

## Original Article

# Knee arthrodesis with external fixation in infected revision knee arthroplasty: a need to use patellar autograft?

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**Abstract:** Objective: Our study aimed to evaluate the outcomes of knee arthrodesis with external fixation in patients undergoing revision surgery due to an infection following knee arthroplasty. Method: The mean age of the patients recruited in the study was 71.1 years (range: 58-84). Of the 40 patients who underwent revision total knee arthroplasty between 2010 and 2014, nine patients developed recurrent infections, which required knee arthrodesis with uniplanar and biplanar external fixation. The patient population consisted of eight females and one male. The ipsilateral patella was used as the autograft in all patients. Complete union was achieved in all patients. Infection was eradicated after debridement and arthrodesis in all patients. The mean duration of follow-up was 16 months (range: 10-22). The elapsed time of external fixation was 4 months (range: 3-5). The exclusion criteria were fracture or septic arthritis sequelae and those undergoing knee arthrodesis due to congenital diseases. Results: Antibiotic therapy targeted to the infectious agents based on the culture results obtained during the surgery was initiated. All patients were monitored for reductions in C-reactive protein (CRP) levels and sedimentation rates. A superficial pin site infection was detected in all patients at the base of the proximal Schanz pins that were inserted into the femur. All patients responded well to the antibiotic treatment. A mean shortening of 2.6 cm (range: 2-5) was observed. No patient reported post-arthrodesis pain, and infection was eradicated in all patients. Conclusion: In the presence of a persistent infection in revision total knee arthroplasty, we suggest that microbial eradication and patellar autografting in addition to external fixation of the knee arthrodesis represents a good option for a successful fusion.

**Keywords:** Knee, arthrodesis, infection, external fixators, patella, autograft

## Introduction

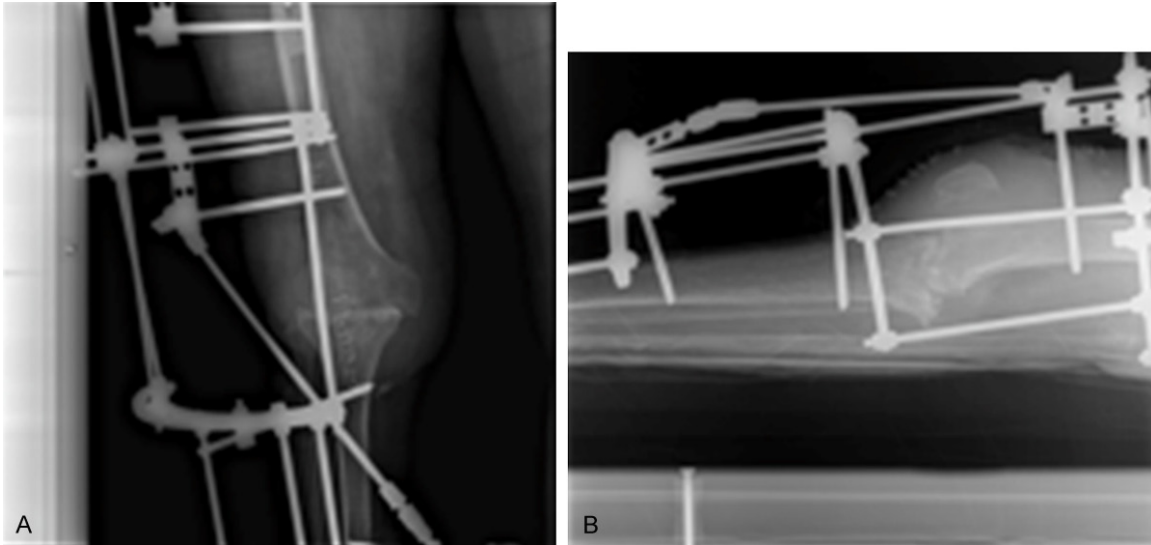
Knee arthrodesis has been used for many years for pain, advanced instability, Charcot arthropathy, poliomyelitis, and tumor resection [1]. Advancements in knee arthroplasty techniques and prosthesis technology have decreased the need for arthrodesis treatment, which is currently mainly used in cases of infected knee arthroplasty [2]. The procedure is also preferred for revised knee arthroplasty patients in whom loss of extensor mechanism, extensive bone loss, and severe soft tissue defects are present [3].

Knee arthrodesis is performed through a variety of techniques and modifications. Union rates are reported to vary greatly; the highest fusion rates were observed with intramedullary

pins [4-6]. Nevertheless, intramedullary pinning has some drawbacks when used for knee arthrodesis performed to treat infected knee arthroplasty. Intramedullary pins can be used when the infection is thoroughly eradicated [7, 8], which may take up to 40 weeks (2-8). Furthermore, repeated cementing and re-operation are required for the eradication of the infection. Indeed, these patients, most of whom have skin defects and wound healing problems, require various flap surgical procedures, most often a medial gastrocnemius flap [9], which results in additional morbidity and treatment costs.

In this study of infected knee revision prostheses with refractory infection, we evaluated knee arthrodesis cases in which the graft was taken from the articular surface of the ipsilateral

## Patellar autograft in knee arthrodesis with external fixation



**Figure 1.** A, B: Postoperative AP and Lateral view of circular EF.



**Figure 2.** A, B: Clinical view of the patient with circular EF.



patella, which is a novel method that we believe increases the success of knee fusion when added to external fixation after antibiotherapy and debridement.

### Materials and methods

#### Subjects

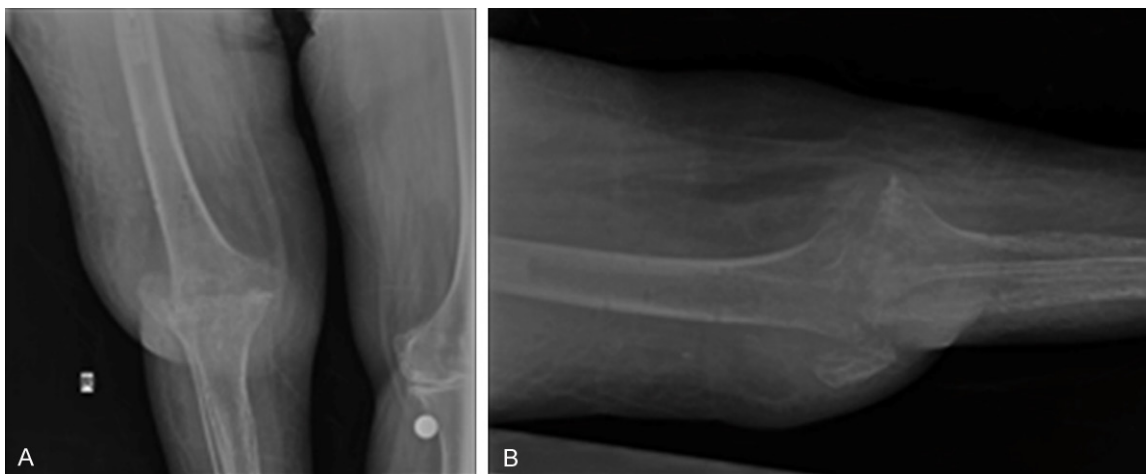
The study was approved by the ethical committee of the hospital. Nine patients (8 females, 1 male) who underwent knee arthrodesis with external fixation to treat infected knee arthroplasty between 2010 and 2014 were retrospectively assessed.

All patients had knee revision prostheses, which had been infected, and undergone multiple operations (5-26). Patients underwent a mean of 8.2 (range: 3-21) debridement and soft tissue operations and a mean of 3.8 (range: 2-5) arthroplasty procedures.

The mean patient age was 71.1 years (range: 54-84). Three of the prostheses (33%) were performed at our clinic,

while the remaining were performed at other clinics (66%). Four patients (44.4%) required flap surgery for soft tissue closure. Comorbidities included colon cancer in one patient, rheuma-

## Patellar autograft in knee arthrodesis with external fixation



**Figure 3.** A, B: X-rays after removal of circular EF.

toid arthritis in one patient, and diabetes mellitus in 4 patients.

All patients had active infections, and all underwent implant removal and debridement during the first surgery. Deep tissue cultures were obtained from the deep tissue, and frozen section examination confirmed the active infection. An antibiotic-coated spacer (containing teicoplanin) was applied as a single unit. For joint stabilization, a temporary external fixator was applied to bridge the knee.

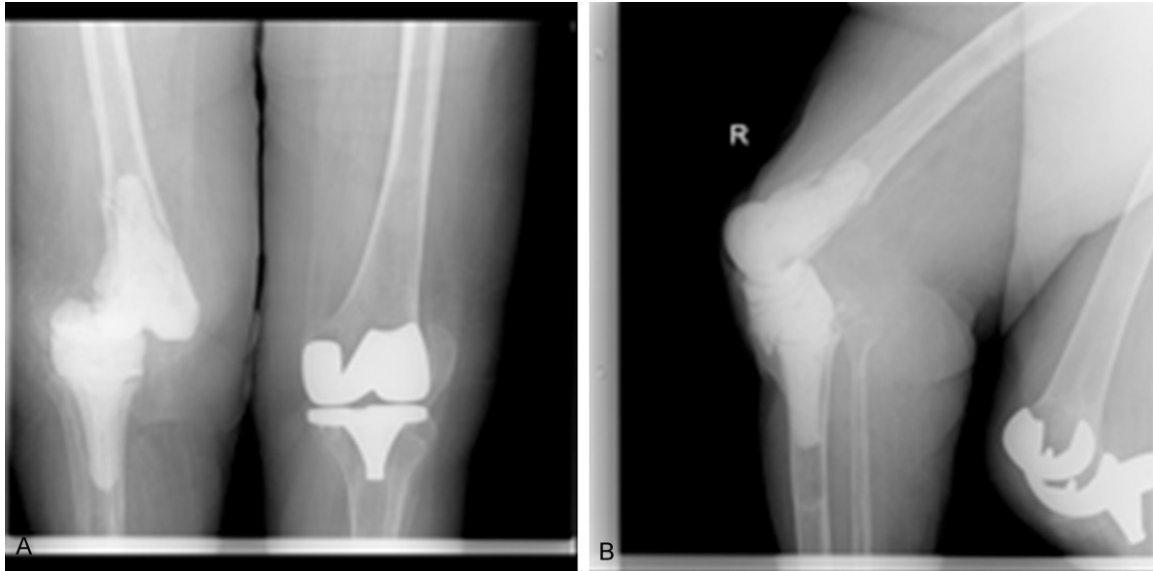
Patients were treated with appropriate antibiotics based on the culture results and were followed until regression of the clinical and laboratory evidence of the infection. The absence of discharge and erythema were the clinical parameters, while reduction of CRP level was the laboratory criterion. Those patients with no evidence of an active infection in the intraoperative frozen sections isolated from surrounding soft tissues during the arthrodesis operation subsequently underwent a repeat arthrodesis surgery. Antibiotherapy was initiated based on the organisms isolated from the cultures from the second operation.

### *Surgical technique*

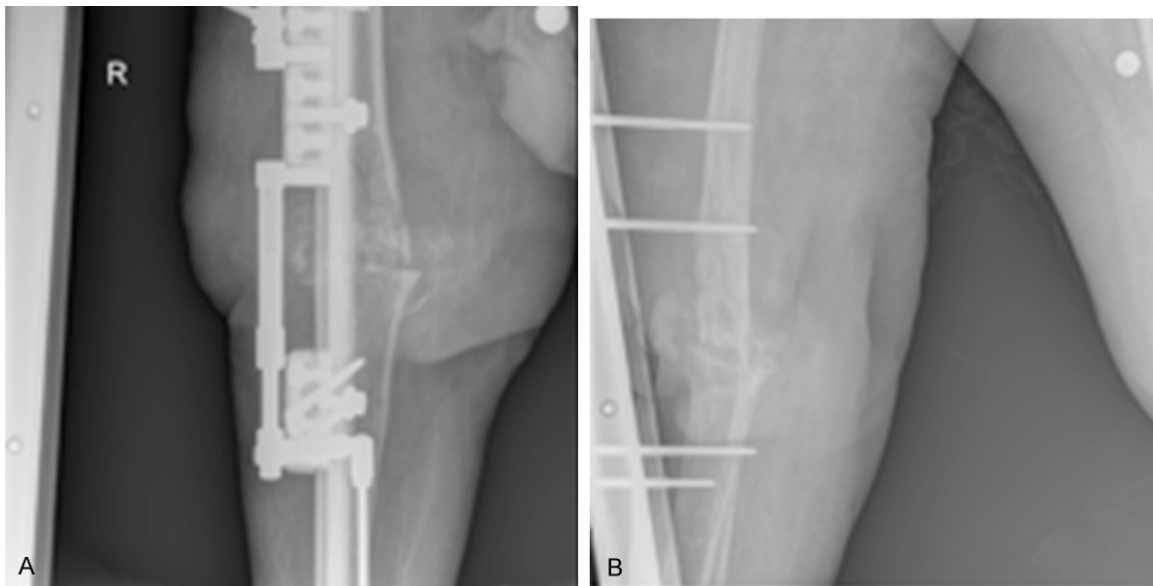
Under general anesthesia, the previous anterior or longitudinal incisions were used to access to affected sites in all patients. Arthrotomy was performed through a median parapatellar incision to not disturb the circulation of the flaps in patients who had previously undergone flap

surgery. In a two-step manner, infected knee implants were initially removed, followed by the collection of deep tissue culture and tissue specimens for frozen section examination of the tissue that appeared to be infected. In patients with evidence of an active infection, a wide debridement and irrigation were performed prior to the application of an antibiotic-coated cement containing 2 g of teicoplanin. Next, 2 hydroxyapatite Schanz pins each inserted into the proximal aspect of the femur and the distal aspect of the tibia, thereby providing stabilization of the antibiotic-coated cement in the knee and knee joint by a tubular carbon fixator. After the antibiotic therapy was administered based on the culture antibiogram obtained 6 weeks later, all patients underwent a second operation to remove of the cement. Knee arthrodesis was performed in the proper position after the erythema and discharge were completely resolved and the CRP levels had decreased. Removal of the cement and debridement of the joint were performed. Specimens from the surrounding tissues were provided for frozen examination, and arthrodesis was performed for those patients with no evidence of an active infection. Articular surfaces of the femur and tibia were appropriately osteotomized. For fusion, the knee was flexed 5-10° with a valgus position of 5-7°, after which a temporary fixation was performed with two 3-cm K-wires under fluoroscopy. In all patients, the chondral tissue on the articular surface of the patella was trimmed and exposed, and spongy grafts were placed on the articular contact surfaces of the femur and tibia where

## Patellar autograft in knee arthrodesis with external fixation



**Figure 4.** A, B: Preoperative AP and Lateral view of cemented knee before arthrodesis.



**Figure 5.** A, B: Postoperative AP and Lateral view of LRS EF.

the fusion was anticipated in an autograft fashion. After graft harvesting, the osseous sutures passed through the patella were further passed through the holes of the medial and lateral side of the femur, approximating the patella to the fusion field. Because two patients had ipsilateral hip prostheses, biplanar fixation consisting of a combined femoral arch in the femur, 5/8 semicircular in tibia, and femoral arch was achieved using an Ilizarov type external fixator, including the previous Schanz pins (**Figures**

**1-3**). The remaining patients received a uniplanar limb reconstruction system (LRS) type external fixator from the anterior aspect. Because two of these patients had advanced osteoporosis, a femoral arch was created from the Schanz pins inserted for the LRS external fixators (**Figures 4-6**), and additional Schanz pins were placed in another plane. Bleeding was then assessed prior to the placement of a drain into the deep tissue, and the incision was closed in a layered fashion. The K-wires that

## Patellar autograft in knee arthrodesis with external fixation



**Figure 6.** Clinical view of the patient with LRS EF.

were previously inserted for the temporary fixation were then removed.

For descriptive statistics of data, the mean, standard deviation, median minimum, maximum and frequency values were used.

### Results

A summary of the demographic data and clinical features for the patients was given in **Table 1**.

No patients experienced a recurrent infection. After the removal of the fixator, a shortening of 5 cm developed in a patient with an extensive bone defect; the patient was offered lengthening surgery but declined because the patient was capable of walking without assistance due to elevator shoes. The mean shortening observed in our patients was 2.6 cm (range: 2-5).

All patients had pin site infections, which were treated by local pin site care and oral antibiotics without the need for Schanz pin removal. We did not detect any other major complication, such as pin site fracture, pin loosening, or non-union.

In terms of arthrodesis positions, a mean flexion of 7.9° (range: 5.4-10.8) and a mean valgus of 6.8° (range: 5.8-7.4) were observed.

The mean duration from the first debridement and implant removal until the full resolution of the infectious indicators by the antibiotic-coated spacer was 4.1 weeks (range: 3-6), and the total duration of fixator use after knee arthrodesis was 16.3 weeks (range: 13-18).

We used biplanar external fixation in three patients, while the remaining patients underwent uniplanar fixation. The patients with biplanar fixator had previous ipsilateral hip prostheses.

No patient developed another infection after arthrodesis. All patients could be mobilized

without assistance except for the patient with a 5-cm shortening who required crutches. Our study population consisted of infected knee revision arthroplasty patients who had previous repeated surgeries.

### Discussion

Infection rates after knee arthroplasty have been reported to range between 0.5% to 15% in the literature [2, 10]. Major predisposing factors for developing infection include rheumatoid arthritis, long-term corticosteroid use, diabetes, advanced age, history of knee surgery, and previous implantation [2, 11]. In addition to providing relatively high stability, external fixation has the following advantages: its level of compression can be adjusted during the post-operative period, the implant can be easily removed, there is minimal risk of dissemination of the infection into the medulla, and it can be used in the presence of an infection [12].

Compared with circular external fixators, patients do not have difficulties in sitting or lying with the use of uniplanar external fixators. Indeed, the application of the fixator from the anterior aspect has minimized these difficulties [2]. Consistent with studies published in the literature, our patients had no with or lying.

In the study performed by Hageman et al, the most important parameter for a successful



## Patellar autograft in knee arthrodesis with external fixation

**Table 1.** Summary of the patients

Cases	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Mean	
Sex	F	F	F	F	M	F	F	F	F		
Age	84	77	65	68	54	71	74	71	76	71.1	
Side	L	R	R	R	L	R	R	L	L		
Clinic	Outside	Outside	Outside	Our clinic	Outside	Our clinic	Outside	Our clinic	Outside		
Comorbidity		DM	DM					DM	DM		
	HT	HT	HT				HT		HT		
	CAD	THA	THA	THA	RA	Colon CA					
Flap used	+	+	+	None	+	None	None	None	None		
Microorganism isolated after debridement	Staph. e.	Staph. e.	MRSA	Proteus	MRSA	E. coli	MRSA	Staph. e.	MRSA		
Cement duration (week)	4	4	6	3	4	3	3	4	6	4.1	
Duration of fixators after arthrodesis operation (week)	18	16	15	16	16	14	16	18	18	16.3	
Fixator type	Uniplanar	Biplanar	Biplanar	Biplanar	Uniplanar	Uniplanar	Uniplanar	Uniplanar	Uniplanar		
Position of the arthrodesis	Valgus (°)	7.1	6.8	7.4	7.1	6.4	5.8	6.1	7.8	7.4	6.8
	Flexion (°)	5	9.5	10.8	10.1	9.5	8.5	5	5	8	7.9
Shortness (cm)	5	2,5	2,5	2	2	2.5	2	2.5	3	2.6	
Complication	PTI	PTI	PTI	PTI	PTI	PTI	PTI	PTI	PTI		
Number of performed prosthesis operations	5	4	5	4	4	2	4	3	4	3.8	
Total number of debridement and flap surgeries	21	12	7	5	10	3	6	5	5	8.2	

F: female, M: male, L: left knee, R: right knee, DM: diabetes mellitus, HT: hypertension, CAD: Coronary Arterial Disease, THA: total hip arthroplasty, RA: Romatoid arthritis, Staph e: staphylococcus epidermidis, MRSA: Methicillin-resistant staphylococcus aureus, PTI: Pin tract Infection.

fusion was reported to be good bone contact [13]. We aimed to obtain viable vascularized bone tissue at the most widespread surface considering the smallest amount of shortening possible. We believed this to be one of the major contributions to the high fusion rates observed in our study.

The highest fusion rates in knee arthrodesis have been reported after intramedullary pinning [14]. Nevertheless, intramedullary pinning has disadvantages, such as prolonged operation time, difficulty in achievement the appropriate arthrodesis position, risk of infectious dissemination, and its inapplicability to infected patients [15, 16]. We preferred the external fixator technique because all of our patients had some infected processes.

Two-step therapies (initial debridement and antibiotic-coated spacer application followed by fusion surgery) have proven to be very successful in the treatment of active infections, as we performed in all patients in this study. After debridement and antibiotic-coated spacer treatment, we applied temporary fixation, including the knee; we considered factors, such as the stabilization necessary for skin healing in patients with healing problems, comfortable mobilization, absence of spacer dislocation, and absence of knee instability. An antibiotic-coated spacer was placed as a single-piece to immobilize the knee. We believe that the fact that we did not experience any wound problems in our patients plus our high infection resolution rates may be a result of this practice. Again, we did not find any similar practice in the published literature.

An active infection in the area of fusion decreases the possibility of fusion. In fact, the absence of an active infection is one of most critical factors for fusion. Fusion rates in arthrodesis surgery were reported to be markedly increased if performed after complete eradication of an infection [17, 18]. We confirmed the absence of active infection in both the first step of debridement and before the second step, i.e., arthrodesis, by sending soft tissue specimens for frozen pathology examination. None of our patients had an active infection during the second step. The assessment of active infection by frozen examination, a differential aspect of our study, is a technique that we did not find in the literature.

Despite the poor fusion rates reported with uniplanar and biplanar external fixation [19] (58% and 65%, respectively), we achieved fusion in all of our patients. To increase our success rates, the cartilaginous area at the chondral surface of the patella was thoroughly removed to harvest spongy bone within the patella, which was subsequently transferred to the fusion site as an autograft. This avoided additional morbidity to the patients.

Earlier studies reported that the optimal position of a knee arthrodesis is 5-7° valgus (2-14). In our cases, the mean angle of valgus was 6.8° (range: 5.8-7.8°), whereas the mean flexion was 7.9° (range: 5.0-10.1°). These values easily obtained with external fixators were consistent with the ideal positions of knee arthrodesis reported in the literature.

### Conclusion

We believe that revision steps warrant more attention to the eradication of the infection after infected knee prosthesis revision surgery and that the use of the patella as a graft in addition to external fixation is a reliable method for a successful arthrodesis.

### Disclosure of conflict of interest

None.

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