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Intertrochanteric Fractures: Ten Tips to Improve Results

By George J. Haidukewych, MD

An Instructional Course Lecture, American Academy of Orthopaedic Surgeons

Intertrochanteric fractures are becoming increasingly common as our population ages. These fractures typically occur in frail patients with multiple medical comorbidities and often result in the end of the patient's functional independence. The all-too-often problematic dispositions and prolonged hospital stays result in a tremendous cost to patients, their families, and society. Effective treatment strategies that result in high rates of union of these fractures and low rates of complications are important. As orthopaedic surgeons, we cannot control the quality of the bone, patient compliance, or comorbidities, but we should be able to minimize the morbidity associated with the fracture. This requires choosing the appropriate fixation device for the fracture pattern, recognizing the problem fracture patterns, and performing accurate reductions with ideal implant placement while being conscious of implant costs. If we treat these fractures expeditiously, minimize fixation failures, and recognize underlying osteoporosis and treat it accordingly, we will improve our patients' outcomes and minimize the cost of treating them. The purpose of this review is to summarize ten simple tips to help minimize failures and improve outcomes when treating intertrochanteric fractures of the hip.

Tip 1: Use the Tip-to-Apex Distance

The tip-to-apex distance has been described by Baumgaertner et al.[1,2] as a useful intraoperative indicator of deep and central placement of the lag screw in the femoral head, regardless of whether a nail or a plate is chosen to fix the fracture (Fig. 1). This is perhaps the most important measurement of accurate hardware placement and has been shown in multiple studies to be predictive of success after the treatment of standard obliquity intertrochanteric fractures. Older theories about screw placement favored a low and occasionally a posterior position of the lag screw, thereby leaving more bone superior and anterior to the screw. This effectively lengthens the tip-to-apex distance and should be avoided. The ideal position for a lag screw in both planes is deep and central in the femoral head within 10 mm of the subchondral bone (Fig. 2)[3,4]. A tip-to-apex distance of <25 mm has been shown to be generally predictive of a successful result; however, most traumatologists aim for a tip-to-apex distance of <20 mm.

Tip 2: "No Lateral Wall, No Hip Screw"

Fractures that involve the lateral wall of the proximal part of the femur are, by definition, either reverse obliquity fractures or transtrochanteric fractures. These fractures do not have any lateral osseous buttress and therefore, if a sliding hip screw is used, medial translation of the femoral shaft and lateralization of the proximal femoral fragment can occur. This results in deformity, nonunion, and screw cutout (Fig. 3). In a series of cases that I reported on with my colleagues[5], there was a 56% failure rate when a sliding hip screw had been used for reverse obliquity fractures of the proximal part of the femur. Although devices with a trochanteric stabilizing plate, those with a proximal trochanteric flare, and those that allow axial compression and locking of the sliding hip screw (such as the

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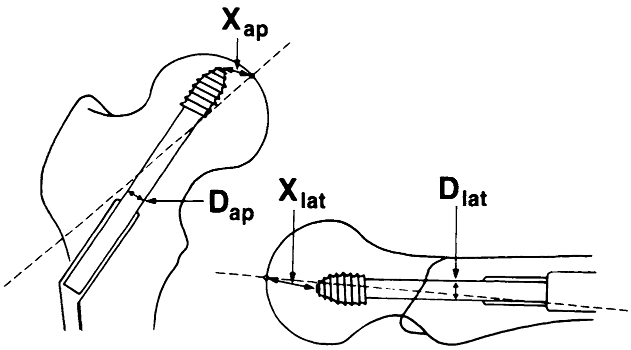

$$TAD = \left(X_{ap} \times \frac{D_{true}}{D_{ap}}\right) + \left(X_{lat} \times \frac{D_{true}}{D_{lat}}\right)$$

Fig. 1

Technique for calculating the tip-to-apex distance (TAD). For clarity, a peripherally placed screw is depicted in the anteroposterior (ap) view and a shallowly placed screw is depicted in the lateral (lat) view. D_{true} = known diameter of the lag screw. (Reprinted from: Baumgaertner MR, Curtin SL, Lindskog DM, Keggi JM. The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. J Bone Joint Surg Am. 1995;77:1059.)

Medoff device) are reported to have reasonably good results, I adhere to the belief that if there is no lateral wall a hip screw should not be used[3-9]. Locking plates and 95° condylar blade-plates may function as prosthetic lateral cortices, but the results of using these devices for more problematic fractures of the proximal part of the femur are not available[9-11]. Intramedullary nails seem to be superior to dynamic condylar screws for reverse obliquity fractures, but I am not aware of any comparative study of intramedullary nails and proximal femoral locking plates.

Tip 3: Know the Unstable Intertrochanteric Fracture Patterns, and Nail Them

There are four classic intertrochanteric fracture patterns that signify instability. When internally fixed, the osseous fragments of these unstable fractures are not able to share the weight-bearing loads, and therefore the loads are predominantly borne by the internal fixation device. The unstable patterns include reverse obliquity fractures, transtrochanteric fractures, fractures with a large posteromedial fragment implying loss of the calcar buttress, and fractures with subtrochanteric extension (Figs. 4 through 7)[3-5,9,12-16]. These fractures, in general, should be treated with an intramedullary nail because of the more favorable biomechanical

Fig. 2

Fig. 3

Fig. 2 Excellent reduction and deep, central placement of the lag screw in the femoral head. **Fig. 3** Failed fixation of a reverse obliquity fracture with lateralization of the proximal fragment and screw cutout.

Fig. 4

Fig. 5

Fig. 4 A reverse obliquity fracture. **Fig. 5** A transtrochanteric fracture.

properties of an intramedullary nail compared with a sliding hip screw. An intramedullary nail is located closer to the center of gravity than is a sliding hip screw, and therefore the lever arm on the femoral fixation is shorter. Intramedullary nails can more reliably resist the relatively high forces across the medial calcar that are typically borne by the implant in an unstable fracture. The intramedullary position of the implant also prevents shaft medialization, which

Fig. 6

Fig. 7

Fig. 6 A four-part fracture with a large posteromedial fragment. **Fig. 7** A fracture with subtrochanteric extension.

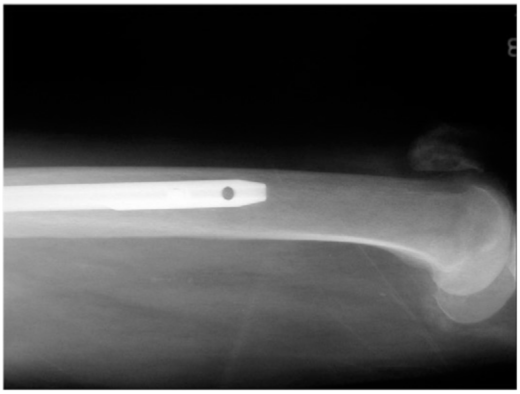

Fig. 8
A straight nail inserted into a bowed femur. Vigorous impaction or a bow mismatch may lead to perforation of the distal anterior femoral cortex.

is a common complication associated with the transtrochanteric and reverse obliquity fracture patterns. Recognizing the unstable patterns preoperatively and choosing to use an intramedullary nail decrease the risk of fixation failure. A simple fracture of the lesser trochanter does not, in itself, automatically imply an unstable fracture, as many three-part and four-part fractures can include a small, relatively unimportant fracture of the lesser trochanter and yet have a primary fracture line that will tolerate compression well. It is not known how large the posteromedial fragment must be to be mechanically important. When there is doubt about the status of the calcar, however, an intramedullary nail is preferable to a sliding hip screw.

Tip 4: Beware of the Anterior Bow of the Femoral Shaft

As a person ages, the femoral diaphysis enlarges and the femoral bow increases[17]. Most commercial intramedullary nails have gradually evolved into a more bowed design, and many of them now have a radius of curvature of <2 m. The concern with using a straight intramedullary nail in a bowed osteopenic femur is that the nail can impinge on, and in some cases even perforate, the anterior femoral metaphyseal cortex distally (Fig. 8). Additionally, when the nail hugs the anterior femoral cortex, any locking screws placed in the distal part of the femur may cause a stress riser in this area, which may lead to a fracture in the postoperative rehabilitation period. It is wise to know the radius of curvature of your particular device, and ideally it should be ≤2 m. Most commercially available intramedullary nails have a radius of curvature of between 1.5 and 2.2 m. It is also important to recognize that, if resistance is encountered during insertion of a long intramedullary nail for fixation of an intertrochanteric fracture, the surgeon should obtain a lateral radiograph of the distal part of the femur rather than trying to impact the device with a hammer. Hammering in a long intramedullary nail that is impinging on the anterior cortex can produce an iatrogenic fracture.

Tip 5: When Using a Trochanteric Entry Nail, Start Slightly Medial to the Exact Tip of the Greater Trochanter

The patient's soft-tissue mass, the operative drapes, the trajectory of the reamer insertion and of the reaming, and the nail insertion can gradually enlarge the pilot hole in the greater trochanter laterally. This enlargement leads to more lateral placement of the intramedullary nail than intended. In turn, this can result in a varus reduction of the proximal fragment or a high lag-screw position in the femoral head, both of which are undesirable. I recommend a starting point that is slightly medial to the exact tip of the trochanter (Fig. 9)[18]. The starter reamer is used while it is observed with fluoroscopy, and subsequent reaming is performed very carefully. Use of the reamers should not be started until they are well contained in the proximal part of the femur. This avoids any gradual lateral enlargement of the pilot hole.

Tip 6: Do Not Ream an Unreduced Fracture

In sharp contradistinction to diaphyseal fractures of the femur, which may be reamed in a position that is not necessarily well reduced because the interference fit in the diaphysis aligns the fracture as the intramedullary nail is passed, a misaligned intertrochanteric fracture cannot be reduced simply by passing the intramedullary nail across it. The intertrochanteric fracture should be reduced to an aligned position before reaming and passing of the intramedullary nail. One must remember that the way that these fractures look during reaming will not change after the nail has been inserted.

It is not possible to make a starting point in the proximal fragment and then manipulate this fragment with a reduction tool or even the intramedullary nail because the bone is too soft and the medullary canal is too large. I recommend obtaining good muscle relaxation and then performing a gentle closed reduction with the patient on a fracture table while observing the fracture with fluoroscopy. If reduction cannot be obtained by closed means, then some form of percutaneous or mini-open reduction is recommended. A bone-hook placed along the lesser trochanter, or even percutaneous joysticks or clamps, can be used to reduce the fragment without the need for substantial periosteal stripping or evacuation of the fracture hematoma (Figs. 10, 11, and 12). The fragment can then be reamed and the intramedullary nail can be inserted.

Tip 7: Be Cautious About the Nail Insertion Trajectory, and Do Not Use a Hammer to Seat the Nail

It is important to achieve a vertical trajectory with nail insertion. This can

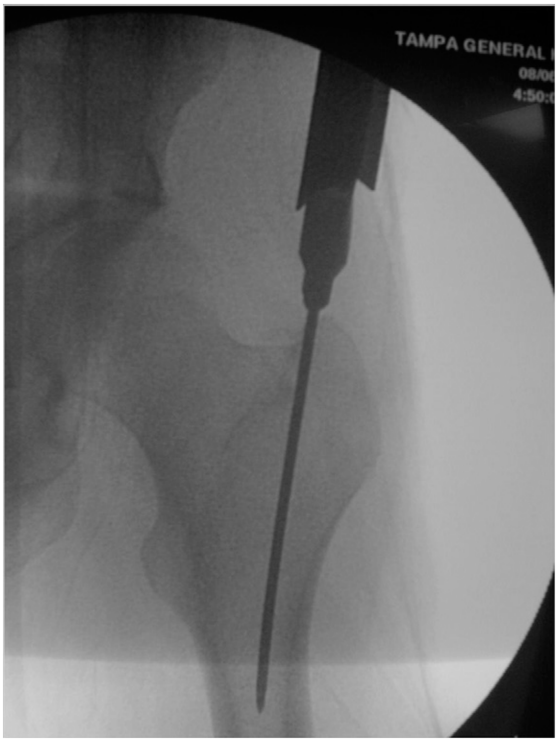

Fig. 9

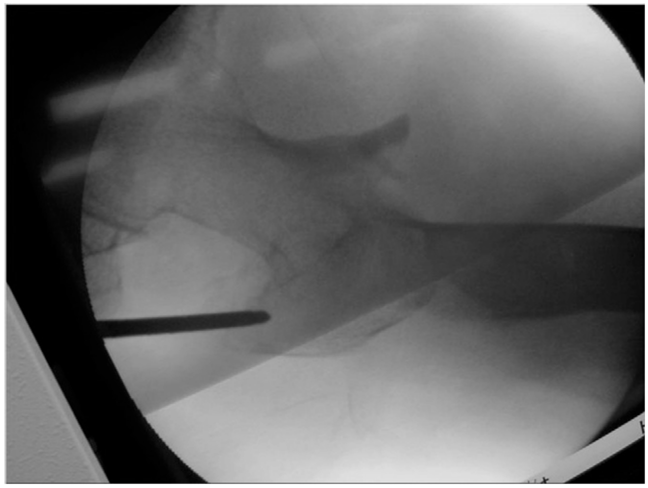

Fig. 10

Fig. 9 The ideal starting point is slightly medial to the exact tip of the greater trochanter. Note the good position of the guidewire distally.

Fig. 10 An unreduced fracture will not reduce with nail passage because of the capacious metaphysis in most patients with osteopenia.

be difficult in obese patients. Even if care was taken with the starting point and the subsequent reaming, if the intramedullary nail is inserted at an oblique angle, the nail itself can impact the relatively soft bone of the lateral aspect of the greater trochanter and lead to a relatively oval entry point and a lateral position of the intramedullary

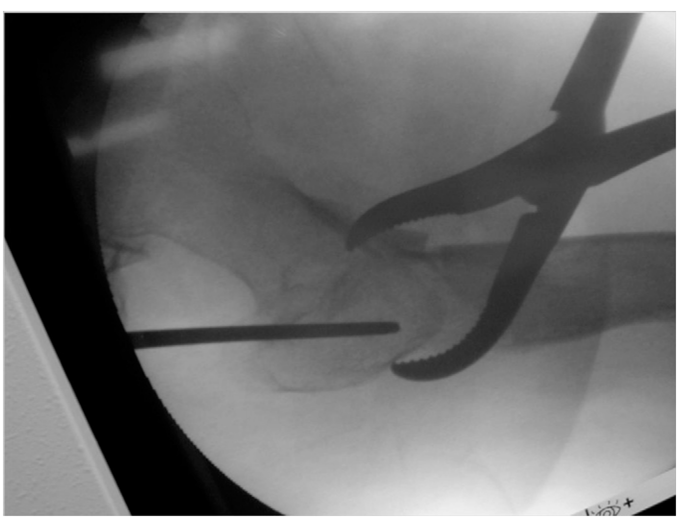

Fig. 11

Fig. 12

Fig. 11 Reduction has been achieved with a clamp placed through a small lateral incision. **Fig. 12** Use of a clamp to reduce a fracture with a subtrochanteric extension. Clamps can be inserted without evacuation of the fracture hematoma and with minimal soft-tissue disruption.

Fig. 13

Fig. 14

Fig. 13 A well-aligned fracture. Note the central position of the lag screw in the femoral head. **Fig. 14** Radiograph showing the relationship between the tip of the greater trochanter and the center of the femoral head. Normally, this relationship is coplanar. Here, the proximal fragment is in varus, the starting point is lateral, and the screw is high in the head.

nail in the proximal fragment. It is critical that the nail be inserted by hand with slight rotational motions. A hammer is not recommended since its use can lead to iatrogenic femoral fracture. It is safe to tap the jig with a mallet for the final seating, since this is an easy way to fine-tune the final position of the intramedullary nail. The mallet should not be used when difficulty is encountered when inserting the intramedullary nail by hand. The variety of diameters at the distal end and valgus angles at the proximal end of modern intramedullary nail systems have decreased the frequency of iatrogenic femoral fractures[19]. It is still important to realize that, if a hammer is needed to advance the nail (as opposed to simply tapping it in a few final millimeters), there is a problem. The femoral shaft may need to be reamed further to prevent nail incarceration (this is not uncommon in younger patients) or there may be impingement on the anterior femoral cortex with a mismatch between the bows of the femur and the intramedullary nail. The cause of the difficulty should be identified and corrected because the intramedullary nail should be passed by hand. I ream the intramedullary canal to a diameter that is 1 mm larger than the diameter of the selected intramedullary nail, and I ensure that the starter reamer has been inserted to the recommended depth. This prevents the funnel shape of the proximal nail from impinging on the endosteum proximally and preventing final seating.

Tip 8: Avoid Varus Angulation of the Proximal Fragment—Use the Relationship Between the Tip of the Trochanter and the Center of the Femoral Head

Varus angulation of the proximal fragment increases the lever arm on the fixation since it makes the femoral neck more horizontal and therefore functionally longer when body weight is applied. This also results in the femoral head fixation being placed more superiorly in the head than is ideal and increases the risk of the device cutting out of the femoral head. It can be difficult to determine the appropriate femoral neck-shaft angle in a patient with an intertrochanteric fracture. When using an intramedullary nail for fixation of an intertrochanteric fracture, most surgeons choose a nail with a 130° neck-shaft configuration (Figs. 13 and 14). It is important to know the neck-shaft angle of the device that is being used. One way to assess varus or valgus position during surgery is to look at the relationship between the tip of the greater trochanter and the center of the femoral head. These two points should be coplanar. If the center of the femoral head is distal to the tip of the greater trochanter, the reduction is in varus. If the center of the head is proximal to the greater trochanter, the reduction is in valgus. Preoperative plain radiographs of the uninjured hip can be used to assess the patient's normal neck-shaft angle as the two sides are normally symmetric. Varus and high lag-screw placement are associated with an in-

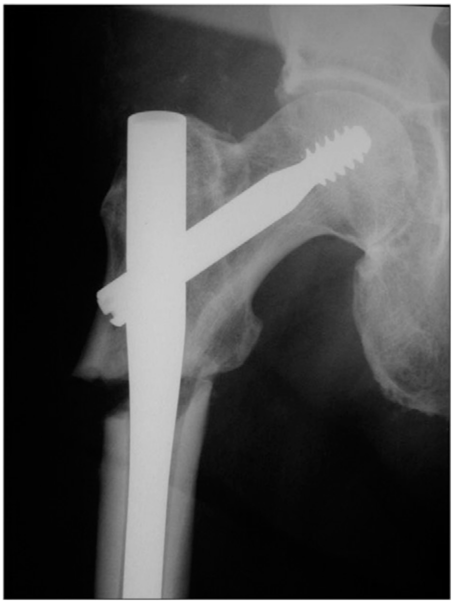

Fig. 15

Fig. 16

Fig. 15 A fracture locked in distraction. Note the typical lateral starting point and the high hip-screw placement.

Fig. 16 Distracted fractures in varus can result in high loads on the implant, causing nail fracture, typically through the aperture for the lag screw.

creased frequency of failure of fixation with an intramedullary nail and sliding hip screw[20,21].

Tip 9: When Nailing, Lock the Nail Distally if the Fracture Is Axially or Rotationally Unstable

Most unstable fractures of the proximal part of the femur require a long intramedullary nail. If there is any question about the stability of a fracture, then a long nail should be chosen and, in most instances, it should be locked distally[15,22-24]. Although short nails may be used for minimally displaced or nondisplaced fractures or very stable patterns, they can be associated with a subsequent fracture in the subtrochanteric area. Although most modern short-nail designs have smaller-diameter locking screws in this high-stress area to prevent the fractures that were encountered with the older, large-diameter locking-screw designs, it is probably wise to protect the length of the femur and choose a long nail. Using a long internal fixation device to protect the entire bone is a common principle for treating a pathologic fracture of bone caused by metastatic disease, and I believe that it is wise to consider most fragility fractures in elderly patients to be pathologic fractures; in addition, this patient population has a propensity for falls, increasing their risk of subsequent fractures.

Tip 10: Avoid Fracture Distraction When Nailing

When nails are used for fractures with a transverse or reverse oblique configuration, it is not uncommon for the fracture to be either malrotated or distracted (Fig. 15). If a fracture is locked in distraction, osseous contact that can accept some of the load with weight-bearing does not occur and the device must withstand all of the forces associated with the activities of daily living. Fractures that are internally fixed in distraction are at risk for nonunion and eventual hardware failure. The nail breaks through its weakest point, which is the large aperture in the nail for the lag screw (Fig. 16). To eliminate distraction, the traction on the lower limb should be released during surgery prior to insertion of the distal locking screws and fluoroscopy should be used to confirm that there is bone-on-bone contact.

Recent Trends

Intramedullary nail fixation has become more common, even for fractures that are stable or nondisplaced[25]. Intramedullary nails should probably not be used for these simpler types of fractures, and it is probably better to choose sliding hip screws for relatively simple patterns and basicervical patterns. Fixation of a stable or minimally displaced fracture with a sliding hip screw is acceptable, and the complication rate and costs are less. Meta-analyses have demonstrated that the rates of iatrogenic fracture with >intramedullary nailing have improved over time, and the risk of femoral shaft fracture with nail insertion has decreased dramatically[19]. This is probably a reflection of the use of modern intramedullary nails with smaller diameters, smaller-diameter locking screws, and less acute proximal valgus angles of the proximal nail as well as the realization that aggressive impaction should be avoided in the nailing of these fractures.

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