Diagnostic arthroscopy: Under tourniquet control a diagnostic arthroscopy was performed through routine anterolateral and anteromedial portals. The lateral compartment revealed no macroscopic chondral wear, and except for meniscal remnants at both horns, the lateral meniscus was deficient (Fig.3a). The ACL, PCL, medial meniscus, patellofemoral joint and medial compartment were normal.

Removal of remnant meniscus: The meniscal remnants at the anterior and posterior horns were excised. The meniscocapsular junction was debrided until bleeding edges could be identified. The exact cephalad-caudal level of the peripheral meniscal rim was identified and the anatomic host site for the donor allograft was marked using knotted sutures. The presence of these markers placed 2 cm apart would subsequently prevent incorrect positioning of the transplant at the periphery when the implant would obscure an otherwise obvious view of the intended recipient edge.

Preparation of meniscal trough: Visualizing from the medial portal, a 9 mm meniscal gouge was inserted into the lateral portal and the recipient meniscal trough was created. The bone was removed from anterior to posterior, remaining in close proximity to the lateral border of the ACL. The trough was fashioned from 1 cm posterior to the anterior edge of the lateral tibial plateau and care was taken not to exit the bone posteriorly. With the use of a power burr, hand gouge and meniscal trough rasp, the trough was extended so as to match the template of the finished allograft bone block. A 1 cm incision was made medial to the tibial tuberosity. Using an ACL tibial jig, 2 transosseous holes were placed 10 mm apart, into the middle of the trough, exiting the tibia adjacent to the tibial tuberosity.

Insertion and fixation of the meniscal allograft: A mini-arthrotomy was performed by enlarging the anterolateral portal to 3 cm length. After each of the sutures inserted in the graft bone block was inserted through its respective transosseous hole in the bottom of the bone trough, the allograft meniscus was introduced into the lateral compartment and recipient bony trough via the mini-arthrotomy. A varus stress on the knee while flexing to 30 degrees was required at this stage. The knee joint was taken through multiple range of motion movements to ensure that the meniscal allograft would seat itself anatomically within the lateral compartment. The

Fig. 4. ***Comparison of preoperative*** **(a)** ***and postoperative*** **(b)** ***standing anteroposterior radiograph showing restoration of lateral joint space. The postoperative radiograph also shows appropriate seating of the allograft bone block within its recipient channel.***

coincidental slopes of the host / donor lateral tibial eminence were matched, and the bone block was punched into its trough. The two bone trough sutures were tied together at the medial edge of the tibial tuberosity. Using a combination of inside-out and outside-in techniques, the periphery of the meniscal graft was sutured to the marked meniscocapsular junction of the host from posterior to anterior (Fig. 3b). The stability, sizing, and anatomical position and of the graft was confirmed, and both incisions were sutured to terminate the procedure.

Postoperative treatment and rehabilitation: The patient received 2 g Cefotaxime and 750 mg Amikacin daily for 5 days. His knee was immobilized in extension. Our protocol incorporates early full range of motion and restricted weight bearing (toe-touch to partial weight bearing) over the first 4 weeks post-surgery. Continuous passive motion was started on the second postoperative day, and full range of knee movements was achieved by 5 weeks. Full weight bearing without crutches was started at 6 weeks, and the brace was continued upto 8 weeks. Strenuous knee activity, high impact, and sports were restricted for 6 months.

Clinical outcome: The patient had complete resolution of symptoms and remains pain free 2 years following surgery. He has no joint line tenderness, and provocative tests for meniscal integrity are negative. He has a full range of knee movements and comfortably performs ground level activities. His muscle girth and strength equals that of his opposite normal limb. At no point of time did he have features suggestive of infection or graft rejection.

Fig 5. ***Postoperative MRI at 6 months showing healing of the meniscal periphery. There is no size mismatch, no extrusion, and no shrinkage of the transplant. Articular cartilage thickness and signal intensity is normal.***

Radiological outcome: Postoperative radiographs revealed appropriate seating of the allograft bone block within its recipient channel, along with restoration of lateral joint space equal to the normal opposite knee (Fig. 4). Union of the central bone block within its channel was noted at 3 months. A postoperative MRI at 6 months confirmed healing and vascularisation of the entire meniscal periphery (Fig. 5). There was no size mismatch, no extrusion, and no shrinkage of the transplant. There was no change in articular cartilage thickness or signal intensity as compared to the preoperative MRI. Serial weight-bearing radiographs upto 2 years follow-up revealed maintenance of the restored lateral joint space and no radiographic evidence of degenerative joint disease (Fig.9).

Functional outcome: The patient resumed his occupation as a sports trainer and is actively involved in recreational sports.

Discussion

The primary function of the meniscus is to distribute loads by increasing the contact area through which the load is transmitted across the knee[9]. Biomechanical studies have shown that the lateral meniscus bears upto 75% of the load on the lateral side[10,11]. Total lateral menisectomy causes a 45% to 50% decrease in joint contact area and 200% to 300% rise in contact stresses[12,13]. Menisci also act as spacers, allowing initial tibiofemoral contact through the more compliant menisci, with direct articular cartilage contact occurring at higher loads[14]. An intact meniscus decreases joint stiffness and diminishes the magnitude of vertical

impulse loads[15,16]. The increase in articular peak stress and impulse loading secondary to menisectomy may be responsible for the increased articular wear and premature degeneration that is seen in these cases.

Milachowski et al performed the first meniscal transplantation at Munich University Hospital[17]. The indications for meniscal allograft transplantation still need to be defined. These procedures have been performed in a large spectrum of patients and have resulted in conflicting outcomes; from prophylactic transplants in young athletic individuals who have undergone complete menisectomy before the onset of symptoms[18], to patients with mild unicompartmental degenerative changes[19]. Early experience found that patients with significant knee arthritis had the most symptomatic improvement, but most grafts failed within two years. As a result, patients with Gr. IV chondromalacia or radiographic evidence of joint incongruity are not candidates for the procedure. Joint stability and alignment are other variables that have a direct effect on success. At present, meniscal transplantation is indicated in young patients with a prior menisectomy, persistent pain in the involved compartment, intact articular cartilage, normal alignment, and a stable joint[5]. Prophylactic meniscal transplantation may be beneficial in the lateral compartment where there is a more rapid progression to degeneration after menisectomy compared with the medial compartment because of the greater role in stress protection of the lateral meniscus[20,21].

To be successful, the relationship of the meniscal allograft transplant with intra-articular bone and soft-tissue must be anatomic[22]. The transplant is immediately expected to withstand strain along the circumferentially oriented collagen fibres at the periphery of the meniscus. The strain rate in these fibres is very low, which prevents excessive point loading of the articular cartilage[22].

Clinical studies with short to medium term follow-up have shown that meniscal allografts do successfully revascularise and heal to the periphery, undergo cellular repopulation and remodeling, can be of subjective benefit, and are encouraging in terms of reducing knee pain and increasing function[5]. However, of the 14 clinical studies evaluating meniscal transplantation, most series have been small and there is a lack of uniformity between patient selection, surgical technique, and follow-up. Despite the high success seen on second-look arthroscopy and clinical evaluation, the ultimate success of a meniscal transplant will be measured by its ability to prevent arthrosis. The durability of the allograft and its long term ability to deter arthritis remain to be established.

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