30 Percutaneous Placement of Iliosacral Screws

John C. France

30.1 Case Example

This is the case of a 46-year-old male who fell 20 ft from a roof while putting up Christmas lights and landed on the driveway, partially striking a car on the way. He suffered numerous injuries including a pelvic "U" fracture or spinopelvic dissociation. The fracture involved the pedicle on the right at L5 as the plane of injury extended up from the sacral ala and into the spine creating a combined lumbar spine and pelvic fracture (Fig. 30.1). This typical pattern benefits from a combined posterior approach to address the spinal and pelvic components. The spine is fixed to the pelvis with lumbosacral fixation (this construct included L4 to span the right pedicle fracture at L5) including iliac wing screws and the fixation between the iliac wings and the sacral vertebrae is reinforced with iliosacral screws placed percutaneously (Fig. 30.2).

30.2 Background

The use of iliosacral screws originated and has traditionally fallen within the realm of the musculoskeletal trauma surgeon. Because sacroiliac joint pain is often in the differential of causes of low back pain, the spine surgeon usually sees these groups of patients. Although the debate about the true incidence and contribution of the sacroiliac joint to back pain roars on, there is enough evidence to believe that it plays a role in some patients. In the patient recalcitrant to nonoperative measures a computed tomography (CT)-guided injection can be used therapeutically and diagnostically by combining a corticosteroid with a long-acting analgesic such as bupivacaine. This author prefers CT guidance to fluoroscopic to maximize the accuracy of needle placement and verify exact location. It is most important to be certain that the needle was in the exact location in patients who fail to benefit. In those patients who experience 100% relief temporarily but no lasting benefit on two separate occasions, one can have reasonable confidence that the pain source has been identified and consider a sacroiliac fusion. Thus, the spine surgeon plays an integral role in evaluation and is often the one to perform the fusion if warranted and needs to be familiar with the technique of iliosacral screws as a means of fixation.

In addition, more complex pelvis fractures can extend through the L5–S1 facet and include a facet dislocation. The pelvic H-fracture or spondylopelvic dissociation is another example of combined spine and pelvic pathology where the lumbar spine and upper sacrum are essentially torn free from the pelvic ring (Fig. 30.3). Under these circumstances, the spine may require stabilization in conjunction with the pelvis. This type of procedure may fall solely under the realm of the spine surgeon or be performed in conjunction with the trauma surgeon depending on the circumstances such as training and level of comfort with the necessary techniques such as iliosacral screw fixation.

J.C. France
Department of Orthopaedic Surgery, West Virginia University, P.O. Box 9196, Morgantown, WV 26542, USA
e-mail: jfrance@hsc.wvu.edu

V.V. Patel et al. (eds.), *Spine Trauma*,
DOI: 10.1007/978-3-642-03694-1_30, © Springer-Verlag Berlin Heidelberg 2010

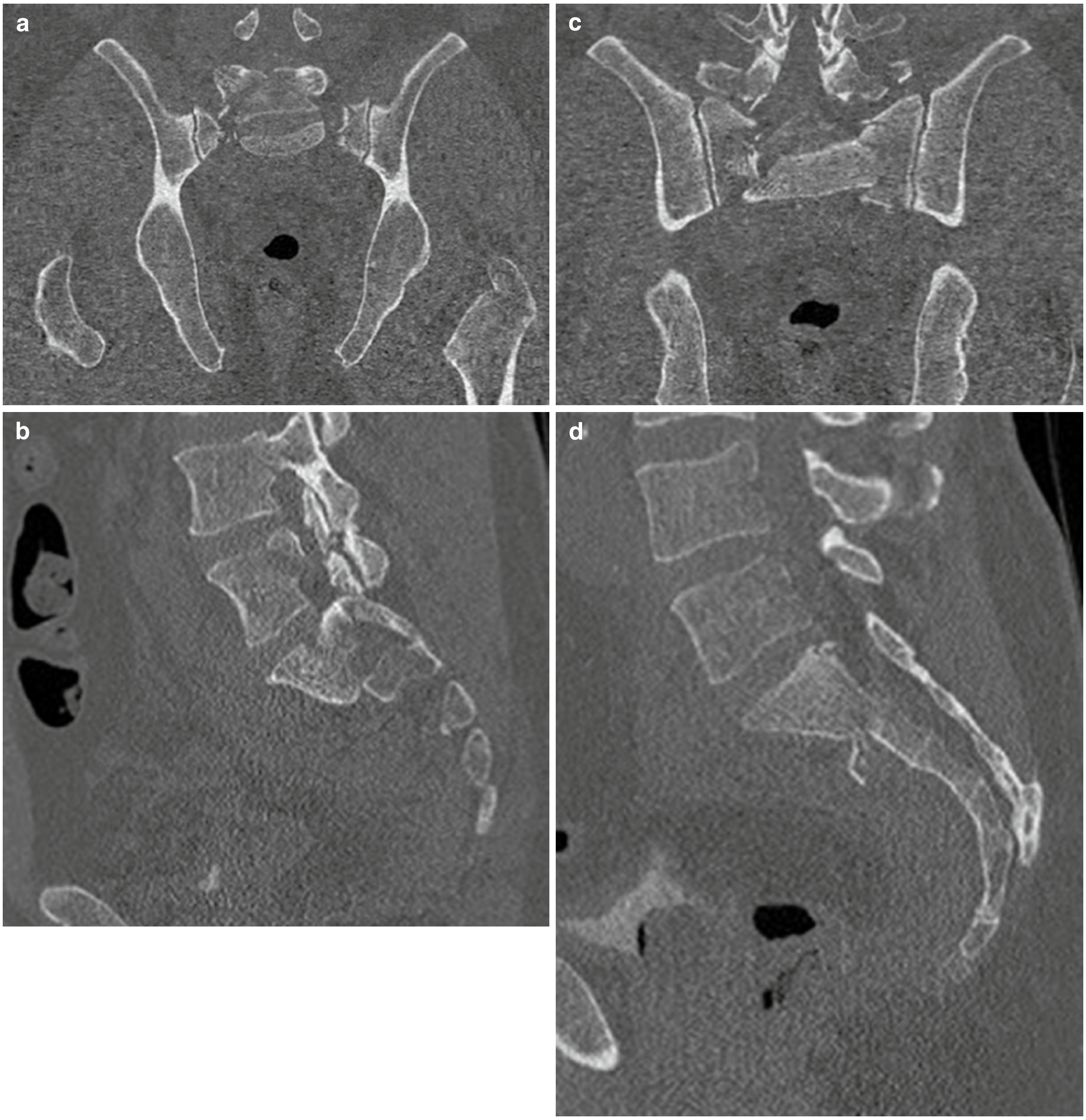

Fig. 30.1 (**a**) Computed tomography (CT) coronal reconstruction showing the right L5 pedicle fracture at the base and one can see how this plane of injury extends up from the sacral ala fracture, and in (**b**) a sagittal reconstruction of the same injury. The coronal in (**c**) demonstrates the bilateral sacral fractures in zone 2 on the *right* and zone 1 on the *left*, and (**d**) is a sagittal of the transverse sacral component through zone 3. The two parallel vertical fracture and one transverse sacral fracture combine into the "U" fracture pattern allowing the spine to separate from the pelvic ring and displace anteriorly

30.3 Indications and Advantages for Procedure Contraindications and Disadvantages for Procedure

Iliosacral screws are generally utilized in the setting of pelvic fractures to address the posterior component. This can be a sacroiliac dislocation or involve fracture through the sacrum. Some fractures through the sacrum extend into the L5–S1 facet and may be associated with a facet dislocation (Fig. 30.4). In these instances the hemipelvis is typically translated posterior and superiorly, and the reduction can be achieved with the patient prone and via a midline posterior spine

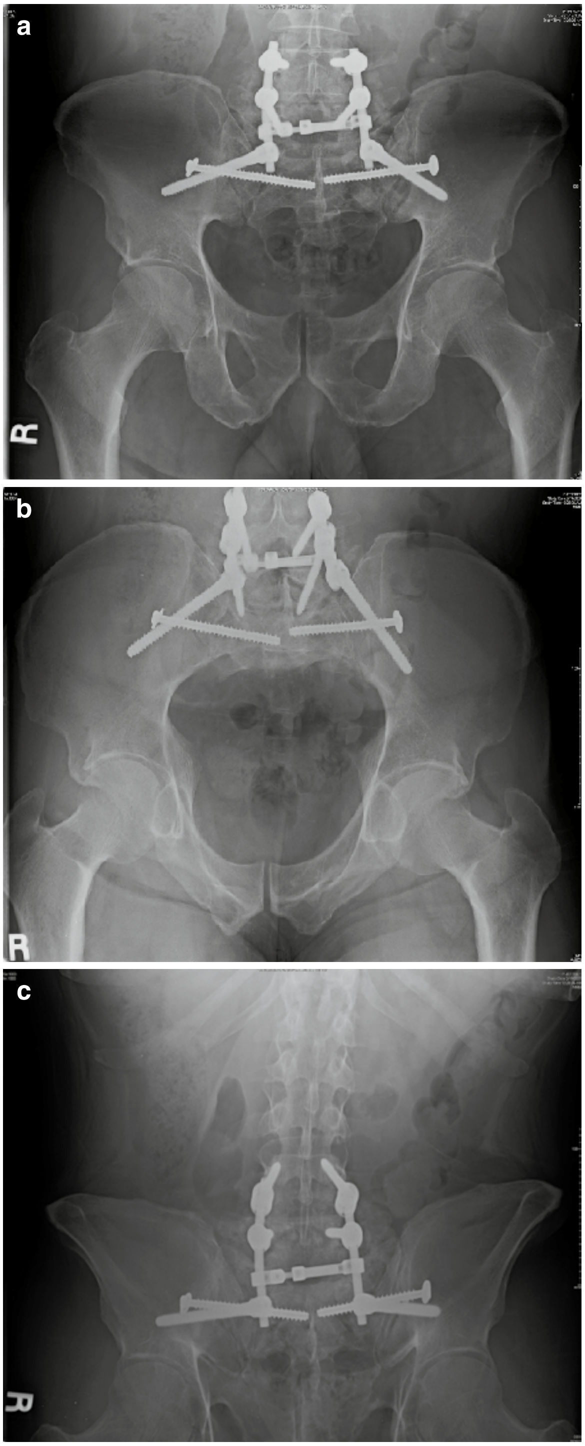

Fig. 30.2 The postoperative fixation with screws at L4 and L5 connecting to iliac wing screws and bilateral percutaneous iliosacral screws is shown in an AP (**a**), inlet (**b**), and outlet (**c**) views

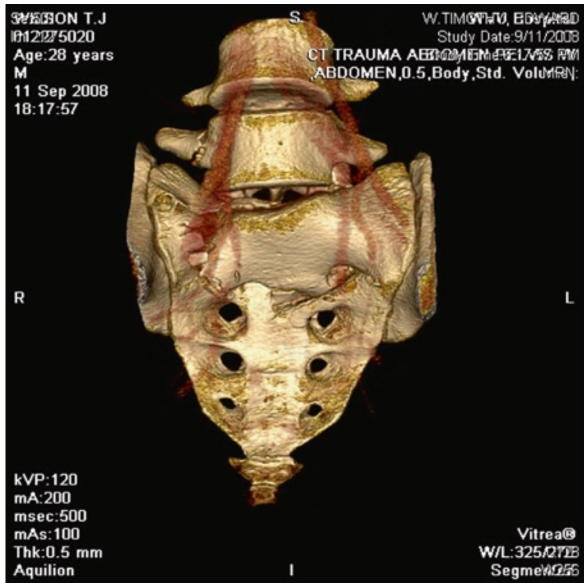

Fig. 30.3 A three-dimensional reconstruction of a lumbosacral spine showing a "U" type fracture of the sacrum with right sacral ala fracture extending transversely across the sacral vertebral bodies and into the left sacroiliac joint essentially breaking the spine free from the pelvic ring

Fig. 30.4 An axial CT of the pelvis at the lumbosacral junction demonstrating a dislocation of the left L5–S1 joint as part of a hemipelvis fracture. The pattern is best handled posteriorly to aid in reduction and fixation can then extend into the lumbar spine to fix both the spine and pelvic components

approach, which may involve the spine surgeon. One effective fixation technique utilizes lumbar pedicle screws and iliac wing screws. The fixation can be supplemented with percutaneous iliosacral screws as in the above case example. These are typically very unstable pelvic fractures and adding iliosacral screws offers another direction of fixation improving the stability without having to reposition or redrape the patient. If an adequate reduction cannot be accomplished then iliosacral screws are relatively contraindicated because the distorted anatomy potentially puts the neural elements into the path of the screw.

Sacroiliac fusion can also be accomplished using iliosacral screws. This can be done easily with the patient prone to allow access for direct exposure of the joint and percutaneous screw placement. Compression across the joint helps to create stability and aids in gaining bony union.

30.4 Procedure

30.4.1 Equipment Needed

If one is treating a sacroiliac fracture that extends through the L5–S1 junction as in the case example, then standard spine instrumentation is needed. For the iliosacral screw insertion, large cannulated screws are used, typically 7.0 or 7.3 mm in diameter. If compression is desired then partially threaded screws are used. If compression is to be avoided then a fully threaded screw is used. This is covered in more detail later in the technique.

30.4.2 Anesthetic and Neuromonitoring Considerations

If reduction of the hemipelvis is necessary then muscle relaxation is beneficial. Because the pelvis has a complex three-dimensional anatomy and air or stool in the colon can impede visualization, the surrounding neural elements are at risk. A bowel prep can be considered especially in the trauma setting where they may received a CT scan with bowel contrast that would markedly impair visualization. Also during reduction the roots can become entrapped. Thus, neuromonitoring specifically to assess L5, S1, and lower sacral root function is prudent. A Foley catheter is used to drain the bladder to improve imaging.

30.4.3 Patient Positioning and Room Setup

The patient can be positioned either prone or supine. This can be based on surgeon preference or may be dictated by the circumstances that warrant the placement of an iliosacral screw. For example, if the patient has a pelvic fracture and an external fixator frame is being used then it would be easier to position the patient supine. If the patient has a sacroiliac fracture dislocation and associated L5–S1 facet dislocation then prone positioning would allow the surgeon to address the spine component and the sacroiliac screw simultaneously.

Prone: C-arm excursion is important and requires enough room under the table to tilt the arm into inlet and outlet views so the operating room table must be radiolucent over a wide area. The Jackson frame is ideal for C-arm access and the spine positioning pads work well. The prep should include the buttock and anteriorly as far as the hip/thigh pads will allow.

Supine: A folded blanket or towel can be placed under the patient's pelvis in the midline to elevate the patient off the table, which improves the access to the lateral aspect of the buttock. The prep should be done as posterior as the table will allow to assure inclusion of the starting point. Criteria for C-arm access are similar to prone positioning and the Jackson flat top again is ideal.

30.4.4 Surgical Approach, Reduction Technique, and Fixation Technique

Step 1: Lateral C-arm

Once positioned and draped, the author's preferred starting position is with the C-arm in lateral. The first step is to manipulate the fluoroscopy unit into a "true" lateral image (Fig. 30.5). The true lateral is determined by aligning the sciatic notches and hip joints in perfect parallel. This finding gives a lateral image of the sacrum. Because the sacrum is aligned obliquely to the floor, one can easily get confused on the anterior–posterior and caudal–cephalad planes, which makes it difficult to direct the guide pin and screw. The anterior–posterior (Fig. 30.6b) and cephalad–caudal (Fig. 30.6a) planes of the sacrum can be marked on the exterior of the patient to be used as a reference throughout the remainder of the procedure (Fig. 30.6c). Lastly, the anterior edge of the sacral ala should be noted.

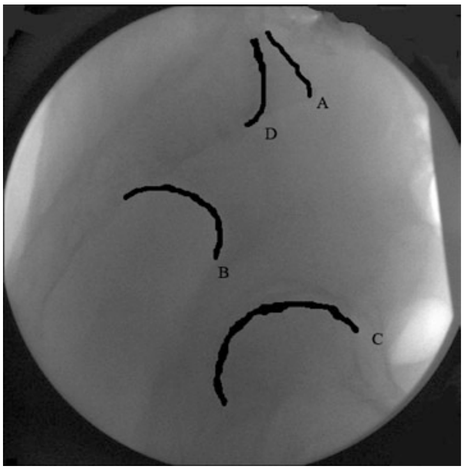

Fig. 30.5 A true lateral fluoroscopic image is necessary to accurately assess the anatomic landmarks. *Line A* is the superior S1 endplate and should be perpendicular to the image beam. *Line B* is the sciatic notches perfectly overlapped and *line C* is the acetabulum perfectly overlapped. Lastly, *line D* shows the sacral ala, which is important to identify in order to avoid the L5 nerve root

While the C-arm is in the lateral position the starting point can be identified (Fig. 30.7a). The anticipated direction in the axial plane runs from posterior to anterior; thus, the starting point on the lateral image appears to be in the central canal and can be planned from the preoperative CT scan of the pelvis (Fig. 30.7b). The guide pin is inserted through a small stab down to contact with the bone. The insertion stab can be widened around the guide pin to accommodate the working cannulas after the site has been radiographically verified as the proper site. By doing this, the insertion site can easily be revised without creating a large incision.

Step 2: Inlet and outlet images

Once the guide pin is positioned on the lateral image, it is held firmly against the bone and the C-arm is rotated into the inlet and outlet views. The starting point can be reviewed and then the direction of insertion can be completed. The *inlet view* (Fig. 30.8) is obtained by tilting the C-arm approximately in line with the cephalad–caudal line drawn on the patient and is used to direct the anterior–posterior direction of the guide pin. A clear picture of the anterior border of the S1 vertebral body, the spinal canal, and the anterior edge of the sacral ala housing the L5 root must be

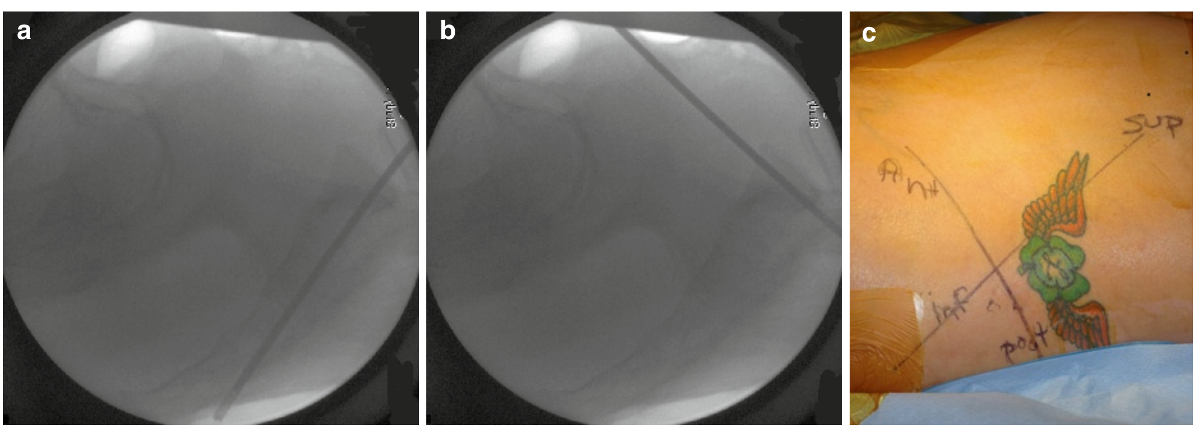

Fig. 30.6 The lateral image can be used to set up the C-arm angles for the inlet and outlet views and to help the surgeon understand the anterior–posterior and cephalad–caudal directions while working under the image. (**a**) Lateral sacral view with a Steinmann pin oriented along the cephalad–caudal direction of the sacrum, this line can translated onto the skin (**c**). Movement along that line guides cephalad–caudal adjustments and when the image beam is parallel to the same line it is in the inlet view. (**b**) The Steinmann pin oriented in the anterior–posterior direction to guide adjustments (**c** this line translated onto the skin) and when the beam of the image is parallel to this line it is in the outlet view

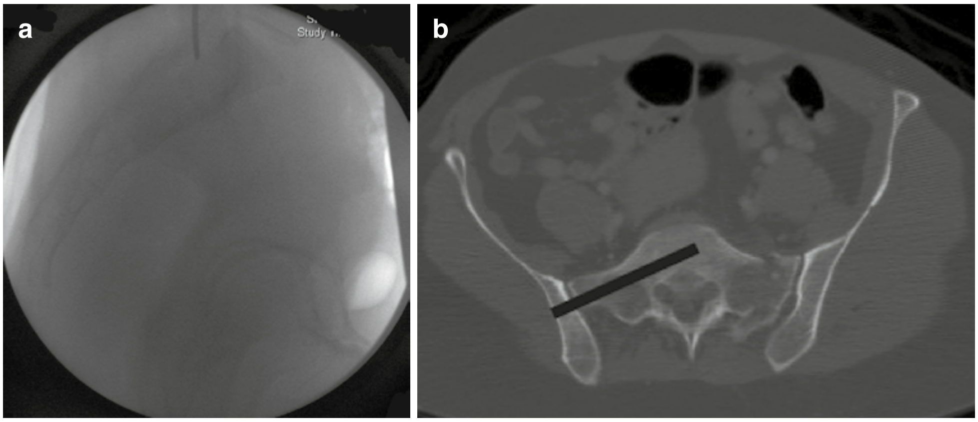

Fig. 30.7 The starting point on the lateral image should appear posterior in the canal (**a**) since the direction of the screw should run posterior to anterior as can be seen on the uninjured side of the pelvis in axial CT scan in (**b**)

Fig. 30.8 The inlet view should provide a good view of the S1 vertebral body and anterior border of the sacral ala, to avoid the canal posteriorly and the L5 root anteriorly

Fig. 30.9 The outlet view should provide a tangential view across the superior endplate of S1 and the S1 neuroforamin should be well seen to avoid the corresponding nerve root

obtained to minimize risk. The *outlet view* (Fig. 30.9) is obtained by tilting the C-arm approximately in line with the anterior–posterior line drawn on the patient and is used to direct the guide pin in the cephalad–caudal direction. A clear picture of the S1 foramina and L5–S1 disc must be obtained to minimize risk of injuries in this view.

By working back and forth between the inlet and outlet views the guide pin can be gradually passed through the ilium, across the sacroiliac joint, and into the body of the S1 vertebrae. The type of screw selected will determine if the path requires drilling or tapping, or is a self-drilling or self-tapping screw.

Step 3: The screw

The author prefers a cannulated 7.3 mm screw that is self-drilling and self-tapping to eliminate steps, others use a 7.0 mm screw that requires drilling and tapping with a noncutting screw tip, but the latter has a smaller diameter guide wire that is more challenging to direct. If there is a fracture through the sacral foramina then one must avoid compression across the fracture that may close the foramina and injure the sacral roots. Similarly, compression should be avoided in a comminuted alar fracture that would contribute to shortening the alar wing. When the prior two circumstances are present a fully threaded screw should be used, otherwise a partially threaded screw can be used to create compression (Fig. 30.10a, b). The author prefers to use a washer to prevent the screw head from penetrating the outer cortex of the iliac wing and to aid the compression force. In addition, as the screw is nearing full insertion the C-arm can be rotated more in-line with the iliac wing to better

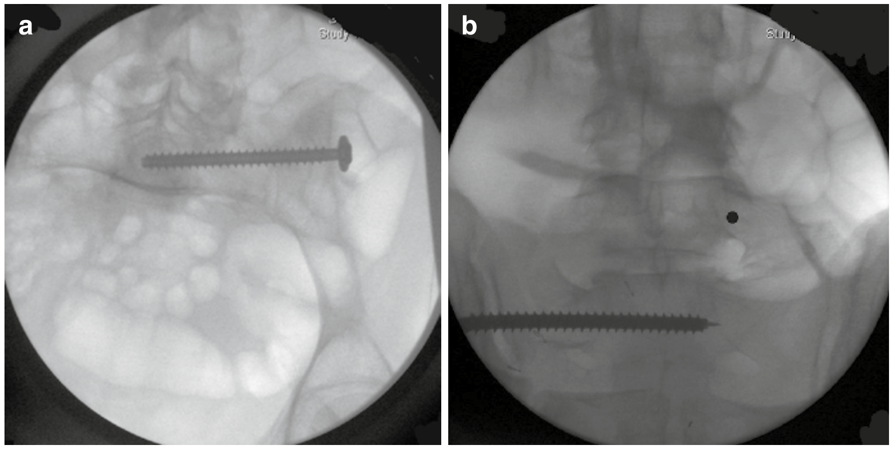

Fig. 30.10 (**a**) Shows the inlet view with a fully threaded screw. (**b**) Shows an outlet view

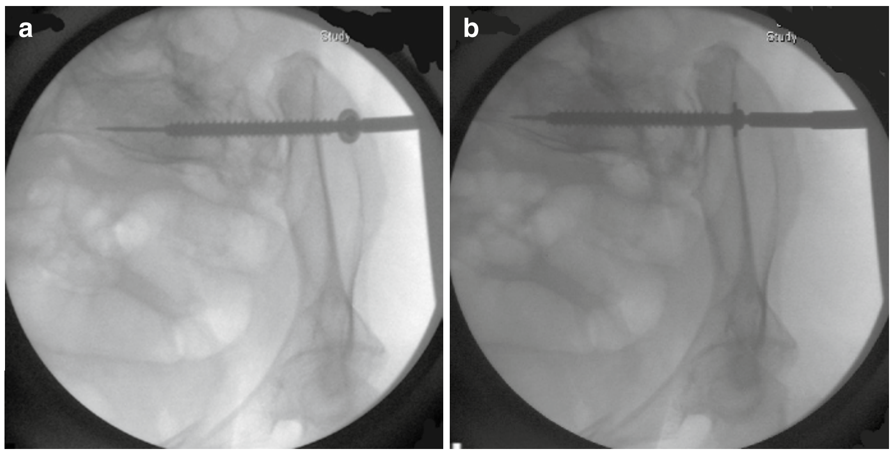

Fig. 30.11 The view can be used to verify that the screw is fully seated with the washer against the lateral ilium. It is an inlet/obturator oblique view (rotate the C-arm about 45° off AP, while in the inlet position). (**a**) Shows the screw short of being seated with the washer loose. (**b**) Shows the screw fully seated with the washer tight against the lateral cortex of the iliac wing

visualize the outer cortex of the iliac wing and the surgeon will see the washer touch the cortex and realign itself flat against the cortex as it is tightened (Fig. 30.11a, b). This appearance resembles an obturator oblique view.

If additional stability is needed a second screw can be inserted. This can sometimes be done at the S1 body level but at times is done at the S2 body level (Fig. 30.12).

Fig. 30.12 An outlet view of two iliosacral screws, one at S1 and the other at S2

30.5 Complications and Postoperative Considerations

The most common significant complication associated with this technique is neurological injury. The L5 nerve is most vulnerable if a screw is directed too anterior since it lays on the anterior surface of the sacral ala (Fig. 30.13). In patients with typical anatomy the anterior surface of the ala can be well visualized on the inlet view (also the lateral can be useful), but there are many anatomic variants that include sacralization of

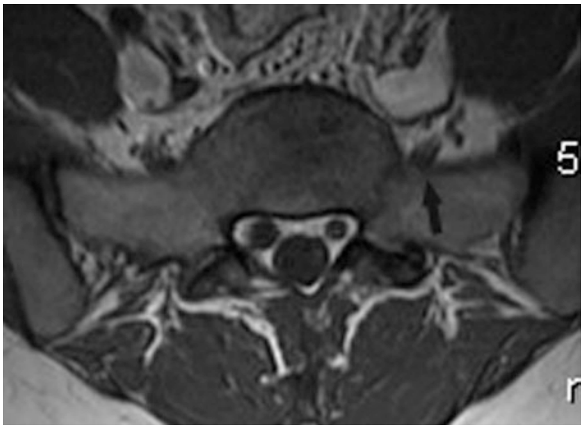

Fig. 30.13 An axial magnetic resonance imaging (MRI) image with the *arrow* pointing at the *left* L5 root as it abuts the sacral ala making it vulnerable to injury if an iliosacral screw is inadvertently directed too anterior

Fig. 30.14 An axial CT of an anomalous sacrum with the anterior surface of the *left* ala more posterior than the anterior surface of the *right* ala. This can be difficult to appreciate on intraoperative fluoroscopy and creates a shallow "safe zone" for passage of the screw

the L5 vertebrae and lumbarization of the S1 vertebrae. Additionally some people have a deeper groove for the ala that narrows the "safe zone" (Fig. 30.14) for screw insertion. Careful inspection of the preoperative CT images can allow the surgeon to recognize these anomalies and minimize risk. The S1 root is vulnerable within the anterior foramen. The outlet view is used to define the S1 foramen. Typically, the C-arm is tilted on the outlet view to make the superior endplate of S1 perpendicular to the beam. But, the S1 foramen may run anterior–inferior to posterior–superior relative to that end plate so it is useful to adjust the tilt into slightly more "outlet" to get a more tangential view through the S1 foramen. The more caudal sacral roots can be injured if the screw is directed too posterior and enters the central canal. The L5, S1, and lower sacral roots are not only vulnerable to screw misdirection but can be injured during reduction when entrapped within an alar fracture and if the fracture extends through the sacral foramen or central canal. When these circumstances are present, a fully threaded screw would be utilized to prevent compression. Because intraoperative fluoroscopy has limited visualization, it is a good idea to obtain a postoperative CT scan to accurately evaluate the screw positions. Once recognized, the offending screw can be removed and replaced or redirected if the degree of neurological compromise warrants.

The potential for bowel or vascular injury is rare but exists if a screw is directed too anterior or if the guide wire is inadvertently advanced while passing the drill, tap, or screw. Thus, frequent fluoroscopic images should be obtained during these steps to recognize this problem and the postoperative CT scan will identify any screw that is excessively long. Some injury could go unrecognized so one must remain vigilant and aware of potential intra-operative while the patient convalesces.

In more severely displaced fractures loss of fixation can occur as the posterior pelvis rotates around the screw or is angulated. This can be minimized with the addition of a second posterior screw and other means to control the anterior pelvis such as plating and external fixation (Fig. 30.15).

Over time many sacroiliac joints will autofuse if the injury is through the joint. When fusion fails to occur, screw loosening or breakage can occur over time. This does not typically pose a problem since the pelvis has usually become stable prior to breakage. In circumstances where sacroiliac fusion is the primary purpose of the procedure the cleaning the cartilage and fibrous tissue from the joint, then packing bone graft is important to avoid a nonunion and screw breakage or loosening (Fig. 30.16).

There is no need for external bracing. The weight-bearing status is more dependent on the pathology

Fig. 30.15 This is an AP pelvis of a 25-year-old female who initially had an unstable pelvic fracture treated with bilateral iliosacral screws and an anterior external fixator frame. Her injury was further complicated by the fact that she had delivered a baby 6 weeks earlier and had lax ligamentous support for her pelvis. Despite an anatomic reduction, initially her hemipelvis continued to rotate and displace. A second iliosacral screw may have better controlled these rotational forces

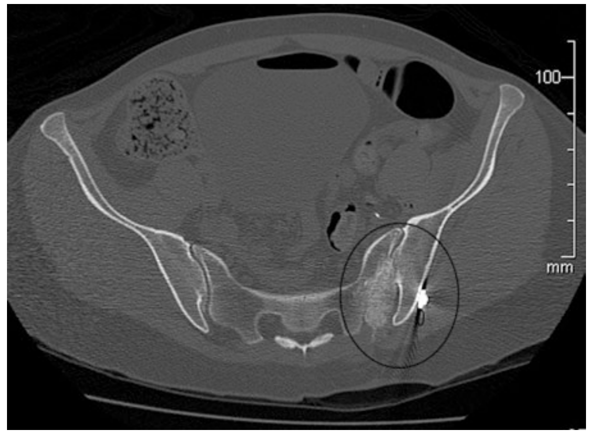

Fig. 30.16 An axial CT with a circle around the bone graft impacted into the sacroiliac joint for fusion

being treated. For a highly unstable pelvic fracture, touch down weight bearing for 6–12 weeks is recommended. For intrinsically stable condition such as sacroiliac fusion for arthrosis, which will maintain that stability postoperatively, weight bearing as tolerated is used, often with ambulatory aids for 6 weeks as a reminder to the patient to minimize the rotational and axial loads across the joint. The healing across the sacroiliac joint can be followed with specific sacroiliac views (essentially an obturator oblique view) to look directly through the joint, and the overall pelvic alignment is evaluated with Antero Posterior (AP), inlet, and outlet pelvic radiographs. If a better view of the actual fusion integrity is required after 6 months then CT scanning is the modality of choice.