The Journal of Arthroplasty Vol. 22 No. 6 2007

Case Report

Minimally Invasive Management of a Floating Prosthesis Injury with Locking Plates

Amir A. Jamali, MD, Mark A. Lee, MD, Rakesh Donthineni, MD, and John P. Meehan, MD

Abstract: Periprosthetic fractures involving a total knee arthroplasty pose a challenging treatment problem with a prevalence of up to 2.5% in the literature (*Instr Course Lect* 2001;50:379-389). The supracondylar region of the femur is commonly involved, often with minimal available bone in contact with the components. The clinical challenges are particularly more complex in the case of a combined distal femoral and proximal tibial periprosthetic fracture. This injury is considered a "floating prosthesis" injury because of the complete separation of the prosthesis from the remaining skeleton. In this report, a floating prosthesis injury, in combination with a femoral shaft fracture, is treated with 2 locking plates using a minimally invasive technique, with limited blood loss, immediate pain relief after surgery, and successful healing of all fractures with minimal deformity. **Key words:** periprosthetic fracture, floating knee, locking plate, supracondylar fracture, minimally, invasive plate osteosynthesis, LISS.

Case Report

Clinical Presentation and Initial Management

An 81-year-old man was involved in a pedestrian-vs-motor vehicle accident. He had a history of a left posterior stabilized total knee replacement (PFC, Depuy, Warsaw, Ind) 2 years before his accident for a diagnosis of osteoarthritis. His family had reported that his arthroplasty had been functioning well with full range of motion and no restriction of walking before the accident. His injuries included a closed head injury with intraparenchymal hemorrhages as well as orthopedic injuries. His orthopaedic injuries included a segmental femoral injury consisting of a femoral shaft and supracondylar periprosthetic fracture with a sagittal split fracture involving the segmental fragment as well as an ipsilateral proximal tibia fracture ("floating prosthesis injury") (Fig. 1A-C). Radiographically, both implants demonstrated no evidence of loosening from the surrounding bone as would be manifested by lucencies, cement fracture, implant migration, or fractures extending to the implants. The patient was initially treated in calcaneal skeletal traction until he was medically cleared for surgical stabilization.

His medical clearance required approximately 24 hours after which he suffered from confusion attributed to his closed head injury, delaying his clearance for the operating room. To allow early mobilization, a spanning external fixator was

From the Department of Orthopaedics, UC Davis Medical Center, Sacramento, California.
Submitted April 11, 2006; accepted August 29, 2006.
No benefits of funds were received in support of the study.
Reprint requests: Amir A. Jamali, MD, Department of Orthopaedics, UC Davis Medical Center, 4860 Y St., #3800, Sacramento, CA 95817.

0883-5403/07/1906-0004$32.00/0
doi:10.1016/j.arth.2006.08.010

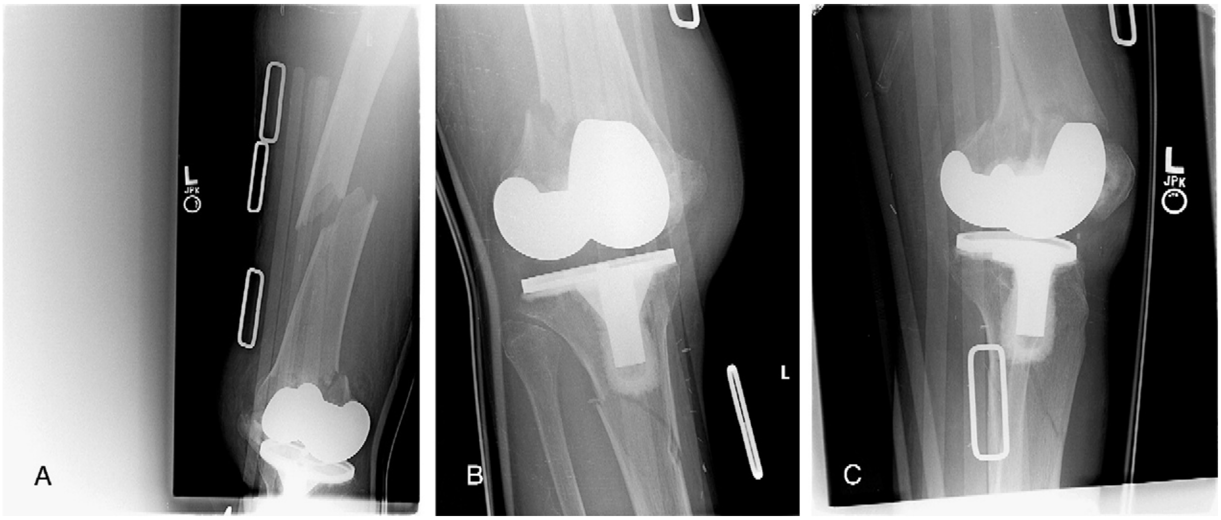

Fig. 1. A-C, Preoperative femur (A) and knee (B and C) radiographs obtained after the injury demonstrating periprosthetic femoral shaft/supracondylar fracture with an ipsilateral tibial periprosthetic fracture. This injury is termed a *floating prosthesis injury*.

applied to the patient's leg on hospital day 6. He underwent definitive fixation on hospital day 18.

Operative Technique

The patient was placed on a radiolucent operating room table. A sterile isolation drape was cut and placed to cover his groin. Both legs, including the spanning external fixator, were then prepared and draped to optimize radiographic evaluation of the entire femur. With both legs being freely draped, the uninjured leg could be elevated above the image intensifier to facilitate fluoroscopy of the injured proximal femur. A 10-cm incision was made on the distal lateral thigh (Fig. 2A). The fracture hematoma was evacuated. There was a minimal amount of bone attached to the distal femur extending just proximal to the anterior flange of the femoral component. The distal femoral fragment was in recurvatum due to the unopposed pull of the gastrocnemius muscle. A Cobb elevator was used to demarcate the implant-bone interface and rule out loosening of the femoral component from the distal femoral bone. The elevator was then placed under the supracondylar fragment to elevate it. A blunt Hohmann retractor was placed under the anterior flange of the prosthesis and over the distal femoral shaft to maintain the reduced position of the distal fragment. Next, a condylar locking plate (Synthes, Paoli, PA) was selected based on the preoperative plan with intraoperative confirmation of the plate length by fluoroscopy. The plate was passed in a submuscular position under the vastus lateralis and proximal to the sagittal fracture of the femoral shaft. The distal aspect of the plate contains a central hole for a locking 7.3 mm cannulated screw and 5 surrounding holes for 5.0 mm locking

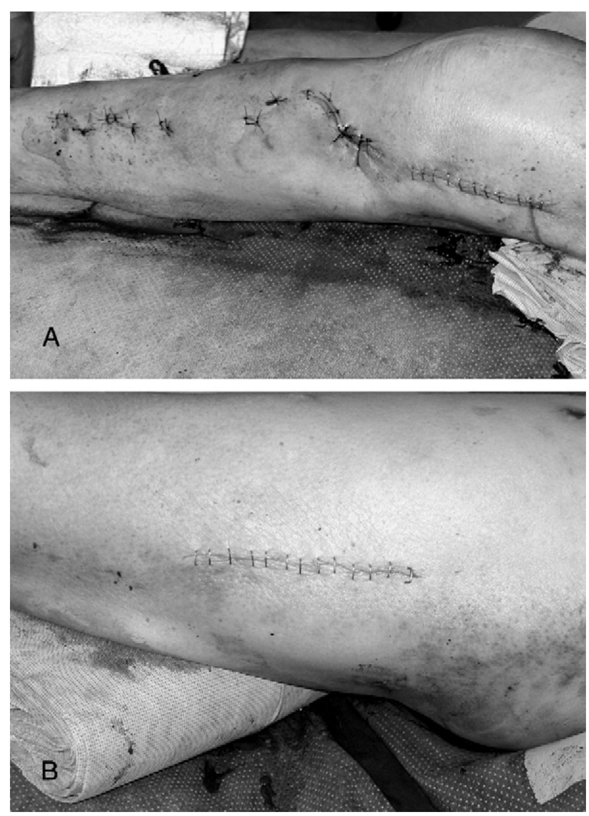

Fig. 2. A and B, Limited skin incisions were utilized on both the distal thigh and proximal leg (A) as well as on the proximal thigh (B) to minimize disturbance of fracture blood supply and surgical blood loss.

screws. With the fracture pattern in this case and the paucity of bone on the distal femoral fragment, it was vital to translate the plate as distal as possible to maximize fixation of the distal femoral fragment and to obtain fixation within the cement mantle with the 7.3-mm screw. Two of the 5.0-mm locking screws were initially placed in order to stabilize the plate at the desired level. Next, the 2.5-mm guidewire for the 7.3-mm cannulated screw was passed with moderate resistance from the cement mantle. This resistance increased with the passage of the 5.0-mm cannulated drill through the cement mantle. The appropriate 7.3-mm locking cannulated screw was passed over the guide pin with excellent purchase in the cement mantle. A second 10-cm incision was made over the proximal aspect of the plate. (Fig. 2B) The plate was clamped to the proximal femoral shaft and stabilized to the femur with a combination of locking and nonlocking screws. At this point, the remaining available distal screws were placed. The intervening distal femoral shaft with the sagittal fracture was left untouched. The tibia fracture was stabilized using a Less Invasive Skeletal Stabilization (LISS) plate (Synthes, Paoli, Pa) also through a 5-cm incision and multiple 1-cm incisions for percutaneous screw placement. (Fig. 2A) The attachment of the tibial component to the proximal tibia was confirmed with a Cobb elevator before fixation. All wounds were irrigated and closed in the standard fashion. The estimated blood loss from the surgical procedure was 150 mL.

Fig. 3. A and B, Anteroposterior and lateral long-cassette radiographs of the lower extremity obtained at the 3-month postoperative visit demonstrate complete healing of all fracture with maintenance of the postoperative reduction.

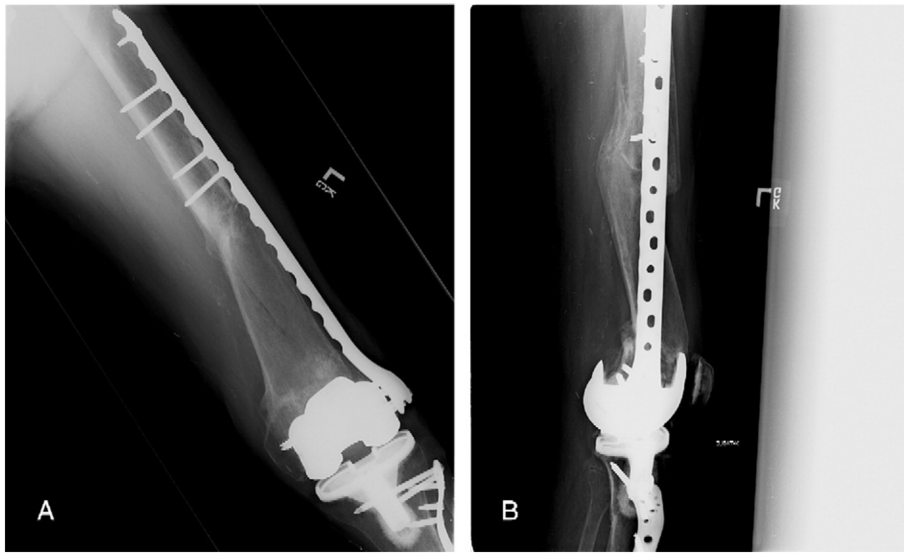

Fig. 4. A and B, Anteroposterior and lateral radiographs of the femur obtained at the 18-month postoperative visit demonstrate continued remodeling of the fractures.

Postoperative Course and Follow-Up

We prescribed a non–weight-bearing regimen for 8 weeks after surgery. After the appearance of early callus, the weight-bearing status was advanced to 25-lb weight-bearing for an additional 4 weeks. He had near-complete pain relief immediately after the surgery and was able to tolerate passive and active-assisted range of motion of his knee during the hospitalization. His range of motion was limited for the first 4 weeks to 90° flexion to avoid stress on the femoral fracture fixation. After that, no range of motion restriction was applied. The fracture was clinically and radiographically healed at 3 months. (Fig. 3A and B) At the 18-month visit, he continued to require a walker for balance but had no residual muscle weakness. (Fig. 4A and B). At that time point, the affected knee had a 10° flexion contracture with further flexion to 110°.

Discussion

Periprosthetic fractures about the knee are a particularly challenging class of injuries because the patients are often elderly with osteopenic bone. These fractures are commonly associated with small segments of remaining available bone adjacent to the prostheses, limiting the fixation options. The use of standard condylar plates requires an extensive exposure along the lateral femur and/or tibia and carries the risks of screw failure secondary to toggling with cyclic loading in poor-quality bone. In addition, because of the osteopenia, the reduction is often difficult to maintain [1]. Intramedullary fixation has the advantage of minimal disturbance of the fracture callus and can be performed using small incisions. Retrograde nail fixation is contraindicated in highly comminuted fractures and extremely distal fractures [2]. This technique is also not an option in many posterior stabilized knee arthroplasty implants due to obstruction of the intramedullary canal by the femoral component. Even in cases where it can be used, there is lower torsional stiffness of the retrograde nail when compared with a fixed angle plating system [3].

When a supracondylar periprosthetic fracture occurs in combination with an ipsilateral tibial periprosthetic fracture, the prosthesis is essentially disconnected from the skeleton. This situation is analogous to a floating knee injury and can be termed a *floating prosthesis injury*. To our knowledge, this has been described in one previous case by Jeong et al [4]. In that case, an 80-year-old patient with rheumatoid arthritis sustained a fall resulting in a supracondylar femur fracture and proximal tibia fracture that were very similar to the current case. However, in that case, there was no femoral shaft fracture, and the distal femur did not sustain a sagittal split fracture. They treated the patient successfully with a revision stemmed modular revision total knee replacement.

Minimally invasive plate osteosynthesis is a general term referring to submuscular plate insertion through limited incisions, with an emphasis on minimal interruption of fracture blood supply in order to allow optimal rapid healing [5-7]. This technique is particularly applicable to periprosthetic fractures because of the epidemiology of these fractures in elderly patients with osteopenia and increased sensitivity to blood loss and secondary fluid shifts. It should be noted, however, that if preoperative radiography or intraoperative assessment demonstrates loosening of the implants from bone, revision of the implants with the appropriate long-stem prosthetic device may provide a more durable method of treatment.

The difficulties of achieving fixation of the distal fragment of the supracondylar fracture has been greatly aided with the use of locking plates, which permit flexible placement of the plate and engagement of the locking screws to achieve a fixed angle construct. We have used the locking condylar plate for this application as a result of its structural rigidity, the option to use a 7.3-mm locking screw, and the larger footprint relative to the femoral LISS (Synthes) plate, allowing optimal fixation of the small distal fragments encountered in these fractures. We have found that the cement that often extrudes into the distal femoral bone just proximal to the prosthesis provides a particularly robust fixation with the 7.3-mm locking screw.

The ipsilateral tibial plateau fracture below the tibial component required concomitant fixation due to the risk of displacement and to allow immediate knee rehabilitation. This fixation could be achieved with both locking and nonlocking plates. The tibial LISS plate was selected in order to optimize minimally invasive application and to minimize soft-tissue disruption of the fracture.

The value of the technique of ipsilateral femoral and tibial locking plate fixation is particularly apparent when one compares this treatment to the traditional alternative of open treatment of both fractures with nonlocking plates or revision to a segmental prosthesis. In our case, if a standard 95° dynamic condylar screw plate (Synthes) had been used, the passage of the lag screw would have been extremely difficult due to the short distal segment of bone on the femur. A 95° angled blade plate would have been another option, but the insertion of the chisel would have been obstructed by the cement in the distal femur and would have been associated with a decreased available number of screws in the distal portion of the plate. Furthermore, both the dynamic condylar screw plate and the blade plate would require an extensile lateral approach compared to that used in this case for the condylar locking plate. One particular benefit of locked plates as used in this case is the immediate rigidity they provide while allowing the intervening segmental fragment to be "bridged" without fixation. With this technique, no fixation was applied to the segmental fragment, facilitating healing with exuberant callus and the maintenance of its periosteal blood supply. This technique has been advocated by a number of authors [8-10]. This bridging technique proved to be particularly advantageous in managing the sagittal split in the distal femoral shaft. The alignment of the fragment is of no consequence as long as the distal fragment relationship relative to the mechanical axis of the femur is maintained. In this case, at final follow-up, the distal femoral articular angle (the angle between the distal condyles of the femoral prosthesis and the proximal femoral shaft) was a 90° leading or a 0° valgus angle. The preinjury radiographs were not available for our patient; however, most surgeons use an intramedullary alignment guide for the distal femoral cut and set the guide angle to between 5° and 7° valgus. At final follow-up, the angle between the tibial component and the mechanical axis of the tibia was 90°. This would be considered optimal based on the expected alignment of modern total knee arthroplasty. On the lateral view, at final follow-up, the femoral component is in 5° of flexion relative to the proximal femoral shaft. This is consistent with expected alignment after total knee arthroplasty using an intramedullary distal femoral cutting guide as a result of the anatomical bow of the femur.

If revision arthroplasty were selected as the treatment in this case, a long-stem distal femoral segmental oncological prosthesis may have been required because there was a displaced fracture of the distal femoral shaft with a sagittal split in the distal shaft fragment. Furthermore, fixation of the tibia would have required bypass of the fracture with a long-stem tibial component. Any of these scenarios would have the disadvantage of increased operative time, incision length, dissection, and blood loss.

In summary, locking plates are a valuable tool in the treatment of periprosthetic fractures. In this case of a "floating prosthesis" with an ipsilateral femoral shaft fracture, supracondylar periprosthetic femur fracture, and periprosthetic tibia fracture, the patient had a successful outcome with a low intraoperative blood loss, minimal incision length, low morbidity, rigid immediate fixation, complete fracture healing, and retention of components.

References

1. Figgie MP, Goldberg VM, Figgie III HE, et al. The results of treatment of supracondylar fracture above total knee arthroplasty. J Arthroplasty 1990;5:267.
2. Dennis DA. Periprosthetic fractures following total knee arthroplasty. Instr Course Lect 2001;50:379.
3. Firoozbakhsh K, Behzadi K, DeCoster TA, et al. Mechanics of retrograde nail versus plate fixation for supracondylar femur fractures. J Orthop Trauma 1995;9:152.
4. Jeong GK, Pettrone SK, Liporace FA, et al. "Floating total knee": ipsilateral periprosthetic fractures of the distal femur and proximal tibia after total knee arthroplasty. J Arthroplasty 2006;21:138.
5. Farouk O, Krettek C, Miclau T, et al. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique? J Orthop Trauma 1999;13:401.
6. Krettek C, Muller M, Miclau T. Evolution of minimally invasive plate osteosynthesis (MIPO) in the femur. Injury 2001;32(Suppl 3):SC14.
7. Schutz M, Muller M, Krettek C, et al. Minimally invasive fracture stabilization of distal femoral fractures with the LISS: a prospective multicenter study. Results of a clinical study with special emphasis on difficult cases. Injury 2001;32 (Suppl 3):SC48.
8. Mast J, Jakob R, Ganz R. Planning and reduction technique in fracture surgery. New York: Springer-Verlag; 1989.
9. Bolhofner BR, Carmen B, Clifford P. The results of open reduction and Internal fixation of distal femur fractures using a biologic (indirect) reduction technique. J Orthop Trauma 1996;10:372.
10. Huang HT, Huang PJ, Su JY, et al. Indirect reduction and bridge plating of supracondylar fractures of the femur. Injury 2003;34:135.