



Salvage of infected intramedullary knee arthrodesis with vascularized free fibula and staged fixation



Pedro C. Cavadas, Alessandro Thione, Alberto Perez-Garcia, Concepción Lorca-García*, Fernando Aranda-Romero

Clinica Cavadas, Reconstructive Surgery, Valencia, Spain

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ABSTRACT

Intramedullary knee arthrodesis is indicated when an infected total knee arthroplasty revision is failed. There is a high risk of infection after this procedure and the only option of treatment considered in these cases is AK amputation.

We present an alternative to AK amputation in intramedullary arthrodesis infected cases that has been successful in all patients we have treated. From 2008 to 2012 five patients (4 men and one woman) were treated. The treatment protocol was staged: (1) debridement, removing intramedullary implant and cement, PMMA as spacer and placement of a double-frame external fixator. Gastrocnemius flap was used when there was a significant cutaneous defect. (2) Removing PMMA and transfer a contralateral free fibular osteocutaneous flap. (3) Change external fixation for an internal fixation. There was no mortality associated to the treatment protocol. There were no septic complications after the first and second stages. Two patients developed deep infection after the third stage. One patient developed stress fracture of the fibular flap. All cases showed integration of the fibular bone six to eight months postoperatively. Limb shortening was 3.8 cm on average. All patients were able to walk independently with one crutch.

In conclusion, although our series is short to export results, our protocol treatment is a good alternative to AK amputation. The treatment entails at least three major surgical procedures through a protracted period of time, but the avoidance of an AK amputation seems worth the risk in a fully informed and compliant patient.

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Introduction

Knee arthrodesis is considered a salvage procedure after all other motion-preserving options have failed. The main indication for knee arthrodesis in developed countries is failed revision of infected total knee arthroplasty (TKA) [1,2]. Knee fusion in these cases is challenging because of the loss of bone stock and bacterial contamination. Intramedullary, or bridge, arthrodesis has gained popularity in this setting because it does not need bone contact and healing between the femur and tibia for a stable construct, and its relative technical ease [3–9]. In this regard, intramedullary bridging implants work like locked endoprotheses. The risk of recurrence of the infection after intramedullary arthrodesis is referred to in all series, usually requiring an AK amputation [5,6,8].

The purpose of the present paper is to address the feasibility of limb salvage in infected intramedullary knee arthrodesis and describe a series of five cases successfully treated with staged debridement, antibiotic-loaded cement spacer, microvascular contralateral fibular transfer, and formal plate fixation.

Patients and methods

From 2008 to 2012 five patients (4 men and one woman) were treated for infected and loose intramedullary bridge arthrodesis of the knee (Table 1). Age ranged from 39 to 71 years (mean 57 years). The indication for knee fusion was infected total knee arthroplasty in all five cases. The number of surgical procedures prior to attempt at intramedullary arthrodesis was 7–15 (mean 10 procedures), with various long-term systemic antibiotic regimes. All patients had been offered an AK amputation as the only treatment choice. There was septic loosening of the intramedullary fixation with cutaneous fistulization and without bone contact between femur and tibia in all cases (Figs. 1 and 2).

* Corresponding author at: Clinica Cavadas, Paseo Facultades 1, 46021 Valencia, Spain. Tel.: +34 963628861; fax: +34 963628870.

E-mail addresses: pcavadas@telefonica.es (P.C. Cavadas), althione@gmail.com (A. Thione), a_perez.garcia@yahoo.es (A. Perez-Garcia), conchi_lg@hotmail.com (C. Lorca-García), ferarandaromero@hotmail.com (F. Aranda-Romero).

Table 1
Patients data and results.

	Gender	Age	No of previous surgeries	Complications	Limb shortening	Outcome	F/U
Case 1	F	71	15	None	5 cm	Independent deambulation Death at 4 years of F/U	4 years
Case 2	M	61	10	None	4 cm	Independent deambulation	4 years
Case 3	M	39	9	Wound dehiscence after the first stage. Infection after 3rd stage	5 cm	Independent deambulation	3 years
Case 4	M	55	7	None	2 cm	Independent deambulation	3 years
Case 5	M	60	9	Infection after 3rd stage. Stress fracture of the fibula	3 cm	Independent deambulation	1 year

F/U: follow-up in years after the last surgical or orthopaedic manoeuvre related to the knee problem.

Treatment protocol

At the first stage the intramedullary implant was removed, the avascular bone debrided and the contaminated granulating tissue and scar were resected. The cement was removed and femoral and tibial canals were reamed. A solid spacer of PMMA (polymethyl methacrylate) with gentamycin and vancomycin shaped to occupy the metaphyseal defect and part of the intramedullary canals was implanted. A long double-frame external fixator was placed between femur and tibia for temporary skeletal stabilization (Synthes, Paoli, PA) (Fig. 3). In three of the five patients, the skin defect resulting from resection of the fistulae was covered with a medial gastrocnemius flap. Intravenous doxycycline and rifampicin were administered for six weeks.

Once the wounds were well healed, about eight weeks after the first stage, and with normal values of C reactive protein, the second stage was performed. The PMMA spacer was removed and a contralateral free fibular osteocutaneous flap was transferred to the intramedullary canal of the femur and tibia spanning the failed fusion space (Fig. 4). The external fixator was not removed and the fibula was fixed with four 3.5 mm screws. Vascular anastomoses were performed to the popliteal vessels using a vascular loop acutely constructed with a contralateral greater or lesser saphenous vein graft.

Two months later, the external fixation was removed and rigid internal fixation was performed with a long LC-DCP 4.5 mm plate (Synthes, Paoli, PA) placed laterally with screws in the femur and tibia, without additional screws in the fibula (Fig. 5). Control X-rays were taken monthly to monitor bone healing. The patients were allowed progressive weight bearing two months after plate fixation with a customized bivalve orthosis, and full weight bearing after evidence of bone healing.

Results

There was no mortality associated to the treatment protocol. One patient (case 1) died four years after the third stage due to previous comorbidities. There were no septic complications after



Fig. 1. An infected bridge arthrodesis of the knee with multiple prior surgeries and cutaneous fistulization.

the first and second stages. There was one wound breakdown after the first stage that required a medial gastrocnemius flap for coverage of the cement spacer (case 3). The three medial gastrocnemius flaps and all fibular free flaps survived without vascular complications (Fig. 6).

Two patients (40%) developed deep infection after the third stage, responsive to local drainage and culture-guided antibiotic suppression, without negative impact in bone healing (cases 3 and 5). Both patients underwent plate removal after radiological bone consolidation. One of these patients developed stress fracture of the fibular flap that healed with cast immobilization (case 5). Time to bone consolidation was difficult to assess because the irregular configuration of the defects, but at six to eight months all cases showed integration of the fibular bone. Limb shortening was 3.8 cm on average (range 2–5 cm). All patients were able to walk independently with one crutch. No delayed amputations or requests to do so by the patients occurred.

Discussion

Recurrent septic complications after TKA may result in repeated unsuccessful attempts at revision surgery with eventual knee



Fig. 2. Lack of bone contact in an intramedullary nail arthrodesis in the same patient.



Fig. 3. In the first stage the nail was removed, the necrotic infected bone debrided, and a solid PMMA spacer was placed. Temporary external fixation between femur and tibia allowed enough stability.

arthrodesis or AK amputation [2,10]. Among the various methods to achieve knee fusion, intramedullary nailing is usually favoured in the literature because it allows early weight bearing and



Fig. 4. In the second stage, a free fibular osteocutaneous flap was transferred, connected to a vascular loop to the popliteal vessels and fixed with minimal osteosynthesis.



Fig. 5. In the third stage, the external fixator was removed and plate fixation was performed between femur and tibia. Evidence of bone healing at six months postoperative.

achieves mechanical stability despite substantial bone loss and lack of bone contact [2–9,11]. The risk of recurrence of the infection after knee arthrodesis in these patients is significant, especially after intramedullary arthrodeses. Intramedullary nailing compared favourably to external fixation in terms of bone union at the cost of higher infection rates [11]. Although this risk is widely recognized, the management of infected, loose, intramedullary bridge arthrodeses has not been specifically addressed in the literature. AK amputation is usually considered as the only treatment option [2,6]. AK amputation seriously impairs the quality of life of patients. Beside the real risk of unsuccessful prosthetic fitting, and the obvious loss of the sense of bodily integrity, the energy expenditure necessary to walk in successfully rehabilitated cases poses a significant burden to the daily living activities in an already debilitated patient [12].

Infected and loose intramedullary bridge knee arthrodeses behave much like infected TKA. In patients with limited life expectancy, long-term antibiotic suppression can be a reasonable option, but otherwise surgery is indicated. Achieving direct bone contact after explantation of the intramedullary nail might require extensive limb shortening, and even after this, poor bone quality would not allow good contact [3]. Vascularized bone has demonstrated better performance than bone grafts in hostile wound environments (irradiated, massively scarred, previously infected, etc.) [13], and has been extensively reported in the reconstruction of complex defects of long bones [14–16]. Few reports can be found on the use of vascularized fibula, either pedicled or free microvascular, for knee fusion after septic complications of TKA [17–20], and none of them dealing



Fig. 6. Healed extremity at three years with stable fusion and no signs of infection.

specifically with infected bridge arthrodeses. The use of a pedicled ipsilateral fibular flap does not need microsurgical repairs, although the proximal reach of the flap is limited and dissection can be challenging in a multiply operated limb [18]. The series by the Mayo Clinic group reports high consolidation rates (12 out of 13 patients), but over 50% complication rate, including one AK amputation [17]. Good results were reported in two similar cases recently [20]. In a series of free fibular flap for knee arthrodesis of varied etiology, 16 out of 17 patients eventually healed, although none of the cases were septic originally [19]. Although including only five patients, the results of the present series are encouraging in that bone consolidation was achieved in all cases of attempted bridge knee fusion. This represents a more severe subset of patients with an end-stage situation after recurrent infection of TKA, whose treatment has been assumed to be an AK amputation. Contralateral free fibular flaps were used because of their greater freedom of inset if vascular loops are used [21], and to reduce vascular morbidity in the affected extremity. The complication rate after the first and second stages was very low. Plate fixation was considered important to provide mechanical stability and it was performed as a separate, third stage to reduce the probability of infection. A 40% infection rate occurred after this third stage, although it did not impact negatively in the final outcome of the patients. All patients eventually were able to walk with one crutch and the final limb shortening was easily managed with footwear modification.

The present study has limitations. It includes a small number of patients and statistical analysis is not possible. The occurrence of infected, loose, bridge intramedullary arthrodesis of the knee is not frequent and building a large series is difficult. The treatment entails at least three major surgical procedures through a protracted period of time, but the avoidance of an AK amputation seems worth the risk in a fully informed and compliant patient.

Conflicts of interest

The authors have no financial interest to declare; they have no conflicts of interest.

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