Transphyseal Fracture of Proximal Femur

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Abstract

Transphyseal fractures of the proximal femur (Delbet 1) are typically the result of high-energy injuries such as motor vehicle accidents or a fall from height and are therefore exceptionally rare, accounting for less than 1% of pediatric fractures. Given the amount of energy involved in these injuries, there are often associated injuries that may require treatment. There is a high risk of avascular necrosis (AVN) (80–100%) associated with this type of fracture, and thus achieving anatomic reduction is important. We present the case of an 11-year-old male who sustained a transphyseal proximal femur fracture and underwent successful closed reduction with percutaneous screw fixation.

1 Brief Clinical History

An 11-year-old male was involved in an ATV-rollover accident and landed directly onto his right hip. He presented with acute right hip pain and inability to bear weight. There was no history of antecedent right hip pain. The right lower extremity was shortened and in an externally rotated and adducted position. He was noted to have a right transphyseal (Delbet 1) femoral neck fracture (Figs. 1 and 2). He had a full trauma workup by the pediatric surgery trauma team. No other injuries noted.

2 Preoperative Clinical Photos and Radiographs

See Fig. 1.

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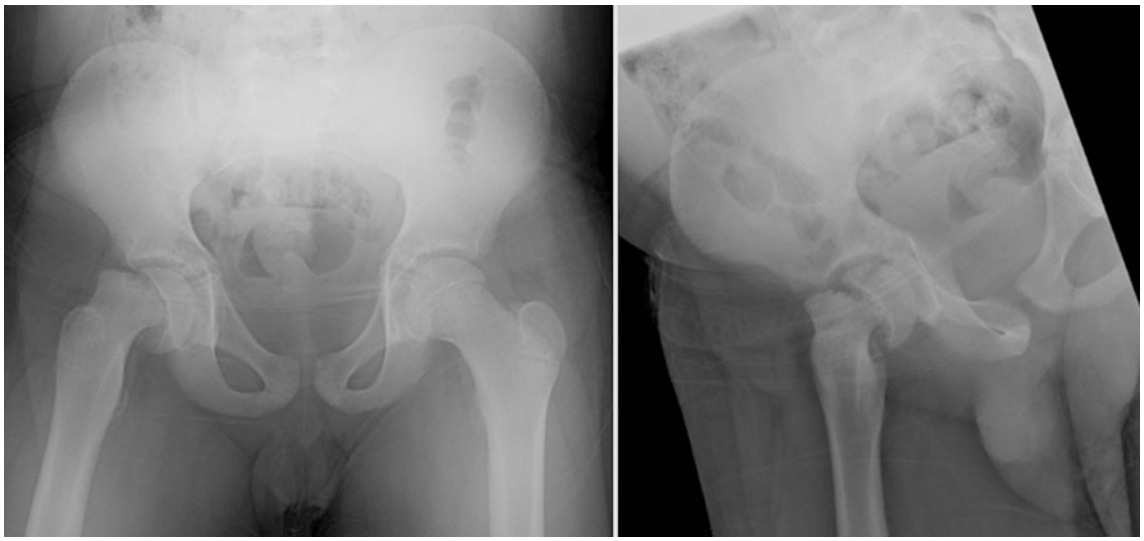

Fig. 1 AP and lateral injury radiograph showing displaced transphyseal proximal femur fracture

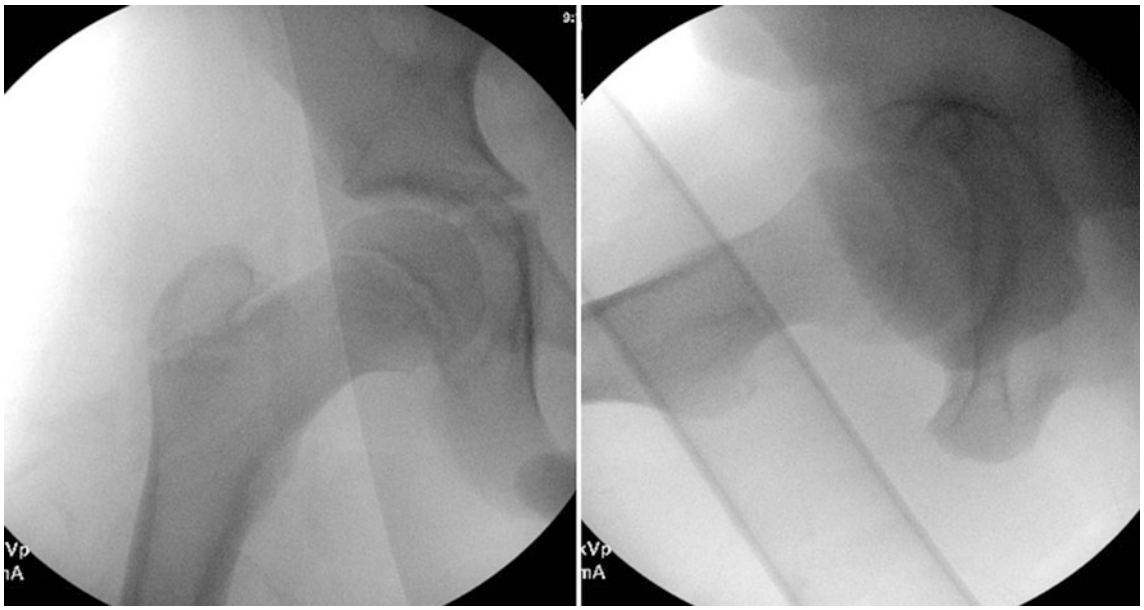

Fig. 2 AP and lateral fluoroscopy showing closed reduction of epiphysis onto metaphysis

3 Preoperative Problem List

- Right transphyseal (Delbet 1) femoral neck fracture

4 Treatment Strategy

Non-operative treatment of transphyseal proximal femur fractures is mostly of historical significance. Cast immobilization alone can have up to a 35% incidence of loss of reduction and varus deformity (Herring 2014). Given the high rate of AVN associated with this type of fracture, anatomic reduction (closed or open) with rigid internal fixation (Kirschner wires or cannulated screws) is the preferred treatment strategy (Flynn et al. 2015). The patient's age and size will help determine the appropriate implant.

5 Basic Principles

Patient should be placed on a radiolucent table, and fluoroscopic images prior to prepping must be obtained to ensure that adequate visualization of the fracture is possible. Either

a fracture table or flat-top table can be used depending on the surgeon's preference. When prepping the leg, split drapes are used to ensure that the entire hip is exposed in case the fracture is unable to be closed and reduced appropriately and open exposure is needed. Gentle reduction is obtained with traction, followed by sequential abduction, flexion, and then internal rotation. If acceptable closed reduction is confirmed on fluoroscopy, a guide pin for appropriately sized cannulated screw is placed in a center-center position. A second cannulated screw is then placed in a slightly more posterior and inferior position. Fluoroscopy is used to monitor guide pin and screw placement. The lateral view provides a more accurate assessment of the proximity of the screw tip to the joint surface (Figs. 2, 3, and 4). Once all screws are in place, the approach-withdrawal technique is used to ensure there has not been penetration into the joint. Decompression of the joint capsule, either by aspiration or by capsulotomy, should be performed in order to evacuate the hematoma from within the joint capsule, thereby decreasing intracapsular pressure and the likelihood of AVN.

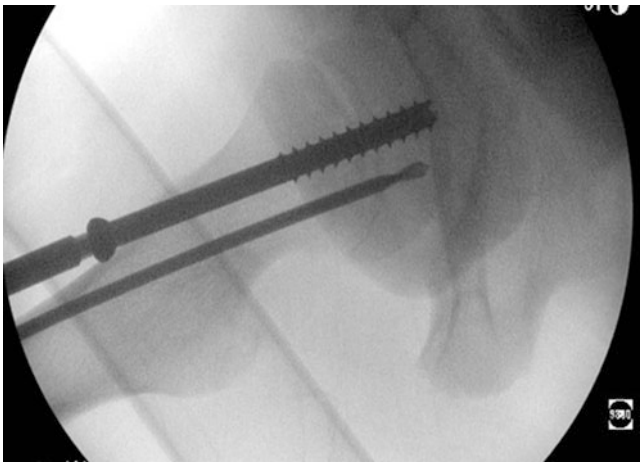

Fig. 3 Lateral fluoroscopy showing central screw in place with second guide pin

6 Images During Treatment

See Figs. 2, 3 and 4.

7 Technical Pearls

Either a fracture table or flat-top Jackson table can be used depending on the surgeon's preference. It is vital to ensure that adequate fluoroscopic images can be obtained prior to prepping and draping the patient. The most important aspect of the procedure is to obtain an anatomic reduction. If this cannot be achieved by closed means, then open reduction must be performed. The authors prefer the anterolateral (Watson-Jones) approach to perform open reduction when necessary; however, a Smith-Peterson approach can also be utilized. K-wires can be used for fixation in very young or small children, while cannulated screws are preferred for older children. 6.5 mm or 7.3 mm screws are best for children in the adolescent age group, while smaller screws (4.5 mm) can be used in younger patients. Two screws will provide adequate stability; however, if there is enough room in the femoral neck, three screws can be used in an inverted triangle configuration. Cast immobilization postoperatively is generally not necessary if screw fixation is performed. In younger children, in whom K-wires are used, or in children who cannot follow weight-bearing precautions postoperatively, consider the use of a spica cast.

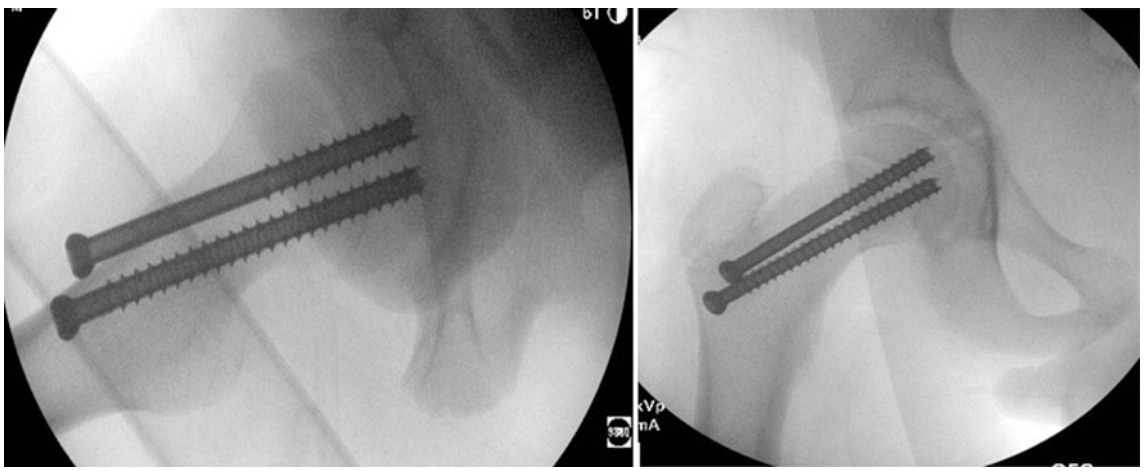

Fig. 4 AP and lateral fluoroscopy showing final screw placement and well-reduced epiphysis

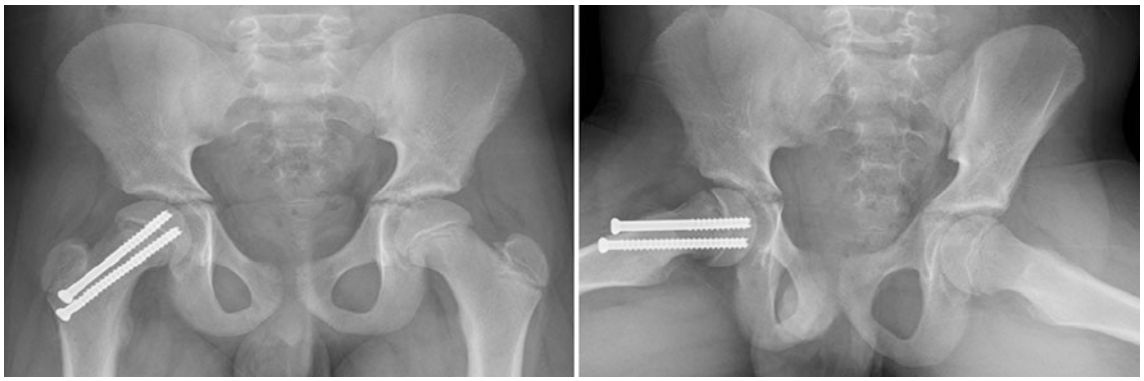

Fig. 5 AP and lateral 1 month postoperative

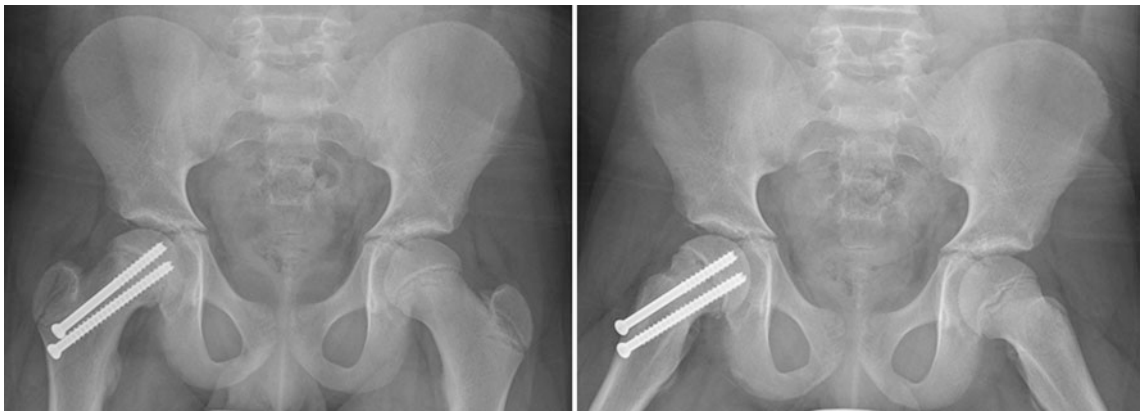

Fig. 6 AP and lateral 5 months postoperative

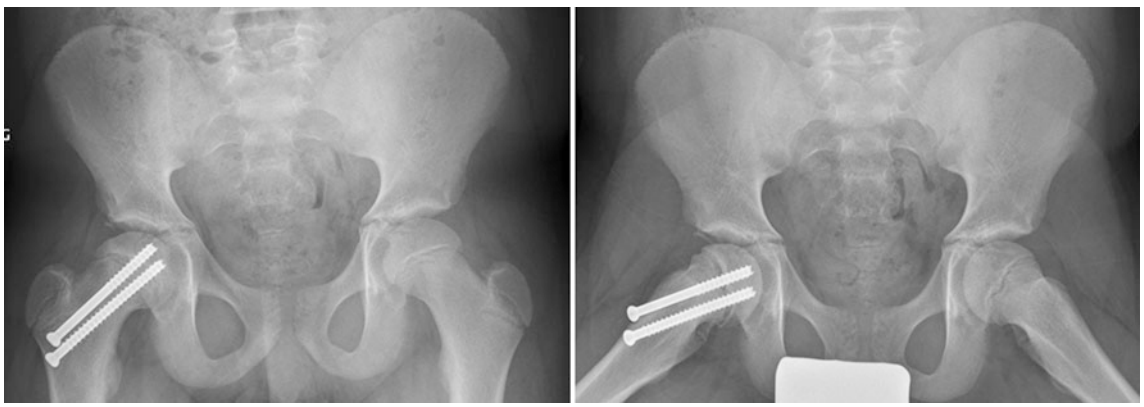

Fig. 7 AP and lateral 7 months postoperative

8 Outcome Clinical Photos and Radiographs

See Figs. 5, 6, and 7.

9 Avoiding and Managing Problems

The most common complication associated with transphyseal fractures of the proximal femur is AVN of the femoral head. The physis creates a unique situation in children, as compared

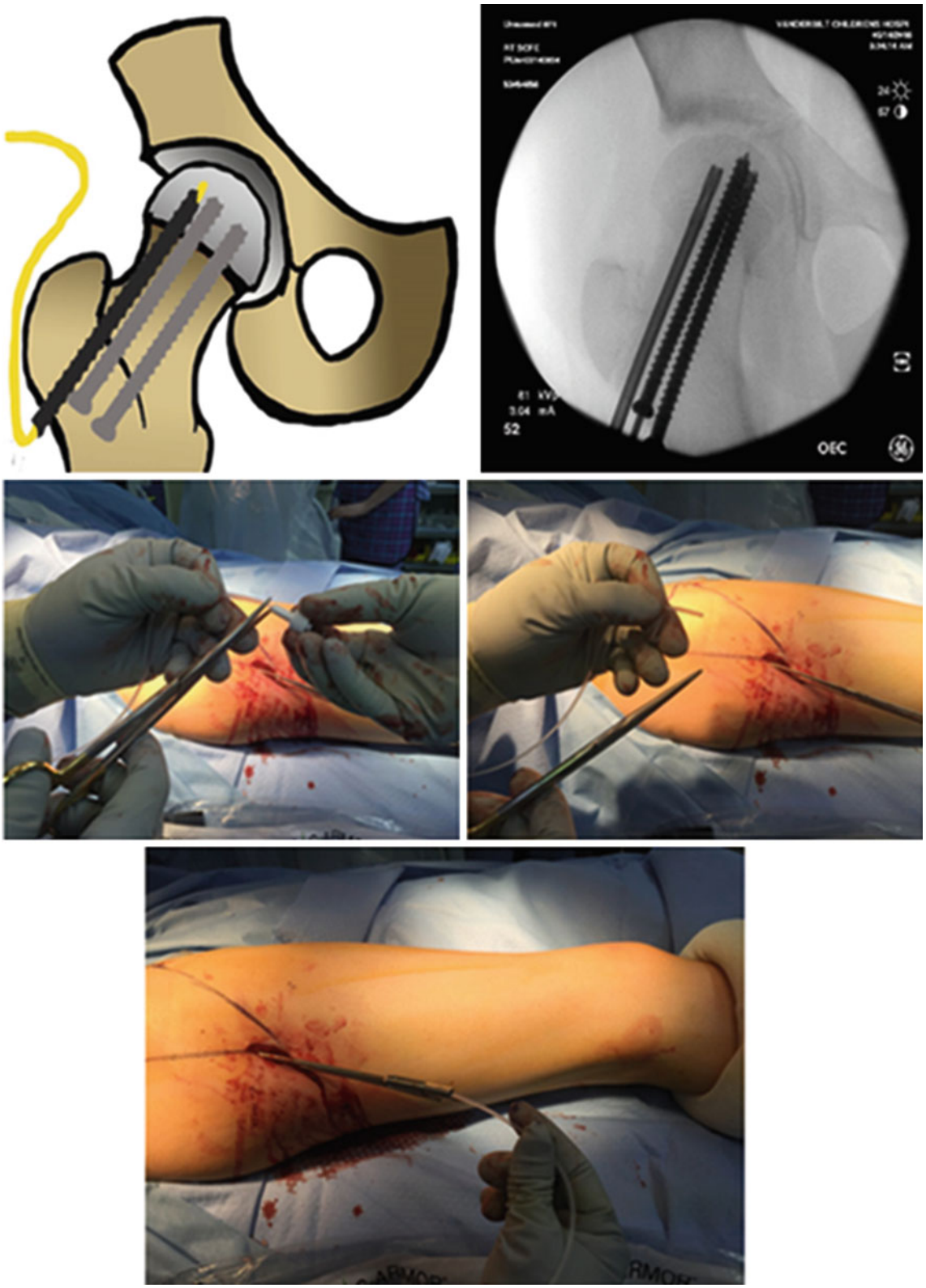

Fig. 8 These images depict the setup for arterial line monitoring of epiphyseal perfusion utilized by the authors

to adults, where the metaphyseal and epiphyseal blood supplies are segregated. Therefore, in the setting of injury to the epiphyseal vessels, the epiphysis cannot be revascularized from the metaphysis. Given this feature, the incidence of AVN for this type of fracture is between 80% and 100% and is often devastating. Historically, it was thought that urgent/emergent treatment of transphyseal femoral neck fractures was necessary to avoid AVN. However, recent studies have demonstrated that compromise of the lateral epiphyseal blood supply is more likely a result of the damage caused by the trauma itself and not the timing of operative fixation. Achieving an anatomic reduction is important to minimize the risk of AVN. If reduction cannot be achieved by closed means, then an open approach must be done to reduce the fracture. Screw placement should be (1) proximal to the lesser trochanter to avoid creating a stress riser and subsequent fracture and (2) lateral to the intertrochanteric line to minimize the risk of screw cut out (Mencio and Swiontkowski 2014).

Close follow-up is necessary to monitor for the development of AVN in these patients. AVN is typically first noted on plain radiographs several months after the original injury. Unfortunately, by this time most kids are advanced to full weight-bearing, which can lead to early collapse of the femoral head. In order to minimize the risk of AVN occurring, it is ideal to determine the status of the epiphyseal blood supply during the operation. The authors utilize an intravenous tubing threaded up a cannula into the epiphysis attached to an arterial line monitor to assess epiphyseal blood flow once the fracture has been reduced and stabilized. While this method is not yet validated, they have had success with it (Fig. 8). Pinhole bone scan is used in conjunction with plain radiographs to assess the blood flow to the femoral epiphysis postoperatively. The bone scan can also be used to assess blood flow across the fracture site (a requisite for fracture union). The authors restrict weight-bearing until blood flow to the femoral epiphysis and fracture healing is confirmed on bone scan.

References and Suggested Reading

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