Hip Fractures: II. Evaluation and Treatment of Intertrochanteric Fractures

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Abstract

Surgical stabilization followed by early mobilization is the treatment of choice for both nondisplaced and displaced intertrochanteric fractures. Fracture stability is dependent on the status of the posteromedial cortex. The sliding hip screw is the device mostly commonly used for fracture stabilization. The most important aspect of its insertion is secure placement within the femoral head. Although the sliding hip screw allows postoperative fracture impaction, it is essential to obtain an impacted reduction at the time of surgery. If there is a large posteromedial fragment, an attempt should be made to internally fix the fragment with a lag screw or cerclage wire. Although intramedullary hip screws have not been shown to be superior to the sliding hip screw, they may have selected indications.

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Intertrochanteric hip fractures represent almost half of all fractures of the proximal femur. Like femoral-neck fractures, they occur with greatest frequency in the geriatric population. Although the evaluation, management, and complications differ somewhat from those of femoral-neck fractures, it is important to recognize the similarities of the patients—elderly, often frail, with multiple preexisting medical and psychosocial problems. Management of the fracture must be guided by the context of the patient in which it occurs, with a primary focus on functional recovery of the preinjury status.

Anatomy

The intertrochanteric region is extracapsular and includes the greater and lesser trochanters and the transitional bone between the femoral neck and the femoral shaft. This region is primarily made up of dense trabecular bone, which transmits and distributes stresses and provides insertion for some of the important gluteal muscles, the rotator muscles, and the psoas. The calcar femorale is a vertical wall of dense bone that extends from the posteromedial aspect of the femoral shaft to the posterior portion of the femoral neck. It forms an internal trabecular strut within the inferior portion of the neck and intertrochanteric region and acts as a strong conduit for stresses. Fortunately, the cancellous bone in this area is well vascularized, and nonunion and osteonecrosis are rarely encountered following intertrochanteric fractures.

Epidemiology

Intertrochanteric fractures occur with approximately the same frequency as femoral-neck fractures in patients with similar demographic characteristics. The incidence increases with aging in both sexes. Early reports indicated that patients who suffered intertrochanteric fractures were approximately 10 years older than patients with femoral-neck fractures. However, more recent reports have shown this not to be true. The reported female-male ratio for this injury ranges from 2:1 to 8:1. Mortality rates for patients with intertrochanteric fractures are comparable with those reported for femoral-neck fractures, ranging from 14% to 50% within the first year of injury.

Mechanism of Injury

Intertrochanteric fractures occur as a result of direct or indirect forces, usually due to a fall on the trochanter or twisting of the lower extremity.

Classification

Of the many classification systems devised for intertrochanteric hip

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fractures, the most commonly used is that introduced by Evans in 1949. His system is based on the stability of the fracture pattern and the ability to convert an unstable fracture to a stable reduction.[1] He recognized that the key to a stable reduction is restoration of posteromedial cortical continuity. In stable fracture patterns, the posteromedial cortex remains intact. Unstable fractures are characterized by comminution of the posteromedial cortex in the area of the calcar femorale. These fractures are inherently unstable, but can be converted to a stable reduction if medial cortical opposition is obtained. Evans also recognized the reverse-obliquity pattern as being inherently unstable because of the tendency for medial displacement of the shaft.

Evans' system was important because it not only differentiated stable and unstable fracture patterns, but also helped define the characteristics of a stable reduction. However, later clinical studies have documented poor reproducibility using the Evans classification.[2] Therefore, it may be better to classify intertrochanteric fractures as either stable or unstable, depending on the status of the posteromedial cortex. Unstable fracture patterns include fractures with comminution of the posteromedial cortex (Fig. 1), intertrochanteric fractures with subtrochanteric extension, and reverse-obliquity fractures (i.e., fractures characterized by an oblique fracture line extending from the medial cortex laterally and slightly distally).

Fig. 1 Unstable intertrochanteric hip fracture with a large posteromedial fragment.

Treatment

Operative management is the treatment of choice for both nondisplaced and displaced intertrochanteric hip fractures. The surgical goal is to achieve and maintain a stable fracture reduction to allow early patient mobilization. Since non-weight-bearing or partial weight-bearing ambulation is difficult for the elderly, the fracture fixation should allow ambulation with weight-bearing as tolerated. Achieving this goal is dependent on a number of factors, including the fracture pattern, the stability of the reduction, and the method of fixation.

A number of implants have been used for the stabilization of intertrochanteric fractures. The first group of implants to be used successfully were the fixed-angle nail-plate devices, such as the Jewett nail. These consisted of a triflanged nail fixed to a plate at angles varying from 130 to 150 degrees. Although these devices provided fixation of the proximal fragment and fixation to the shaft, they did not allow fracture impaction. If later postoperative fracture impaction occurred, the nail penetrated into the hip joint or "cut out" through the superior portion of the head. If impaction did not occur and there was lack of bone contact, increased loads on the device often resulted in either breakage of the device at the nail-plate junction or separation of the plate and screws from the shaft, particularly in unstable fractures. Use of stronger devices, such as the Holt nail, reduced some of these complications. The unacceptable complication rate with unstable fractures resulted in the development of different reduction techniques designed to restore the posteromedial buttress, including the Hughston-Dimon medial displacement osteotomy, the Sarmiento valgus osteotomy, and the Wayne County lateral- displacement reduction.[3-5]

The experience with fixed-angle nail-plate devices clearly indicated the need for a device that allowed controlled fracture impaction. This gave rise to sliding nail-plate devices (Massie nail, Ken-Pugh nail); these consisted of a nail that provided fixation in the proximal fragment and a side plate and barrel that allowed the nail to telescope within the barrel. This mechanism allowed controlled fracture impaction. Impaction provided bone-on-bone contact, which encouraged osseous healing and decreased the stress on the implant, thereby decreasing the incidence of implant failure. In addition, sliding of the implant decreased the moment arm, further decreasing the stresses on the implant.

The sliding nail-plate devices were followed by the sliding screw-plate devices, in which the nail portion was replaced by a blunt-ended screw with a large outside-thread diameter. This modification resulted in improved proximal fragment fixation and decreased the possibility of cutting out superiorly by removing the sharp edges found on the nails. Today, the sliding hip screw is the device most commonly used for fixation of intertrochanteric fractures.[6-8]

Sliding hip screws are available in varying plate angles (from 125 to 155 degrees). The 135- and 150-degree devices are the most popular. There are theoretical advantages to the 150-degree devices. The angle of the 150-degree plate creates forces closer to the resultant vertically directed forces acting across the hip, which theoretically facilitates telescoping of the nail and fracture impaction. In addition, an arm with a smaller varus moment acts on the implant, theoretically reducing the risk of implant failure. However, in clinical practice, it is more difficult to insert a 150-degree device into the center of the femoral head and neck than it is to insert a 135-degree device. In addition, the insertion point in metaphyseal bone produces less of a stress-riser effect than does the diaphyseal insertion point required for the 150-degree device. Clinical studies have not shown a significant difference in the amount of sliding and impaction between these two plate angles.

Biomechanical analysis of various plate angles (130 to 150 degrees) to determine load transmission in the proximal femur and screw sliding has shown no statistical difference in plate strain or distribution of proximal femoral strain between the different plate angles tested.[9] Although the 150-degree plate showed better sliding capacity than plates with smaller angles showed, it also had a greater propensity to cut out, probably related to superior screw placement in the femoral head. Therefore, we prefer 135- and 140-degree plates to higher-angle devices.

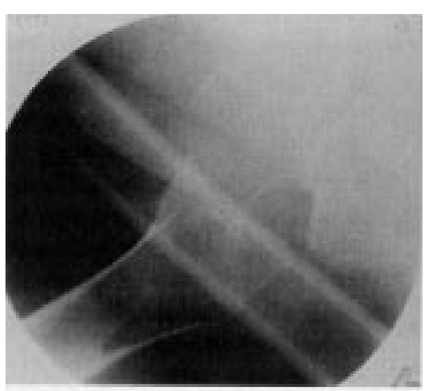
Surgical Technique

The patient is placed supine on a fracture table with both lower extremities resting in foot holders. The ipsilateral groin is placed against a padded perineal post, with care being taken that there is no impingement of the labia or scrotum. Reduction is accomplished with the use of gentle longitudinal traction with the leg first externally rotated and then internally rotated. The uninvolved leg is then flexed at the hip and knee, abducted, and externally rotated to allow the image intensifier to be brought into position for a lateral view.

Prior to preparing the surgical field, it is important to be certain that biplanar visualization of the entire proximal femur, including the hip joint, is possible. It is also important to assess for varus angulation, posterior sag, and malrotation and to correct these deformities. Fracture reduction with varus angulation or posterior sag will result in difficulty centering the lag screw in the femoral neck and head. Varus angulation can be corrected by placing additional traction on the lower extremity to disengage the fracture fragments and then reducing the fracture. Posterior sag requires manual correction during surgery with use of a periosteal elevator or crutch (Fig. 2). The lower extremity should be rotated under fluoroscopic control to determine whether the fracture fragments move as a unit. If the femoral head moves independently from the femoral shaft, excessive internal rotation of the lower extremity is avoided and operative positioning in neutral or slight rotation is used to prevent internal-rotation malalignment.

The vast majority of intertrochanteric hip fractures can be reduced by closed maneuvers. If an acceptable closed reduction cannot be obtained after a few attempts at gentle manipulation and traction, more forceful manipulation should not be used. Rather, an open reduction is preferred. With limited fracture exposure and release of traction, the fragments can usually be manipulated into an acceptable position.

The need for a medial-displacement osteotomy with use of the sliding hip screw remains controversial. Because the sliding hip screw allows controlled fracture collapse, anatomically aligned unstable fractures can be expected to spontaneous impact to a stable and often medially displaced position. This usually results in less extremity shortening than is possible with a formal medial displacement osteotomy. Recent clinical studies comparing medial displacement and anatomic reduction for unstable fractures with use of the sliding hip screw found no advantage of medial displacement over anatomic reduction.[10,11]



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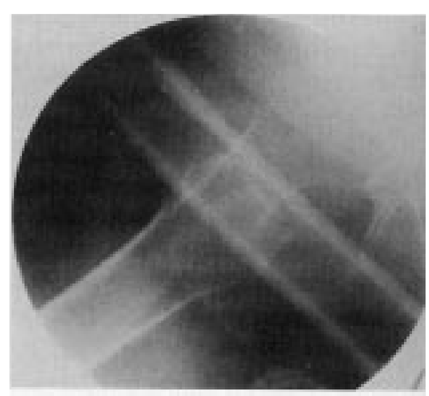

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Fig. 2 **A,** Intertrochanteric fracture with posterior sag. **B,** Manual correction with use of a crutch placed under the proximal aspect of the thigh.

The most important aspect of insertion of the sliding hip screw is secure placement of the screw within the proximal fragment.[12,13] The screw head should be positioned within 1 cm of the subchondral bone. A central position within the femoral head and neck is most commonly recommended. If a central position is not possible, a posteroinferior position is preferred. Anterosuperior positions should be avoided because the bone is weakest in that area, thereby increasing the likelihood of superior screw perforation.

Although the sliding hip screw allows postoperative fracture impaction, it is essential to obtain an impacted reduction at the time of surgery, because excessive postoperative collapse may exceed the sliding capacity of the device. If screw sliding brings the threads in contact with the plate barrel, additional impaction is impossible, and the device becomes the biomechanical equivalent of a rigid nail-plate (Fig. 3). The surgeon should impact the fracture when the screw and side plate are in place, but prior to fixation of the plate to the shaft. This is performed by releasing the traction and manually impacting the distal fragment to the proximal fragment, taking care to maintain the reduction. Radiographs then should be evaluated to be certain that the reduction is acceptable, the fixation device is in good position, and an adequate amount of sliding capacity remains.

If there is inadequate sliding capacity, a plate with a shorter barrel should be used. A recent study advocated the use of a short-barrel dynamic hip-screw side plate when a screw measuring 80 mm or less is inserted to maximize the available sliding capacity. The length of the plate used is based on the fracture pattern and the security of the fixation. Recent studies have shown that a three-hole plate is sufficient in most cases,[14] but we continue to prefer a four-hole plate.

Fig. 3 Loss of sliding capacity of this unstable intertrochanteric fracture resulted in fixation failure.

If there is a large posteromedial fragment, an attempt should be made to internally fix the fragment in a near-anatomic position with a lag screw or cerclage wire (Fig. 4). Axial-load analyses of unstable fractures have confirmed that when anatomic reduction of the posteromedial fragment is possible, its fixation becomes progressively more important as its size increases. In one recent study,[15] anatomic reduction of a large posteromedial fragment increased load resistance by 57% compared with identical fractures with the fragment excluded. Fixation of a small posteromedial fragment increased stability by only 17%. If a fracture table is being used, traction should be released for easier mobilization of this fragment. External rotation of the extremity may be necessary to expose the fragment, and the iliopsoas tendon may have to be released. Fixation of the posteromedial fragment may be difficult, particularly if comminution is present. It is important to realize that an anatomic reduction of this fragment is not required. Rather, the fragment should be brought back to the area of the posteromedial defect and secured in that position to provide a buttress against varus displacement.

Fractures with comminution and displacement of the greater trochanter require additional fixation to maintain optimal abductor function. In cases in which the greater trochanter is displaced, a tension-banding technique can be used. A cerclage wire is placed under the abductor tendon and is passed around the plate barrel in a figure-of-eight fashion. After the plate is fixed to the shaft, the wire is tightened.

Methylmethacrylate has been advocated as adjunctive fixation in extremely osteoporotic, unstable fractures treated with a sliding hip

Fig. 4 Fixation of a large posteromedial fragment with a cerclage wire and lag screw.

screw.[16] However, its routine use with sliding-hip-screw fixation for nonpathologic fractures is currently not recommended.

Basilar neck fractures require a modified approach. Insertion of the screw into the head and neck may cause the fragment to rotate. Therefore, two guide wires are inserted, one in an inferior position and the second more superiorly. The hip screw is inserted over the inferior guide wire, and an antirotation cancellous screw is inserted over the superior guide wire. This technique prevents rotation of the head and neck fragment during reaming and screw insertion, as well as in the postoperative period.

In reverse-obliquity fractures, the location and direction of the fracture line result in a tendency to medial displacement from the pull of the adductor muscles. The usually controlled impaction of the sliding hip screw will not occur because of the location and direction of the fracture line. In these fractures, the sliding portion of the device should be placed entirely within the proximal fragment, while the plate and screws fix the distal fragment. Fixation of the proximal fragment is therefore limited and may actually be inadequate. Although the sliding hip screw is frequently used to treat reverse-obliquity fractures, they are probably better treated with devices used for subtrochanteric fractures, including intramedullary nails, intramedullary hip screws, and 95-degree blade-plates or condylar screws.

Alternative Devices

Intramedullary devices have been used extensively for the treatment of intertrochanteric fractures. Ender nails have been the most popular of these devices. The stated advantages of Ender nails are decreased operative time and blood loss due to the distal insertion site and lack of the necessity to expose the fracture. The operative procedure is technically demanding and requires the use of an image intensifier.

Complication rates have ranged from 16% to 71%. The most common complications are varus deformity, knee pain caused by distal migration of the nails, supracondylar femoral fractures, and external rotation deformity.[17] The highest complication rates have resulted when Ender nails were used for unstable fractures. Early reoperation has been necessary in up to 19% of cases.

At present, the indications for Ender nailing of intertrochanteric fractures are uncertain. It may be most useful in elderly, debilitated patients with stable fractures who can tolerate only minimal operative intervention. An adequate number of Ender nails must be used, and they should be driven deeply into the femoral head, with prebending into anteversion to prevent postoperative external-rotation deformity. We believe that Ender nails should be avoided in the treatment of unstable intertrochanteric fractures.

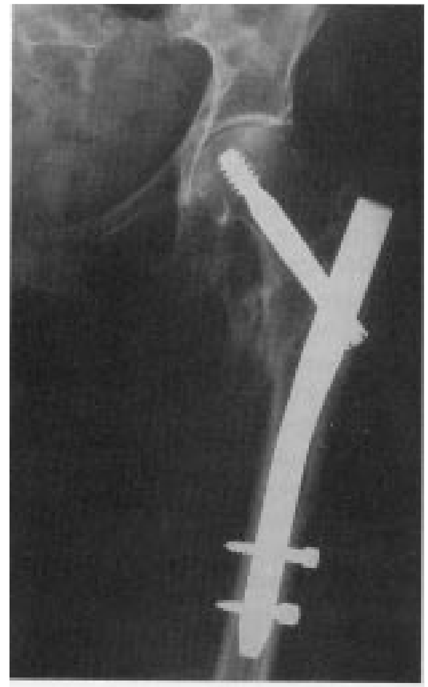

Fig. 5 Stabilization of an unstable intertrochanteric fracture with an intramedullary hip screw.

Intramedullary hip screws have recently been introduced for the treatment of intertrochanteric fractures. These devices combine the features of a sliding hip screw and an intramedullary nail (Fig. 5) and have theoretical technical and mechanical advantages. Theoretically, they can be inserted in a closed manner with limited fracture exposure, resulting in less blood loss and less tissue damage than occur with a sliding hip screw. In addition, these devices are subjected to a lower bending moment than the sliding hip screw due to their intramedullary location. However, recent studies have found no clinical advantage with the intramedullary hip screw compared with the sliding hip screw. One prospective, randomized study comparing the Gamma nail and the sliding hip screw for the treatment of 100 intertrochanteric hip fractures found no difference with respect to operating time, blood loss, duration of hospital stay, infection rate, wound complication rate, implant failure, screw cutout, or screw sliding.[18] The major difference was that four patients in whom Gamma nails had been used sustained a femoral-shaft fracture at the nail tip or the insertion point of the distal locking screw.

A biomechanical evaluation of the Gamma nail in an experimental model of stable and unstable intertrochanteric fractures was recently reported.[19] The Gamma nail transmitted decreasing load to the calcar with decreasing fracture stability. Virtually no strain on the bone was seen in four-part fractures with the posteromedial fragment removed. Insertion of the distal locking screws did not change the pattern of proximal femoral strain.

Although intramedullary hip screws have not been shown to be superior to the sliding hip screw for the treatment of intertrochanteric hip fractures, they may have selected indications, such as the reverse- obliquity intertrochanteric hip fracture; the intertrochanteric fracture with subtrochanteric extension, which would require a long side plate; and the subtrochanteric femur fracture.

Prosthetic replacement for intertrochanteric fractures has been used successfully to treat postoperative loss of fixation when another attempt at open reduction and internal fixation is not possible or desirable.[20] A calcar replacement prosthesis is necessary because of the fracture level. Primary prosthetic replacement for comminuted unstable fractures has been utilized successfully in a limited number of patients. The disadvantages include a larger, more extensive surgical procedure and the potential for dislocation. The indications for its use in the treatment of acute intertrochanteric fractures remain undefined, and certainly prosthetic replacement does not appear to offer any advantages over treatment with a properly inserted sliding hip screw in the vast majority of patients.

Complications

Surgical complications are dependent in part on the method of fixation chosen. We will focus on complications with the use of the sliding hip screw, since this is the most commonly used device. Generally, weight- bearing as tolerated should be allowed postoperatively. There have been no studies showing that limited weight-bearing reduces the risk of postoperative loss of fixation for intertrochanteric fractures treated by a properly inserted sliding hip screw. The complications most frequently encountered are varus displacement of the proximal fragment, malrotation, and nonunion. Osteonecrosis, screw disengagement from the barrel, and migration of the screw into the acetabulum are extremely uncommon occurrences.

Varus displacement following internal fixation is usually associated with unstable fractures and results from lack of posteromedial support. Varus displacement is usually followed by cutting out of the screw through the anterosuperior portion of the femoral head. Other associated complications, such as implant breakage or bending, screw penetration into the joint, and dissociation of the plate from the shaft (by screws breaking or pulling out), are less likely with the sliding hip screw than with fixed nail-plate devices.

Complications occur as a result of various factors including (1) misplacement of the screw into the anterosuperior aspect of the femoral head; (2) improper reaming, which creates a second channel; (3) inability to obtain a stable reduction; (4) excessive fracture collapse, so that the sliding capacity of the device is exceeded; (5) inadequate screw-barrel engagement, which prevents sliding; and (6) severe osteoporosis, which precludes secure fixation. Retrospective review of cases with loss of fixation often indicates that technical problems contributed to the complication. Achieving a stable reduction with proper insertion of the sliding hip screw remains the best way of preventing postoperative loss of fixation.

When complications occur, management choices include acceptance of the deformity; a second attempt at open reduction and internal fixation, which may require methylmethacrylate; and conversion to hemiarthroplasty or total hip replacement. Acceptance of the deformity should be considered in nonambulatory patients who are poor surgical risks.

Malrotation deformities usually result from internal rotation of the distal fragment at the time of internal fixation (Fig. 6). In unstable fractures, the proximal and distal fragments may move independently. Therefore, the distal fragment should be fixed in neutral to slight external rotation to prevent this complication. Nonunion occurs in less than 2% of cases. In some cases in which there is good bone stock, repeat internal fixation combined with a valgus osteotomy and bone grafting can be considered. However, in most elderly patients, conversion to a calcar-replacement bipolar endoprosthesis is preferred.

Osteonecrosis of the femoral head following intertrochanteric fracture is quite rare. Thus far, no association has been found between the location of the fracture fixation in the proximal fragment and the development of this complication. Various case reports have documented unusual complications

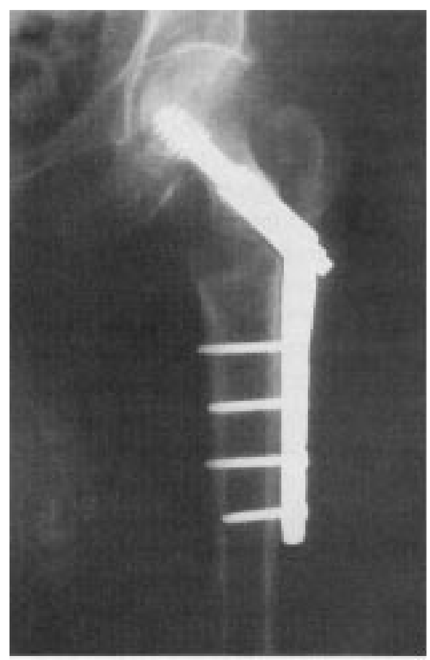

Fig. 6 Rotational malalignment of a stabilized intertrochanteric fracture.

relating to screw-barrel disengagement or screw migration into the pelvis. Screw-barrel disengagement can be prevented by leaving the compression screw in place. Most cases of screw migration occur in unstable fractures and are associated with improper reaming and violation of the hip joint.

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