Technical note

Reconstructing the chronically disrupted knee extensor mechanism after total knee arthroplasty: Hourglass variant of the original partial allograft technique

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Allograft reconstruction is a valuable treatment option for patients with chronic extensor mechanism disruption after total knee arthroplasty. Here, an hourglass variant of the original partial allograft technique is described. An hourglass-shaped patellar bone block is press-fit into the native patella. The graft is fixed to both the patella and the tibia then sutured with the knee fully extended. Outcomes of this technique were assessed in 5 patients after at least 24 months’ follow-up. The mean knee and function Knee Society Score values were 77.8 and 64.0, respectively. Extension lag was less than 10 in all 5 patients. This hourglass variant of the partial allograft technique is a useful treatment option that can be used even after patellar resurfacing.

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1. Introduction

Chronic knee extensor mechanism disruption is a rare but devastating complication after total knee arthroplasty (TKA). The resulting extension lag induces severe functional impairment with instability. The disruption may involve the quadriceps tendon, patella, patellar tendon, or tibial tubercle [1].

The treatment of chronic knee extensor mechanism disruption is challenging. Both simple repair [2] and repair with augmentation by a neighbouring tendon [3,4] are of limited efficacy. Similar to reconstruction with artificial ligaments [5,6], partial allograft reconstruction is a useful treatment option associated with less morbidity compared to autograft reconstruction. In addition, there is evidence that biological integration of tendon allografts may be similar to that of tendon autografts [7].

The technique described here was developed from previous work [8–11] with the goal of maximally preserving host tissue, particularly the patella, as described by Murgier et al. [11]. Massive allograft reconstruction, in contrast, requires excision of the native patella. However, partial allografts may be difficult to stabilise at the patella, where migration may occur. Here, we describe a technical variant consisting in giving an hourglass shape to the patellar bone block in order to enhance primary graft stability.

2. Operative technique

The dimensions of the contralateral knee must be accurately assessed using a 1 mm graduated lateral radiograph to determine the size of the allograft, particularly in its patellar portion. The allograft is then ordered from the tissue bank.

At the beginning of the procedure, the dimensions are checked and recorded. The allograft is soaked for 20 minutes in a rifampicin solution then rinsed with saline (Fig. 1). Samples for bacteriological studies are taken routinely.

The allograft patella is cut in the coronal plane to remove the cartilage-covered aspect. The remaining bone is then cut into an hourglass shape (Figs. 2 and 3) and press-fit into a groove fashioned in the native patella (video). Great care should be taken to create an hourglass shape identical to the shape of the groove in order to ensure primary stability. A metallic wire 1.2 mm in diameter is threaded distally through the tibial bone block, which measures about 6 cm.

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The skin incision is made and the extensor mechanism exposed, while remaining within the dissection plane (which may be difficult to identify in the multiply operated knee) to preserve the blood supply to the skin. Damaged tissues are removed and a space is created within the host tissues to accommodate the allograft. A groove is created in the tibial tubercle to receive the tibial bone block. If possible, a dovetail joint is fashioned proximally to improve fixation stability. After exposure of the patella (Fig. 4), an hourglass-shaped groove 8 to 10 mm in depth is created using an oscillating saw and a burr (Fig. 5). The shape of the groove must exactly match that of the patellar bone block. Three transosseous metal cerclage wires are inserted transversally (Fig. 6).

The tibial bone block is then press-fit into the tibial groove. Two or three compression screws or two ligament staples are inserted to improve stability. Post-fixation is achieved by wrapping the metal wire around a screw and washer (Fig. 2). The screws or staples apply compression to the tibial bone block, while the metal wire wrapped around a screw and dovetail shape of the proximal groove prevent proximal migration.

The patellar bone block is press-fit into the patellar groove and firmly fixed using the metallic wires (Fig. 7). Primary stability is enhanced by the hourglass shape of the bone block, and most of the tendon attachments are preserved. In addition to primary stability, the metallic wires and proximal fixation to the quadriceps tendon combine to prevent migration of the patellar bone block.

The quadriceps component of the allograft is sutured to the native quadriceps tendon, with the knee fully extended, using multiple separate stitches of non-absorbable suture. The pulvertaft suture technique was not used in our patients, in contrast to the technique proposed by Murgier et al. [11], but constitutes an
interesting additional option. The prepatellar plane is then sutured over the graft.

The knee is kept extended in a resin brace for 8 weeks. Immediate weight bearing is allowed. Gradual rehabilitation therapy is started after 8 weeks to achieve stepwise restoration of knee flexion. Follow-up includes imaging studies at regular intervals (Figs. 8 and 9).

3. Clinical study

The study included 5 patients, 4 females and 1 male with a mean age of 63 years. Mean time from TKA to reconstruction was 13.2 months (range: 0–24 months) and mean follow-up was 34.4 months (range: 21–49 months). No patient experienced recurrent extensor mechanism disruption. Extension lag was less than 10° in all 5 patients and mean extension lag were 4°. No cases of construct disassembly or other complications were recorded.

Table 1 reports the functional and radiological outcomes, including patellar height before and after reconstruction.

4. Discussion

This particular technique was first described in 1992 by H. Dejour, Ph. Neyret, and S. Denjean [8] for the treatment of neglected patellar tendon rupture. However, these authors used an autograft taken from the contralateral knee. In addition, the rectangular shape of the patellar bone block induced a high risk of migration. We therefore developed a technical variant characterised by an hourglass shape of the patellar bone block that precludes distal
migration. We reported the use of this variant in native knees in 2012 [9], as well as outcomes in a patient with osteogenesis imperfecta in 2011 [10].

In 2015, Murgier et al. reported promising preliminary results after partial allograft knee extensor mechanism reconstruction in patients with prosthesis knees [11]. However, the shape of the patellar bone block and patellar groove was not specified. We therefore felt that a description of the hourglass variant built on earlier techniques for treating prosthetic knees was timely.

Massive allografting with removal of the entire native patellar remains the most widely used technique for knee extensor mechanism reconstruction. Emerson et al. pioneered this method and reported no extension lag in 6 of 9 prosthetic knees after 2 years [12]. Nazarian and Booth used the massive allograft technique on 40 prosthetic knees and obtained a 26% failure rate [13]. In contrast, in a study of 7 prosthetic knees, Leopold et al. had a 100% failure rate despite scrupulously applying the technique described by Emerson et al. [14]. This last study led to universal recognition that the graft must be sutured under tight tension, with the knee fully extended, to limit the risk of failure due to elongation. Nevertheless, long-term failure rates remained high in the most recent studies [15,16].

The original technique described here relies on preserving the native patella, in contrast to massive allograft reconstruction, and builds on the autograft and allograft techniques developed by Dejour et al. [8] and Murgier et al. [11], respectively. The high risk of graft elongation inherent in massive allograft reconstruction is eliminated. However, stabilisation of the patellar bone block in its groove is a key step, as excellent primary stability is crucial to ensure complete healing and to minimise the risk of migration. We therefore developed the hourglass variant that provides stable press-fit fixation while maximising the surface areas of attachment of the patellar and quadricipital tendons onto the bone block. One limitation of this technique is the need to obtain an allograft of appropriate size for the patient, particularly in its patellar component, which may require a waiting period.

5. Conclusion

Our technique for partial allograft reconstruction of the extensor mechanism of the prosthetic knee involves an hourglass shape of the patellar bone block to minimise the risk of migration within the native patella. It requires the availability of an appropriately sized allograft and of sufficient patellar bone stock.

Disclosure of interest

CF, AS and RB: declare that they have no competing interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.otsr.2017.07.001.

References