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Educational Corner

Reduction Techniques in Displaced Femoral Neck Fracture: Educational Corner

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Background

Femoral neck fractures are considered as a significant decision-making challenge among most orthopedic surgeons. Some factors affect the decision-making ability of the surgeons, including surgical timing, quality of reduction, and mechanics of fixation (1). Beside the degree of initial fracture, anatomic reduction is thought to be the key for successful uneventful fracture union. The goal of this educational corner is to introduce a classical approach to reduction techniques and issues in displaced femoral neck fractures. Another aim is to address some learning objects in this paper such as fracture configuration, close reduction techniques, assessing reduction accuracy, and the open reduction techniques.

Fracture Configurations

Based on the fracture type, some femoral neck fractures can be successfully treated with closed reduction and internal fixation (CRIF), whilst some require open reduction and internal fixation (ORIF). For easy understanding, we describe two types of displaced femoral neck fracture with attention to reducibility of them (2). The reducible fracture defines when closed manipulative maneuver is sufficient for achieving anatomic reduction and a irreducible one defined as those with great difficulty in achieving anatomical reduction after routine closed reduction, such as the Whitman maneuver or Leadbetter maneuver, with the patient under general anesthesia (2).

There are two mechanisms for such fractures; The First one is the proximal fragment disconnecting entirely from the distal femur (Figure 1.A) and the second one is the proximal segment impacting into the distal part after rotation and moving along with the distal part as one unit (irreducible) (Figure 1.B) (2).

How to Evaluate Accuracy of Reduction

If CRIF or ORIF is selected as the operative management method, it is important for a surgeon to realize that the accuracy of anatomic reduction is critical; malreduction is a strong indicator for fracture healing complications, lower functional outcome, and subsequent reoperation (2). The acceptable reduction criteria for displaced femoral neck fractures is a neck-shaft angle between 130 and 150 degrees, 0 and 15 degrees of anteversion, up to 15 degrees of valgus angulation, and S shaped curve. Conversely, varus angulation, inferior offset, and retroversion are not acceptable and must be corrected (3).

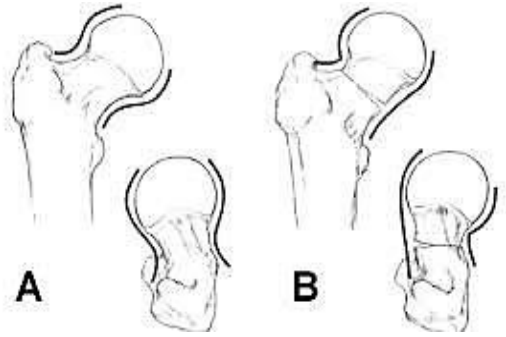

Figure 1. Two mechanisms for displaced femoral neck fractures; the first one is the proximal fragment disconnecting entirely from the distal femur (A) and the other is the proximal segment impacting into the distal part after rotation and moving along with the distal part as one unit (irreducible) (B)

Reducible Fracture and Closed Reduction

There are seven different closed reduction techniques in the treatment of reducible displaced femoral neck fractures using the fracture table including Whitman, Bazan, Leadbetter's, King, Smith, Mcelvenny, and Deleyer. The Wellmerlinge's technique that is preferred because of its utility predictable results and flexibility in treatment alternatives (4).

Wellmerlinge Technique

The anesthetized patient is placed supine on the fracture table, with their legs placed in parallel condition. The affected side is held in its fractured external rotation position and pelvis does not tilt. Reduction of the fracture (Fx) performed by the surgeon standing on the affected hip side with one forearm over the anterior thigh near the groin and the other one underneath the thigh near the popliteal space with hand clasped together. This force combined with internal rotation reduce the fracture. Finally, the unaffected side can be removed from traction (4) (Figure 2).

Irreducible Fracture and Reduction Techniques

In this section, we describe three techniques for reducing irreducible displaced femoral neck fractures, including minimally traumatic reduction, minimally invasive transfix technique, and open reduction.

Figure 2. Wellmerlinge maneuver of manipulation of the left femoral neck while in traction on the fracture table; Upward pressure at the knee increases traction, while downward pressure reduces the distal neck in line with the femoral head fragment

Minimally Traumatic Reduction

The patient is placed in supine position under general anesthesia. The femoral artery has to be located first by palpation. The insertion site of the K-wires or Steinman pins on the proximal thigh is 1.5-3 cm lateral to the femoral artery. The insertion angle of the wire should be carefully prepared. One or two K-wires or Steinman pins are first inserted percutaneously through the soft tissue to the femoral head with the tip of the pins directed slightly lateral under the guidance of intra-operative fluoroscopy. The K-wires or Steinman pins are vertically inserted into the middle 1/2–2/3 of the femoral head, and more than 1 cm inferior to the sub-chondral bone of the femoral head.

The pins are inserted into the femoral head with a depth of about 1/2 diameter of the femoral head (Figure 3).

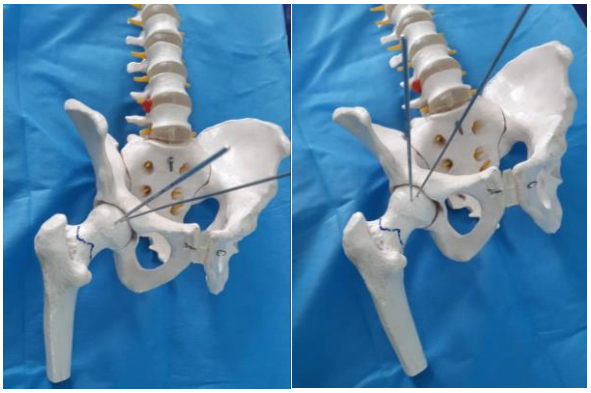

Figure 3. K-wire pins inserted to the proximal segment of femoral neck fracture and the anatomical reduction achieved with rotating the segment by the pins

If the patient has osteoporosis, the K-wires should be inserted further than 2/3 of the femoral head to ensure good purchase and control. Intra-operative C-arm fluoroscopy is used to guide and adjust the direction and location of the K-wire, accordingly (Figure 4.A).

Then, the femoral head is rotated to its original displaced status. To manage the dislocated-impacted femoral neck fracture in which one fragment is firmly driven into the other, the K-wires are inserted into the femoral head to function as a joystick, which allows manipulation of the proximal fragment. The distal femur is then rotated slightly and pulled out in the lateral-inferior direction, whilst the proximal fragment is held in place to facilitate the disconnection from the distal femur. When the displaced-impacted fracture is converted into a complete dislocated fracture, the proximal fragment can be lifted and rotated with the help of the joystick to reduce the fracture (Figure 3). Standardized anteroposterior (AP) and lateral radiographic views are taken to assess the reduction of the proximal fragment (2) (Figure 4.B).

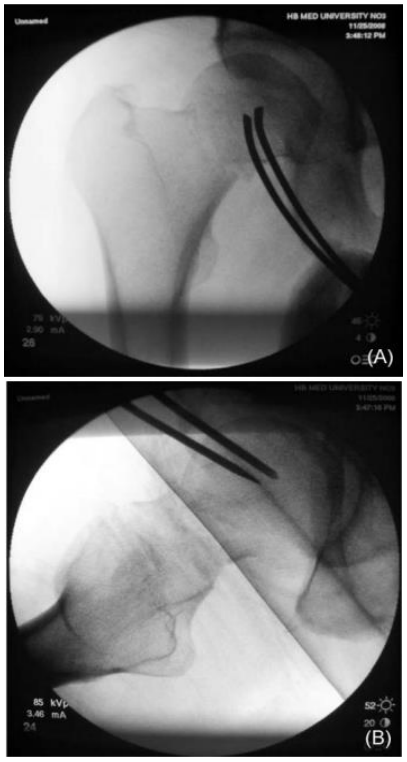

Figure 4. Pins inserted to the proximal segment guided by x-ray (C-arm) (A) and reduction checked by the C-arm (B)

The reduction is initially assessed by comparison of the radiographic views with those of the contralateral, normal proximal femur. If the reduction is acceptable, the proximal fragment will be held in place by controlling pins. Then, the reduction of the distal fragment of the femur is performed using the Leadbetter maneuver, Deyerler maneuver, or Whitman maneuver (2) (Figure 5).

Figure 5. The aid rotates the two K-wires to reduce the fracture and holds them in stable position when the guide pins are inserted into the femoral neck. The distal fragment is dislocated inferomedially due to the traction of muscles. The sterile sheet is used to pull the fragment superolaterally.

In some cases, the distal fragment dislocates inferomedially due to the traction of muscles, and the aseptic drape can be used to pull the distal fragment superolaterally. If, after such efforts, anatomical reduction still cannot be achieved, simultaneous rotation and abduction of the proximal and distal fragments can be tried as a last effort for reduction. Standardized AP and

lateral radiographic views are then taken to assess the reduction of the distal fragment. Comparing the lesser trochanter of the injured limb with that of the contralateral limb can prevent the malalignment of the distal femur. Three guide pins are inserted into the femoral neck whilst the reduction is held in a stable position by the K-wires (2). Three cannulated screws are then inserted to achieve definitive fixation.

Minimally Invasive Trans Fix Technique

The patient is positioned on the traction table and AP and lateral images of the hip are obtained with image intensifier. The operating area is painted and draped. A stab incision is made two inches superior to the tip of the greater trochanter in line with the femur. A threaded guide wire (transfixing guide wire) is inserted to pass through supero-lateral aspect of the femoral head. The guide wire traverses through the femoral head from supero-lateral aspect towards infero-medial aspect. The guide wire enters the teardrop to transfix the head fragment. The distal fragment is now maneuvered to position in line with the head fragment in a "gentle controlled manner" until acceptable position is achieved. The reduction is confirmed under image intensifier (5) (Figure 6).

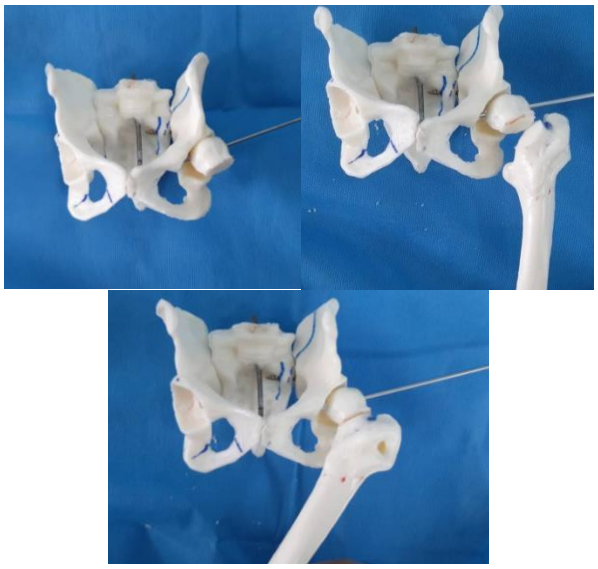

Figure 6. Transfixation reduction technique for femoral neck fracture

Open Reduction

An open approach to the femoral neck is achieved either through a Watson-Jones or via Smith-Peterson incision (6) (Figure 7).

Figure 7. In the supine position, with Smith-Peterson approach (Between tensor and sartorius muscles), the fracture was reduced with open technique.

Therefore, with the leg draped free, the leg can be brought to the head-neck segment and rotated as needed to aid in reduction. Multiple instruments are at the disposal of the treating surgeon to help affect reduction and they should be readily available. The instruments used and required are as follows: A femoral distractor with pin placement in the pelvis and femur, a ball spike pusher to help reduce the apex anterior deformity of the fracture, a 3.5-mm tap, a Schanz pin, or k-wire each may allow for a "joystick" affect in helping to rotate fragments into position, small drill holes can be used as docking sites for weber or pointed reduction clamps, a collinear clamp can be used to hold reduction and gain compression, and a Jungbluth clamp can be used to gain compression and can be quite useful (6) (Figure 8). Once the fracture reduction is achieved, provisional fixation to definitive stabilization occur.

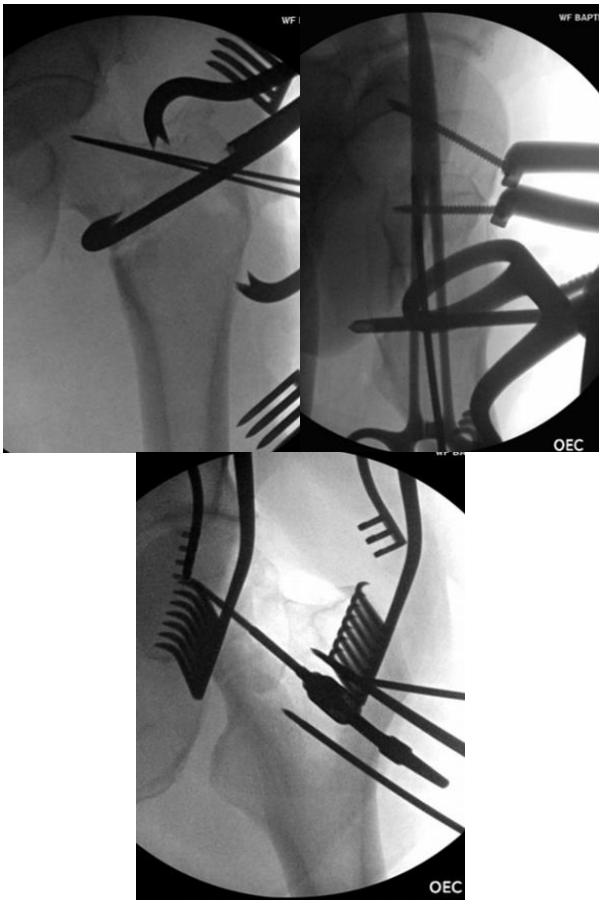

Figure 8. The open reduction technique guided by C-arm and provisional fixation with K-wires under x-ray guidance from the lateral incision

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgments

None.

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