Long-term fate of femoral allograft for periprosthetic fracture around a revision knee arthroplasty: A case report and review of the literature

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Abstract

Introduction

The management of periprosthetic fractures is challenging and is guided by the configuration of the fracture, stability of implants and quality of the patient's bone. This case report discusses the long-term fate of femoral allograft for periprosthetic fracture around a revision knee arthroplasty.

Case report

We present the operative technique and long-term fate of a bivalved femoral allograft used for the treatment of a periprosthetic fracture around a stemmed femoral component of a revision total knee arthroplasty (TKA) in a patient with rheumatoid arthritis and osteoporosis. Regular radiographic follow-up confirmed incorporation and docking of the allograft. A subsequent ipsilateral femoral neck fracture 4 years after allograft implantation was treated with routine total hip replacement.

Conclusion

The use of femoral allograft for augmenting fixation of periprosthetic fractures above a TKA is not widely reported, and, at 11 years, this case represents the longest published follow-up above a revision TKA. Our case supports the use of a bivalved total femoral allograft in the treatment of long-bone periprosthetic fractures with poor bone stock.

Introduction

Data from joint registries indicate an increase in the number of primary and revision knee arthroplasties being performed each year internationally, and the volume of revision knee arthroplasty being performed in the USA alone is expected to increase by 601% between 2005 and 2030. Periprosthetic supracondylar femoral fractures can occur intraoperatively and postoperatively, with an overall incidence of 0.3–2.5% above primary total knee arthroplasties (TKAs)²–⁷. Estimates of the incidence after revision knee arthroplasty vary greatly from 1.7% to 38%⁶–⁸, with most reports quoting closer to 2%. Periprosthetic femoral fractures above TKA and revision TKA have historically been associated with high complication rates when treated nonoperatively or with internal fixation⁴,⁵. Periprosthetic fractures are more common in the elderly population and in females⁷. Additional risk factors include rheumatoid arthritis, chronic steroid treatment, reduced bone stock, neurological disorders, revision surgery, notching of the anterior cortex of the femur, and in particular poor bone stock⁵,⁹–¹¹. Primary osteopenia or secondary to stress shielding around a stemmed revision femoral component further increases the difficulty of achieving good fracture fixation by traditional methods. Whilst the introduction of locked plate technology has revolutionized surgery in the presence of osteoporotic bone⁶; the use of a combination of cortical femoral allograft and compression plate⁶ or a bivalved total femoral allograft⁶–⁷ may be indicated when a periprosthetic fracture around a well-fixed implant is complicated by deficient bone stock or significant comminution. Unfortunately, there remains insufficient evidence to strongly support the use of a single method of surgical treatment in this complex fracture group.

In this case report, we aim to provide further evidence that a bivalved total femoral allograft can be successfully used in the treatment of periprosthetic femoral fractures above/around a well-fixed stemmed revision TKA and that incorporation of the graft with the host femur is possible thereby increasing the patient's bone stock. This technique can provide a reliable long-term solution in this complex fracture group.

Case report

One month after primary TKA for valgus arthritis, a 60-year-old lady with polyarticular rheumatoid arthritis and severe osteoporosis re-presented with a sintering fracture of the lateral femoral condyle after a simple stumble. The femoral component was revised to an uncemented stemmed implant, and the lateral femoral condyle was reconstructed with femoral head structural allograft.

Three months after discharge, she fell and sustained a spiral periprosthetic fracture around the femoral stem (Figure 1).

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Due to the poor bone stock, it was decided to treat the fracture with a total femoral allograft. The donor femur was bivalved and prepared/ shaped with high-speed burrs to fit the host femur (Figure 2).

After primary fracture reduction with two lag screws and cerclages, the allografts were placed medially and laterally, leaving the vasculature along the linea aspera intact. The allografts were temporarily held around the reduced femur with sterilized hose clamps whilst cerclage wires were sequentially tightened in grooves that had been burred on the outer surface of the allograft to stop the cerclage sliding (Figure 3).

After partial weight bearing for 6 weeks, the patient was walking unaided at 3 months having achieved full knee extension and 85° flexion. Radiographic allograft integration proximally and distally was observed after 2 years. Four years postoperatively, she re-presented with an ipsilateral femoral neck fracture and underwent an uncomplicated cemented total hip replacement (THR) via a transgluteal approach. Intraoperatively, the proximal allograft docking revealed a smooth continues structure of allograft merging into the host femur. The latest radiographs were taken at 8 and 10 years (Figures 4 and 5).

Discussion
The use of bivalved total femoral allograft in the treatment of femoral periprosthetic fractures is not a new technique and has been widely reported following fractures around hip arthroplasty implants. Wang et al. in 2002 recommended the use of a combination of compression plate and cortical strut allograft. They reported a 100% union rate but did have one case of osteomyelitis and one malunion after a maximum follow-up of 68 months. When bivalved total femoral allografting is compared with locked plate fixation, the use of a cortical allograft and a locked plate is stiffer than a locked plate alone but is not as stiff as using two locked plates positioned orthogonally. The similar modulus of elasticity between the cortical allograft and the host bone reduces the effect of stress shielding. The use of cortical allograft has the potential...
In this case of rheumatoid arthritis, we were confronted with extremely poor stock in a patient who had previously sustained multiple osteoporotic fractures including distal radius and lumbar vertebrae. The initial lateral condyle sinter fracture had occurred after a simple stumble, hence meeting the criteria for a pathological fracture secondary to osteoporosis. At revision of the femoral component, an allograft femoral head was used to correct the recurrent valgus deformity and restore deficient lateral condyle bone stock. At the time, it was noted that the cancellous bone was so weak that it could be indented by digital pressure. Therefore, when the patient re-presented with the second, now diaphyseal periprosthetic fracture, the decision was made to treat the fracture with a total bivalved allograft to improve bone stock, as we did not trust internal fixation devices to provide reliable stability to allow mobilization of her TKA, which would have been at significant risk of stiffness.

**Conclusion**

To our knowledge, this case represents the longest (11-year) follow-up of a bivalved total femoral allograft above a stemmed revision TKA published. The radiographs and intraoperative findings during hip replacement have confirmed bony incorporation. In this particular case, the absence of the potential alternative of a locking plate with multiple screws crossing the canal has allowed straight forward implantation of a THA, which otherwise would have not been the case. In our opinion, bivalved total femoral allograft should be considered for periprosthetic fractures above TKAs where there is reduced bone stock and/or fracture comminution. The potential advantages of cortical allograft—increased bone stock, reduced stress shielding, acceptable rates of union and customization of the graft—must be weighted against the complications, reported as high as 17% with deep infection occurring at a rate of 4–13%. The large mass of dead bone may increase the deep infection rate as the devitalized bone allows proliferation of bacteria leading to infection. Disease transmission is possible with the use of allograft, but contemporary bone bank protocols have reduced this risk.

The process of incorporation of a strut has been described as going through a number of definable stages (creeping substitution). Complete reabsorption is rarely seen in practice; however the stages that precede this reabsorption have been observed in this case and include round off, scalloping, bridging and cancellization. The most recent radiological examination of this patient demonstrated cancellization, but not reabsorption, and this indicates revascularization of the cortical graft, which was evident at THR implantation.
Figure 5: Routine 10-year follow-up radiograph of the pelvis. Note bony incorporation of allograft proximally.

potential disadvantages—increased complexity of surgery, risk of infection and disease transmission.

Consent
Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Abbreviations list
THA, total hip replacement; TKA, total knee arthroplasty

References