22 Trauma of the Hip and Femoral Shaft

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Hip Dislocations

Posterior Hip Dislocations

Hip dislocations are usually high-energy injuries. Posterior dislocations are the most common and often associated with sciatic nerve injury. The classical clinical picture includes pain, shortening, and a flexion/adduction/internal rotation posture. A plain AP pelvis x-ray will confirm the diagnosis and rule out associated bony injuries. Anesthesia or sedation, preferably with muscle relaxation, is necessary for reduction. Trolleys and OR tables are narrow and unstable, making it safer to place the patient on a mattress on the floor for reduction, while an assistant applies downward pressure on the ASISs. Traction in line with the axis of the femoral displacement—the Allis maneuver—will reduce the dislocation, usually with a clunk after which the leg is extended and externally rotated.

A "grinding" sensation on attempted postreduction hip motion suggests an entrapped osteoarticular fragment or missed fracture. If repeated attempts at closed reduction are unsuccessful, interposition or buttonholing is likely, requiring open reduction through a posterior approach.

A postreduction AP x-ray of the pelvis (not just the involved hip) is essential to confirm a concentric and congruent reduction with bilaterally comparable joint spaces (Fig. 22.1). For congruent joints, the degree of instability will dictate further management. A hip stable at 90° can be treated symptomatically, with weight bearing as tolerated and instructions to avoid excessive flexion, adduction, and internal rotation for 2 months. If the hip re-dislocates between 60° and 90°, straight skin traction in external rotation is indicated for at least 2 weeks. External rotation can be maintained by placing the leg in a stockinette tied to the side of bed or a derotation bar incorporated in a slipper cast. The patient should be allowed to lie supine, prone, and on the involved side, but not on the contralateral side to avoid adduction. Traction can be relaxed while the patient is awake but should remain in place at night. Sitting is allowed as tolerated within the safe zone. Inlet/outlet or iliac/obturator oblique views can be helpful, but CT is rarely available.

Another management option involves placing the leg in a straight knee cylinder POP, with or without a derotation bar, to keep the hip in external rotation and an abduction pillow.

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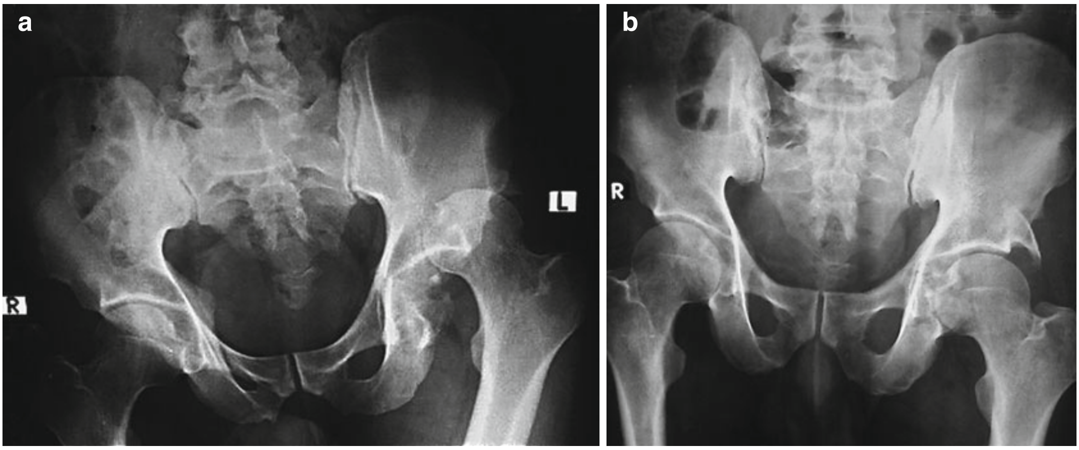


Fig. 22.1 (**a**) AP x-ray of a posterior dislocation of left hip with fracture of the posterior wall. (**b**) Postreduction x-rays show concentric reduction of femoral head, but the posterior wall fragment remains displaced. Further management depends on clinical stability

The cast-enforced knee extension prevents hip flexion.

Recurrent dislocation of a concentrically reduced hip is rare.

A hip that re-dislocates at 45° flexion or less usually indicates a sizeable fracture of either the posterior wall or femoral head. Large posterior wall fragments should be fixed (see Chap. 21). Large femoral head fragments—from the weight-bearing area, between 10 and 2 o'clock—should be fixed, otherwise excised, with the ligamentum teres. Ideal fixation is with 2 lag screws starting from the femoral neck. For small fragments, a screw head can be countersunk below the articular surface or small threaded K-wires cut flush with the articular surface. The hip is reduced and assessed for stability and the posterior capsule repaired. A non-weight-bearing gait with range of motion starts early and continues for 6–8 weeks. In selected cases, 2–3 weeks traction may be beneficial. In theory, surgery is indicted for more than 2–3 mm of residual displacement of the posterior wall or dome fragment, and the hip is unstable. But this is only true if appropriate resources are available; otherwise, the patient is best treated conservatively as outlined above.

The incidence of AVN increases with the duration of the dislocation, but it is unclear at which point the curve flattens [1]. If the dislocation is relatively fresh, the patient usually presents with only mild discomfort at rest, pain on passive motion, shortening, and inability to bear weight. AVN may or may not be present or visible on x-rays. Potential benefits of regaining length and the ability for painless ambulation must be weighed against risks of creating or exacerbating AVN or neurovascular injury. Open reduction is not indicated if the head is already deformed.

For long-standing dislocations with severe shortening, it is safer to put the patient in skeletal traction for 2 weeks and evaluate the position of the head on x-ray. Or perform a complete hip release and place the patient in straight leg skeletal traction, with the added risks of a second anesthetic or infection. A successful reduction may still lead to AVN or a painful, stiff hip. Fusion or Girdlestone excisional arthroplasty (see Chap. 41) are the only other surgical options. Patients seen after 6 months have adapted to a large extent and should be left alone.

Anterior Hip Dislocations

These are much less common than posterior dislocations (Fig. 22.2). The hip is usually slightly flexed, abducted, and externally rotated, and the head is often palpable in the groin. Closed reduction is by traction in the axis of the dislocation, followed by internal rotation and extension. The hip should be examined for instability and joint

Fig. 22.2 Chronic obturator dislocation with neo-acetabulum. The patient walked with an abduction contracture and relative shortening, but no pain

incongruity or retained fragments as described above for posterior dislocations.

Stable hips can be placed in skin traction for comfort for a few days, avoiding external rotation. Instability in extension is usually due to an associated fracture, with or without fragment entrapment. An open reduction through an anterior approach is indicated, but fixing a fractured anterior wall or column is technically more demanding than the posterior wall, sometimes requiring a separate ilioinguinal approach.

Fractures of the Proximal Femur

The incidence of these fractures in austere environments is increasing as population ages [2]. They are challenging and remain "unsolved fractures" due to lack of fluoroscopy and fracture tables, delayed presentation, poor implants, and few viable alternatives such as prosthetic replacement [3]. Painful nonunions condemn the patient to use walking aids or a wheelchair.

Femoral Neck Fractures

Intracapsular fractures with varying degrees of compromise to the femoral head circulation. Valgus impaction or undisplaced fractures (Garden 1 and 2) have a better prognosis of healing and less AVN than fractures with varus or total displacement (Garden 3 and 4). Nonoperative management of fractures impacted in valgus can be considered, but all other fresh fractures are candidates for internal fixation, particularly in younger patients.

If fluoroscopy and a fracture table are available, percutaneous compression screw fixation is routine. With fluoroscopy but no fracture table, percutaneous treatment is still possible with a radiolucent table and good assistants by slightly elevating the patient's involved buttock on a cushion so that the femoral neck is roughly parallel to the ground. One scrubbed assistant provides traction on the leg, while an unscrubbed assistant gives countertraction over the contralateral shoulder via a folded sheet passed under the patient and over the perineum. The difficulty with this technique is the lack of lateral projection, requiring the surgeon to go by feel along the anterior neck to determine reduction and implant placement.

Regular short-threaded 6.5 mm cancellous screws can be used when cannulated screws are unavailable. Overdrill the lateral cortex with a 4.5 drill bit and advance the blunt tip of a K-wire in a push-pull fashion. This maximizes the tactile information as one crosses the fracture and prevents neck perforation. Positioning and depth can be assessed on a through-table AP view. A second or third K-wire should be inserted as parallel to the first as possible, replacing the wires one by one with the screws. Even divergent screws will provide some compression. Fluoroscopy will confirm that the construct moves as a unit, supplemented with a partial frog-leg position or a portable lateral.

When no intraoperative x-rays are available or the fracture is so old that it cannot be reduced closed, the only surgical option is an open reduction through an anterior approach. The anterior neck is rarely comminuted, making the reduction assessable both visually and palpably. A 3.2 mm drill bit can be advanced blindly in the axis of the neck, and parallel to the floor, in a push-pull fashion as described above to a depth as measured on the pre-op x-ray. A second drill bit of equal length is helpful in determining the screw length and is used to drill a second path parallel to the first.

The screw is inserted with the first drill bit still in place to prevent the head spinning. The 2 screws are compressed, and the construct is tested for stability in movement with no adventitious grinding sensation. A third screw is an option, but the risks of misplacement are higher with this blind technique.

Established painful nonunions without AVN and head deformity may benefit from open reduction, curettage, and compressive fixation, with or without a Judet/Myers procedure (see Chap. 41) [4]. An alternative, especially for neck fractures presenting after 10 days at which point an open reduction may cause more harm than good, is an extra-articular valgus osteotomy at or below the level of the lesser trochanter, to avoid the risk of iatrogenic AVN. Our choice is a 10–20° valgus correction that when fixed with a sliding hip screw, cephalic nail, or regular short-threaded screws should allow compression at the nonunion and the osteotomy with weight bearing. Temporarily pinning the head to the acetabulum before reaming and taping avoids spinning the proximal fragment.

Hemiarthroplasty is the treatment of choice when available. If degenerative changes in the acetabulum are already present, it should be reamed to subchondral bone and to the size of the selected prosthetic head. When head sizes are limited, reaming to the next size up is a better alternative than using too small a head.

Many elderly, low-demand patients with months-old fractures do well with the use of a walking aid, and the western surgeon needs to resist his or her training reflexes and avoid surgery based on x-rays and ingrained habits.

Intertrochanteric (Pertrochanteric) Fractures

These fractures are extracapsular and less likely to develop AVN. They are common insufficiency fractures in the elderly, but significant energy is required for a similar fracture in young adult bone. Patients present with pain, shortening, and external rotation of the limb. Nonoperative management with skeletal traction is usually successful in treating this fracture but requires 6–8 weeks bed rest before patients can be mobilized without significant discomfort and often leads to malunion with shortening, varus, and rotation. Complications related to bed rest may require earlier mobilization at 3–4 weeks, with an increased incidence of malunion or nonunion. It is not easy to find the delicate balance between what is best for the fracture and best for the patient. Patients who present late may benefit from a shoe lift, as most patients accommodate well to the malunion.

Where fluoroscopy, fracture table, and appropriate implants are available, treatment is closed reduction and internal fixation with a sliding hip screw device or a cephalic nail. Cephalic nails are mechanically better for unstable fractures—those with posterior-medial comminution. Nails with larger proximal diameters risk added comminution at the entry site, making trochanteric entries preferred to piriformis fossa entry.

The proximal locking screws of an antegrade SIGN nail (SIGN Fracture Care International) can engage the head and neck fragment of more stable intertrochanteric fractures with the added stability of directed screws running up into the head and neck (Fig. 22.3). SIGN's hip fracture construct increases the precision of screw placement (Fig. 22.4). As with a DHS-type device, this allows impaction of the fracture with early weight bearing. The lack of a fracture table is compensated by manual traction/countertraction as described above. The lack of fluoroscopy makes reduction and fixation more difficult but can be overcome by partially detaching or splitting the vastus lateralis. This allows direct finger access to the fragments anteriorly and medially. A pilot K-wire introduced at the desired angle from an overdrilled entry site on the distal fragment can be advanced in a push-pull fashion and repositioned as needed, until it reaches a depth grossly corresponding to that templated preoperatively. The same technique of "semi-open reduction" is also helpful for determining the depth of insertion for a cephalic nail and its rotation for proximal interlocking.

When comminution is severe, a stable construct is more important than near-anatomical reduction. The distal fragment can be medialized,

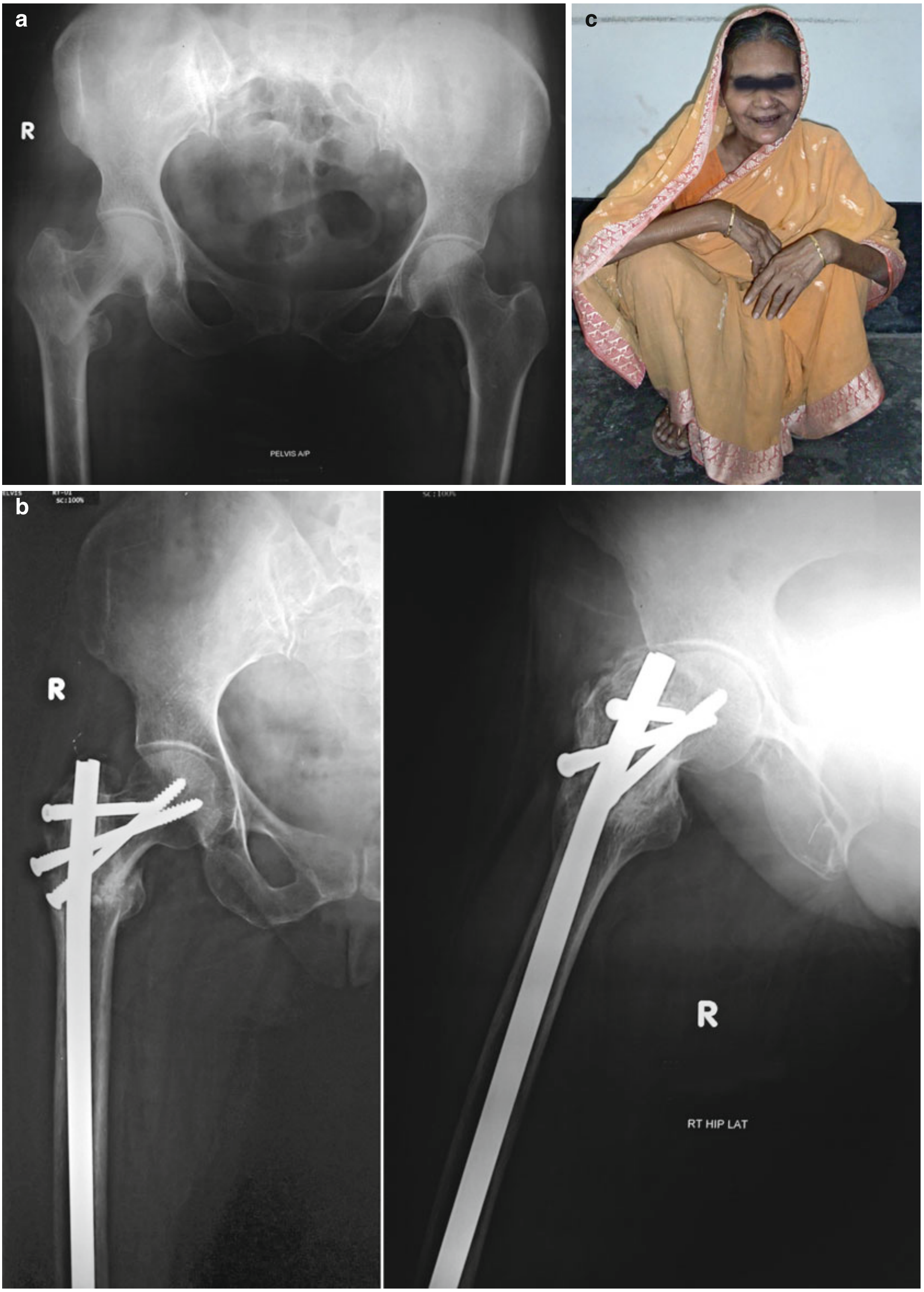


Fig. 22.3 (**a**) X-ray of a 2-part intertrochanteric fracture. (**b**) ORIF with the antegrade SIGN nail, with free screws secured into femoral neck and head. (**c**) The patient after surgery, able to independently walk and perform ADLs

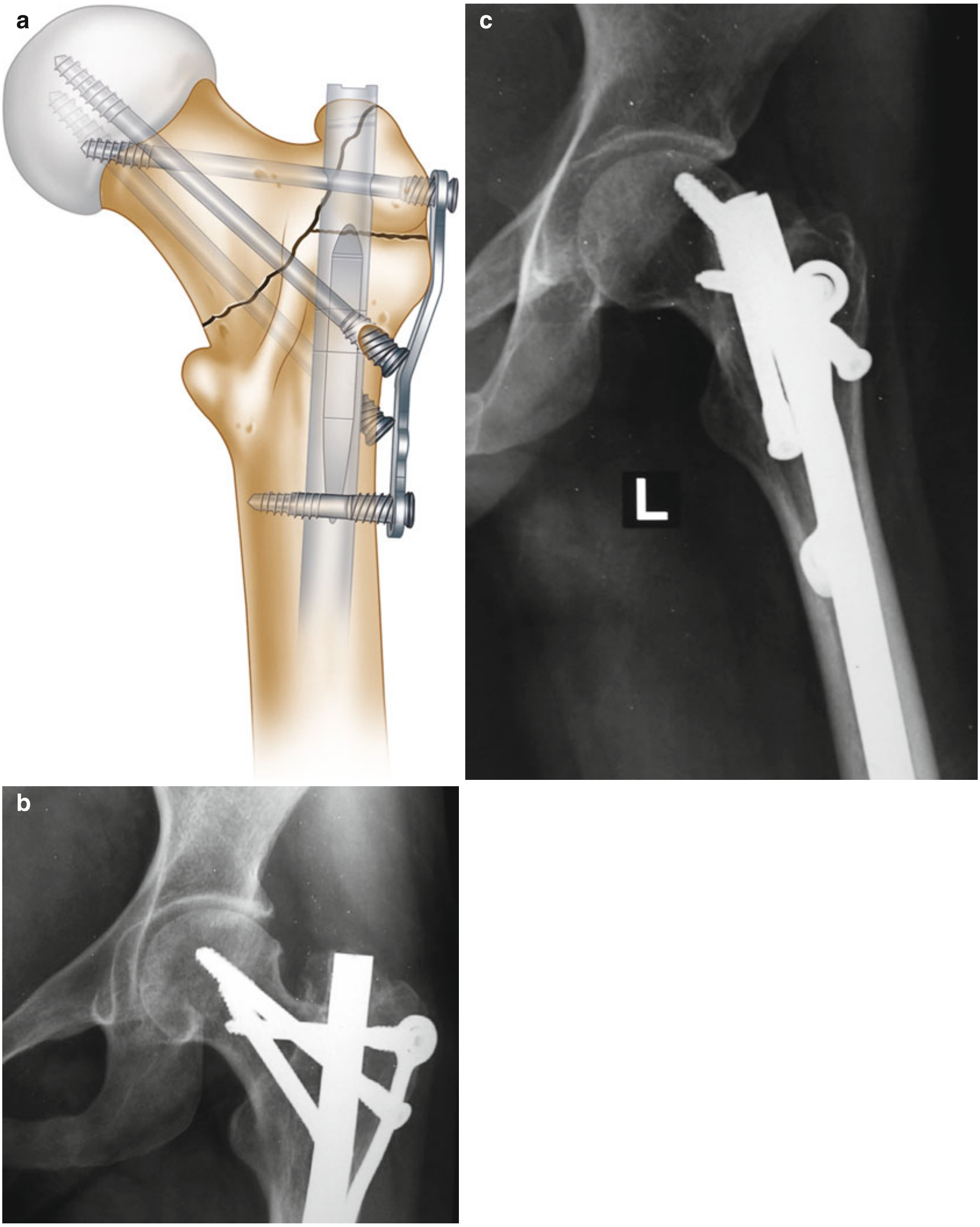


Fig. 22.4 (**a**) Engineer's drawing of the SIGN Hip Construct Device. The orientation of the device and its attachment to the proximal locking screw of the SIGN nail allow placement of the remaining screws by a "miss a nail" technique. (**b**, **c**) X-rays of Hip Construct Device in use

and the spike of inferior cervical cortex impacted into the medullary cavity (Dimon-Hughston or pushover technique) (Fig. 22.5). The sliding screw can be inserted under direct vision in the neck and the plate secured to the distal fragment. Once the fixation is completed, the surgeon

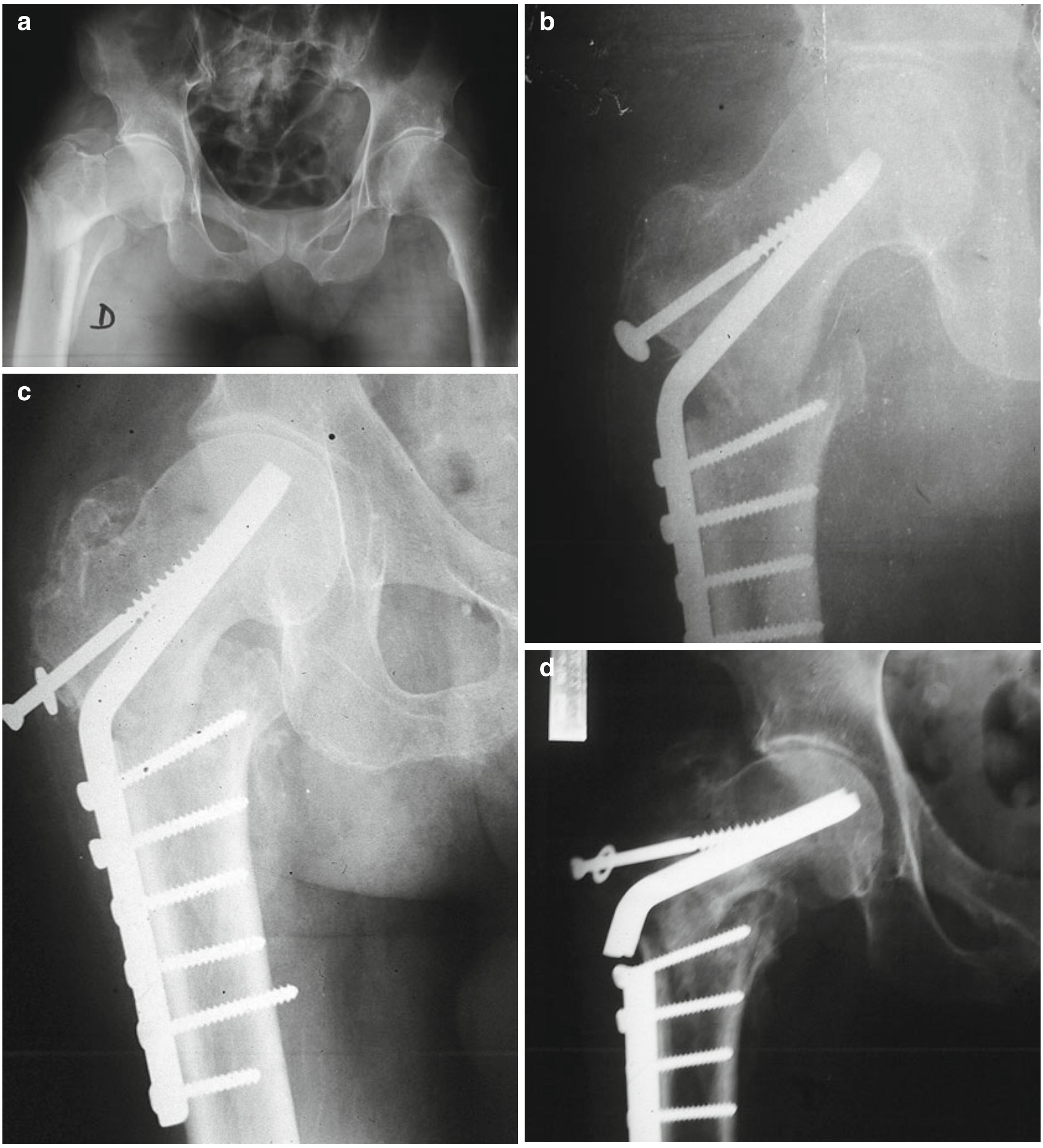


Fig. 22.5 (**a**) X-ray of comminuted intertrochanteric fracture with posteromedial instability (**b**) ORIF with blade plate and medialization of distal fragment (Dimon-Hughston). (**c**) The blade plate allows for only limited impaction at the fracture site, and the proximal fragment has slid as far as it will go on the rigid blade, defeating the purpose of the impaction. (**d**) The race of bone healing against hardware failure is lost

verifies that the construct moves as a unit, confirmed by portable x-rays if available. This gives a stable construct that allows early weight bearing. The healing rate is high, and shortening is treated with a shoe lift.

External fixation in distraction between iliac crest and distal femoral fragment is a poor alternative to internal fixation, only to be considered for wounds on the proximal/lateral thigh.

Painful nonunion of pertrochanteric fractures is not as common as in neck fractures and should be treated with internal fixation, with or without bone grafting, or osteotomy.

Femoral Shaft Fractures

Fractures of the femoral shaft require significant energy. The clinical presentation is usually self-evident, though a comprehensive clinical exam to rule out associated injuries is necessary. Isolated femoral shaft fractures rarely cause hypovolemic shock, but many patients in LMICs are borderline anemic before the injury and can quickly decompensate. We cannot overemphasize the importance of seeing the ***entire*** bone on x-rays, as associated fractures of the femoral neck need to be systematically ruled out. Articular fractures of the distal femur, patella fractures, and/or ligamentous damage should be suspected in the presence of a knee effusion.

Associated Femoral Neck and Shaft Fractures

Whether the femoral shaft fracture is treated surgically or conservatively, the presence of an ipsilateral neck fracture affects the treatment, as well as the functional prognosis. A missed undisplaced neck fracture will displace with skeletal traction or with the manipulation and traction needed for internal fixation. Surgical treatment of both fractures is the best option. The neck should be fixed first, after reduction if necessary, with compression screws that are positioned (usually anteriorly) so as not to impede nailing of the shaft fracture. Temporary Steinmann pins can be used and replaced with screws after shaft nailing. Proximal interlocking screws can also be used to complement neck fixation, depending on the nail design.

Associated Intertrochanteric and Shaft Fractures

This combination of fractures represents a particularly challenging combination. There is little bone in the proximal femur fragment for secure purchase of an implant. Rigid fixation most often requires long implants such as DHS-type devices or blade plates, or IM nails that allow proximal interlocking in the femoral neck and head. If the segment between the two fractures is long enough, each can be treated with separate implants, the hip component as described above and the shaft component with a separate plate or a short retrograde nail.

The SIGN hip system can also be used for this problem in an antegrade fashion with static interlocking. Unless rigid fixation can be achieved, these patients should be treated in traction. Nonrigid fixation, such as flexible nailing, should be avoided as it exposes the patient to the same surgical risks without the benefits, as postoperative traction is usually necessary.

Subtrochanteric Fractures

These are usually high-energy injuries, with the proximal fragment displacing in flexion and external rotation from pull of the psoas muscle. When skeletal traction is the only option, it should be done through the distal femur and the limb put in the 90–90 position (90° of flexion at both hip and knee), with the calf suspended in a sling or lightweight POP boot to prevent equinus. Russell's traction at 45° hip flexion is an acceptable compromise. Healing requires prolonged bed rest, which poses significant nursing challenges. Whenever possible, ORIF should be performed, ideally with an interlocked IM nail. Plating is mechanically weaker, and medial comminution ensures a high nonunion rate and hardware failure. Using implants with cervical purchase can be difficult without fluoroscopy (Fig. 22.6). Autogenous iliac crest bone grafting is recommended, adding little to the acute morbidity.

Femoral Shaft Fractures

Skeletal traction remains the only treatment option in many austere environments. Unless there are significant wounds, external fixation is a poor substitute for sound internal fixation. Acceptable alignment is difficult to obtain and maintain, pins loosen or become infected, and knee stiffness is common, often with functional

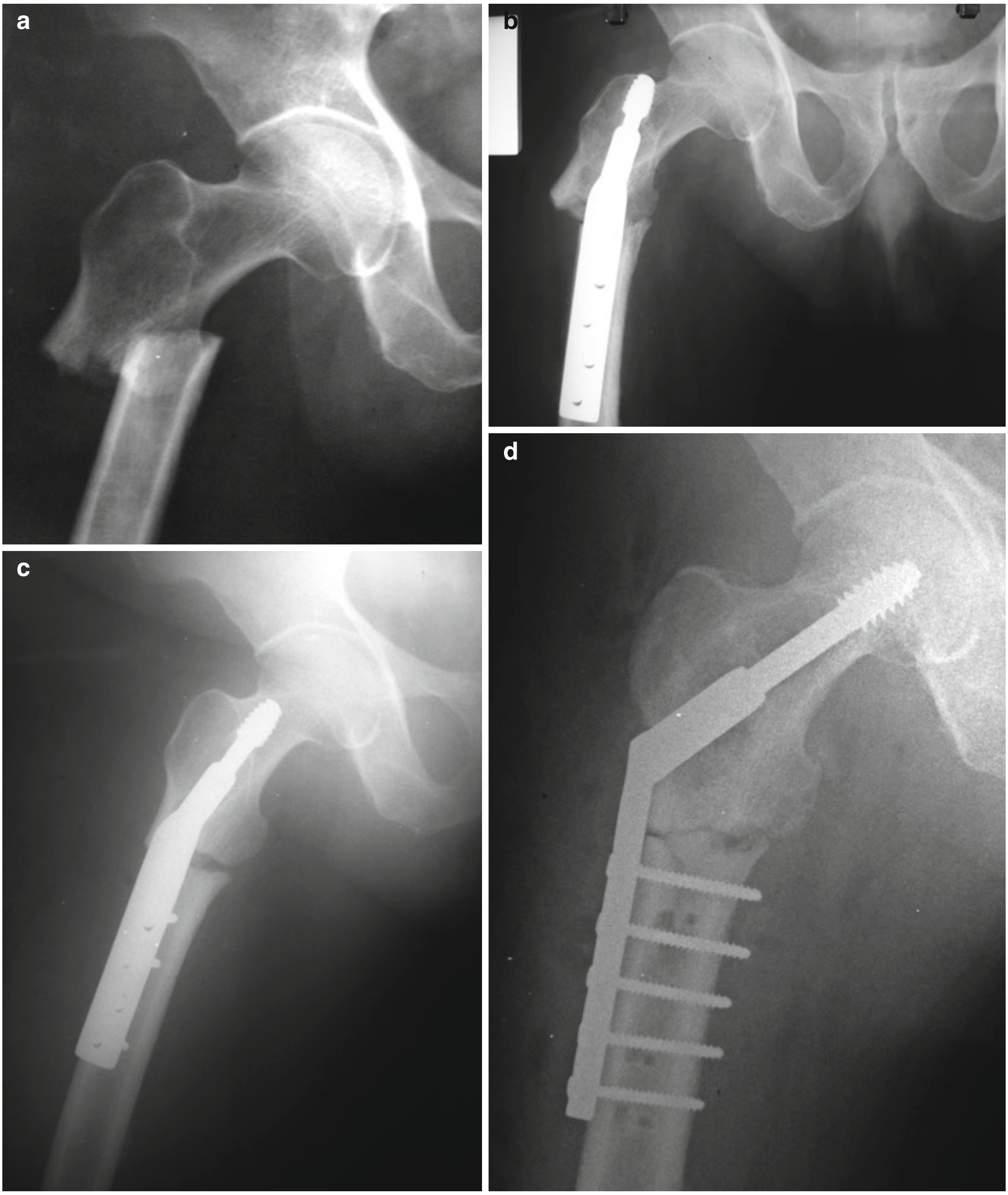


Fig. 22.6 (**a**) X-ray of transverse subtrochanteric fracture (**b**, **c**) attempt at blind use of DHS. The compression screw is likely located on or in the superior neck. (**d**) Salvage required an open reduction and direct visualization of the anterior neck. Note the anteroposterior direction of the previous screw holes

disability long after the bone has healed. In most cases, these negatives override the main benefit of early mobilization that external fixation potentially provides. If an ex-fix is used, insert the pins with the knee in flexion, to minimize tethering the vastus lateralis, and once the fixation is secure, the knee should be maximally flexed while under anesthesia.

Skeletal traction applied as temporalizing treatment should always be applied as if it is the

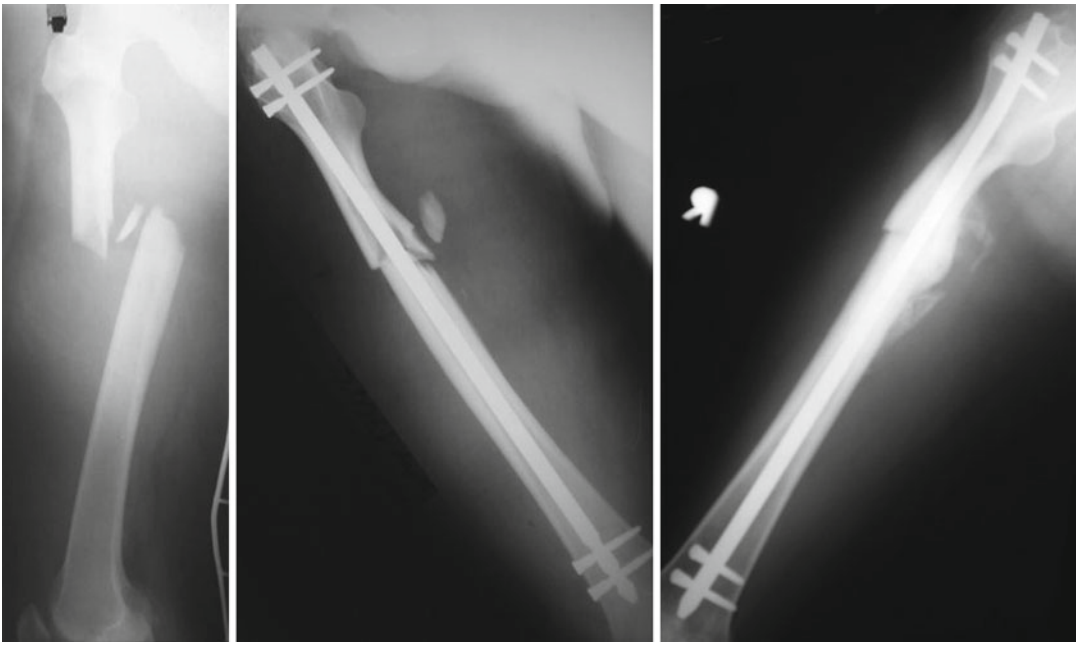


Fig. 22.7 Closed moderately comminuted femur fracture (*left*), fixed with SIGN nail (*middle*) and allowed full early weight bearing as tolerated. (*Right*) Patient is fully independent without limp at 5 months

definitive treatment, as it is common that surgery is delayed indefinitely and traction becomes the definitive treatment by default (for a discussion on femoral shaft fractures treated in traction, refer to Chap. 13).

Whenever possible, internal fixation is the treatment of choice for femoral shaft fractures. Many fractures present late, making a closed reduction impossible. Open reduction of a femur fracture, particularly if old, bleeds copiously, and blood should be available. Many of these patients have underlying chronic anemia before the fresh blood loss from the fracture, and careful monitoring of hemoglobin is mandatory. Prophylactic antibiotic coverage should be routine, according to available wide-spectrum antibiotics.

Intramedullary devices are the implant of choice for most diaphyseal fractures (Fig. 22.7). Traditional open nailing with a Kuntscher nail or other non-interlocked nail relies on 3-point fixation to prevent shortening and rotation. This can be achieved in very few fracture patterns. The same applies to flexible nailing with multiple Ender nails or Rush rods (Fig. 22.8). Nonrigid fixation serves mainly as “alignment” fixation, and postoperative traction may still be necessary, obviating some of the benefits of surgery. In such situations, a well-molded cylinder POP may be needed to hold the proper rotation. In general, unless the patient can benefit from rigid fixation and early mobilization, nonoperative treatment is safer. However, if one is certain from the time elapsed, the position of the fracture ends on x-ray, and the clinical exam that the fracture is incapable of healing without surgical intervention, the surgeon needs to weigh the options.

Interlocking or stacked K-nails with multiple interference screws proximally and distally have been described, but the technique is unreliable and should only be attempted when this is all that is available and nonoperative methods have failed. It is possible to use a generic interlocking nail without fluoroscopy (technique in Appendix 3). The interlocking screws may have little purchase on both the far and near cortices, but the construct is usually strong enough to maintain rotational alignment and length.

The SIGN system was developed to allow locked IM nailing without power, fracture table, or fluoroscopy [5]. The system uses a solid nail with no arc of radius but a 9° proximal bend with 1 screw hole and 1 slot proximally and 2 slots distally with all screws placed in one plane perpendicular to the nail. The same nail and targeting system are used for femur, tibia, and humerus fractures, keeping inventory to a minimum. Interlocking is achieved with a rigid external target arm and a system of sleeves and slot finders. The reduction is usually open and reaming is done by hand, using sharp T-handle reamers, which are part of the system. The femur can be nailed in an antegrade fashion, using a trochanteric entry, or retrograde fashion through the knee. It is found in multiple austere environments, and its user base is expanding [6]. Replacement nails and screws are provided gratis to the hospital, as long as patient data are entered in an online data bank. It has the unique advantage to be free of charge to the patient. Volunteer surgeons are likely to be exposed to this system, and local surgeons are usually proficient in its use and excellent teachers [7].

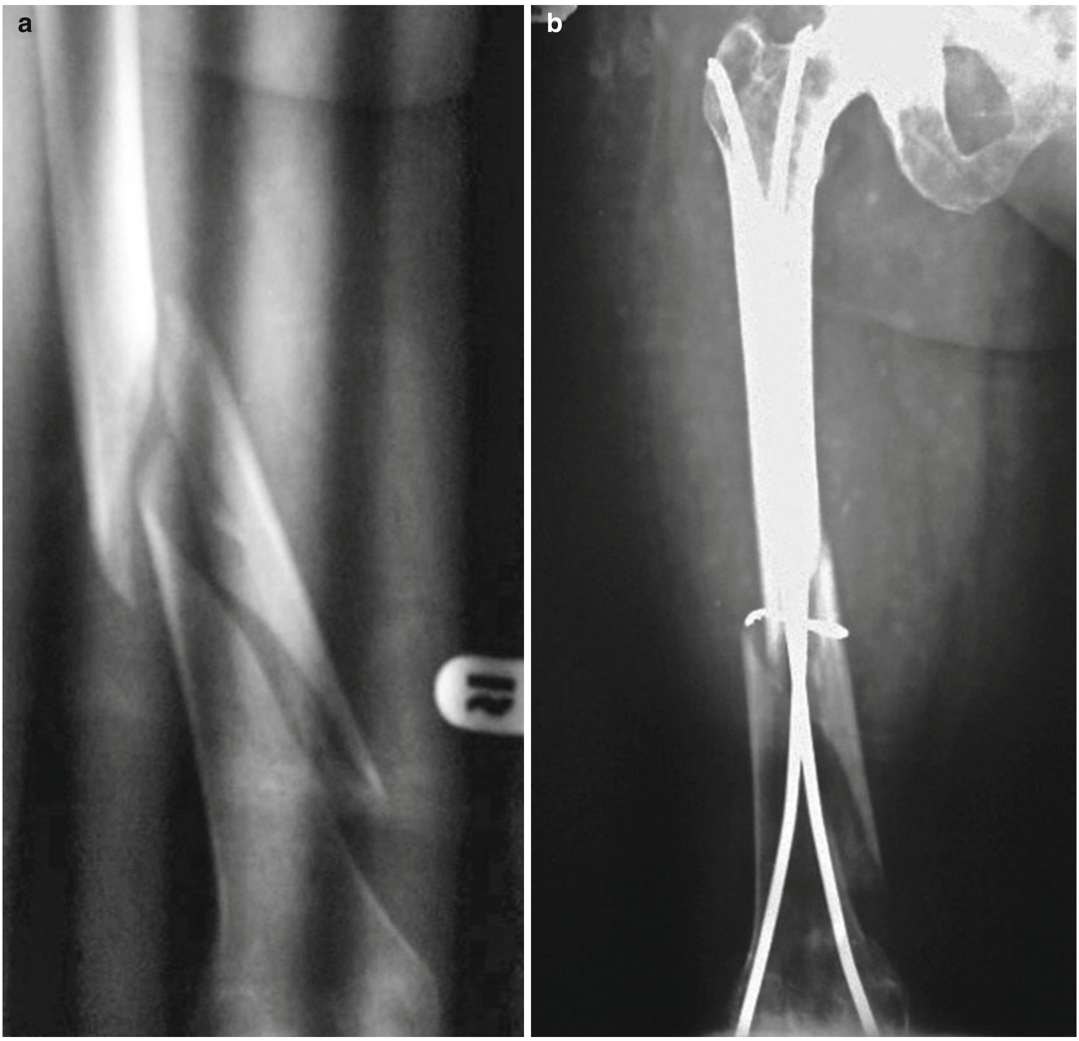


Fig. 22.8 (**a**) X-ray of a comminuted, unstable fracture of the distal femoral shaft. (**b**) ORIF with cerclage wire and 2 Ender nails, a construct without sufficient rigidity and stability. Note that one of the rods already protrudes through the femoral neck. (**c**) Predictable malunion with shortening and external rotation. Note migration of the nails distally at their point of insertion. (**d**) Protrusion of the lateral nail through the skin

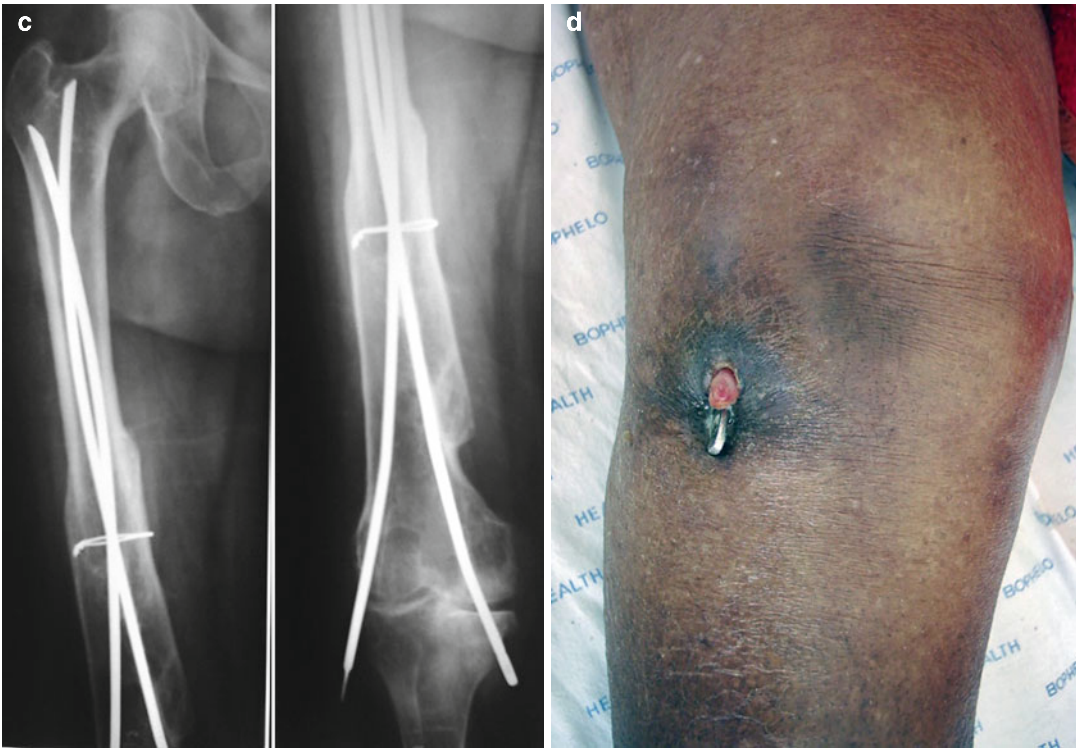


Fig. 22.8 (continued)

The fracture age, pattern, and location will dictate the type of nailing: antegrade or retrograde and static or dynamic. Fresh fractures may require a small opening at the fracture so the finger can feel as reamers and the nail engage the distal fragment. The periosteum should be disturbed no more than necessary. Older fractures require a more extensive exposure. An intact isthmus allows some degree of 3-point fixation, particularly for straight nails. Nails placed retrograde should end above the level of the lesser trochanter or more than 6 cm below it. The area in between is a high-stress area, and the patient may refracture at the level of the end of the nail or the interlocking screws. Dynamic nailing can be considered for simple, non-comminuted fractures of a stable pattern. Proximal shaft fractures should be done in an antegrade fashion, and vice versa. Comminuted, isthmic, long oblique, or segmental fractures should be nailed statically. Antegrade nailing is done in the lateral or semi (floppy)-lateral position; retrograde nailing is done with the patient supine.

Bilateral femur fractures can be done in the same session in the supine position (Fig. 22.9). Ipsilateral femur and tibia fractures can both be nailed through a single medial parapatellar or transpatellar tendon approach. If a "triangle" (easily made in the hospital workshop) is available to support the femur, the closed tibia fracture can be nailed first, followed by the femur. If the tibia fracture is open and external fixation will be the initial treatment, the ex-fix can be used for traction while fixing the femur. In this case, it is safer to redrape the ex-fix out of the field and reprep the thigh. If the femur fracture cannot be secured by these methods, it should be addressed first. Once the femur is nailed, it is always possible to revisit the tibial reduction and adjust the external fixateur as needed.

When the tibia will also be nailed, it can be temporarily immobilized with a 2-pin single-bar ex-fix, a cast, or back slab draped out of the field and removed later or by tightly rolling 2 or 3 nails or long plates in sterile towels and securing them

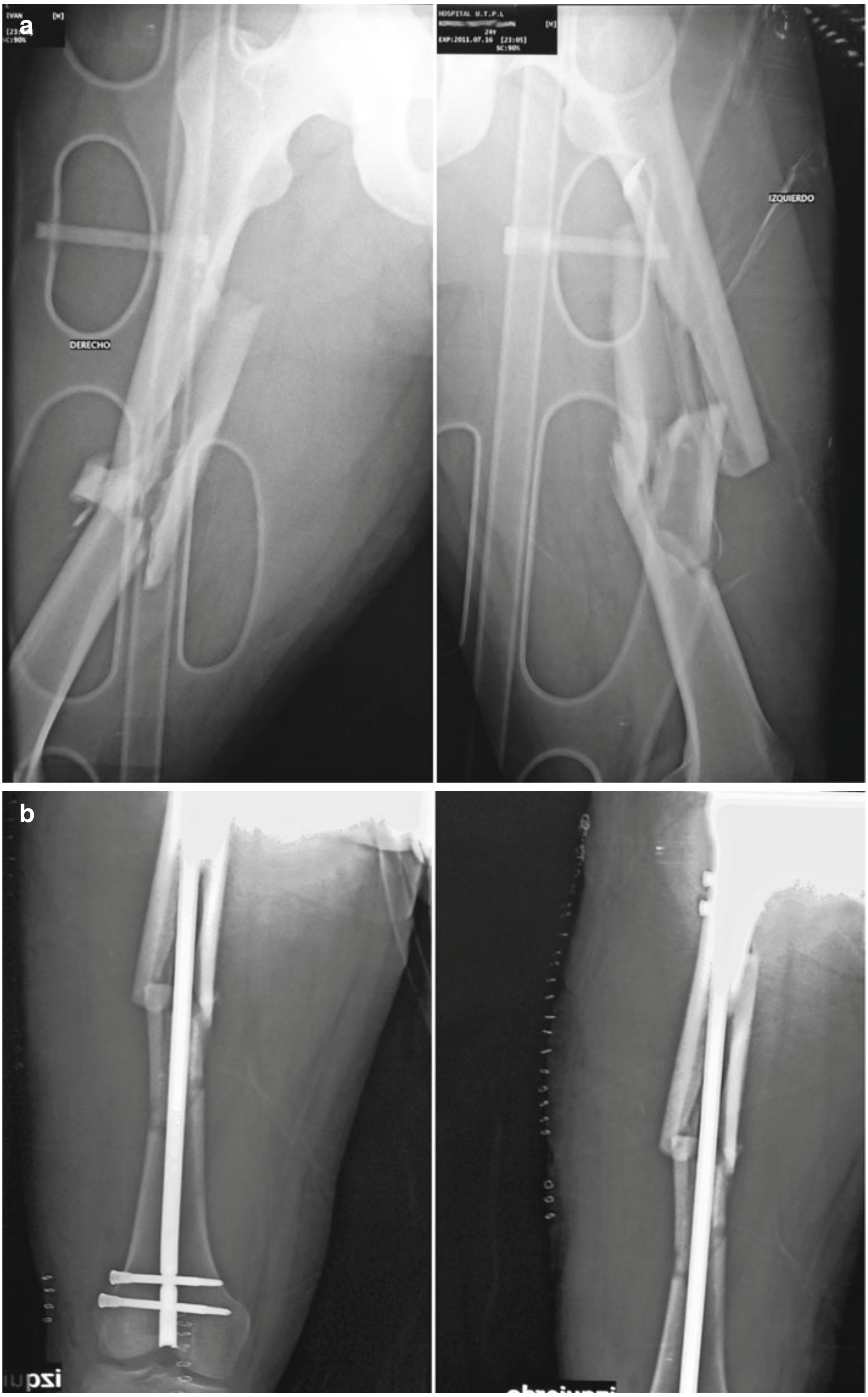
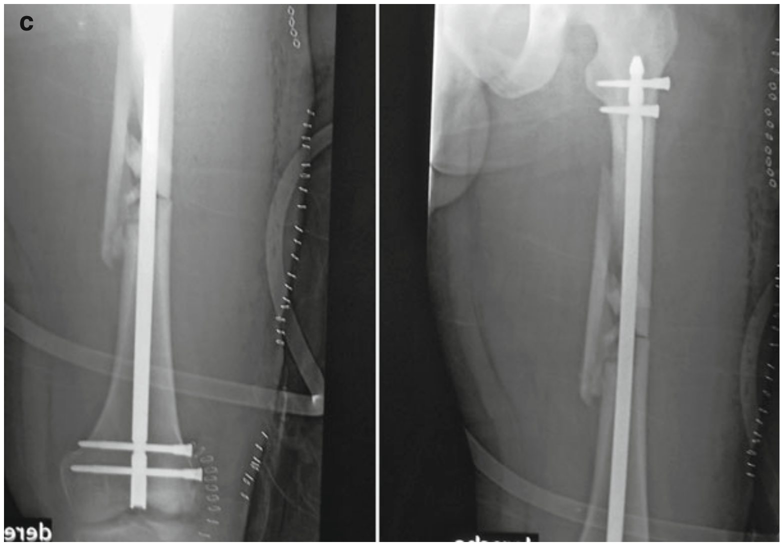


Fig. 22.9 (**a**) Bilateral closed femur fractures. (**b**, **c**) Bilateral retrograde SIGN nailing was done in the supine position

Fig. 22.9 (continued)



to each side of the leg with an Esmarch band or ace wrap to act as a stabilizing splint. A dried back slab can also be "dropped" in a sterile Mayo stand cover, secured on the leg, and removed after the femoral nailing is secured.

Intramedullary devices are not always available or affordable, and in many places plate and screws are the only surgical option. Inexpensive implants are available almost everywhere, and it is not unusual for a patient to buy a plate and screws at a local pharmacy. More commonly, semi-standard large fragment sets are available in the hospital, although often with a hodgepodge of plates and screws of different sizes or metallic composition. The surgeon should be aware of available implants ***before*** surgery. Do not accept the word of the OT supervisor. Plates and screws that are too long can be cut, but the reverse is not true. The same is true for any hardware removal—make sure you have the appropriate screwdriver ***before*** you embark in what may be an extremely frustrating endeavor.

Newer technologies such as locking plates are almost never available. Still, principles of minimal periosteal stripping, indirect reduction, and submuscular sliding of the plate should apply when there is a large comminuted fragment. Standard DC plates are hard to contour properly without plate benders. Pliers, or ideally a vise grip, and a screwdriver or small curette or elevator placed through a screw hole along with a strong assistant and a healthy dose of enthusiasm will usually suffice. Large bone fragments can be fixed with lag screws, but cerclage wire is detrimental to the periosteal blood supply and should be avoided.

Postoperative management depends on many factors, not the least of which is patient compliance and collaboration [8]. Early weight bearing, at least partial, is rarely contraindicated when using an IM nail, and we encourage weight bearing depending on pain in most fractures that are interlocked. Active ROM of joints above and below the fracture is encouraged. A static nail that shows no or poor callus formation at 3 months could be dynamized distally, although no one agrees that it is effective or makes any difference. Many such fractures heal with more time. Established nonunions at 6 months require re-intervention: hardware removal and exchange, unless infection is present or suspected, in which case a few strategies need to be considered (see Chap. 41) [9].

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