Femoral Neck Fractures in Children

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Contents

Abstract

Femoral neck fractures in the pediatric population are uncommon injuries, making up less than 1% of all pediatric fractures. The mechanism of injury is typically high-energy trauma or a fall from height. As with all high-energy traumas, it is common to find cranial, visceral, or other serious injuries. The presence of concomitant trauma can make treatment of these injuries challenging. Early reduction and stable internal fixation are critical to minimize complications, which are common. The most dreaded and, unfortunately, most common complication is avascular necrosis of the femoral head.

The following case typifies a pediatric femoral neck fracture and illustrates surgical management of the injury. The patient sustained a Delbet type III basicervical femoral neck fracture after being involved in a high-energy automobile accident. This case demonstrates a method of surgical management and shows the follow up including addressing possible complications. We present the clinical decision-making and considerations in approaching treatment of this type injury.

1 Brief Clinical History

A 13-year-old male was an unrestrained passenger in an automobile travelling approximately 50 miles per hour that collided with a stalled car in an intersection. The patient was ejected from the back seat and the right half of his body struck the front console. The patient had a transient loss of consciousness, and was transported to a local hospital by ambulance in stable condition. Radiographs from the outside facility demonstrated a displaced right femoral neck fracture. After evaluation for other injuries at the outside facility, he was transferred to our hospital for management of the femoral neck fracture. He had no neurovascular compromise in the right lower extremity and sustained no other major injuries.

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2 Preoperative Clinical Photos and Radiographs

See Figs. 1, 2, and 3.

3 Preoperative Problem List

1. Displaced right basicervical femoral neck fracture

4 Treatment Strategy

Initial management of this injury, as it presents to the trauma bay, is systematic employment of Advanced Trauma Life Support principles. The patient's hemodynamic status must be assessed and stabilized. It is common for the patient to present with head and visceral injuries. Careful evaluation of all critical body systems will help to avoid missed untreated injuries. When the patient is stable, definitive orthopedic management of the femoral neck can occur. In this case, the patient had a full evaluation and workup by the trauma service, which did not reveal any additional injuries. The patient was cleared for surgery. The key principles to treatment of femoral neck fractures are anatomic reduction of the fracture and stable fixation of the fracture fragments (Morsy 2001; Riccio et al. 2013). Urgent treatment (less than 24 h) and capsular decompression may influence the rate of postoperative avascular necrosis (Shrader et al. 2006; Yeranosian et al. 2013). However, Riley et al. showed no correlation between the time to reduction nor capsular decompression in the development of osteonecrosis of the femoral head (Riley et al. 2015). Younger age at injury has been shown in several studies to be protective in the development of avascular necrosis (Riley et al. 2015; Moon and Mehlman 2006).

The patient was brought to the operating room emergently, approximately six hours after injury. In the operating room, the patient was placed supine on a fracture table. The right foot was secured in the fracture table boot and closed reduction with fluoroscopy was utilized. Fracture table was used to pull longitudinal traction, internally rotate, and slightly abduct the right leg. After the reduction, the fracture appeared well-aligned, but comminution was noted at the inferior femoral neck near the calcar. Fluoroscopy and a Steinmann pin were used to mark starting points outside the skin and an incision was made on the lateral thigh. Subcutaneous tissue and iliotibial band were incised and starting point for the 6.5 mm cannulated screw guide wires was identified using c-arm. Three guide wires were placed, using fluoroscopy, in an inverted triangle pattern. Care was taken to stop short of the physis. The superior anterior cannulated screw was placed first to provide some compression on the noncomminuted side of the facture. The inferior screw was placed last with care taken not to compress through the comminution and increase varus malalignment of the fracture. After all screws were placed, the c-arm was used to confirm satisfactory reduction and fixation. A Cobb elevator was used to perform a capsular decompression by carefully sliding up the anterior cortex of the femoral neck and gently elevating the joint capsule off the anterior femoral neck. Final x-rays showed a well-aligned femoral neck fracture. The wound was irrigated, closed, and dressed. The patient was taken to the recovery room and admitted for postoperative care and observation for occult injuries.

Fig. 1 AP pelvis radiograph that demonstrates a basicervical femoral neck fracture of the right femur

5 Basic Principles

Children subjected to high-energy trauma should undergo initial evaluation and stabilization of life-threatening injuries. Femoral neck fractures should then be an urgent priority of treatment following stabilization. Complications are common in this infrequent injury (Riccio et al. 2013). The most dreaded complication and, unfortunately, most common is avascular necrosis of the femoral head (Boardman et al. 2009). Anatomic, or near anatomic, reduction, when able, and stable fixation, are two important principles guiding treatment in this case. Anatomic reduction and stable fixation have been shown to decrease risk of avascular necrosis, fracture malunion, and nonunion (Shrader et al. 2006). Time to fracture reduction is also a factor that may contribute to risk of avascular necrosis. Some studies have

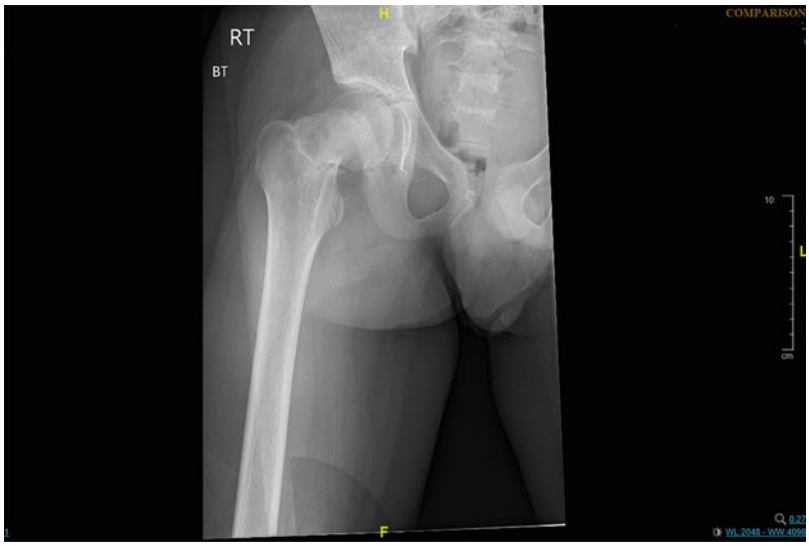

Fig. 2 AP radiograph of the right proximal femur demonstrating basicervical fracture of the femoral neck and no noted femoral shaft fracture

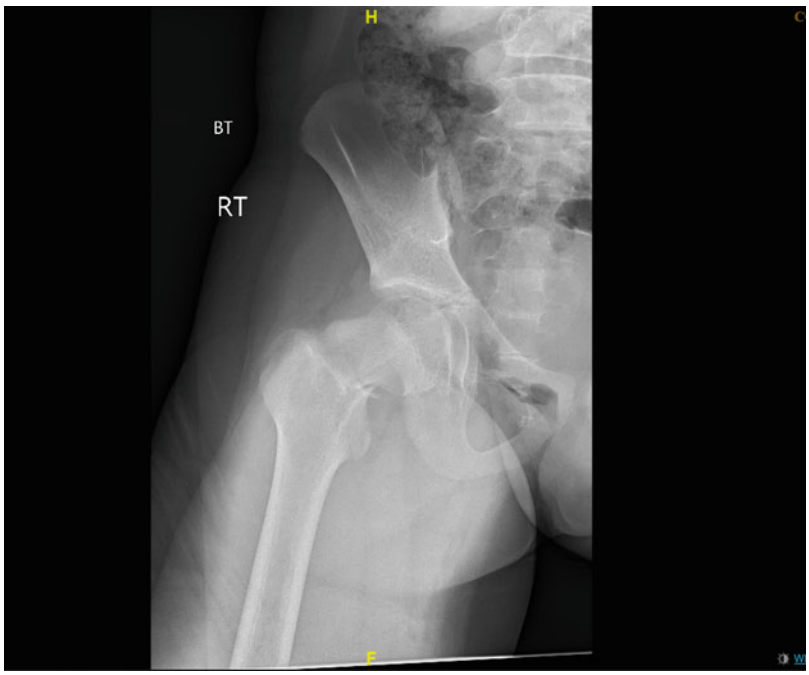

Fig. 3 Coned down radiograph of the right hip. Note the inferior femoral neck comminution with displacement and angulation of the fracture

shown that aggressive early intervention (less than 24 h) reduces the risk of avascular necrosis (Yeranosian et al. 2013). Capsular decompression has been advocated to potentially reduce risk of avascular necrosis (Boardman et al. 2009), but has been disputed in other studies (Riley et al. 2015).

A clear explanation of potential complications with patient and parents can help establish expectations. The Delbet classification system describes fracture pattern by anatomic location. This system can aid in predicting risk of avascular necrosis (Riccio et al. 2013). The literature has identified three surgeon independent variables that increase risk of avascular necrosis. Age of patient at time of injury, magnitude of displacement of the fracture, and anatomic location of the fracture are all variables that the surgeon has no control over. Younger age has been shown to have lower risk of avascular necrosis. Greater magnitude of displacement increases risk of avascular necrosis. Delbet type I fractures have the highest risk of avascular necrosis and this risk decreases stepwise with fracture type (Yeranosian et al. 2013). There is still much debate regarding capsular decompression, open versus closed reduction, and timing to surgical intervention.

6 Images During Treatment

See Figs. 4 and 5.

7 Technical Pearls

Use of the fracture table may be helpful in certain fracture patterns. The fracture table allows for indirect reduction of the fracture and maintenance of the reduction without multiple assistants. In the very young patient, fracture table may not be appropriate based on patient size. Very young patients may be treated with hip spica casting if alignment is satisfactory. There is a limited ability to perform open reduction using a fracture table. Selecting more minimally displaced fractures in older patients for use with fracture table will aid in surgical planning.

Capsulotomy for decompression can be performed in a number of ways. Needle decompression with aspiration of the deep capsular hematoma can be done early following

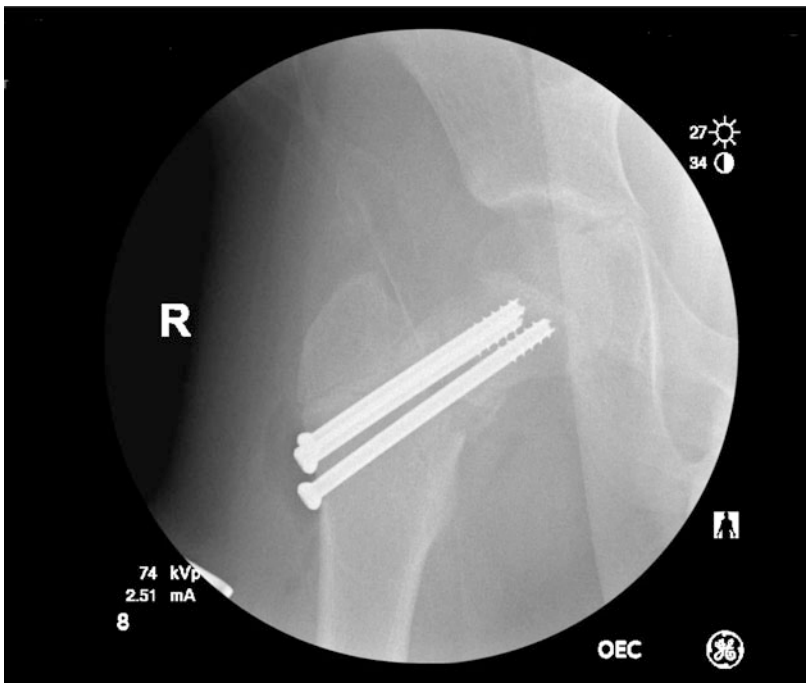

Fig. 4 AP radiograph of the right hip demonstrating satisfactory reduction of the femoral neck fracture with three cannulated partially threaded 6.5 mm cancellous screws

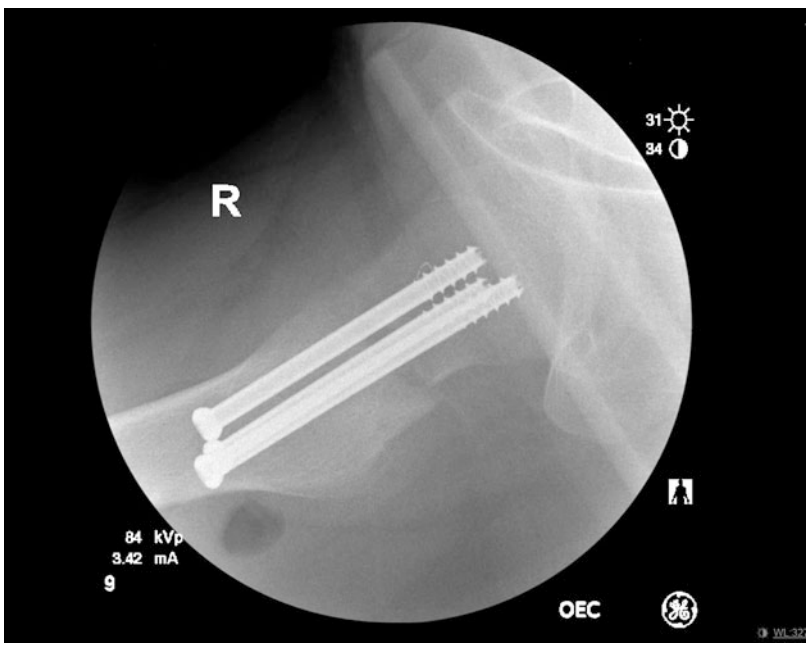

Fig. 5 Lateral radiograph of the right hip demonstrating satisfactory alignment of the fracture with screws outside proximal femoral physis

injury. Coagulation of hematoma with time can limit the ability to adequately decompress the hip capsule with needle alone. Open approaches to the hip with a variety of capsular incisions are possible (Riccio et al. 2013). In this case, the lateral aspect of the proximal femur was exposed and the Cobb elevator was passed along the anterior aspect of the femoral neck to perform capsulotomy. It is important to fixate the fracture, in this case, prior to capsular decompression because of potential loss of reduction while manipulating the femoral neck with the Cobb. Applying compression to the fracture allows for improved bone healing. Compression can minimize risk of malunion and nonunion. Typically, the use of the inferior screw to provide compression along the inferior neck or calcar is desirable. In the above case, the inferior femoral neck was comminuted and compression was achieved with the superior screws. Care was taken with the inferior screw not to pull the femoral head into varus, altering hip mechanics.

If adequate fixation can be achieved without violating the proximal femoral physis, it should be considered. The proximal femoral physis contributes to only 15% of lower extremity length, but premature physeal closure can result in functional alterations. If stable fixation cannot be achieved short of the physis, it should be crossed to provide appropriate stability (Boardman et al. 2009). Accurate screw measurement should be an area of focus. This will prevent violation of the physis but also limit complaints of postoperative hardware prominence. Removal of hardware here is controversial and is surgeon-dependent. Closed reduction maneuvers should be gentle and limited in number of attempts. This prevents excessive trauma to the already tenuous vascular supply to the femoral head. A low threshold for open reduction should exist in difficult cases. A standard Smith-Peterson anterior approach should be utilized when satisfactory reduction cannot be achieved or maintained with closed means.

8 Outcome Clinical Photos and Radiographs

See Figs. 6, 7, 8, 9, and 10.

9 Avoiding and Managing Problems

Complications historically are very common with femoral neck fractures in children (Morsy 2001). Improvements in treatment have reduced the rates of complication but the incidence is still high. Urgent (<12 h) anatomic reduction should be the guiding principle in treatment of these injuries (Shrader et al. 2006). Although, most cases of osteonecrosis of the femoral head occur within 6–7 months, these fractures

Fig. 6 AP radiograph of the right hip at 6 months postop demonstrating healing fracture of the femoral neck with suggestion of premature physeal closure

Fig. 7 Lateral radiograph right hip at 6 months postop demonstrating healing fracture of the femoral neck

Fig. 8 AP radiograph of right hip after removal of hardware at 1 year following injury

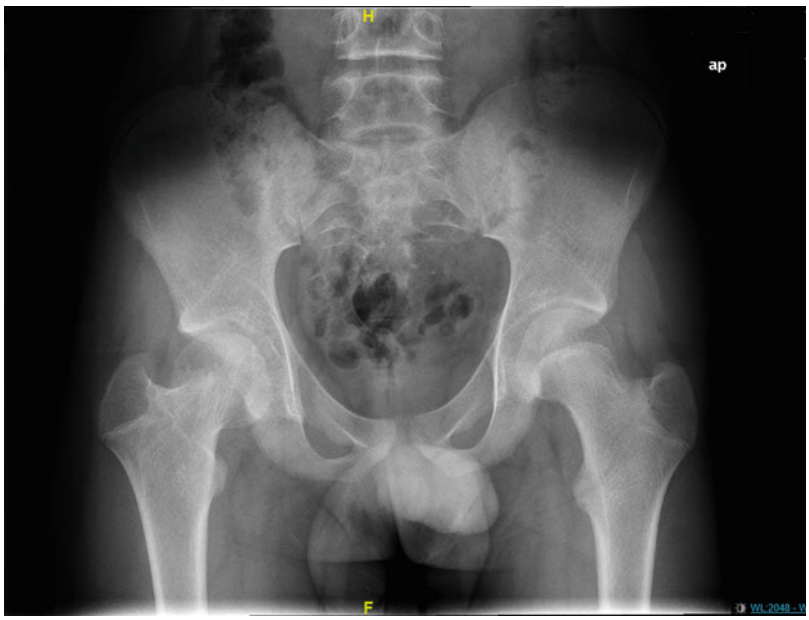

Fig. 9 AP radiograph of the pelvis at 2 years follow up demonstrating no evidence for head collapse secondary to avascular necrosis, but notable right-sided coxa magna, breva, and vara.

should be followed for a minimum of one year after fixation before avascular necrosis of the femoral head can be ruled out. In this case, at 3 years follow up, the patient continued to be pain free, without any symptoms attributed to avascular necrosis, although the minimal coxa magna noted on xray suggests he likely did experience some small degree of AVN which would not be expected to alter his treatment. He was also noted to have premature physeal closure with growth arrest of the proximal femur, causing mild leg length discrepancy of 8 mm. This occurred despite physeal sparing internal fixation. The shortening of the femoral neck is evidence of this complication. The patient has a mild leg length discrepancy of 8 mm at skeletal maturity, which is asymptomatic, and would not be expected to require further treatment. More significant leg length discrepancies at may require additional treatment such as shoe lifts, contralateral epiphysiodesis, or lengthening procedures, depending on the degree of discrepancy. This patient did develop coxa vara as well which can be

Fig. 10 Full-length radiograph of bilateral lower extremities taken 3 years after injury demonstrates a 8 mm leg length discrepancy

attributed to the inferior femoral neck comminution allowing for varus collapse or from physeal closure. Significant symptomatic coxa vara can be addressed with valgus osteotomy. The patient did have some abductor weakness likely related to relative greater trochanteric overgrowth. He was treated with therapy regimen directed at strengthening the abductors. If this continues to be symptomatic, a trochanteric osteotomy with advancement is an option to re-tension the abductor musculature.

When placing cannulated screws, they should be placed proximal to the lesser trochanter to avoid causing a subtrochanteric stress riser. If patients wish to participate in contact sports, hardware removal should be considered to prevent future fracture. Activity restriction is critical after hardware removal to protect the screw tracts while they heal and prevent re-fracture. The selection of what screw size one should use to fix these fractures is dependent on patient age and size. One should select a screw size that allows for maximal strength, while still allowing multiple screws to be placed. This is important in a narrow femoral neck that does not permit three screws in the optimal inverted triangle configuration. All guide wires should be placed prior to drilling or placing screws. This prevents rotation of the proximal fracture fragment that could potentially devascularize the femoral head.

It has been suggested that an early post-operative bone scan may be an effective tool in establishing an early diagnosis of AVN of the femoral head so that treatment before x-rays. This may prove beneficial as treatment may be instituted prior to femoral head collapse (Parikh et al. 2017).

10 Cross-References

- ▶ Femoral Head Fractures
- ▶ Hip Dislocation
- ▶ Transphyseal Fracture of Proximal Femur

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