Chapter 26
Percutaneous Iliac and S2AI Fixation

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Pelvic instrumentation in the form of iliac bolts [1] or S2AI screws provides distal fixation to long-construct fusions for deformity or scoliosis [2]. The techniques, while similar, provide unique challenges, such as necessitating cross-connectors for iliac bolts, or breaching the sacroiliac (SI) joint in S2AI. Anatomically, the axial spine consists of vertebrae from cervical to lumbar, ending atop the sacrum distally. The sacrum articulates with the ilia bilaterally forming a flat sacroiliac (SI) joint with minimal motion. Both the ilium and the sacrum provide distal fixation points for instrumented spinal fusions. Studies have shown a high pseudoarthrosis rate at the lumbosacral junction when distal fixation ends at S1 [3–5]. Several biomechanical studies have shown increased rigidity at the lumbosacral junction with the addition of iliac fixation [6–9]. Alternatively, pelvic fixation can serve as an adjunct to internal fixation or definitive treatment for comminuted sacral fractures and pelvic ring injuries with spinopelvic dissociation.

The ilium provides a bony corridor from the posterior superior iliac spine (PSIS) to the anterior inferior iliac spine (AIIS) that can hold one or two large diameter screws. The sacroiliac joint is a wide, flat joint between the sacrum and the ilium bilaterally. This joint has two areas, the inferior half of which is lined with cartilage and does allow minimal motion. S2AI screw trajectory is such that placement does not always penetrate this area of articulation [10] and the long-term effects of such are not well-studied.

Radiographically, this corridor of bone is visualized on the obturator outlet view and known as the teardrop. The teardrop is the confluence of three points: the posterior superior iliac spine, the sciatic notch, and the anterior inferior iliac spine [11]. This starting point can be entered from the PSIS with trajectory toward the AIIS or via a sacral start point in S2 and directed across the sacroiliac joint toward the

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AIIS. Trajectory should be confirmed on the iliac outlet view to ensure the greater sciatic notch is not penetrated. Alternatively, placement of these screws can be performed with the assistance of CT-guided navigation [12].

Technical Notes

The S2AI start point is inferior and along the lateral edge to the first dorsal foramen. An AP view of the sacrum can provide visualization of the start point as seen in Fig. 26.1. With the trajectory toward the greater trochanter for reference, an incision should be made approximately 1/2 cm medial to the start point to allow placement of the screw without issues with the skin. Sharp incision is made and dissection through the fascia is crucial. A cannulated needle, such as the Jamshidi™, is then placed onto the start point with an AP sacrum. The C-arm is then brought into the obturator outlet view to identify the teardrop which demonstrates the iliac corridor, as shown in Fig. 26.2. The ideal image as shown in Fig. 26.2a shows the teardrop sitting atop the hip joint. The cannulated needle is then advanced down the length of the iliac corridor. The S2AI trajectory appears more horizontal and with more posteriorly oriented as it enters the sacrum more medially. At approximately 40 mm, the c-arm is rotated to view the iliac wing, iliac outlet view (Fig. 26.2c). On this image, one visualizes the SI joint and the needle crossing it into the ilium, as well as the trajectory across the ilium but superior to the greater sciatic notch. Once confirmed that the trajectory is in bone, the cannulated needle can be passed into the ilium to a depth of up to 120 mm [12]. The center needle is removed, and a guidewire is placed down its length. The remainder of the cannulated needle is removed. The guidewire can be used like a ball-tip probe to feel the track and ensure there is no breach.

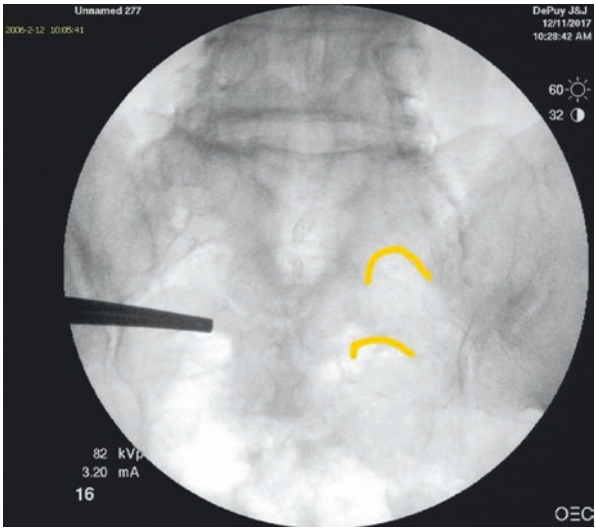

Fig. 26.1 Cadaveric fluoroscopic images of S2AI fixation. AP sacrum demonstrating S2 start point on prone specimen, left. Right-sided first and second dorsal foramen are outlined

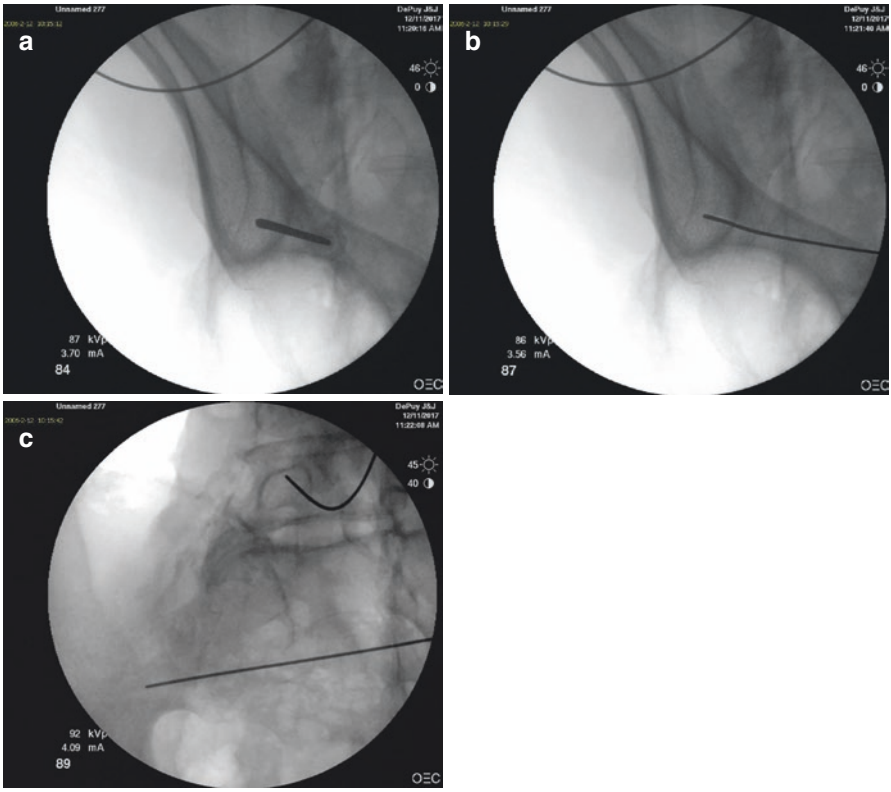

Fig. 26.2 Cadaveric fluoroscopic images of S2AI fixation. Images (**a**) and (**b**) demonstrate the teardrop view from obturator-outlet radiograph. The femoral heads are removed from this cadaveric specimen, but the teardrop is visualized atop the acetabulum. The cannulated needle/guidewire trajectory has a more horizontal and posterior orientation. The notch view (**c**) shows the guidewire across the SI joint and superior to the greater sciatic notch

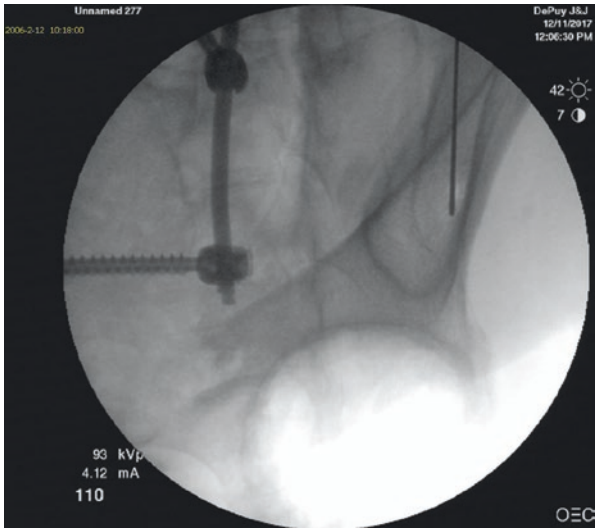

Fig. 26.3 Cadaveric fluoroscopic image of iliac fixation. Image demonstrates the teardrop view from obturator-outlet radiograph. The femoral heads are removed from this cadaveric specimen, but the teardrop is visualized atop the acetabulum. The guidewire trajectory is directed down the length of the ilium

Placing an iliac bolt requires an incision again medial to its start point on the PSIS. Dissection is carried down through fascia to the PSIS. Through even a small incision, a narrow leksell rongeur can be used to remove cortical bone in order to countersink the head of the screw, making it less prominent. Alternatively, a high-speed burr can be utilized to provide a cortical window for screw placement. Following this, a standard pedicle gearshift probe may be utilized to develop the tract from PSIS to AIIS in the iliac wing for iliac bolt placement. Again, the trajectory is toward the greater trochanter, or visualized on the teardrop, obturator outlet view. Once the iliac wing is probed, a guidewire is placed down the length of the corridor for placement of the cannulated screw, as demonstrated in Fig. 26.3.

Connecting one's S2AI screw to the cephalad construct is simpler than an iliac bolt, as the placement is such that the head of the screw is in-line with the construct. Whereas the iliac bolt may require an additional connection to the cephalad construct requiring larger mini-open incision or a separate incision altogether. In certain cases, such as lumbopelvic fixation for lumbopelvic dissociation, where an S1 screw is not placed, connecting an iliac bolt to L5 is feasible without additional connections, as shown in Fig. 26.4.

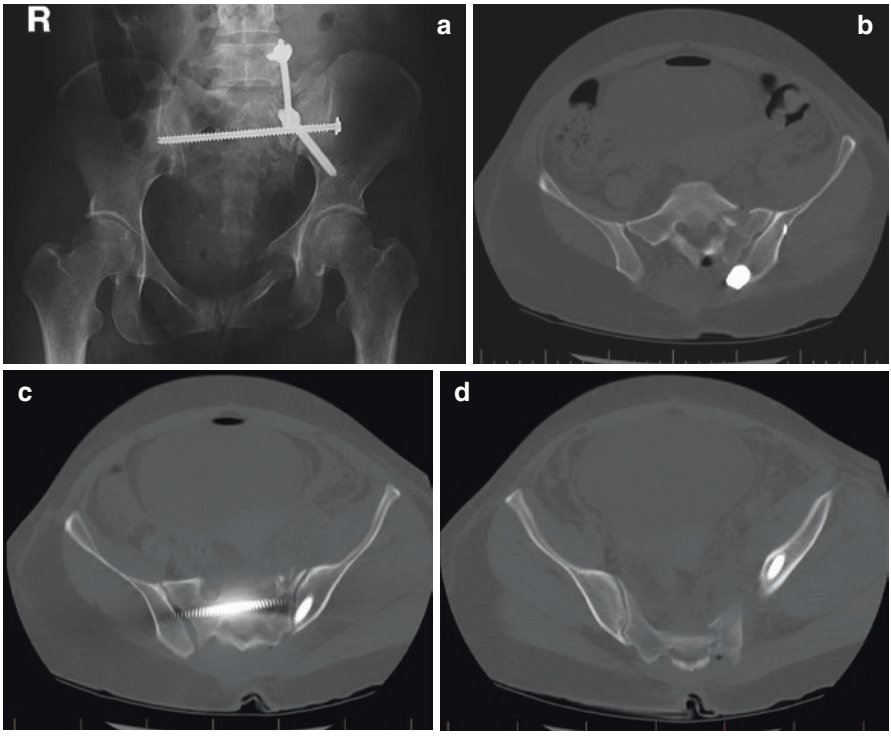

Fig. 26.4 Post-operative radiograph (**a**) and CT (**b–d**) images depicting adjunct lumbopelvic fixation for comminuted pelvic ring injury. The iliac bolt traverses the ilium passed the transsacral screw and is affixed to the L5 pedicle screw without the need for a transconnector

Conclusion

Pelvic fixation is an important technique utilized for increased rigidity at the lumbosacral junction to lessen the risk of pseudoarthosis in long-construct fusions, or additional fixation in trauma cases. These techniques have been shown to be feasible and safe in percutaneous fashion. Understanding anatomy provides the knowledge to place screws with minimal risk to vital structures.

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