Challenges in Subtrochanteric Femur Fracture Management

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Abstract: Subtrochanteric femur fractures present significant treatment challenges. The deforming muscle forces make fracture reduction difficult. Treatment options include cephalomedullary nailing and various types of plate fixation. There is a high rate of treatment complications, including malunion, delayed union, nonunion, and implant failure. [Orthopedics. 2015; 38(8):498-502.]

Subtrochanteric femur fractures have a bimodal age distribution. Younger patients sustain a subtrochanteric fracture as a result of a high-energy injury and typically they have associated traumatic injuries. Older patients often have advanced osteoporosis with deterioration of the calcar strength. In contrast, these fractures usually occur from a low-energy ground-level fall.

The subtrochanteric femur is a region of high stress, placing major demands on implants used for fixation. There are high compressive forces medially, and high tensile forces laterally. When there is medial comminution, the implant used for fixation is subjected to high bending load.

Compared with diaphyseal femoral shaft fractures, subtrochanteric femur fractures present significant treatment challenges. Failure to appreciate the complexities of this injury may lead to unplanned difficulties with fracture reduction and implant fixation. Deforming muscle forces often make fracture reduction challenging. The intense concentration of these deforming forces and the decreased vascularity of the region have been associated with a high rate of treatment complications, including malunion, delayed union, nonunion, and implant failure.

Definition of Subtrochanteric Fractures

Various descriptions have been provided for what constitutes a subtrochanteric femur fracture. One commonly accepted definition is that it includes fractures that involve the lesser trochanter and extend distally up to 5 cm. Other definitions include fractures from the lesser trochanter to the junction of the proximal and middle third of the femur. Subtrochanteric fractures may extend proximally to involve the piriformis fossa or distally into the isthmus of the femur.

Classification

Although several classification systems have been developed for subtrochanteric femur fractures, the classification system proposed by Russell and Taylor has probably seen the greatest popularity (Figure 1). The Russell-Taylor classification system focuses on the integrity of the piriformis fossa and thus the feasibility of using a piriformis entry intramedullary nail for fracture fixation. Russell-Taylor type I fractures do not have extension into the piriformis fossa, but type II fractures do. Each of these categories is subdivided into 2 groups. In type IA, the lesser trochanter is intact and these patterns...
Deforming muscle forces
to the lesser trochanter, flexing and externally rotating the proximal fragment. The short external rotators (ie, piriformis, superior and inferior gemellus) and the obturator internus also cause external rotation of the proximal fragment. The adductors attaching distally result in varus and shortening (Figure 2).

Closed reduction of the fracture in the supine position may require the use of a Schanz pin placed in the proximal fragment to counteract the flexion force. Even when performing an open reduction, correction of the flexion deformity of the proximal fragment can be difficult. Fracture reduction can often be more easily achieved in the lateral position because the distal fragment can be flexed up until it aligns with the proximal fragment.

Subtrochanteric fractures generally heal slower than intertrochanteric fractures. This slow rate of healing places additional demands on the implants. Failure to obtain an adequate reduction, or unnecessary periosteal and soft tissue stripping, may lead to nonunion and hardware failure (Figure 3). A cerclage wire or cable can aid in reduction of spiral or long oblique subtrochanteric fractures, but this potentially increases periosteal devascularization. When choosing to use a cerclage technique, the surgeon must balance the improvements in fracture reduction with the potential detrimental effects on the fracture site vascularity. Historically, adjunctive bone grafting was often used to avoid nonunions; however, contemporary indirect reduction techniques and appropriate soft tissue handling usually result in good outcomes without the need for bone grafting.

TREATMENT OPTIONS

95° Blade Plate
Prior to the development of reconstruction-type cephalomedullary nails, the 95° blade plate was the commonly recommended implant for the fixation of many subtrochanteric fractures. The need to precisely align the cutting blade in 3 planes makes this implant technically challenging. Yoo et al2 reported on 38 patients with subtrochanteric or reverse-obliquity-type fractures treated with the 95° blade plate. Union occurred at an average of 19 weeks. Com-
95° Condylar Screw

The 95° condylar screw, based on the 2-part design of the dynamic hip screw, was developed to decrease the difficulty of implant insertion (Figure 4). Pai reported on 16 subtrochanteric fractures with greater trochanteric extension treated using the AO dynamic condylar screw implant. Indirect reduction was used to avoid the need for bone grafting. The overall union rate was 93.7% (15 of 16), with 1 implant failure occurring following repeat trauma.

Locking Proximal Femur Plate

Development of locking plate technology has provided improved mechanical stability of plate fixation. The locking proximal femur plate was designed as an alternative to the blade plate for subtrochanteric fractures (Figure 5). Biomechanically, the locking proximal femur plate with a “kickstand” screw has been shown to provide more axial stiffness, less torsional stiffness, and equivalent irreversible deformation to cyclic axial loading when compared with an angled blade plate.

Saini et al reviewed 35 consecutive patients with comminuted subtrochanteric fractures treated with a locking proximal femur plate using an indirect reduction technique. Union was achieved in all cases at an average time of 16 weeks and there were no implant failures or nonunions. Complications included 2 delayed unions, 2 infections, 2 cases with shortening of 1 cm, and 1 external rotation malunion. In contrast, other authors have raised concerns regarding a high rate of failure of this implant even when surgery is performed by experienced and fellowship-trained traumatologists. Wirtz et al reported major complications in 7 of 19 patients treated with a locking proximal femur plate.

Piriformis Entry Cephalomedullary Reconstruction Nail

French and Tornetta reported on the use of a cephalomedullary nail for the treatment of 45 Russell-Taylor type IB subtrochanteric fractures. All patients achieved union, but 61% were noted to be reduced in some varus (5°-15°). They reported an intraoperative complication rate of 13.5% and 1 hardware failure in a patient who began weight bearing prematurely. While emphasizing the importance of careful intraoperative technique, they suggested that an interlocking cephalomedullary nail may be the implant of choice for stabilization of Russell-Taylor type IB fractures.

Trochanteric Entry Cephalomedullary Nail

Trochanteric entry nails have an apex-medial proximal bend that allows insertion in the greater trochanter rather than the piriformis fossa. Similar to cephalomedullary reconstruction nails, most trochanteric entry nails provide cephalomedullary-directed screws or blades that engage the femoral head and neck (Figure 6). Because the proximal intramedullary canal is larger than the nail diameter, some residual flexion deformity is often seen with both piriformis and trochanteric entry cephalomedullary nails (Figure 7).

Several studies have reported successful outcomes using trochanteric entry nails.
for both intertrochanteric and subtrochanteric fracture patterns.\textsuperscript{12-14} Robinson et al\textsuperscript{13} reported on 302 low-energy subtrochanteric femur fractures treated with a long Gamma nail (Stryker, Mahwah, New Jersey). They reported an 8.9% reoperation rate for implant-or fracture-related complications. Their patient population was primarily elderly, with a median age of 78.5 years. They noted a 1-year mortality rate of 24.5%, similar to other studies of elderly patients sustaining hip fractures. Starr et al\textsuperscript{15} compared trochanteric entry vs a periformis entry nail in a small series of younger patients sustaining high-energy proximal femur fractures. They found no difference in the surgeons’ perceived ease of reduction, surgical time, blood loss, or malunion rates. Muñoz-Mahamud et al\textsuperscript{16} reported on a retrospective review of 23 patients with subtrochanteric femoral fractures using a Long Trochanteric Fixation Nail (DePuy-Synthes, West Chester, Pennsylvania). They noted that implantation required more surgical time than the standard nails, but had significant complications in only 1 patient in whom the distal locking screw had migrated.

**Complications**

Delayed union or non-union is more common in subtrochanteric femur fractures than in diaphyseal femur fractures. Limited contact surface area, decreased vascularity, and high mechanical stresses have been identified as the reasons for impaired healing.\textsuperscript{2} Although modern implants have improved mechanical properties, loss of fixation and implant failure can occur following subtrochanteric femur fractures due to the high stresses and prolonged duration of healing.

As with all indirect reduction methods, when subtrochanteric fractures are treated with an intramedullary nail, there is a risk for femoral malrotation.\textsuperscript{16} When the lesser trochanter is intact, the iliopsoas externally rotates the proximal segment. This must be taken into account during intramedullary nailing to avoid malrotation.

Complications commonly seen following other lower extremity fractures, such as deep venous thrombosis and wound infection, appear to occur with a similar frequency in subtrochanteric femur fractures.

**CONCLUSION**

Deforming muscle forces make treatment of subtrochanteric fractures challenging, and surgeons must be prepared to use techniques to address these forces. Periosteal stripping should be avoided and optimal reduction obtained to minimize the risk for delayed union and nonunion, as these fractures are often slow to heal. Implants are exposed to high stresses and are at risk for fatigue failure when fracture healing is delayed.

**REFERENCES**

