Intertrochanteric fractures: 10 tips to improve results

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Intertrochanteric hip fractures are among the most common types of fractures, and their numbers are increasing as the population ages. Most intertrochanteric fractures are treated surgically. It is therefore important that the treatment methods are effective and have minimal risk of complications. The goals of treatment include a predictable union, unrestricted early weight bearing, and avoidance of fixation failure or excessive deformity of the proximal femur. Careful attention to the fracture pattern (obliquity or other hallmarks implying instability) can guide fixation device selection. Regardless of the device, accurate reduction and implant placement are important for a good outcome.

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Introduction

Intertrochanteric hip fractures are becoming increasingly common as the population ages. These fractures typically occur in frail patients with multiple medical comorbidities and often result in loss of the patient's functional independence. The all-too-often problematic dispositions and prolonged hospital stays prove very expensive to the 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. Orthopedic surgeons cannot control the quality of the bone, patient compliance, or comorbidities, but they should be able to minimize the morbidity associated with the fracture. Doing so requires choosing the appropriate fixation device for the fracture pattern, recognizing the problematic fracture patterns, and performing accurate reductions with ideal implant placement, while being conscious of implant costs. If these fractures were treated expeditiously, fixation failures minimized, and underlying osteoporosis recognized and treated accordingly, the patient outcomes will improve and the cost of treatment will decrease. The purpose of this review is to summarize 10 simple tips to help minimize failures and improve outcomes when treating intertrochanteric fractures.

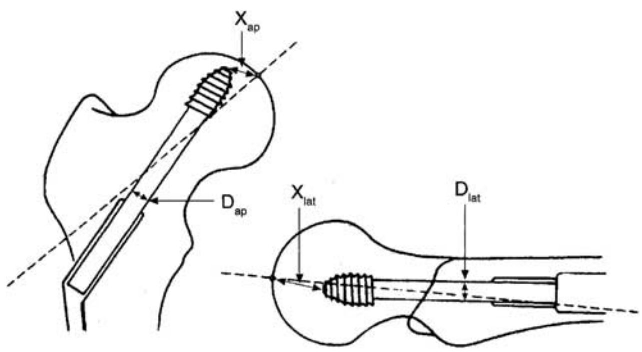
Tip 1: use the tip-to-apex distance

The tip-to-apex distance has been described by Baumgaertner and colleagues [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 position effectively increases 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 [3,4] (Fig. 2). A tip-to-apex distance of less than 25 mm has been shown to be generally predictive of a successful result; however, most traumatologists aim for a tip-to-apex distance of less than 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 buttresses, and, therefore, if a sliding hip screw is used, medial translation of the femoral shaft and lateralization of the proximal femoral fragment

Figure 1



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

The 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. Reproduced with permission from Baumgaertner *et al.* [1].

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Figure 2

Radiograph showing excellent reduction and deep, central placement of the lag screw in the femoral head.

Figure 3

Radiograph showing failed fixation of a reverse obliquity fracture with lateralization of the proximal fragment and screw cutout.

Figure 4

Radiograph showing a reverse obliquity fracture.

can occur. The result is deformity, nonunion, and screw cutout (Fig. 3). Haidukewych *et al.* [5] found 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 Medoff device) are reported to yield reasonably good results, a hip screw should not be used if there is no lateral wall [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; however, comparative studies on intramedullary nails and proximal femoral locking plates are not available.

Tip 3: know the unstable intertrochanteric fracture patterns and nail them

There are four classic intertrochanteric fracture patterns that signify instability. When fixed internally, 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,

Figure 5

Radiograph showing a transtrochanteric fracture.

Figure 6

Radiograph showing a four-part fracture with a large posteromedial fragment.

transtrochanteric fractures, fractures with a large posteromedial fragment implying loss of the calcar buttress, and fractures with subtrochanteric extension [3–5,9,12–16] (Figs 4–7). These fractures, in general, should be treated with an intramedullary nail because of the more favorable biomechanical 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 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 in 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 in 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. However, when there is doubt about the status of the calcar, an intramedullary nail is preferred over a sliding hip screw.

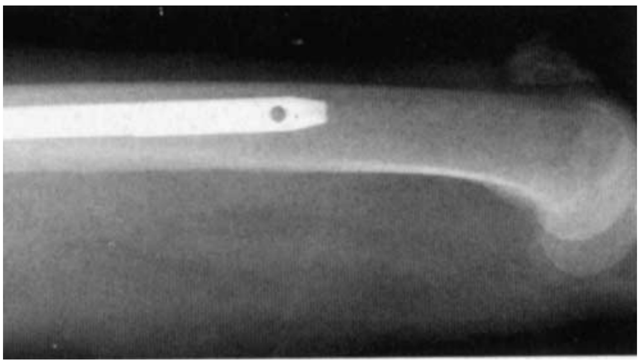
Tip 4: beware of the anterior bow of the femoral shaft

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 less than 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). In addition, 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 during the postoperative rehabilitation period. It is wise to know the radius of curvature of the particular device, which ideally should be no more than 2 m. Most commercially available intramedullary nails have a radius of curvature 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 try to impact the device with a hammer. Hammering in a long intramedullary nail that is impinging on the anterior cortex can lead to an iatrogenic fracture.

Figure 7

Radiograph showing a fracture with a subtrochanteric extension.

Figure 8

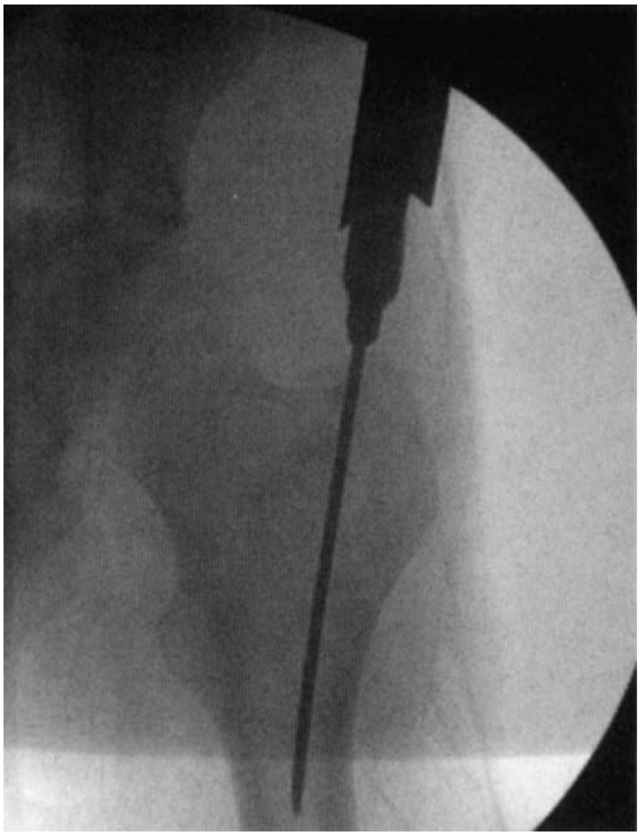


Radiograph showing a straight nail inserted into a bowed femur. Vigorous impaction or a bow mismatch may lead to perforation of the distal anterior femoral cortex.

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 surgical drapes, the trajectory of reamer insertion and reaming, and 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. This in turn 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. A starting point slightly medial to the exact tip of the trochanter is recommended [18] (Fig. 9). 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.

Figure 9

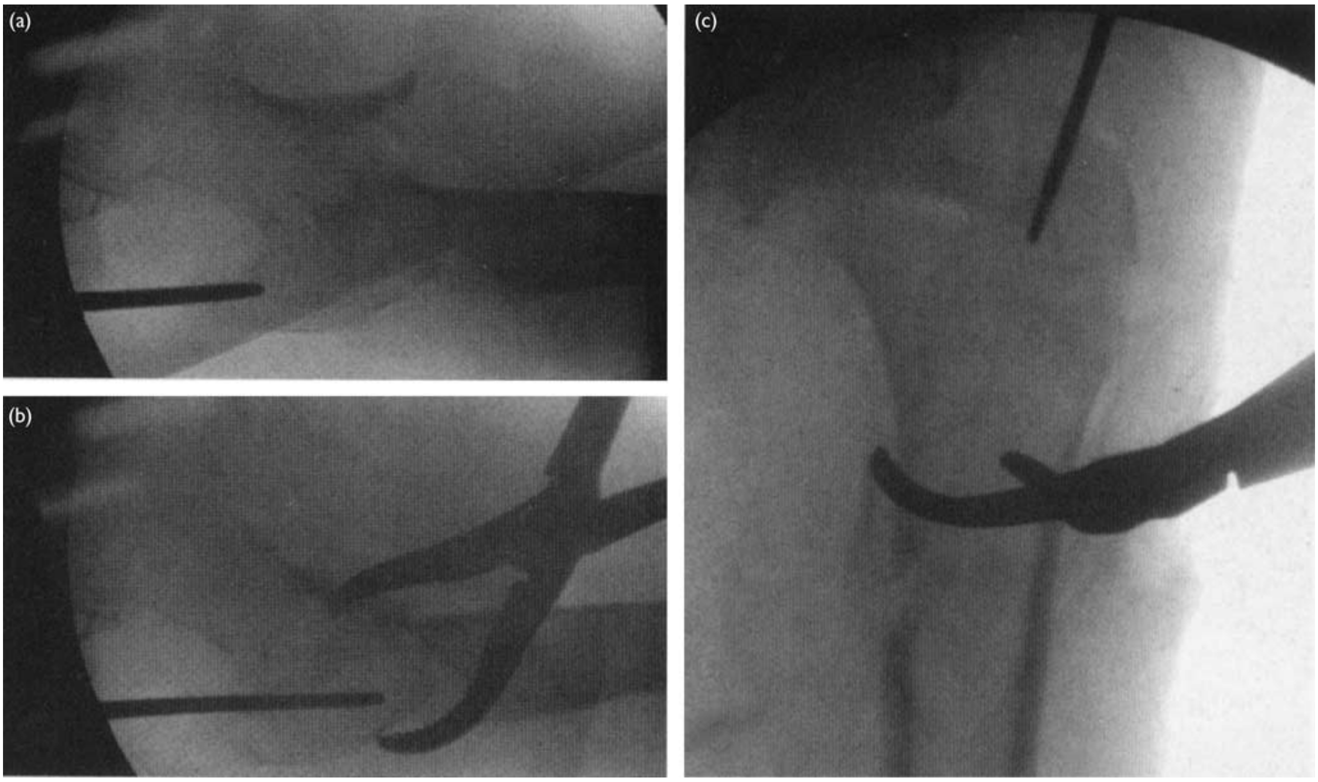


A fluoroscopic image showing the ideal starting point slightly medial to the exact tip of the greater trochanter. Note the good position of the guidewire distally.

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 by simply 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.

Figure 10



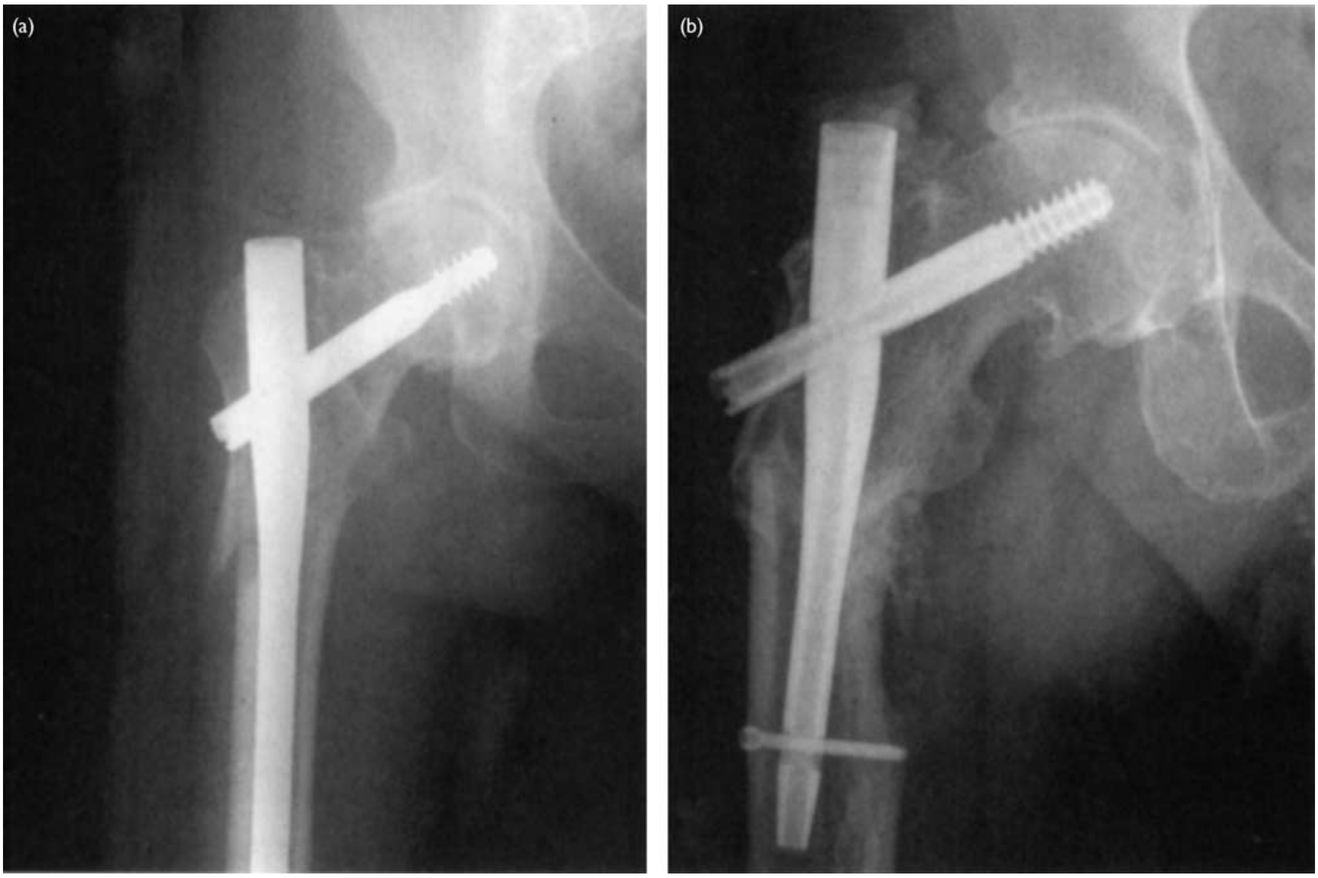
Fluoroscopic images of an unreduced fracture. (a) An unreduced fracture cannot be reduced with nail passage because of the capacious metaphysis typically found in most patients with osteopenia. (b) Reduction has been achieved with a clamp placed through a small lateral incision. (c) A clamp is used to reduce a fracture with a subtrochanteric extension. Clamps can be inserted without evacuation of the fracture hematoma and with minimal soft tissue disruption.

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. Obtaining good muscle relaxation and then performing a gentle closed reduction with the patient on a fracture table while observing the fracture with fluoroscopy is recommended. If reduction cannot be obtained by a closed means, some form of percutaneous or miniopen 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 (Fig. 10). 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 during nail insertion. This can be difficult in obese patients. Even when care is taken with the starting point and 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 lateral positioning of the intramedullary nail in the proximal fragment. It is critical that the nail be inserted by hand with a slight rotational motion. A hammer is not recommended because its use can lead to an iatrogenic femoral fracture. It is safe to tap the jig with a mallet for the final seating; this is an easy way to fine tune the final position of the intramedullary nail. The mallet should not be used if 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 inserted by hand. The suggested procedure is to ream the intramedullary canal to a diameter that is 1 mm larger than the diameter of the selected intramedullary nail and to 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.

Figure 11



Radiographs of an intertrochanteric fracture. (a) A well-aligned fracture. Note the central position of the lag screw in the femoral head. (b) The relationship between the tip of the greater trochanter and the center of the femoral head is shown. 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.

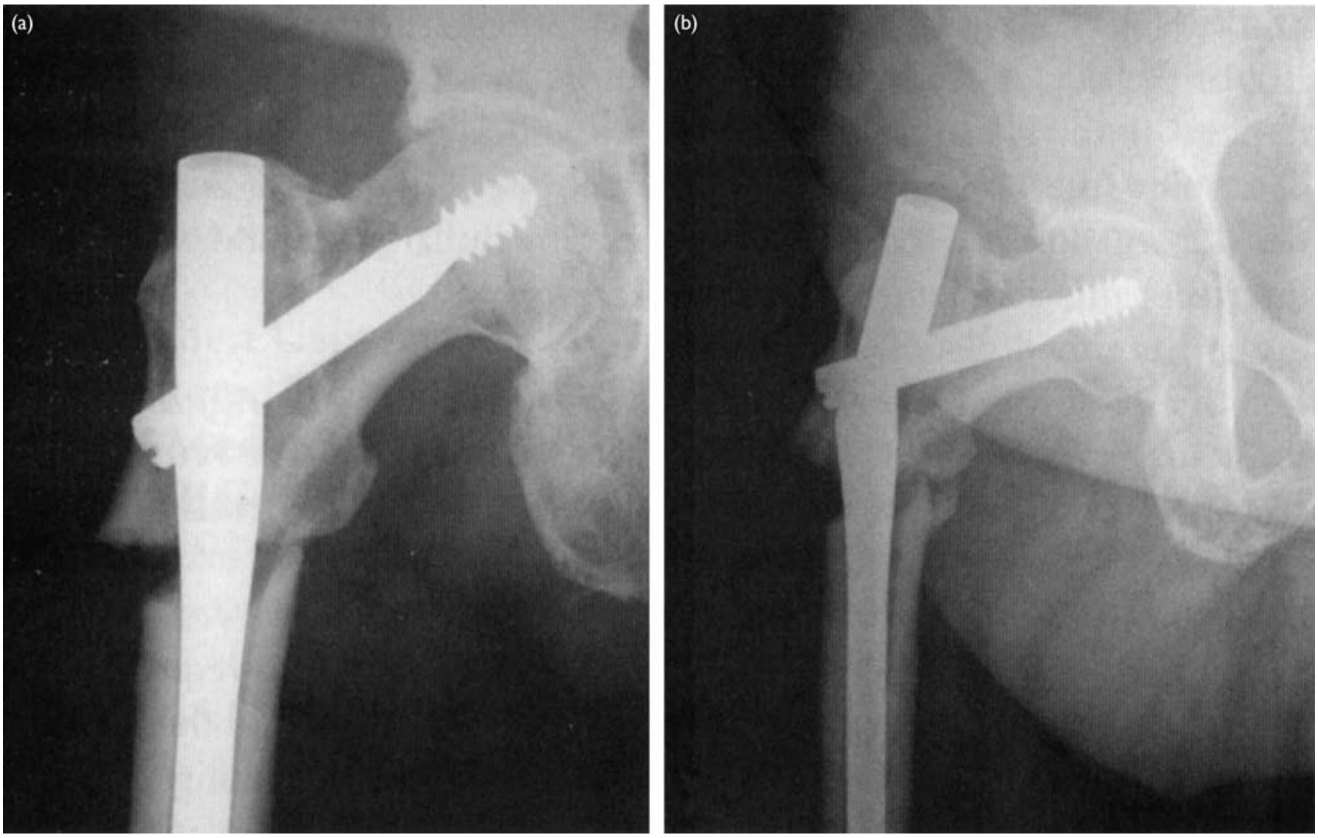
Tip 8: avoid varus angulation of the proximal fragment: use the relationship between the tip of the trochanter and the center of the femoral head

Varus angulation of the proximal fragment increases the lever arm length on the fixation because 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 (Fig. 11). 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 because the two sides are normally symmetric. Varus and high lag-screw placement are associated with an increased 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, a long nail should be chosen and, in most instances, 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 the bone caused by metastatic disease, and it is wise to

Figure 12



Radiographs showing a fracture locked in distraction. Note the typical lateral starting point and the high hip-screw placement (a). Distracted fracture in varus can result in high loads on the implant, causing nail fracture, typically through the aperture for the lag screw (b).

consider most fragility fractures in elderly patients to be pathologic. In addition, these patients have a propensity for falls, increasing their risk for 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. 12a). 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. 12b). To eliminate distraction, the traction on the lower limb should be released during surgery before insertion of the distal locking screws, and fluoroscopy should be used to confirm whether there is bone-on-bone contact.

Summary

Most intertrochanteric hip fractures are treated surgically. Intramedullary nail fixation has become more common, even for fractures that are stable or nondisplaced [25]. Intramedullary nails probably should not be used to treat 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 fractures managed with intramedullary nailing have improved over time, and the risk of management of femoral shaft fractures 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 of the realization that aggressive impaction should be avoided during the nailing of these fractures.

Acknowledgements

Conflicts of interest

Dr Haidukewych or an immediate family member serves as a board member, owner, officer, or committee member of the Florida Orthopaedic Institute; has received royalties from DePuy and Zimmer; is a member of a speakers' bureau or has made paid presentations on behalf of DePuy; serves as a paid consultant to or is an employee of DePuy and Surmodics; has received research or institutional support from DePuy; and has stock or stock options held in Surmodics.

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