Stabilization of Unstable Pelvic Fractures With Supraacetabular Compression External Fixation

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Summary: External fixation for pelvic stabilization is an important component of the overall treatment of patients with high-energy pelvic fractures. Traditional constructs include single and multiple pin placements in several locations in each iliac crest. Biomechanical and anatomic studies have focused on pin placement lower on the pelvis, specifically in the supraacetabular region. Pins in this location are more stable biomechanically, allow for pelvic reduction in the transverse plane of deformity, facilitate concurrent or subsequent laparotomy procedures, and may allow improved reduction of the posterior elements with a femoral distractor as a compressor. We describe the technique for placement of supraacetabular external fixation pins, pelvic reduction, and compression using a femoral distractor.

Key Words: pelvis, fracture, external fixation, supraacetabular, pin placement, femoral distractor, pelvic compressor

(*J Orthop Trauma* 2007;21:269–273)

INTRODUCTION

Stabilization of unstable pelvic fractures in critically injured patients is a necessary component of the early resuscitation protocol. Anterior pelvic external fixation has become a mainstay of initial pelvic stabilization and has been shown to reduce mortality in the multiply injured patient with a severe pelvic fracture.[1–4] The efficacy of external fixation may be due to several mechanisms including reduction of pelvic volume, stabilization of the fracture surfaces, allowing venous tamponade, providing containment of the pelvic hematoma, and allowing for upright patient mobilization.[1,5–9] Rotationally unstable (APC II or LPC III) or vertically unstable (APC III or VS) injuries are most likely to benefit from initial external fixation,[10–12] but external fixation may also be useful for deformity correction in lateral compression injuries.[13]

Many techniques for external fixation pin placement in the pelvis have been described, but the superior position in the region of the anterior superior iliac spine and iliac wing has been used most frequently.[10,14] Several authors have reported on placement of pins in the dense supraacetabular (SA) region at the anterior inferior iliac spine (AIIS),[13,15–21] which may have some particular advantages over traditional superior pins. However, a concise and comprehensive technique specifically for SA pin placement has not previously been described.

Technique

The patient is placed supine on a radiolucent table, and the skin is sterilely prepared and draped from the xiphoid to the proximal thighs, isolating the perineum. The starting point for the pin is identified radiographically as the column of bone that runs from the AIIS (anteriorly) to the posterior superior iliac spine (PSIS) posteriorly, which appears as a teardrop when viewed directly on end (Fig. 1). The fluoroscopic beam is placed in an obturator-outlet position relative to the affected hemipelvis. Initially, the beam is rotated 30 degrees cephalad (outlet) and 30 degrees externally (obturator oblique), and the angle in both planes is adjusted until directly parallel with this osseous column. Correctly identifying this landmark is critical to placing the pin, so care should be taken with minor fluoroscopic adjustments to achieve the perfect view. The inferior aspect of the teardrop should be just above the acetabular dome and the greater sciatic notch, the cortex of the inner table should be have no double density and will appear as a medial radiographic line, and the corridor of bone should appear as narrow as possible (Fig. 1). Thorough knowledge of pelvic anatomy and this specific radiographic view will expedite pin placement in emergency situations. Once this view is obtained, a radiolucent marker such as a pin is placed in line with the beam and positioned over the bony column to determine the skin entry site, and a 1 cm incision is made. The soft tissues are bluntly spread vertically to minimize risk of damage to the lateral femoral cutaneous nerve branches.[22,23] A drill guide is placed through the incision and down to bone, ensuring that it rests in the center of the column and is at least 2 cm superior to the acetabular articular surface to avoid intracapsular pin placement.[15] A 3.2 mm drill is then placed through the guide and advanced approximately 5 cm, aiming superiorly and medially as directed by the intraoperative imaging. Fluoroscopy is used periodically to ensure that the drill remains within the radiographic corridor of bone and at the proper orientation. The drill is exchanged for an appropriately sized partially threaded pin that is 5.0 mm in diameter and at least 250 mm in length. The pins are not coated or tapered. The guide sleeve can then be removed and

Accepted for publication December 6, 2006.
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The devices that are the subject of this manuscript are FDA approved.
The authors did not receive grants or outside funding in support of their research or preparation of this manuscript.
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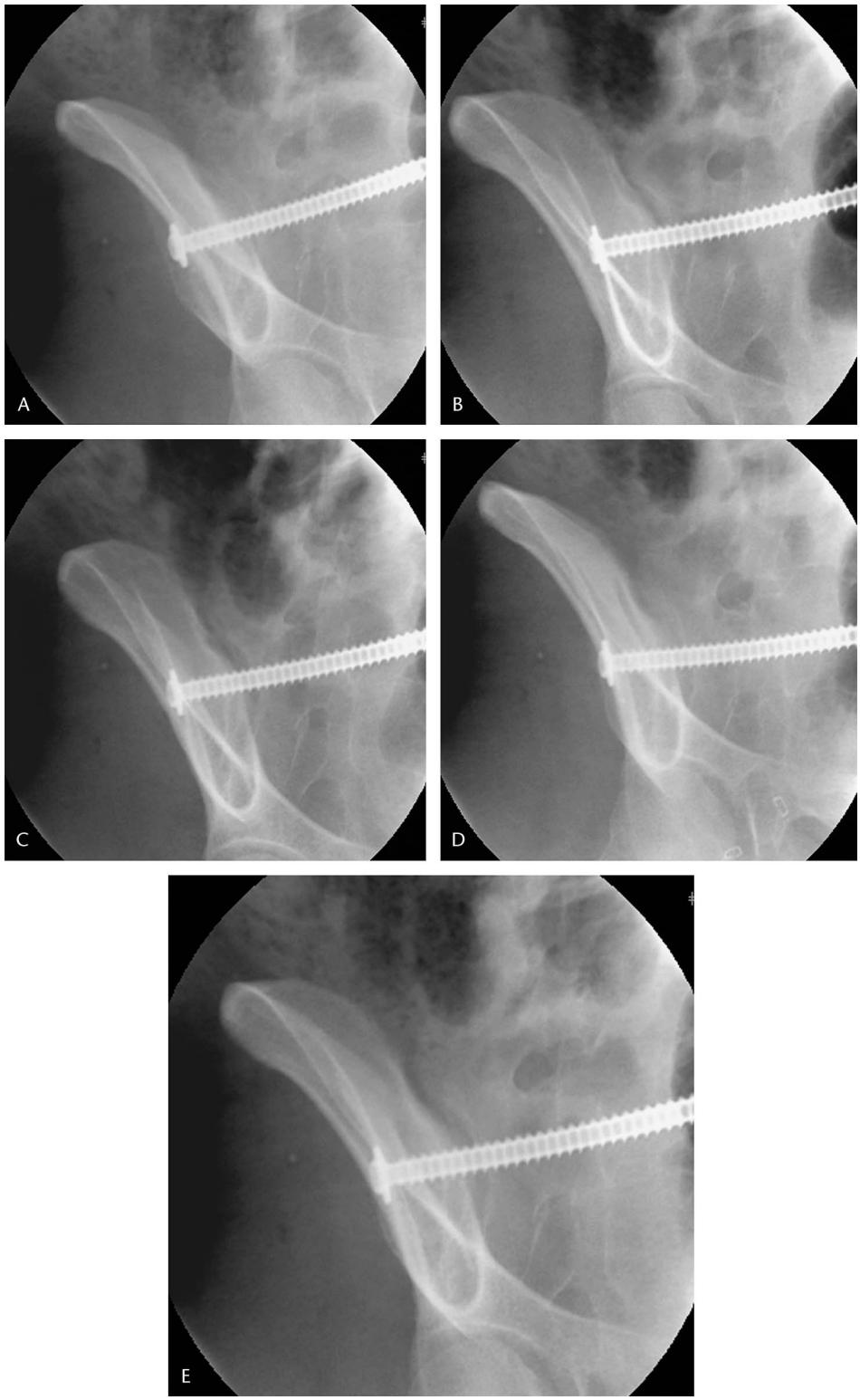

FIGURE 1. Identifying the correct starting point is critical for accurate and efficient pin placement. This series of radiographs demonstrates 5 degrees of overrotation (A) and underrotation (B) in the obturator oblique plane, 5 degrees of excess cephalad (C) or caudad (D) rotation in the outlet plane, and the desired view (E).

pin position can be verified on this view (Fig. 2). Although we have observed no mechanical failures of the construct with these pins, 6.0 mm pins may provide better frame stability in larger patients.

At this point, the fluoroscopic view is changed to an iliac oblique to confirm the relationship of the pin to the superior gluteal notch. The pin position should be approximately 1 to 2 cm above the notch. Finally, the fluoroscopy is changed to an

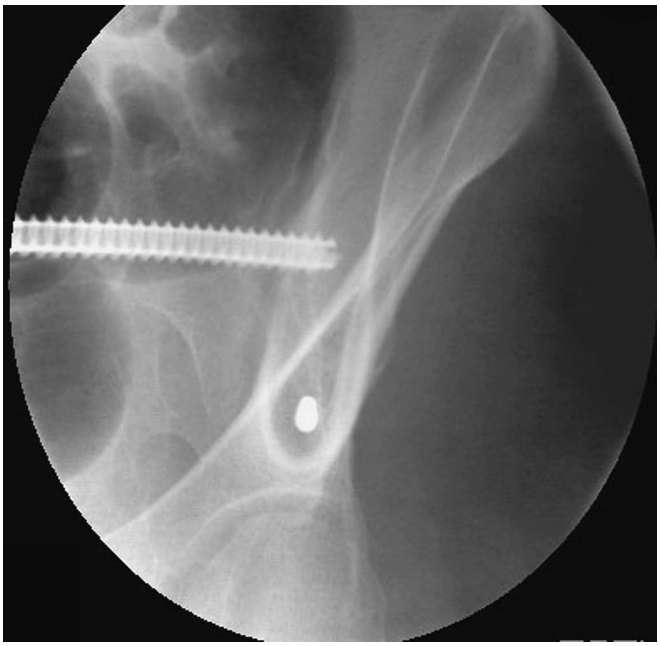

FIGURE 2. The obturator oblique view demonstrates correct pin position in the center of the corridor of bone from the AIIS to the PSIS.

inlet-obturator oblique view, which is perpendicular to the anterior-to-posterior corridor of bone and allows complete visualization of its entire length (Fig. 3). This view is used to ensure that the pin remains in bone along its length. A second pin is placed in the contralateral hemipelvis in a similar manner, and although moving the C-arm to the other side of the table may facilitate placement of the contralateral pin in a nonacute situation, it is not necessary.

After the pins have been appropriately placed, the pelvic deformity is reduced. The rotational deformity (typically external rotation of one hemipelvis) is addressed by manually manipulating the pin. Anterior symphyseal widening is often reduced with this maneuver. The sagittal plane deformity is similarly corrected with flexion or extension of the pin. Cephalad translation of the hemipelvis can be corrected with application of longitudinal traction, usually through a distal femoral traction pin.

With the injured hemipelvis grossly realigned, posterior widening at the sacroiliac joint may persist. Although control of the posterior pelvis with an anterior frame is only partially possible, the use of a femoral distractor as a compressor can produce some posterior reduction. The long sleeves for the femoral distractor are then placed over the pins until they contact bone, effectively translating the forces to the large threaded rod. The femoral distractor is tightened in this position, thereby locking the corrected deformities (Fig. 4).

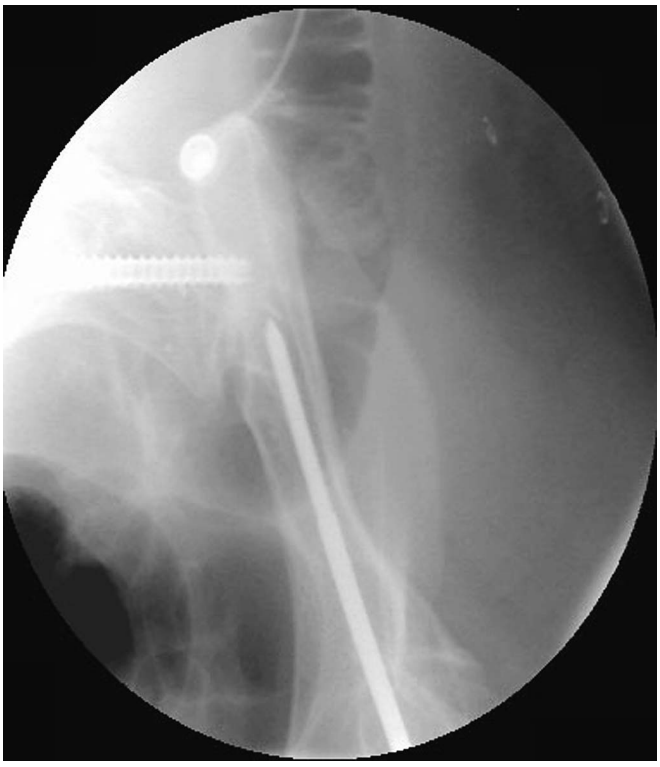

FIGURE 3. The final view in this series is an obturator inlet, which shows the length of the corridor and the pin contained within.

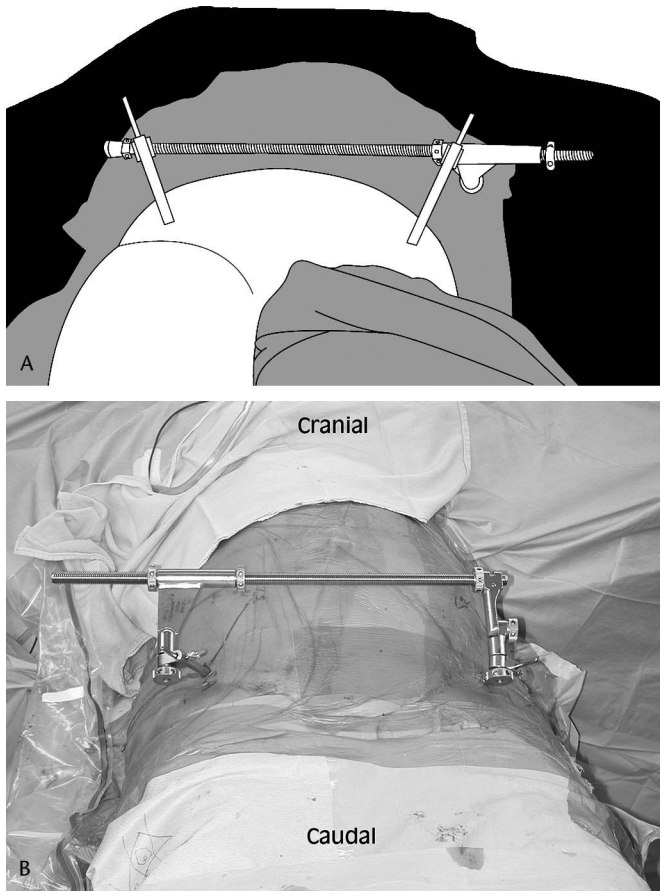

FIGURE 4. Schematic demonstrating the pelvic compressor in place and the appropriate angles of the pins, from an inferior vantage point (A), and a clinical example of the pelvic compressor (B).

The primary remaining deformity is the lateral translation of the hemipelvis, which is addressed by tightening the knurl nut on the threaded rod to allow compression along its axis and to medially translate the hemipelvis. The patient may be transported to the intensive care unit with the compressor in place until definitive fixation is performed (Fig. 5).

DISCUSSION

Several authors have reported on the biomechanics of pins placed in the SA position. Egbers et al[19] tested several AO frame constructs and found that placement in the dense SA bone yielded the strongest construct, particularly when the pins were directed from lateral to medial. Kim et al[16] used osteoporotic cadavers to compare SA pins to iliac crest pins and showed that the SA pin constructs were stronger in both B-type and C-type injuries. These authors hypothesized that this difference may have been even greater in young bone.[16] Additionally, the greater length of bone pin-interface allows for improved purchase.[24] Haidukewych et al[15] studied the neurovascular risks with placement of SA pins and noted that the high variability of the course of the lateral femoral cutaneous nerve placed it constantly at risk, and it should be protected using blunt dissection techniques. Additionally, they identified that the capsule of the hip joint extended 16 mm above the acetabulum on average, and pin placement at least 2 cm above the joint was recommended.[15] To our knowledge, inserting the pins from the anterior superior iliac spine into the PSIS and applying a femoral distractor as a compressor has not previously been reported.

Aside from achieving improved purchase along the maximum length of the ilium, several additional factors may make using SA pins advantageous. The inferior pin position greatly facilitates subsequent abdominal procedures compared to traditional anterior superior iliac spine pins. If the pins are angled cephalad appropriately, the pins and the frame can be safely draped out of the field while allowing full access to the abdomen. Reducing deformity, especially in an externally

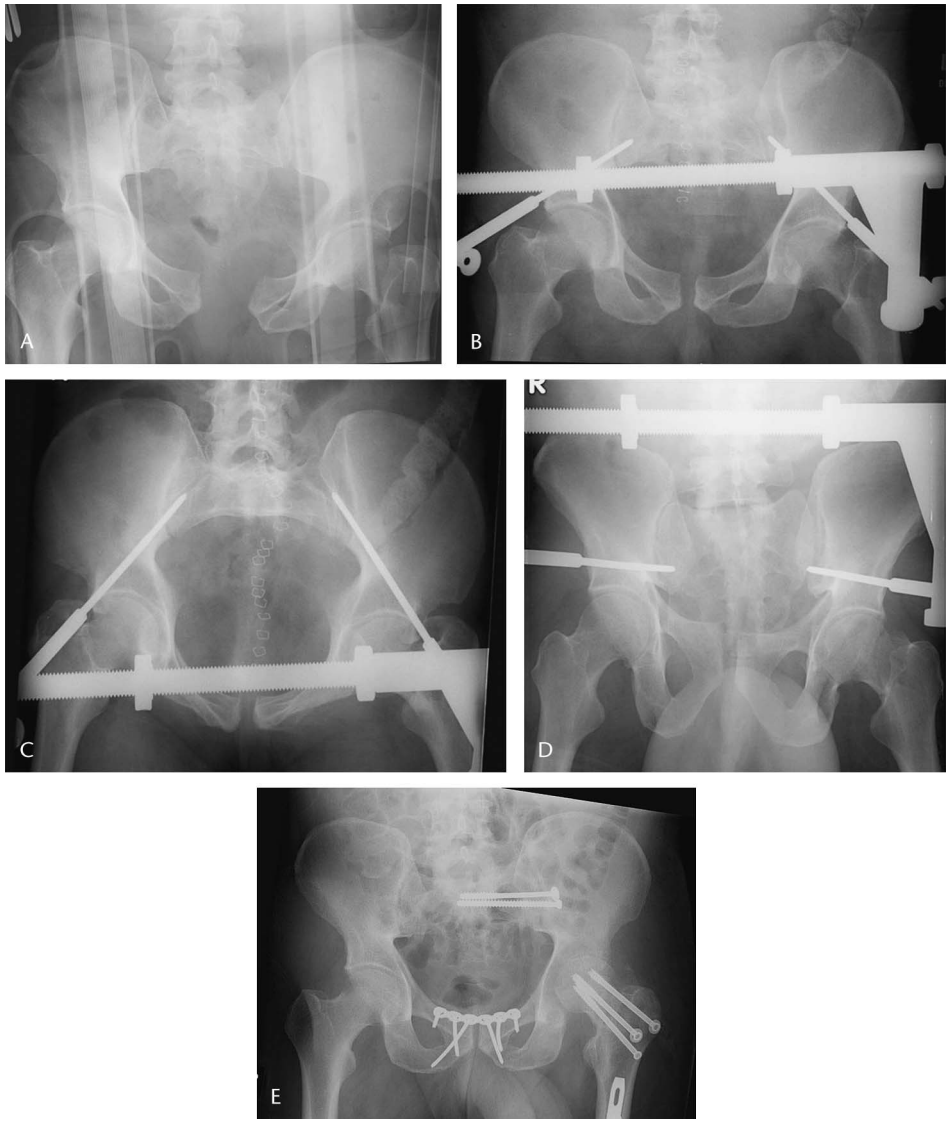

FIGURE 5. A 52-year-old man sustained multiple injuries after being struck by a motor vehicle. His pelvis was initially wrapped in a circumferential sheet, but his complete pubic symphyseal and left sacroiliac joint injuries remained significantly widened (AP view, A). Because of the patient's hemodynamic lability, definitive operative fixation of the pelvic ring was not initially possible. An anterior pelvic compressor was placed as described, and the reduction achieved is shown on the AP (B), inlet (C), and outlet views (D). Four days later, the patient stabilized and was cleared for definitive fixation of the pubic symphysis and the sacroiliac joint injury (AP view, E).

rotated hemipelvis in a B-type lesion, is also easier and more accurate because the SA pins are in the primary plane of the external rotation deformity.[25]

This anterior frame configuration using the femoral distractor allows for compression along the axis of the transverse threaded bar. The distractor pin sleeves, which connect the pins to the threaded bar, are tightened to securely stabilize this interface, as is typically done when this device is used. In addition, the pins are inserted until they are within the PSIS, a region that is anatomically posterior to the sacrum. In our anecdotal experience, both of these mechanical features contribute to medialization of the sciatic buttress, with compression across the sacroiliac joint. This posterior compressive force may be particularly useful in resuscitation, with stabilization of the ruptured presacral venous plexus or cancellous fracture surfaces. Because the biomechanical adequacy of this construct for stabilizing the entire pelvis is unknown, we do not recommend using this construct if vigorous patient mobilization is required before definitive fixation. However, this procedure may be considered as an alternative to posterior external fixation, circumferential sheeting, binding of the pelvis, and traction alone, especially in APC III injury patterns. Early adjunctive posterior (and anterior if applicable) internal fixation should ultimately be considered in these circumstances.

Since 2003, the use of SA pins for temporary pelvic stabilization has been performed successfully in the senior author's (S.E.N.) practice in 25 cases, and a pelvic compressor was applied in 4 of these cases. Moderate reduction and compression of the posterior pelvis was achieved with the compressor. No cases of injury to the lateral femoral cutaneous nerve have been observed. In several instances, a small region of heterotopic bone was seen to form at the pin entry site, but never larger than several millimeters, and no patient required excision of the bone. Compression dressings are placed on the pin sites for 7 to 10 days to allow soft-tissue stabilization, and this is followed by cleansing of the bases of the pins with dilute hydrogen peroxide twice daily. Superficial serous drainage is common, but antibiotic requirement was rare, and no deep infection or pin loosening requiring removal occurred. Patients are allowed to sit in bed and to transfer from the bed to chair; touchdown weight bearing on the injured side is supervised by a physiotherapist if the associated injuries allow.

Definitive open reduction and plating of the anterior pelvis is performed whenever possible, but if soft-tissue compromise or infection is present, the pins may remain in place for as long as necessary to allow bony and ligamentous healing. Overall, we have found this technique to be an extremely useful tool for treating patients with unstable pelvic fractures, and using a femoral distractor as a compressor may offer an additional dimension of control of the posterior pelvic ring.

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