Indirect Reduction and Plate Fixation, without Grafting, for Periprosthetic Femoral Shaft Fractures About a Stable Intramedullary Implant

Surgical Technique

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INTRODUCTION
The treatment of periprosthetic femoral fractures must be individualized on the basis of the location of the fracture relative to the prosthesis, the stability of the prosthesis, and the presence or absence of associated bone loss. The technique described here is applicable to fractures of the femoral shaft that are at or near the tip of an intramedullary implant. Although the technique is most commonly used for fractures associated with hip arthroplasty stems, the operation has also been successfully applied to fractures about intramedullary nails and those about total knee arthroplasty femoral stems. Each of these situations poses similar technical challenges to the surgeon. The hallmark of the described technique is the application of modern biologic fracture fixation principles that minimize the soft-tissue disruption about the fracture and therefore maximize the healing potential. When these techniques are combined with use of a single lateral plate, a periprosthetic femoral fracture about a stable implant can be treated successfully without the use of adjuvant

ABSTRACT

BACKGROUND:
The application of indirect reduction techniques has improved fracture-healing and reduced the need for bone-grafting compared with the outcomes of older, direct reduction techniques. We investigated the results of such indirect reduction techniques for the treatment of periprosthetic femoral shaft fractures.

METHODS:
Fifty consecutive patients with a femoral shaft fracture about a stable intramedullary implant (a Vancouver Type-B1 fracture) were treated with a protocol that included open reduction with use of indirect reduction techniques and internal fixation with a single lateral plate without structural allografting or other bone-grafting. Four patients died in the early postoperative period, and five had inadequate follow-up. The remaining forty-one patients (average age, seventy-two years) were evaluated clinically and radiographically at an average of twenty-four months.
Patient Positioning

The patient is placed in either the supine or the lateral decubitus position on a radiolucent operating table. If the lateral position is utilized, radiolucent positioning aids such as a beanbag should be used. A fluoroscopy c-arm is positioned on the contralateral side (when the patient is supine) or toward the front of the patient (when the patient is in the lateral position). The ability to make bone-graft material.

RESULTS:

All fractures healed in satisfactory alignment at an average of twelve weeks (range, seven to twenty-three weeks) after the index procedure. One patient had one fractured cable and two others had one fractured screw, but all of the fractures healed without evidence of implant loosening or malalignment. There was one deep infection in the perioperative period.

CONCLUSIONS:

The results of this study support the use of indirect open reduction and internal fixation with a single extraperiosteal lateral plate, without the use of allograft struts, for the treatment of a femoral shaft fracture about a stable intramedullary implant.

Thirty of the forty-one patients returned to their baseline ambulatory status.

FIG. 1-A

This intraoperative photograph demonstrates the surgical approach used for fixation of a distal femoral shaft fracture about the tip of a long-stem revision femoral hip arthroplasty prosthesis. Note the surgical exposure proximal and distal to the fracture with preservation of the soft-tissue envelope about the fracture site.
anteroposterior and lateral radiographs of the entire femur is confirmed prior to preparation and draping. The fluoroscopy monitor is placed on the same side as the c-arm and near the foot of the table.

**Preparation and Draping**
Standard surgical preparation and draping are performed with care taken to allow access to the limb from the top of the ilium to the midpart of the calf. The affected extremity is draped free and, in general, a tourniquet is not used. However, for more distal exposure, a sterile tourniquet may be utilized and then removed.

**Exposure**
A straight lateral thigh incision is used for exposure of the lateral aspect of the femur. In some instances (usually when the fracture is comminuted), a skin bridge centered at the fracture site is intentionally maintained to help minimize inadvertent soft-tissue stripping at the site of the fracture (Fig. 1-A). The dissection is carried down to the iliotibial fascia with care used to minimize stripping of the fat from the fascia. The iliotibial fascia is incised parallel to its fibers. The fascia of the vastus lateralis is also incised parallel to its fibers, approximately 3 cm from its attachment to the intermuscular septum. The vastus lateralis muscle is carefully elevated from the posterior fascial flap and is retracted anteriorly. Perforating vessels are identified and ligated as needed. Meticulous deep soft-tissue dissection is used to minimize devascularization of bone.

Exposure is limited to the region necessary to apply and secure a plate proximal and distal to the fracture. Whenever possible, the muscle is left undisturbed in the region of the fracture and the plate is slid in an extraperiosteal plane deep to the muscle (Fig. 1-B). When direct access to the fracture is required, to remove entrapped soft tissue for example, care is taken to work through the fracture site rather than to strip muscle from around the bone.

**Plate Selection**
A broad large-fragment plate with offset holes or its equivalent is used for fixation. The plate should be of a length that allows it to overlap as much of the intramedullary implant as possible and extend beyond the region of

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**FIG. 1-B**
The plate is placed submuscularly, spanning the fracture site.
the implant by at least six, and preferably eight, holes. A plate that extends proximally enough to allow screws to be placed into the greater trochanter proximal to the cerclage wires placed in the zone of the intramedullary implant is beneficial in the treatment of a fracture around a primary hip arthroplasty stem (Figs. 2-A and 2-B). Also, when a fracture is associated with osteoporotic bone, care should be taken not to create a stress riser at the end of the plate. Therefore, a longer plate that ends near the end of the bone is preferable to one that ends in the metaphyseal zone. Newer locked plates may be advantageous to improve fixation in osteoporotic bone and to provide stable unicortical screw fixation in the zone of the intramedullary implant. The plate is contoured to accommodate the trochanteric and/or the distal metaphyseal flare as needed (Figs. 2-A and 2-B).

Plate Insertion, Fracture Reduction, and Plate Fixation
The plate is applied to the lateral aspect of the femur extraperiosteally (when possible) and is provisionally secured to the femur in the region of the implant with two cables (Fig. 3). With use of careful technique, the cables can be passed extraperiosteally through muscle without additional stripping of the muscle from the bone. The plate is then provisionally centered on, and...
secured to, the femur in the region without an intramedullary implant (native bone) with use of standard reduction clamps, provisional fixation pins, and/or cables. Provisional fixation pins are threaded self-drilling pins with a shoulder that is larger than the hole in the plate. They are inserted into bone unicortically through an empty hole in the plate. Tightening of the pin gently compresses bone to the plate (Fig. 4). Using these pins reduces the soft-tissue injury associated with use of clamps and cables. Adjustments of the plate contour may be required to optimize the coronal plane (varus-valgus) reduction. Manual manipulation of the limb (with the provisional plate fixation devices loosened) is used to obtain proper length, rotation, and sagittal plane alignment, which should be confirmed with fluoroscopy. Once a satisfactory reduction is confirmed, the

**CRITICAL CONCEPTS**

**INDICATIONS:**
The procedure is indicated for a periprosthetic femoral shaft fracture about a stable intramedullary implant.

**CONTRAINDICATIONS:**
- A periprosthetic fracture about an unstable implant, which usually requires revision of the intramedullary implant. The described technique can be applied after such a revision.
- A periprosthetic fracture associated with bone loss, which usually requires structural allografting to span the defect.
CRITICAL CONCEPTS | continued

PITFALLS:
- Inadvertent or excessive muscle stripping around the fracture site. This occurs most commonly in the treatment of simple spiral and oblique fractures. In these cases, the surgeon may feel compelled to obtain an anatomic reduction and may inadvertently strip a substantial amount of tissue from bone in the process. Taking care to work through the fracture plane and place reduction clamps through, rather than beneath, muscle can minimize such soft-tissue stripping. Soft-tissue stripping is easier to avoid when treating comminuted fractures, as restoration of limb length, alignment, and rotation is accomplished without necessarily reducing individual fracture fragments anatomically.
- The use of plates that are too short. The plate should be long enough to span nearly the entire length of the intramedullary implant. Protection of the entire length of native bone should be considered to help prevent a subsequent fracture associated with a stress riser at the end of a short plate.

provisional fixation devices are retightened. Then the plate is definitively secured to the native bone with standard screws and, in the region of the intramedullary implant, additional cerclage cables (Fig. 5). Usually, four, five, or six cables are required around the zone of the intramedullary implant, with the cables closest
to and farthest from the fracture being the most important. Additional unicortical screws, especially locked screws, placed in the zone of the intramedullary implant may further enhance fixation. Screw fixation in the native femur may include a combination of nonlocked and locked screws. When such a combination is used, the nonlocked screws should be inserted and tightened prior to the insertion of the locked screws. Locked screws are most effective when they are placed closest to and farthest from the fracture.

A slight modification of this technique can be useful for a simple spiral oblique fracture pattern. In such a case, a satisfac-
tory reduction and provisional fixation can often be accomplished with manual manipulation of the fracture and placement of one or two cables around the zone of the fracture. The plate is then placed over these initial cables, which can be either left under the plate or adjusted to be over the plate after fixation of the plate to the proximal and distal fracture fragments. This modification should not be used at the expense of a substantial increase in muscle stripping around the fracture site. As described above, cable placement can, and should, be accomplished with minimal soft-tissue stripping.

**POSTOPERATIVE PROTOCOL**

Active, active-assisted, and passive range-of-motion exercises are initiated immediately after the surgery. Weight-bearing is generally limited to toe-touch for six to ten weeks and then is advanced on the basis of clinical and radiographic evidence of healing.

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