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Case Reports

Distraction osteogenesis as a salvage method in infected knee megaprostheses

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ABSTRACT

Infection of total knee replacement represents a severe complication. Especially in cases of infected megaprostheses, treatment options are limited and even amputation may become unavoidable. We present two cases of infected knee hinged megaprostheses. Both were treated by prosthesis removal and debridement of all surrounding infected bone and soft tissue, followed by distraction osteogenesis for the bridging of the large bone defect which had resulted. Implant removal and surgical debridement were combined with Ilizarov frame application and femoral and tibial osteotomies in a one-stage procedure, for commencing distraction osteogenesis. After bone transportation was completed, arthrodesis of the knee in both cases was successful. Two years after completion of the treatment, both patients demonstrate a stable knee arthrodesis and a satisfactory clinical result. The described treatment plan represents an effective salvage method in cases of infected knee megaprostheses that can successfully address both the need for a stable arthrodesis and the avoidance of a severe leg-length discrepancy by bridging the extensive bone defect.

1. Introduction

Infection following total knee arthroplasty is a severe complication [1], where a one- or two-stage revision arthroplasty or resection followed by knee arthrodesis is the most common salvage method of treatment [2,3]. However, when a megaprosthesis is infected, the extensive bone defect renders revision arthroplasty often impossible [2,4] and any attempt of arthrodesis presupposes a significant shortening of the leg [2,5], while there is also a substantial reduction of the success rate of the arthrodesis itself [2,6]. In many of these cases, amputation above the knee seems to be inevitable, but the outcome of such an amputation is predictably poor with a low likelihood of ambulation [7]. The only alternative limb salvage procedure may be the reconstruction of such large septic bone defects using distraction osteogenesis.

We hereby present our experience in two cases of deep infected knee megaprostheses that were successfully treated by one-stage implant removal and commencement of distraction osteogenesis through Ilizarov frame application, for simultaneously addressing the issues of knee arthrodesis and bridging the large bone defect, thus avoiding a severe limb-length discrepancy.

2. Case report

2.1. Case 1

A total knee arthroplasty with a cemented custom-made hinged prosthesis (Link®, Hamburg, Germany) was performed in a 23-year-old male (Fig. 1) following a radical excision of a giant cell tumor of the proximal end of the right tibia. The inability to control a deep infection caused by *Acinetobacter baumanii* 3 weeks postoperatively led to the decision to perform a knee arthrodesis.

Radical debridement of all necrotic tissue and cement remnants resulted in a 25 cm large bone defect and was followed by one-stage application of an Ilizarov ring fixator.

The external fixator was measured directly on the patient's limb and was preassembled the day before surgery. Intraoperatively, osteotomies of both the upper third of the femur and the distal third of the tibia were performed with a gigli saw in order to enable the commencement of distraction osteogenesis. One week postoperatively, approximation of the 2 bone segments began at a rate of 0.25 mm/6 h. Antibiotics were administered for 6 weeks postoperatively. On the 23rd postoperative day the patient was discharged from the hospital and allowed to ambulate with weight bearing as tolerated (Fig. 2).

Since femoral bone defect was smaller, femoral segment transportation was completed after 70 days, while tibial segment transportation continued for an additional 208 days in order to approach the docking site at the knee level.

Docking site consolidation was augmented by freshening of the apposed bony ends and placement of demineralized bone matrix (DBM) and autologous bone marrow aspirate concentrate.

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Fig. 1. The infected custom-made megaprosthesis had to be removed.

Fig. 2. A postoperative picture of the first patient following Ilizarov frame application.

Following consolidation of the regenerate, the femoral part of the fixator was removed 147 days after initial application. The remaining part of the frame was removed 812 days postoperatively, when callus formation was judged to be adequate both clinically and radiologically and the patient was allowed full-weight bearing (Fig. 3).

Healing index (days of treatment/centimeter of bone defect) was 32.5 d/cm.

Regarding complications through the distraction osteogenesis period, there were 13 cases of pin track infection, successfully treated by oral antibiotics, while open treatment of the docking site was complicated by postoperative infection and wound necrosis, that necessitated surgical debridement and intravenous antibiotics.

At the latest follow-up, 2 years after completion of the treatment, the patient is able to walk without support, he has no leg-length discrepancy and there are no signs of infection or tumor recurrence. He demonstrates a painless, radiologically sound arthrodesis and appears to be completely satisfied with his lower limb (Fig. 4). The patient was retrospectively evaluated with use of the Short Form (SF-36) health survey questionnaire (SF-36v2, Greek version). According to this, physical health summary increased from 27 preoperatively (very much below average, even taking into account the margin of error) to 48 postoperatively (about average), while the mental health summary increased from 22 (very much below average) to 63 (very much above average).

2.2. Case 2

The second patient was a 38-year-old male, who had a cemented, hinged megaprosthesis (Link®, Hamburg, Germany) implanted for treating an extensive posttraumatic bone loss and bone malformation following a failed internal fixation for a Schatzker type VI tibial plateau fracture..

Because of an uncontrolled postoperative deep infection caused by *Streptococcus agalactiae* prosthesis removal and knee arthrodesis were decided.

Surgical debridement resulted in a 19 cm bone defect and was followed by one-stage application of an Ilizarov ring fixator as previously described. Femoral segment transportation was completed after 53 days, while tibial segment transportation continued for additional 191 days.

To improve docking site consolidation autologous iliac bone grafts were applied following bony ends freshening.

The femoral part of the fixator was removed after 224 days, the remaining tibial part 1043 days postoperatively and the healing index was 54.9 d/cm.

There were 15 cases of pin track infection successfully treated by oral antibiotics. There was also a clubfoot deformity during transportation of the tibial segment, treated by additional application of a foot plate of the Ilizarov frame, combined with a Z-plasty lengthening of the Achilles tendon. The footplate was removed upon completion of tibial transportation. Finally, there was a noticeable delay of the consolidation of the regenerate, especially of the tibia and a residual varus deformity of the femur, measuring 15°, as well as a valgus deformity of the tibia measuring 7°.

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Fig. 3. Control radiographs taken after removal of the Ilizarov frame display a solid consolidation of the arthrodesis.

Two years after final frame removal, the patient is able to walk with a cane, he has a leg-length discrepancy of only 3 cm and there are no signs of infection recurrence. The patient is complaining only of a mild pain after prolonged walking.

According to SF-36 score, physical health summary was 23 and mental health summary 22 (both very much bellow average) preoperatively and increased respectively to 40 (below average) and 59 (above average).

3. Discussion

Failed total knee arthroplasty remains nowadays the most common indication for knee fusion, while infection represents the commonest reason for fusion, among causes of total knee arthroplasty failure [3]. Reported incidence of infection following total knee arthroplasty varies from 0.57% to 15% [8]. Previous knee surgery [9,10] as well as implantation of a hinged prosthesis [9,11] are described to be among others significant risk factors for infection. Reported union rate of knee arthrodesis was 86% in patients treated with a resurfacing implant, while it decreased to 29% when a hinged implant was used [6].

Fig. 4. Two years after completion of the treatment, the patient displays a painless, stable lower limb with a solid arthrodesis.

Consequent limb-length discrepancy ranging from 1.5 to 6.4 cm with shortening of the operated extremity was found in all patients treated with knee arthrodesis. In cases of extensive bone loss after removal of megaprostheses leg shortening is even larger and has to be treated operatively [2,5].

There exists strong evidence that arthrodesis is preferable to an amputation in any population [2]. The outcome of amputation following total knee arthroplasty is predictably poor with a low likelihood of ambulation [7].

In current literature, there are only a few reports on attempted arthrodesis for treating infected knee megaprostheses [4,12] and on the use of Ilizarov external fixation for knee arthrodesis after infected total knee arthroplasty [13]. Reported fusion rates ranged from 68% to 100%, while complication rates varied from 43% to 100% [5,8,12,14–17]. In most cases infected implants were removed at one stage, while Ilizarov frame application followed at a second stage, several weeks later.

The presented cases incorporate the majority of problems faced when treating an infected total knee arthroplasty. Previous surgical procedures, extensive bone loss after removal of a hinged megaprosthesis, persistent infection and poor surrounding soft tissue quality constitute factors that jeopardize arthrodesis success and have to be effectively addressed. We have used the Ilizarov type external fixators since we have had good results in treating large bone defects and performing simple cases of knee arthrodesis by applying distraction osteogenesis. The reported fusion rates for knee arthrodesis with use of circular external fixators range from 68% to 100% [2].

In contrast to others, we performed implant removal, osteotomies and Ilizarov frame application as a one-stage procedure. According to

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literature and our experience, in cases of persistent infection, implant removal and fixator application can be performed in one operative setting [18]. It may also be important for the prevention of infection recurrence, that there are no implants remaining after fixator removal [19].Overall, arthrodesis for treating an infected total knee arthroplasty is associated with a relatively low risk of infection [2]. Completion of all operative phases in one stage significantly accelerates the whole procedure and simultaneously avoids a second operation.

The results of the SF-36 score demonstrate that the applied treatment significantly improved the patients' quality of life in terms of both physical and mental status.

Although it could be argued that among the drawbacks of this technique is the extraordinarily long period of time that the ring fixator often needs to be left *in situ* (total of 812 days in case 1 and 1043 days in case 2), this does not seem to negatively affect the patients' compliance.

To our knowledge, this is the first description in English literature of combining implant removal with application of an Ilizarov fixator with simultaneous osteotomies for commencing distraction osteogenesis as a one-stage procedure, for achieving arthrodesis in treating infected knee megaprosthesis. Our results indicate that this represents an effective treatment option in cases of complex knee prosthesis infection with expected significant leg-length discrepancy due to extensive bone loss.

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