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Surgical/Technical Tips

Percutaneous Screw Fixation of Slipped Capital Femoral Epiphysis Using Biplanar Fluoroscopy

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ABSTRACT

Percutaneous screw fixation for slipped capital femoral epiphysis (SCFE) is a standard surgical procedure. This can be performed on a radiolucent "flattop" table or a fracture table, which holds the leg stable and can help with the serendipitous reduction of unstable SCFE's. Pivotal to success is accurate screw placement in the center of the epiphysis, adequate threads crossing the physis, and avoidance of screw penetration into the joint. Adequate fluoroscopic visualization in all planes is essential. We have used simultaneous biplanar fluoroscopy for accurate screw placement on a fracture table. The indications, techniques, pearls, and pitfalls of this procedure are presented in this study.

Key Concepts:

(1) Percutaneous screw fixation of SCFE is a mainstay of treatment.
(2) Simultaneous biplanar fluoroscopy facilitates accurate screw placement.
(3) Positioning on a fracture table can promote incidental reduction in cases where this is desirable.
(4) Meticulous attention to room setup, patient positioning, and operative technique are necessary for success.

Introduction

Slipped capital femoral epiphysis (SCFE) is primarily a disorder of adolescents occurring with a rate of 1 in 10,000 [1]. Percutaneous screw fixation with a cannulated screw is a mainstay of treatment [1,2]. Typically, single screw fixation is sufficient, though two screws can be considered for unstable slips [3,4]. Essential to successful screw fixation is adequate radiographic visualization of the capital femoral epiphysis in all planes so that adequate fixation can be achieved, while avoiding unrecognized screw penetration into the joint. Percutaneous screw placement using intraoperative fluoroscopy can be particularly challenging, especially in the morbidly obese patient [5]. A technique utilizing biplanar fluoroscopy for simultaneous visualization in both the anteroposterior (AP) and lateral planes was first described by Killian et al. in 1999 to streamline the process of screw placement and improve the accuracy and quality of fixation [5]. The present study aims to provide an updated perspective on the biplanar fluoroscopy technique.

Description of method

Indications

The indications for screw fixation of SCFE have been previously elucidated [1,2]. Any patient who meets those indications is also a candidate for the biplanar fluoroscopy technique, though there are scenarios where it is particularly advantageous. In patients with an acute component to the slip, where incidental reduction is desirable, placement on a fracture table with the addition of traction and internal rotation can result in improved epiphyseal position (Fig. 1). In cases of bilateral SCFEs; our technique requires sequential positioning, reduction (if needed), prepping and draping, and pinning of each hip. We acknowledge that in cases of bilateral stable SCFEs, using a radiolucent flattop table may be more efficient without the advantages of biplanar fluoroscopy.

Room set-up and positioning

For this technique, the patient is positioned supine on a fracture table. The arm of the affected side is placed across the chest (Fig. 2a). The unaffected side arm is placed perpendicular to the torso on an armboard or across the chest. The contralateral limb is placed in the "well leg holder" with the hip in moderate flexion and abduction, while the affected limb is placed in the traction boot with the hip and knee extended. Abduction, internal rotation, and traction can be added to improve the alignment in unstable SCFEs. The lateral C-arm is positioned between the legs with the C portion beneath the patient. The C is then rotated 30° toward the affected extremity to allow room for the AP C-arm (Fig. 2b). The AP C-arm is positioned on the unaffected side lateral to the

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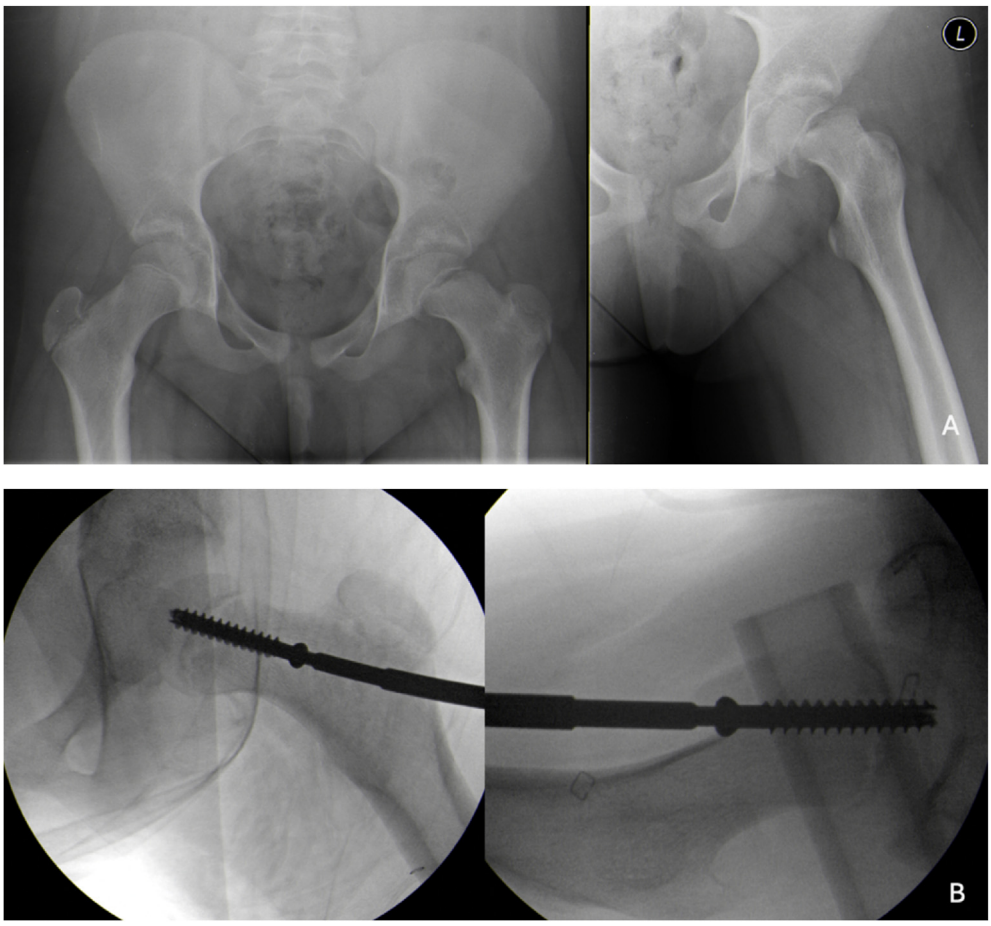

Figure 1. A: AP and lateral radiographs of the hips in an adolescent female with an unstable left slipped capital femoral epiphysis (SCFE). B: Intraoperative radiographs disclose incidental reduction of epiphysis after placement on the fracture table with the addition of traction and internal rotation of the foot and fixation using biplanar fluoroscopy. AP, anteroposterior.

abdomen (Fig. 2c). AP and lateral radiographs are obtained to confirm adequate positioning. The AP C-arm can then be backed out for prepping and draping. The anterior and lateral thigh and hip are prepped and draped, with the sterile drape covering the "lateral" C-arm. A sterile cover is placed over the AP C-arm, and it is moved back into position.

Operative technique

Markings are made on the skin (Fig. 3a-d) as per the technique described by Lindaman et al. [6] The guidewire is placed along the anterior femoral neck in the desired location of the screw, an AP image is obtained, and the skin is marked. This is repeated for the lateral image. The entry point for the guidewire is generally at the junction of the two lines (Fig. 3e). A small portion of "sticky drape" is removed in this area to prevent it from wrapping around the guidewire and becoming introduced into the patient. The guidewire is advanced to the anterior femoral neck, parallel with the drawn lines in the AP and lateral planes. AP and lateral views are obtained as necessary as the guidewire is advanced into the center of the epiphysis. A 5–7 mm incision is made over the guide wire, the depth gauge is inserted, and a lateral radiograph is obtained to be sure the depth gauge is on the bone. This is followed by drilling and screw placement. The guide pin is backed out until it no longer protrudes from

Figure 2. A: Patient positioned with uninvolved side hip flexed and abducted and involved side in foot traction device with internal rotation of foot. Note arm across chest on involved side, which facilitates lateral C-arm positioning. B: The lateral C-arm is brought in between the legs. The "C" is then rotated 30° toward the involved side to make room for the AP C-arm. C: The AP C-arm comes in from across the torso on the uninvolved side. AP, anteroposterior.

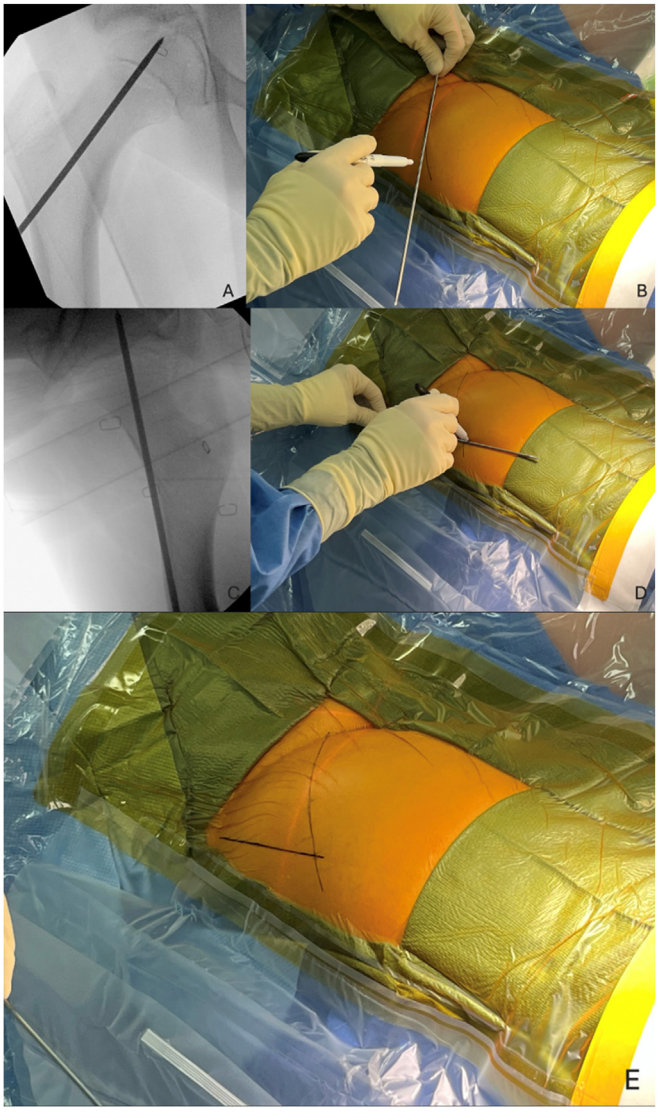

Figure 3. A, B, C, D, E: Markings are made on the skin as described by Lindaman et al. E: Pin insertion is at the junction of the two lines.

the tip of the screw. The surgeon or assistant then removes the foot from the traction boot. The hip is taken through a full range of internal and external rotation under "live" imaging sequentially in both AP and lateral projection to verify no hardware protrusion into the joint.

Tips and pearls

The biplanar C arm technique facilitates accurate guidewire and screw placement. It avoids bending the guidewire when the extremity of a very large patient is rotated for a lateral view on the flattop table. The arm of the affected side must be across the chest to bring the lateral C-arm up against the torso. The "C" of the lateral C arm must be rotated toward the involved side to make room for the AP C arm. We have found that the time invested in the setup is recouped with rapid and accurate pin/screw placement.

The fracture table and dual C-arm technique may be the optimal approach for a patient with an unstable SCFE who is at risk for avascular necrosis and may require two screws. The fracture table allows for serendipitous reduction via traction and internal rotation of the foot; some abduction can be added if there is relative varus slippage on the AP view. Biplanar fluoroscopy improves the accuracy of pin placement, and this is increasingly important for unstable slips, which may require two screws. Biplanar fluoroscopy can also be useful for mild slip or preslips where guidewire placement is challenging due to the tendency for the guidewire to skive along the anterior neck.

Comparison to other methods

Intraoperative fluoroscopy has become an invaluable tool for screw placement in SCFE [5,7,8]. This article highlights the technique of biplanar fluoroscopy as first described at the senior author's institution by Killian et al. [5].

In 2004, Klug et al. outlined their experience using biplanar fluoroscopy for SCFE. They noted a reduction in fluoroscopy time and an overall reduction in the maneuvering needed with two C-arms instead of one, which carried the implied benefit of a decreased risk of contamination [9]. Westberry et al. compared the utility of one vs two C-arms for in situ cannulated screw fixation of SCFE. They compared operating room set-up time and operative time. They determined the accuracy of screw placement relative to perfect placement [8] as described by Blasier et al. [10] In their cohort treated with two C-arms, 88.2% had optimal screw placement compared to 69.1% when one C-arm was used. Neither setup nor operative time varied significantly between the groups [8].

An alternative technique described by Blasier et al. in a retrospective study of 65 patients utilize one C-arm with a radiolucent table. All patients were treated with single screw fixation on either a fracture table (36) or a radiolucent flat-top table (29). Rather than manipulate the C-arm, the surgeon maneuvers the operative extremity to obtain orthogonal views of the hip while the C-arm is locked in the AP position. The radiolucent table and stationary C-arm proved advantageous in terms of operative time compared to the fracture table and mobile C-arm. Still, they provided no discernible benefit concerning screw placement [10]. In the senior author's experience, some bending of the guidewire can occur when the extremity is rotated for the lateral view, even with a larger diameter device such as a drill bit, depth gauge, or screwdriver, is placed over the pin for protection. This bending of the pin can lead to inadvertent advancement or heat generation. Biplanar fluoroscopy avoids this risk. However, the senior author continues to use a flattop radiolucent table, particularly in stable, bilateral SCFE, when no reduction is anticipated.

Summary

The use of a fracture table with biplanar fluoroscopy can facilitate accurate screw placement in percutaneous screw fixation of SCFE. This is particularly effective in cases with an acute component where incidental reduction is desirable. This technique avoids the guide wire bending that can occur during rotation of the thigh in screw fixation performed on a radiolucent flattop table. This technique is less advantageous in bilateral stable slips where improvement in epiphyseal position is not anticipated.

Consent for publication

Prior to the start of the procedure, informed consent was obtained from both the patient's legal guardian and the patient to submit deidentified intraoperative photographs taken during the patient's operation.

Author contributions

Emilio Feijoo: Writing – original draft, Writing – review & editing, Investigation, Methodology, Visualization. **Michael J. Conklin:** Conceptualization, Methodology, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

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Declaration of competing interests

The authors Emilio Feijoo and Michael Conklin declare that they have no disclosures.

Appendix A. Supplementary material

Supplementary video related to this article can be found at https://doi.org/10.1016/j.jposna.2024.100157

View this video on POSNAcademy here: http://www.kaltura.com/tiny/zn9s5

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