Knee Arthrodesis Using Combined Intramedullary Rod and Plate Fixation

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Intramedullary arthrodesis of the knee is a satisfactory method for treating difficult salvage cases of infected arthroplasty, bone loss, and severe osteoporosis. In eight cases, a medial compression plate was routinely used for complete fixation. Union occurred in all cases, including two proximal tibial segmental allografts. Five previously infected cases were healed at follow-up examination (average, six to 44 months). Complications included proximal rod prominence, partial peroneal nerve palsy, recurrent sepsis in one case, and tibial shaft perforation on nail insertion. Seven of the eight patients used some form of walking aid for extended ambulation. Leg length was generally 1.5–2.5 cm shorter than the opposite limb.

Compression knee arthrodesis is a standard orthopaedic technique used in difficult reconstructions of knees damaged by infection, severe ligamentous instability, and bone loss after total knee arthroplasty (TKA). In cases where arthrodesis is the primary treatment after trauma, arthritis, or instability, rates of union are high: more than 95% by various methods. After failed TKA with bone loss and infection, reported rates of fusion decrease dramatically and may be as low as 21%. Most of these earlier studies used external fixation devices as the primary mode of fixation. This technique is frequently complicated by pin-site infection, pin loosening, and failure of fixation stability.

Recent support for the use of intramedullary rod fixation in the most severe salvage cases suggests that more rigid fixation may be obtained, thus promoting bony union. Similarly, dual-compression plating provides excellent initial stability and obviates the disadvantages of externally placed pins. This report describes a new technique of knee arthrodesis accomplished by combined intramedullary rod fixation and compression plating. Eight cases in which this technique has been employed are reviewed retrospectively.

MATERIALS AND METHODS

From 1988 to 1991, eight knee arthrodeses were performed in difficult salvage cases. The age of the patients (six women and two men) ranged from 30 to 81 years. Four arthrodeses involved the right knee and four were on the left side. Four patients had fusion for failed TKAs, two for chronic osteomyelitis, and one patient for Charcot neuropathy after a childhood spinal cord tumor.

The complications of TKA that led to fusion were severe bone loss after a failed revision arthroplasty and chronic sepsis in three patients. The infected patients had developed postoperative wound complications after arthroplasty, and one of these patients had instability due to chronic patellar tendon rupture. The wounds in two infected patients were closed and dry and the patients were receiving oral antibiotics (Ancef and amoxicillin) at the time of arthrodesis. Cultures from both patients were negative for sepsis at the time of prosthesis removal, and there was no evidence of active inflammation on frozen section. The third patient had gross sepsis with drainage at initial

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debridement. Fusion was performed seven days later after two serial debridements where cultures became negative for *Staphylococcus aureus* and Peptostreptococci.

The patient with Charcot arthropathy was insensate from the knee down to the foot but had experienced pain caused by severe arthritis and articular cartilage loss demonstrated on preliminary arthroscopy. Severe ligamentous laxity was present and this patient walked with a 30° valgus deformity that could be passively corrected to neutral.

Two patients were treated with arthrodesis after serial debridements for osteomyelitis, which had left 6- and 14-cm defects after the entire proximal tibia had been removed. One patient had developed infection after high tibial osteotomy, and the second had a Grade III B open tibial plateau fracture treated with primary internal fixation and wound closure. A gastric muscle flap had been used for soft-tissue coverage in the osteotomy case, and a free latissimus dorsi flap was needed to cover the large defect in the open tibia fracture case. External fixation was needed to stabilize the leg of the infected open fracture until soft-tissue healing was assured. The fixator then was removed and pin sites curetted before arthrodesis. The wounds of both patients were closed and dry at the time of arthrodesis and their sedimentation rates had returned to normal. Proximal tibia segmental allografts were employed in each case to fill the segmental bone defect. In the tibia fracture case, the wound became infected in the early postoperative period after arthrodesis requiring removal of allograft and reapplication of external fixation. Subsequent parenteral vancomycin and ciprofloxacin were administered for three months followed by fixator removal and pin site curettage. A second attempt at arthrodesis was successful.

One patient had a severe Grade IIIIB close-range shotgun wound to the knee resulting in extensive soft-tissue injury and bone loss of the distal femur and proximal tibia. After two serial debridements, intramedullary arthrodesis was accomplished with an uncomplicated wound closure.

Follow-up examination for all patients ranged from six to 44 months. Radiographic and clinical union was assessed. Functional evaluation included relative leg length measurement, requirement of shoe lift, use of walking aids, and level of ambulation.

**Operative Technique**

Knee arthrodesis was performed with the patient supine in the semilateral decubitus position by placing covered intravenous bags under the chest and sacrum. Fluoroscopy was used to view from the hip to the ankle on a radiographic operating table. The entire lower extremity and pelvis were prepared on the affected side. A sterile inflatable tourniquet was applied to the thigh for hemostasis.

A midline anterior knee incision was made through the previous scar. The distal femur and proximal tibia were exposed and prosthetic components were removed. If there was no evidence of active inflammation, arthrodesis was performed, and osteotomy cuts of the distal femur and proximal tibia were made. A lateral incision was made over the greater trochanter, and an awl was used to make an entry hole in the piriformis fossa. A femoral guide wire was inserted down the femur for flexible medullary reaming. Distally, a hole was made in the intercondylar notch through which the rod could pass. Proximal femoral sequential reaming to 12 mm was performed. At this point, a guide pin was placed down the medullary canal of the tibia and reaming was carried out to the supramalleolar level under fluoroscopic control.

The proximal femoral guide then was passed distally into the tibia and measurements were made to determine the length and diameter of rod needed. The femur was overreamed by 1 mm and the tibia by 0.5 mm for the actual rod insertion. From a set of prebent 75-cm Kuntscher cloverleaf rods, the appropriate diameter rod was selected. The ideal rod length was considered to extend from the tip of the greater trochanter to a level 2 cm above the ankle joint. A carborundum wheel was used to cut excess length, and the rod tip was filed smooth.

Final adjustments were made on the osteotomy cuts using a saw with the femoral guidewire passed into the tibia. The rod then was inserted over the guide wire with the bend of the rod directed anteriorly to restore the natural valgus angle of the lower extremity. The rod was driven across the osteotomy site as the fusion site was held tightly closed. In certain femurs, the anatomic axis tends to lead the rod anteriorly on the distal femoral osteotomy cut. The rod was inserted distally under fluoroscopic control to avoid tibial fracture or perforation from the nail. In all cases, the nail passed the tibial isthmus.

In the cases in which segmental allografts were used, the tibial shaft host-bone junction was created with a stepcut osteotomy, which was secured with cerclage wires after rod insertion. At this point, the arthrodesis site was held closely approximated and an eight- or ten-hole AO neutralization plate was applied to compress the osteotomy. Additional autogeneic graft was added at the junction sites. Closure was performed over drains and no immobilization or splints were used postoperatively.
All patients with infections received a six-week postoperative course of parenteral antibiotics selected specifically for the cultural organisms by the infectious disease consultant. Patients were kept nonweight-bearing for a minimum of six weeks and patients with allografts were protected for at least 16 weeks.

RESULTS

Arthrodesis was confirmed in all eight knees both clinically and radiographically. All patients could bear full weight on the affected extremity without pain. Radiographic union, judged by the presence of trabecular bone crossing the fracture site, was present within three to eight months. The patient with the infected tibial osteotomy experienced pain at two years that appeared to localize over the distal allograft tibial junction site. Because radiographs did not clearly demonstrate junctional union, reexploration of the distal allograft site was performed and showed solid union. The neutralization plate was removed and the patient was pain free. One patient had incidental tibial perforation on rod insertion. The rod was withdrawn, and then reinserted under fluoroscopic control. The leg healed uneventfully. Nail removal was required in one patient at two-year follow-up examination because of prominence of the nail into the gluteal musculature.

None of the patients with infections (including the patient with a reoperated open tibial fracture) demonstrated evidence of reinfection at follow-up examination. The open tibial fracture case was the only case that developed infection after arthrodesis, and this was detected acutely within the first two weeks after surgery. Subsequent debridements and a repeated attempt at arthrodesis was successful.

The relative leg-length discrepancy was believed to be optimum in four cases without need of shoe lift, and was 1.5–2.5 cm. Four patients had adjusted the functional leg length to 1.5–2.5 cm with a shoe lift. Six patients were considered to be community ambulators, but five of the six required a walking aid to walk distances. All five, however, could walk comfortably in the home without the walking aid. Two patients developed foot abnormalities: foot drop in one and equinus contracture in the other. Both were limited household ambulators requiring aids at all times.

DISCUSSION

Arthrodesis of the knee becomes increasingly difficult in the face of extensive bone loss after infection or revision knee arthroplasty. External fixation does not usually provide the amount of stability for bone healing in these more difficult situations, as reflected by reported decreased union rates. However, external fixation is still required with massive soft-tissue infections as a means of limb stabilization.

Internal fixation for arthrodesis can be used safely in previously infected cases, but successful debridement of infected bone and soft tissue is a mandatory preliminary step. Antibiotic coverage is recommended as a secondary adjunct for controlling deep-seated infections. Soft tissue defects, as noted in this small series, can be managed by muscle flaps or free tissue transfer. The use of intramedullary rods for knee arthrodesis has had excellent results even in the face of infection or massive bone loss. Donley et al. have reported union in seven of eight cases of chronically infected knee arthroplasties. Knutson et al. were able to achieve fusion in 100% of 11 similar cases. The greatest advantage is the ability to stabilize bones weakened by osteoporosis or bone atrophy, where fixation pins or screws may pull out. With loss of medullary bone stock, however, supplemental fixation may be required.

Dual-plate fixation is an excellent technique for gaining rigid fixation in knee arthrodesis. The disadvantage is the occasional need for late plate removal. Also, a longer plate with more screws may be required for poor bone stock. Combining intramedullary fixation with a neutralization plate offers the rigidity necessary for predict-
able osseous union in the most difficult situations. This is particularly true in the cases where segmental allografts were used and optimum fixation is mandatory for host-graft union.13,16,21

Intramedullary nail arthrodesis of the knee provides the highest union rates of any technique described. With the addition of a compression plate, this technique can be extended to the most difficult situations where bone loss may require the addition of a segmental allograft. With careful attention to detail, this technique is no more difficult than the other procedures that use intramedullary nailing.

REFERENCES