Anterior Pelvic External Fixation: Is There an Optimal Placement for the Supra-Acetabular Pin?

Leo A. Calafi, MD, and ML Chip Routt, MD

Abstract

Anterior pelvic external fixation using supra-acetabular bone pins is frequently used for manipulation and reduction of unstable pelvic ring injuries prior to definitive fixation. The supra-acetabular bone pin must be strategically placed in order to provide optimal frame stability, patient comfort, and hip mobility, without obstructing subsequent osseous fixation pathways. We describe a technique for alternative placement of supra-acetabular bone pins. The intraoperative imaging is detailed. The bone pin starting point is located more cranially at the anterior inferior iliac spine than previously described and the pin is directed to accommodate better hip motion.

Fractures of the pelvis comprise approximately 2% of all skeletal fractures.[1] In patients with unstable pelvic fractures and hemodynamic instability, pelvic external fixation has become an integral part of the early resuscitation protocol, significantly reducing mortality rates.[2-5] It provides better bony stabilization than noninvasive methods such as binders or sheets, and contributes to hemostasis by maintaining a reduced and stable pelvic volume.[6] Pelvic external fixation may also be used as an adjunct to internal fixation in the management of unstable pelvic ring injuries.

The 2 common types of anterior pelvic external fixation (APEF) are based on the bone pin application sites: (1) iliac crest and (2) supra-acetabular. The early clinical and biomechanical series described APEF using bone pins inserted along the iliac crest and positioned between the iliac cortical tables. Some surgeons suggested that these iliac crest pins were simple and quick to apply using a variety of techniques. In reality, the iliac crest bone pins were difficult to reliably insert between the iliac cortical tables, and as a result, provided fixation that was often not durable. More recently, several authors have advocated for APEF using bone pins inserted at the anterior inferior iliac spine (AIIS) and contained within the pelvic brim bone.[7,8]

Although the technique for supra-acetabular external fixation has been previously described,[9-15] important details regarding optimal pin placement are lacking. The optimal supra-acetabular pins should provide maximal frame stability, patient comfort, hip mobility, and avoid obstructing potential internal fixation osseous pathways. This is an important consideration, since external fixation is often a temporary resuscitative measure prior to subsequent definitive fixation of anterior and posterior pelvic ring injuries.

We describe a simplistic and alternative fluoroscopically guided technique for supra-acetabular bone pins insertion that does not obstruct other local pelvic osseous fixation pathways.

Surgical Technique

The patient is placed supine on a radiolucent operating table. The entire abdomen and bilateral flanks are prepared with iodine solution and isopropyl alcohol, and then draped. The bone pin insertion is guided using C-arm fluoroscopy and the machine can be positioned on either side of the patient since bilateral bone pins are placed. A combination image of the obturator oblique and pelvic outlet (ie, obturator outlet) tilts is used initially to superimpose the AIIS on the pelvic brim osseous pathway. This potential osseous pathway has medial and lateral iliac cortical bone boundaries and has the appearance of a raindrop. Depending on the patient's positioning and pelvic deformity, the C-arm has to be adjusted to obtain an optimal view of the raindrop as previously described.[15]

A narrow diameter (2 mm) wire is then positioned on, but not through, the skin and superimposed on the cranial region of the AIIS (ie, apical portion of the raindrop). Since the obturator outlet C-arm position obstructs the wire insertion, the C-arm is repositioned maintaining the obturator oblique tilt but rotated to provide an obturator inlet combination image. This C-arm unit positioning allows the surgeon to work without obstruction. The obturator inlet combination image identifies the medial and lateral iliac cortical limits of the planned osseous pathway, and reveals the AIIS on profile. The K-wire is then inserted through the skin and onto the AIIS.

Authors' Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

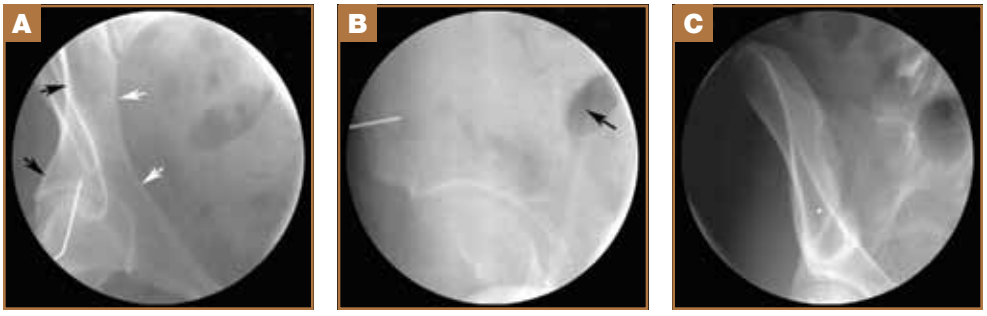

Figure 1. This obturator inlet view (A) of the right hemipelvis demonstrates that the trajectory of the K-wire is within the iliac tables. The cortical density depicted by the black arrows marks the outer ilium and the white arrows represent the pelvic brim. This iliac oblique view (B) shows the cranial to caudal direction of the K-wire pointing towards the greater sciatic notch, as depicted by the arrow. This obturator outlet view (C) demonstrates the raindrop-shaped osseous pathway available for pin placement extending from AIIS to posterior superior iliac spine. Notice that the starting point of the K-wire is in the more cranial aspect of the osseous pathway avoiding the pathway of a potential ramus screw.

The obturator inlet view demonstrates the directional aim of the wire within the iliac tables (**Figure 1A**). An iliac oblique view is also obtained to confirm that the wire is aimed as planned towards the greater sciatic notch (**Figure 1B**). The starting point of the K-wire is rechecked with an obturator outlet view to ensure that it is inserted as planned into the cranial aspect of the AIIS (**Figure 1C**). The wire can be cut or bent to allow the C-arm to be positioned appropriately. The wire is then inserted into the AIIS approximately 2 cm. Next, a 1 cm transverse skin incision is made around the K-wire. Blunt dissection is then carried down to the AIIS.[16] A 5 mm cannulated drill is placed over the wire and advanced with an oscillating motion for approximately 2-3 cm, opening the outer cortex of the AIIS. The 3 images are used to adjust the drill aim as needed. The drill is then replaced by a partially threaded 5 mm x 250 mm self-drilling Schanz pin, which is inserted through a soft tissue-protecting sleeve.

The pin's aim is periodically checked with both the iliac oblique and the obturator inlet images. The iliac oblique view should demonstrate a cranial to caudal advancement of the pin, from the superior aspect of the AIIS towards the greater sciatic notch. The pin can be placed into the dense bone of the notch (**Figure 2A**). The obturator inlet demonstrates that the pin is located between the iliac tables, medial to the dense lateral iliac cortex and lateral to the cortical density of the pelvic brim (**Figure 2B**).

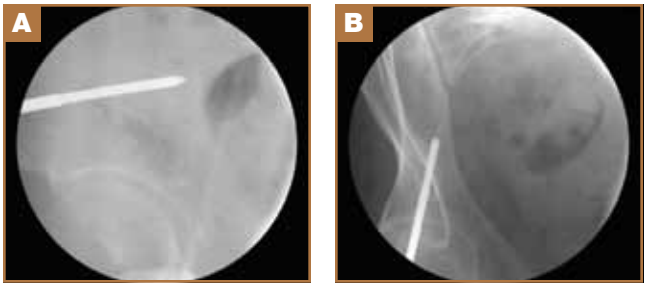

Figure 2. Iliac oblique view (A) and obturator inlet view (B) demonstrating that the Schanz pin is directed towards the greater sciatic notch into the dense bone of the sciatic buttress and located within the iliac tables, respectively.

The same steps are repeated for Schanz pin insertion in the opposite hemipelvis. After insertion of the pins, the external fixator is assembled using clamps and connecting bars. The reduction can be either achieved or refined using the pins as manipulation devices prior to frame assembly. The frame position anticipates and considers any potential abdominal procedures and additional soft tissue swelling.

Discussion

In the initial management of unstable pelvic ring injuries, anterior external fixation can play an important role. It can be a definitive fixation or a temporizing measure, depending on the patient's condition and/or pelvic injury pattern. However, the mechanical properties of current external fixation systems are not optimal for definitive management of most pelvic ring injuries and the long-term results are often unsatisfactory.[17,18]

Percutaneous fixation has become an integral part of pelvic ring surgery.[19-25] It is possible for both anterior and posterior ring disruptions, in forms of anterior column and iliosacral screws, respectively. APEF is frequently used for manipulation and reduction prior to percutaneous fixation. Therefore, proper external fixator pin placement is an important aspect of the overall treatment strategy and preoperative planning of pelvic ring injuries. Hence, if patients' medical conditions do not necessitate emergent placement of a pelvic external fixator without the use of fluoroscopy, we recommend fluoroscopically-guided placement of the supra-acetabular pins.

In this paper, we described a technique for optimal placement of supra-acetabular fixator pins, taking subsequent percutaneous fixation of anterior and posterior pelvic ring into account. The trajectory of an anterior column screw placed in an antegrade fashion or in a retrograde fashion, extending beyond the hip joint, frequently traverses the radiographic raindrop, as seen on the obturator outlet view. Therefore, a more cranial starting point of the supra-acetabular pin will not only avoid the path of a superior ramus screw, but also will allow for a cranial to caudal placement of the pin.

A cranial to caudal pin trajectory has numerous advantages. First, it ensures that the pin is placed above the sciatic notch into the dense bone of the sciatic buttress, optimizing pin fixation. Second, the pin will be out of the planned pathway of an iliosacral screw, since it will terminate short of the sacroiliac joint (**Figure 3A-D**). Finally, it ensures improved

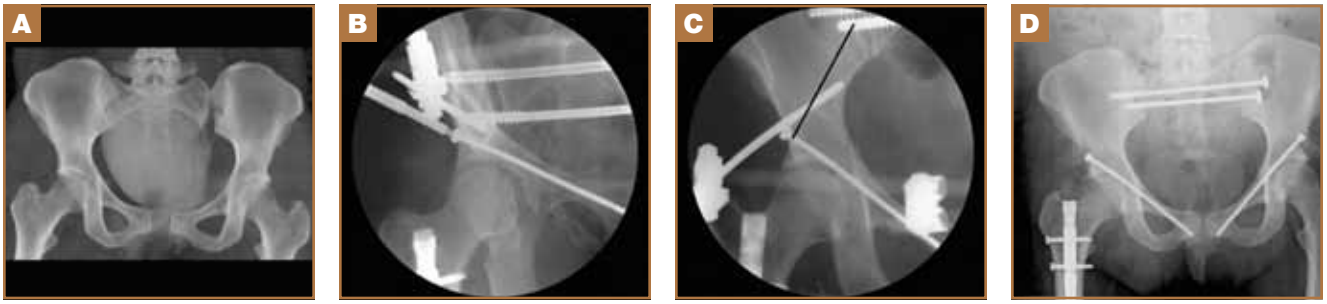

Figure 3. (A) This patient presented with a type C pelvic ring injury and a right-sided transverse acetabular fracture. (B) Using an anterior pelvic external fixator the pelvic ring was reduced and temporarily stabilized. After stabilizing the sacroiliac injuries with screws, a ramus screw was used to fix the acetabular fracture. Notice the cranial starting point of the AIIS Schanz pin, enabling the placement of the ramus screw. Fixator pins inserted deeper towards posterior superior iliac spine with less cranial to caudal tilt, as depicted in (C) by the black line, could potentially interfere with the pathway of an iliosacral screw. (D) The final result is shown 1 year after injury. Asymptomatic yet obvious ectopic bone formed at the APEF bone pin sites.

patient comfort and sitting balance by allowing increased hip flexion. This method of supra-acetabular pin placement has been used successfully and safely for more than 10 years by the senior author (MLCR) on over 300 patients with no adverse events and we recommend its use.

Dr. Calafi is Assistant Professor, Orthopaedic Trauma, Saint Louis University School of Medicine, Department of Orthopaedic Surgery, Missouri. Dr. Routt is Professor, Orthopaedic Trauma, The University of Texas Medical School at Houston, Department of Orthopaedic Surgery, Texas.

Address correspondence to: Leo A. Calafi, MD, Saint Louis University School of Medicine, Department of Orthopaedic Surgery, 3635 Vista at Grand Blvd, Saint Louis, MO 63104 (tel, 314-577-8850; e-mail, calafila@slu.edu).

Am J Orthop. 2013;43(12):E122-E124.

References

1. Perry JF Jr. Pelvic open fractures. *Clin Orthop Relat Res*. 1980;(151):41-45.
2. Riemer BL, Butterfield SL, Diamond DL, et al. Acute mortality associated with injuries to the pelvic ring: the role of early patient mobilization and external fixation. *J Trauma*. 1993;35(5):671-675.
3. Burgess AR, Eastridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *J Trauma*. 1990;30(7):848-856.
4. Poka A, Libby EP. Indications and techniques for external fixation of the pelvis. *Clin Orthop Relat Res*. 1996;(329):54-59.
5. Gylling SF, Ward RE, Holcroft JW, Bray TJ, Chapman MW. Immediate external fixation of unstable pelvic fractures. *Am J Surg*. 1985;150(6):721-724.
6. Mears DC. Clinical techniques in the pelvis. In: Mears DC, ed. *External skeletal fixation*. Philadelphia, PA: Lippincott Williams & Wilkins; 1983:342.
7. Kim WY, Hearn TC, Seleem O, Mahalingam E, Stephen D, Tile M. Effect of pin location on stability of pelvic external fixation. *Clin Orthop Relat Res*. 1999;(361):237-244.
8. Egbers HJ, Draijer F, Havemann D, Zenker W. [Stabilizing the pelvic ring with the external fixator. Biomechanical studies and clinical experiences]. *Orthopade*. 1992;21(6):363-372.
9. Gänsslen A, Pohlemann T, Krettek C. [A simple supraacetabular external fixation for pelvic ring fractures]. *Oper Orthop Traumatol*. 2005;17(3):296-312.
10. Kanlic Em, Pacheco HO. Pelvic Fractures: External fixation and C-clamp. In: Wiss DA, ed. *Master Techniques in Orthopaedic Surgery – Fractures*. Philadelphia, PA: Lippincott Williams & Wilkins; 2006: 621-637.
11. Poelstra KA, Kahler DM. Supra-acetabular placement of external fixator pins: a safe and expedient method of providing the injured pelvis with stability. *Am J Orthop (Belle Mead NJ)*. 2005;34(3):148-151.
12. Haidukewych GJ, Kumar S, Prpa B. Placement of half-pins for supra-acetabular external fixation: an anatomic study. *Clin Orthop Relat Res*. 2003;(411):269-273.
13. Noordeen MH, Taylor BA, Briggs TW, Lavy CB. Pin placement in pelvic external fixation. *Injury*. 1993;24(9):581-584.
14. Kellam JF. The role of external fixation in pelvic disruptions. *Clin Orthop Relat Res*. 1989;(241):66-82.
15. Gardner MJ, Nork SE. Stabilization of unstable pelvic fractures with supraacetabular compression external fixation. *J Orthop Trauma*. 2007;21(4):269-273.
16. Sen M, Harvey EJ, Steinitz D, Guy P, Reindl R. Anatomical risks of using supra-acetabular screws in percutaneous internal fixation of the acetabulum and pelvis. *Am J Orthop (Belle Mead NJ)*. 2005;34(2):94-96.
17. Pohlemann T, Tscherne H, Baumgärtel F, et al. [Pelvic fractures: epidemiology, therapy and long-term outcome. Overview of the multicenter study of the Pelvis Study Group]. *Unfallchirurg*. 1996;99(3):160-167.
18. Lindahl J, Hirvensalo E, Böstman O, Santavirta S. Failure of reduction with an external fixator in the management of injuries of the pelvic ring. Long-term evaluation of 110 patients. *J Bone Joint Surg Br*. 1999;81(6):955-962.
19. Giannoudis PV, Tzioupis CC, Pape HC, Roberts CS. Percutaneous fixation of the pelvic ring: an update. *J Bone Joint Surg Br*. 2007;89(2):145-154.
20. Barei DP, Bellabarba C, Mills WJ, Routt ML Jr. Percutaneous management of unstable pelvic ring disruptions. *Injury*. 2001;32 Suppl 1:SA33-44.
21. Routt ML Jr, Nork SE, Mills WJ. Percutaneous fixation of pelvic ring disruptions. *Clin Orthop Relat Res*. 2000;(375):15-29.
22. Starr AJ, Reinert CM, Jones AL. Percutaneous fixation of the columns of the acetabulum: a new technique. *J Orthop Trauma*. 1998;12(1):51-58.
23. Routt ML Jr, Kregor PJ, Simonian PT, Mayo KA. Early results of percutaneous iliosacral screws placed with the patient in the supine position. *J Orthop Trauma*. 1995;9(3):207-214.
24. Routt ML Jr, Simonian PT. Closed reduction and percutaneous skeletal fixation of sacral fractures. *Clin Orthop Relat Res*. 1996;(329):121-128.
25. Rommens PM. Is there a role for percutaneous pelvic and acetabular reconstruction? *Injury*. 2007;38(4):463-477.