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Case Report

Orthopaedics Section

A Resource-limited Approach for Stabilising Paediatric Femoral Neck Fracture: A Case Report

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ABSTRACT

Paediatric Femoral Neck Fracture (PFNF) is rare, and its repair is challenging for orthopaedists. Surgical treatment should be performed, as soon as, possible with anatomical repair to avoid postoperative complications, including Avascular Head Necrosis (AVN) and bone deformity. In the present case scenario, a 14-year-old male patient presented to the Orthopaedic Emergency Department with hip pain and an inability to bear weight or move his right lower extremity. He arrived at the hospital at night and was examined immediately. The patient reported a fall from the second floor two days prior. Due to the unavailability of some necessary surgical instruments at the time of the emergency surgery, orthopaedic surgeons adopted a new procedure for treating a PFNF. The fracture reduction was maintained under general anaesthesia, and the incision site was properly sterilised before using a 3 mm Kirschner wire (K-wire). The 3 mm K-wire was removed before compressing the fracture site with screws. The wires were cut to a length that allows them to be bent over the femoral shaft and secured to the shaft using ligature wires. This is a modification of the Wagner technique, which involves passing the ligature wire around the femoral shaft.

Keywords: Avascular necrosis, Bone fracture, Femur, Modified Wagner technique

CASE REPORT

A 14-year-old male patient presented to the Orthopaedic Emergency Department with severe hip pain and an inability to bear weight or move his right lower extremity. He reported at the hospital at night and was examined immediately. The patient gave a history of fall from the second floor two days prior and described the pain as sharp and intense. His medical history was unremarkable, with no known medical disorders.

During the clinical examination, there were no other significant findings and all vital signs and laboratory tests were within normal limits. An orthopaedic assessment revealed some lacerations on his body, but no fractures except for the right femur. There was marked tenderness in the hip area and an inability to move the right hip joint. The radiographic evaluation indicated a spiral-pattern fracture of the right femoral neck [Table/Fig-1a].

Based on the clinical examination and radiological findings, the diagnosis was confirmed as a fracture of the right femoral neck, which required urgent surgical intervention. The patient was then transferred to the operating theatre for the necessary surgery. A Computed Tomography (CT) scan was conducted to assist with proper preoperative planning, which revealed a spiral fracture near the base of the right femoral neck, just above the intertrochanteric line [Table/Fig-1b]. The standard orthopaedic procedure for cases like this is the Wagner procedure [1], which is specifically designed to address the unique challenges of hip injuries. Unfortunately, when the patient arrived at the hospital late at night, the authors faced a significant hurdle: there were no paediatric Dynamic Hip Screws (DHS) or paediatric locking hip plates available due to limited resources. Given the circumstances, the authors needed to act quickly and perform the surgery, as soon as, possible, especially considering the extended transport time the patient had endured before arriving for definitive care.

After obtaining consent from the patient's parents, routine preoperative tests were conducted, which came back normal. This allowed us to proceed with the surgery without delay.

Closed reduction under general anaesthesia was performed with the assistance of the traction table [Table/Fig-1c]. Subsequently, draping and scrubbing were carried out. A 7 cm incision was made starting just proximal to the level of the lesser trochanter and extending downward. The reduction was maintained using 3 mm K-wire placement [Table/Fig-1d].

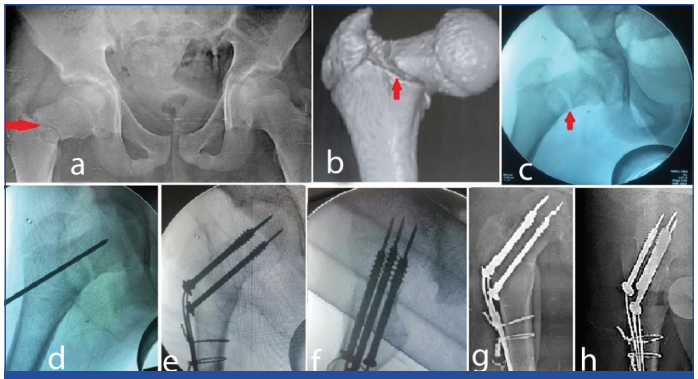
Three parallel guide wires were placed in an inverted triangle configuration to guide the insertion of cannulated screws. Drilling was performed over the guide wires, stopping before reaching the proximal femoral physis to avoid any damage. A 6.5 mm cannulated screws were used (although 4 mm cannulated screws can be used in younger cases), with their lengths measured to allow the screws to stop just before reaching the physis. The 3 mm K-wire used to maintain the reduction was removed before compressing the fracture site with screws. To achieve greater stability, three K-wires were passed through the cannulated screws, traversing the physis and stopping just beneath the articular cartilage (subchondral position). The wires were cut to a length that allowed them to be bent over the femoral shaft and secured to the shaft using cerclage wires [Table/Fig-1d].

It is important to note that modification of the Wagner technique involves the application of cerclage wire around the femoral shaft, as illustrated in [Table/Fig-1e,f].

No postoperative cast was required. Postoperative investigation showed good results with fracture alignment. At 6-month follow-up, no loss of fracture alignment or signs of inadvertent closure of the proximal femoral physis were detected [Table/Fig-1g,h]. Follow-up revealed a good result and without any clinical complaints from the patient.

DISCUSSION

The PFNF is rare, accounting for less than 1% of all paediatric fractures [2]. Although it is rare, its treatment is challenging due to the potential complications associated with surgical repair. These postoperative complications include AVN of the femur head and growth disturbance. The higher risk of AVN can be attributed to poor



[Table/Fig-1]: a) Anteroposterior view of a plain X-ray over the pelvis and both hips showing a fracture of the right femoral neck (red arrow); b) Preoperative 3D reconstructed CT image showing the fracture configuration (red arrow); c) Intraoperative C-arm images with anteroposterior view with anatomic closed reduction of the spiral pattern of fracture (red arrow); d) Maintenance of the reduction with 3 mm K-wire; e,f) Intraoperative C-arm images showing the final construct fixing the fracture in anatomic reduction; g,h) Six-month follow-up plain X-rays.

blood supply and bone anatomy in children [3]. The incidence of AVN increases with certain risk factors, including children aged 12 years or older, as well as, defects in the anatomical reduction of PFNF [4]. Other complications can occur, including non union, early physeal closure, infection, coxa vara and lower limb length discrepancy. The quality of surgical reduction is the most important factor influencing the clinical outcome of PFNF [5]. Moreover, the high incidence of complications associated with PFNF makes it a high emergency for early surgical intervention and timely treatment [6].

The fracture can be caused by high-energy traumatic events, such as traffic accidents, or pathologic fractures precipitated by low-energy trauma or excessive activity [3]. PFNF is treated with open or closed reduction and internal fixation surgery [7].

Knowledge of the anatomy of different parts of the human body is essential for proper clinical practice [8]. The main goal of surgical intervention in cases of PFNF is anatomical reduction with stable fixation of bone fragments [9]. Any displacement of the PFNF can impair blood flow to the femoral head. This is because the displaced fracture usually causes injury of the ascending cervical branches that arise from supplying the arterial annulus formed from the peripheral arteries and affects the ability to heal from the fracture, inevitably leading to non union or osteonecrosis [10].

In the present case, the authors were concerned about the method of fixation to achieve stability without damage to physis plate. This is because stabbing the femoral neck physis to stabilise the PFNF poses a risk of stunted growth [11]. Unfortunately, there were neither available paediatric DHS or hip locking plates at the time of presentation and the authors had to perform surgery without delay. Therefore, the authors used nearly parallel classic inverted triangle cannulated screws to provide as much compression over the fracture site as possible, stopping just before the physis of the femoral head. Because of the fracture pattern in these cases, at least one screw grips a small portion of the neck bone of the femur, with the risk of pulling out. Therefore, the authors passed three K-wires through the holes of the cannulated screws, stopping just subchondral in the femoral head to provide more stability. The wires were then folded over the femoral shaft and held in place with a cerclage wire, as reported in the Wagner technique, to avoid backout of both the K-wires and the surrounding screws [1].

Although the patient was 14 years old and relatively older, to be concerned about physeal damage, some surgeons may opt to pass the screws through the physis. However, fusion of the proximal end with the shaft of the femur may be delayed until the age of 18 years. The growth of the proximal femoral tissue constitutes about 30% of the total length of the femur and only 13% of the length of the lower limb and fuses with the femoral shaft at the age of 14 to 18 years [12]. Moreover, the current modified technique can be beneficial in young children with significant growth remaining through the proximal femoral physis. It allows for enhanced stability with minimal physeal damage, especially when faced with limited resources. In cases such as current PFNF, Locking Compression Plates (LCP) are commonly used, but their application usually takes longer and is associated with more blood loss than procedures performed with cannulated screws and K-wires [13].

In numerous studies, three screws with diameters greater than 6 mm have been found effective in treating femoral neck fractures [14-16]. The addition of a fourth screw has not been consistently shown to provide such biomechanical benefits, most likely due to the weakening of the lateral bone wall by the addition of screw insertion holes. Furthermore, the screws should be inserted triangularly next to the lower, front and rear cortices in an inverted triangle formation and they should be spaced, as far apart spaced, possible. This arrangement can provide good axial and bending stiffness, thus reduce the ultimate failure load [17]. On the other hand, it has been suggested that the femoral neck system, a minimally invasive implant, may also be suitable for these injuries in adolescent patients [18]. However, the current modification in technique was made due to a shortage of equipment for an emergency. Long-term follow-up of this new modification is recommended and should be studied in more cases to evaluate the long-term outcome.

CONCLUSION(S)

It is suggested that the use of a combination of K-wire and cannulated screws is a reliable method to repair anatomical PFNF. The wires are made to pass through the head and the other ends are wrapped around the shaft of the femur and secured to avoid any possible retraction of both the screws and wires. The outcome of the surgery looks good. However, further studies of this procedure with larger case numbers and extended follow-up are recommended.

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