

Knee Arthrodesis After Infected Total Knee Arthroplasty Using the Ilizarov Method

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Numerous treatments have been proposed for infected total knee arthroplasty. In selected patients, a knee arthrodesis is a well-recognized salvage procedure. However, there are no reports in the literature discussing the treatment of infected total knee arthroplasty using the Ilizarov method. The authors reviewed their experience with this technique in infected total knee arthroplasty, presenting six patients (four women, two men) treated between 1992 and 1998. The average age was 56.6 years (range, 23–70 years) and the mean number of previous surgical procedures was seven (range, 4–10 procedures). From the time of frame removal, the patients were followed up for a mean of 34.2 months (range, 12.4–87.5 months). Full weight-bearing was allowed 1 week after surgery if half-pins were used and after a mean of 2.6 months if Kirschner wires were used. Of the five patients who have completed treatment, all have obtained a stable knee arthrodesis after a mean external fixation time of 6.8 months without additional surgical procedures or bracing. All of the

patients were satisfied with the treatment. The authors recommend knee arthrodesis by the Ilizarov method for infected total knee arthroplasty, particularly in patients with extensive bone loss, significant limb shortening or axial deformity or both, active infection, or previous failed arthrodesis.

Infection in total knee arthroplasty represents one of the most challenging problems facing the orthopaedic surgeon. Despite a reported mean incidence of only 1% to 2%, numerous treatments have been proposed.^{4,14}

In some patients the situation is complicated by poor bone stock, soft tissue compromise, and limb shortening or axial deformity or both. Revision arthroplasty is not always possible or desired by the patient, whereas a resection arthroplasty is not well tolerated.^{6,9} In selected patients a knee fusion is a salvage procedure that can offer a practical solution to these problems.^{2,14}

Different techniques for performing a successful knee arthrodesis have been proposed. Internal fixation, with a plate or an intramedullary nail, provides rigid fixation.^{1,5,11,17} According to recent reports, intramedullary nailing has the added advantage of allowing early weightbearing with no need for additional immobilization.^{1,16} External fixation can

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be used in knee arthrodesis, although it requires considerable surgical skill to obtain stable compression with good alignment, and the patient does not always tolerate the external frame.^{7,10,15} However, external fixation offers potential advantages, including possible progressive adjustment to stimulate the bone fusion and to correct malalignment, no risk of intramedullary dissemination of the infection, and easy removal of the hardware.³ The Ilizarov method offers the unique advantage of allowing the surgeon to combine knee fusion with limb lengthening and correction through a proximal or distal limb osteotomy or both.

There are no reports in the orthopaedic literature regarding the treatment of a septic total knee arthroplasty using the Ilizarov method. The current study presents the authors' experience with this technique.

MATERIALS AND METHODS

Between 1990 and 1998, six patients with a septic total knee arthroplasty that was nonresponsive to various treatments were referred to the authors (Table 1). The average age of the patients was 56.6 years (range, 23–70 years). There were four women and two men. All patients were in general good health, and none had any predisposing factors to infection, such as diabetes mellitus, rheumatoid arthritis, or steroid therapy. The original diagnosis before the primary total knee arthroplasty was idiopathic osteoarthritis in four patients, posttraumatic osteoarthritis in one patient, and a failed high tibial osteotomy for genu varum in one patient (Fig 1). Four patients had uncemented prostheses. One patient had cemented femoral and tibial components, and one patient had a cemented tibial component only. A patella resurfacing had been done in one patient.

All of the patients had several surgical procedures (mean, 7 procedures; range, 4–10 procedures) before being referred to the authors. Three patients had two-stage revision arthroplasty. Two patients had failed knee arthrodesis after prosthesis removal: one with a plate and one using a combination of lag screws and external fixation. An excision arthroplasty was done in one patient. Multiple irrigation and debridements were undertaken in all of the cases. All of the patients reported continuous pain exacerbated by ambulation, continuous drainage of

sinuses, and restriction of the knee range of motion to an average of 30° (range, 10°–60°). Four patients wore a long rigid brace with the knee in full extension. All patients needed two canes to ambulate and were able to bear weight only partially. The infecting organism was *Staphylococcus aureus* in four patients, *Staphylococcus epidermidis* in one patient, and a combination of *Pseudomonas aeruginosa* and *Staphylococcus aureus* in one patient.

The indications for knee arthrodesis were extensive soft tissue loss (in one patient the plate was exposed after a failed knee arthrodesis), poor bone stock, and multiple recurrences of the infection. None of these patients were suitable for a new reconstruction, and all expressed the desire for a predictable solution.

All patients had shortening of the affected lower limb (average, 3.3 cm; range, 1.1–7.2 cm) with an associated slight valgus deformity (average, 6°; range, 0°–12°). A 23-year-old woman had a 7.2-cm leg length discrepancy after two failed total knee arthroplasties for posttraumatic osteoarthritis. Distal tibial lengthening was done simultaneously with the knee arthrodesis to address this problem.

In the first two patients who had frame fixation only, wires were used. More recently, to improve frame stiffness and permit immediate full weight-bearing, 5.0- and 6.0-mm half-pins were used, allowing the use of fewer wires.

Clinical evaluation was conducted at followup with assessment of postoperative pain and pain during treatment, pin site infections, patient satisfaction, wound site, patients' ability to ambulate, and stability of the arthrodesis. Progressive bone fusion and lower limb alignment were evaluated on serial radiographs. The criterion for a successful arthrodesis was complete bone bridging on at least two projections.

Surgical Technique

The apparatus is preassembled before starting the surgery, sizing the rings directly on the patient's limb. In the monofocal treatment (arthrodesis only without lengthening), a proximal 90° arch and one distal ring usually are used for the femur. Two rings are used for the tibia, one proximal and one distal. The whole construct is connected with threaded rods. Using the same surgical approach as the previous total knee arthroplasty, the prosthetic components are removed, and wide accurate debridements with multiple lavages are done. After skin closure, the knee is stabilized temporarily with two

TABLE 1. Demographic Data, Infective Organisms and Outcomes of Six Patients With Septic Total Knee Replacement Treated With a Knee Arthrodesis Using the Ilizarov Method

Age/Gender	Diagnosis Leading to TKA	Surgical Procedures Before Ilizarov Knee Arthrodesis	Infecting Organism	External Fixation time	Outcome
68 years/male	Failed high tibial osteotomy	High tibial osteotomy TKA TKA removal Revision TKA TKA removal Failed knee arthrodesis (plate) Debridements + multiple irrigations	Staphylococcus aureus	10.3 months	Stable knee arthrodesis without brace
70 years/female	Osteoarthritis	TKA Debridements + multiple irrigations	Staphylococcus epidermidis	5.1 months	Stable knee arthrodesis without brace
66 years/female	Osteoarthritis	TKA TKA removal Debridements + multiple irrigations	Staphylococcus aureus	5.6 months	Stable knee arthrodesis without brace
54 years/female	Osteoarthritis	TKA TKA removal Failed knee arthrodesis (screws + external fixator) Debridements + multiple irrigations	Staphylococcus aureus	7.2 months	Stable knee arthrodesis without brace
59 years/male	Osteoarthritis	TKA Revision TKA Debridements + multiple irrigations	Staphylococcus aureus	5.8 months	Stable knee arthrodesis without brace
23 years/female* (* excluded from the final results)	Posttraumatic osteoarthritis	ORIF in distal femoral fracture Hardware removal TKA TKA removal Revision TKA Antibiotic beads Debridements + multiple irrigations	Staphylococcus aureus and Pseudomonas aeruginosa	7.7 months	Stable knee arthrodesis, tibial lengthening proceeding

TKA = Total knee arthroplasty; ORIF = Open reduction and internal fixation.

percutaneous crossed transosseous wires, keeping the knee in approximately 5° flexion. These wires can be removed after the apparatus is in place. A transverse wire is first passed approximately 3 to 8 cm from the ankle in the distal tibia perpendicular to the bone axis. A 5.0- to 6.0-mm half-pin is inserted in the proximal femur. These are connected to the distal tibial ring and proximal femoral arch

and act as reference points for additional frame construction. A wire is placed in the distal femur and connected to the distal femoral ring. This wire usually is removed after the first radiologic appearance of bone bridging. The frame is additionally stabilized with at least one wire and one half-pin for each tibial ring and two pins for the femoral arch and ring (Figs 2, 3). While the patient remains

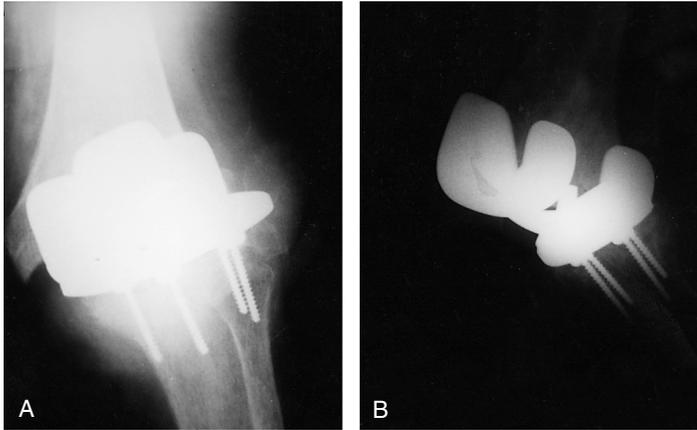


Fig 1A–B. (A) Anteroposterior and (B) lateral radiographs of a 54-year-old man with an infected total knee arthroplasty.

in the frame, it is possible to correct the limb axis and improve bone fusion with progressive distraction or compression across the threaded rods or both.

When Kirschner wires were used, only partial weightbearing was allowed 1 week after surgery. Full weightbearing was permitted after bone fusion appeared radiologically. A recent modification to the technique (hybrid advanced technique) involved the use of half-pins, and patients treated with this technique were encouraged to fully bear weight 1 week after surgery.

RESULTS

The results of five patients were evaluated. One patient was excluded because, despite a stable knee arthrodesis, the patient required a second distal tibial lengthening for a 7.2-cm limb shortening. The average followup from frame removal was 34.2 months (range, 12.4–87.5 months). Full weightbearing was allowed after a mean of 2.6 months (range, 1 week–6 months). In all five patients, a stable

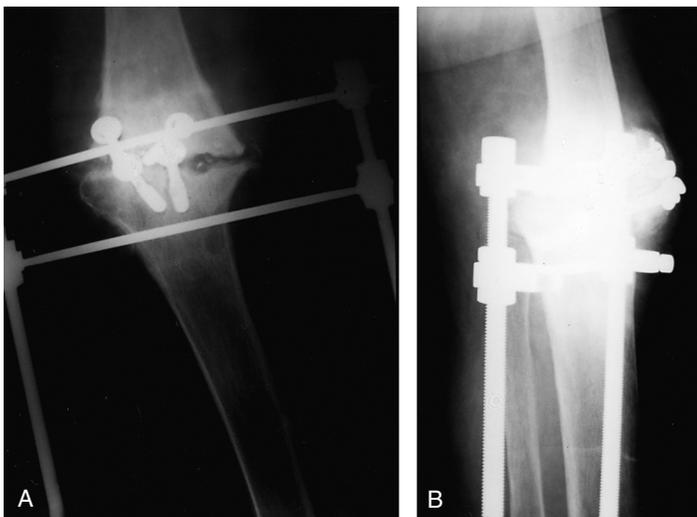


Fig 2A–B. (A) Anteroposterior and (B) lateral radiographs of the same patient as in Figure 1 showing failed knee arthrodesis using a combination of lag screws and external fixation

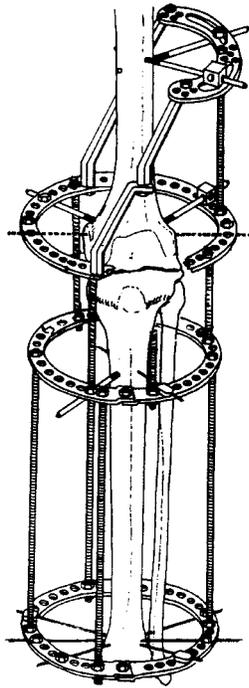


Fig 3. Diagram of the Ilizarov frame construction for a knee arthrodesis using the hybrid advanced technique involving a combination of half-pins and wires.

arthrodesis was achieved after a mean external fixation time of 6.8 months (range, 5.1–10.3 months) (Figs 4, 5). In four patients, progressive compression of the arthrodesis site was done to increase bone formation. The mean degree of flexion at the arthrodesis was 8° (range, 5° – 14°). No patient required continuous bracing (four patients wore a long knee brace for 1 month after the frame removal for additional protection). The frames were removed in the clinic after the patients had been discharged from the hospital.

According to the Paley complications classification,¹² there were no sequelae or obstacles; however, all of the patients had pin site infections. Each patient had a mean of two pin site infections (range, 1–4 infections) and all were superficial. These infections were more common in the proximal femoral pin sites, and the frequency of the infections increased the longer the patient wore the frame. All pin site infections were treated successfully with oral antibiotics. No patient required admission to the hospital for a pin site infection, and no wires or pins needed to be removed because of infection. After modification of the technique, to reduce the number of wires used, the incidence of pin site infection was reduced. Antibiotic beads were used in one patient for 40 days after prosthesis removal because of an extensive infection. This patient had two sub-

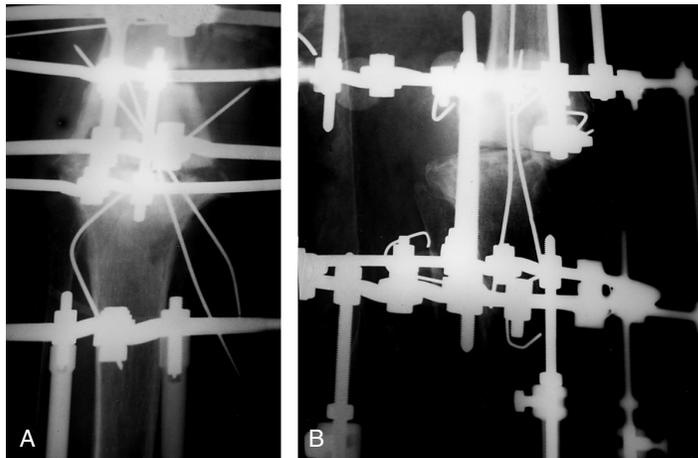


Fig 4A–B. (A) Anteroposterior and (B) lateral radiographs of the same patient showing percutaneous crossed transosseous wires and Ilizarov frame.

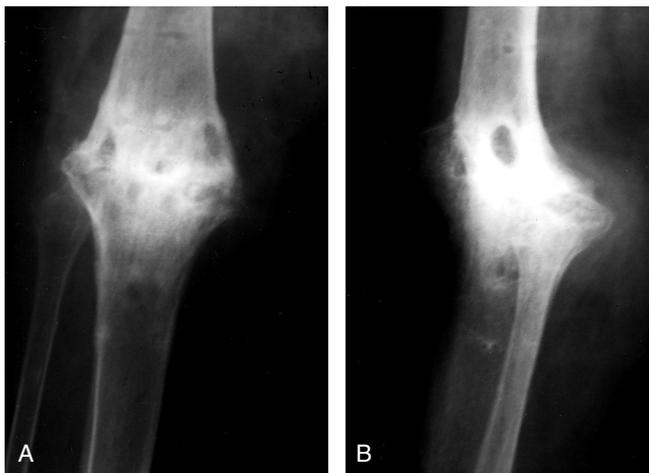


Fig 5A–B. (A) Anteroposterior and (B) lateral radiographs of the same patient after Ilizarov frame removal showing a successful knee fusion.

sequent procedures for antibiotic bead removal and debridement without requiring removal of the fixator. No patient had recurrence of infection, and complete soft tissue recovery was achieved in all patients.

During the postoperative period, all patients reported mild pain successfully treated with nonsteroidal antiinflammatory drugs; the pain diminished with time. No patient required a walker; however, all but one patient used a cane on the opposite side to ambulate. All of the patients were satisfied with the treatment and returned to a more normal lifestyle.

DISCUSSION

Successful arthrodesis after failed total knee arthroplasty is more difficult to achieve than when done as a primary procedure.¹³ Using an external fixator, successful fusion has been reported at rates ranging from 67% to 100%.⁴ The main disadvantages of using an external fixator are delayed weightbearing, patients' intolerance of the hardware, and pin site infections.⁴ The fusion rate in the current study was 100%, which compares favorably with that reported in the literature. Despite studies showing a need for bone grafting in 5% to 42% of patients treated with an external fixator,^{4,10} no patient in the current study required bone grafting to achieve union. Arthrodesis

was achieved after a mean of 6.8 months, which is consistent with that found in other studies using external fixation or an intramedullary nail.^{4,16} The problem of delayed weightbearing was addressed by modifying the technique to use half-pins. In the patients in whom half-pins were used, full weightbearing was allowed immediately after surgery. None of the patients reported any difficulties with the frame, and all patients were satisfied with the treatment. A small number of pin site infections occurred with the treatment, but all responded to oral antibiotic treatment. No patient required admission to the hospital for a pin site infection, and no wires or pins required removal because of infection.

Studies have suggested an intramedullary nail is a superior method of achieving fusion after infection of a total knee arthroplasty.^{16,17} Recently, Waldman et al¹⁶ reported that a multicenter study had an arthrodesis rate of 95% after septic total knee arthroplasty using a modular intramedullary nail after a mean of 6 months. However, there are problems with the use of an intramedullary nail in an infected total knee arthroplasty.^{4,16} These problems include the risk of intramedullary dissemination of the infection, difficulty in treating a recurrent infection with an intramedullary implant, the inability to lengthen or adjust axial alignment during treatment, nail migration, the inability to

compress the arthrodesis site at time of surgery, and the inability to assess stability of the arthrodesis clinically during treatment.^{5,16}

The Ilizarov method provides numerous additional advantages. Rand¹³ reported that the extent of bone loss is the most important factor influencing knee arthrodesis. When knee arthrodesis is attempted in an acute joint infection, there is an absolute contraindication to immediate bone grafting. The Ilizarov fixator provides, with progressive distraction and compression, a mechanical stimulus for bone formation. This improves the quality of bone forming across the arthrodesis. Rigid fixation with a plate or intramedullary nail offers only mechanical stiffness, which does not contribute to increasing bone stock. Rothacker and Cabanela¹⁵ showed that the main requisite for achieving good arthrodesis is rigid fixation. Better results were obtained with multiplanar external fixators than with biplanar fixators.⁸ The Ilizarov frame is circular; it provides more rigid fixation and gives the surgeon the ability to increase or diminish the hardware's rigidity by adding or removing the points of fixation. The Ilizarov technique also offers the ability to modify alignment of the arthrodesis by using hinges. Finally, in patients with a significant limb shortening, the Ilizarov method permits an associated limb lengthening (bifocal or trifocal) with the knee fusion.

The authors recommend knee arthrodesis by the Ilizarov method as a salvage procedure for infected total knee arthroplasty, particularly in patients with extensive bone loss, significant limb shortening or axial deformity or both, active infection, or previous failed arthrodesis.

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