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Educational Corner

Femoral Neck Fracture Fixation with a Buttress Medial Plate: Technical Note and Educational Corner

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Background

A 35-year-old man who had fallen from a 4-meter height was brought to the emergency department with pain in the left hip region. On the radiograph, a type 3 Pauwels femoral neck fracture was evident (Figure 1). What is the best fixation method for this type of fracture?

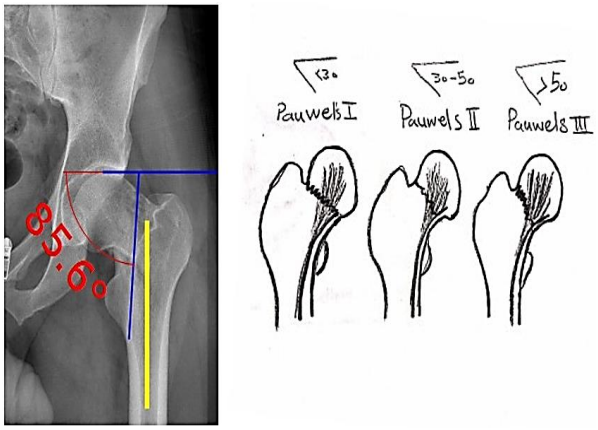

Figure 1. Pauwels classification of femoral neck fractures

Femoral neck fractures are rare in the young population and usually occur after high energy-trauma. The Pauwels classification differentiates femoral neck fractures based on the angle between the fracture line and an imaginary horizontal line perpendicular to the anatomical femoral shaft axis (type 1 < 30°, type 2 = 30°-50°, type 3 > 50°). In a type 3 fracture, choosing a suitable fixation device has always been a challenge, since strong varus force moments can cause complications like neck shortening, varus deformity, avascular necrosis (AVN), and nonunion (1).

Here, we discuss different methods of fixation for this type of fracture with a focus on the medial buttress plate, its fixation technique, biomechanical advantage, and outcome.

Fixation Methods for Type 3 Pauwels Femoral Neck Fractures

Despite various methods suggested for Pauwels type 3 fixation, the best choice remains uncertain. Some of these techniques include fixation by screws, angle blade plates, sliding hip screws, proximal femoral locking plates, intramedullary nailing in combination with medial buttress plate, and cannulated screws. Table 1 presents a summary of studies on the advantages and disadvantages of these fixation methods (2-9).

Role of Medial Buttress Plate in Vertical Femoral Neck Fractures

Obtaining and maintaining anatomical reduction is the most important issue in type 3 fractures (10). Older techniques do not directly provide sufficient medial buttress support. Using medial buttress plate is based on tibia and distal radius fixation method, which requires additional support against shear forces produced by compression or axial loading (11-13).

Femoral Neck Fixation with a Medial Buttress Plate

Reduction Technique: Under spinal or general anesthesia, the patient was placed in supine position on a radiolucent table. Some studies have used fracture table for its easier traction maintenance during surgery (14). A fluoroscope was positioned contralateral to the affected limb to obtain anteroposterior (AP) and lateral radiographs of the hip. The affected limb had to be draped free to help manipulate the shaft component and it had to be in traction and rotation to make the patella perpendicular to the floor (Figure 2).

Table 1. Different methods of fixation for type 3 Pauwels femoral neck fracture

Study	Number of fractures	Number of Pauwels type 3 fractures	Fixation method	AVN (%)	Nonunion (%)	Malunion (%)	Infection (%)
Slobogean et al. (3)	1558 fractures from 41 studies			14.3	9.3	7.1	5.1
Liporace et al. (6)	76		Cannulated screws	11.0	16.0		1.0
Haidukewych et al. (8)	83	51		27.0	9.8		
Yousrya et al. (2)		306		25.0	30.0		
Schwartsmann et al. (4)		53	DHS	24.0	26.0		
Osarumwense et al. (5)		12	Fixed-angle blades	8.0	8.0		
Khoo et al. (7)		36	Cannulated screws	2.7	25.0		
Gautam et al. (9)		25	Cannulated screws	4.0	12.0		4.0

AVN: Avascular necrosis

Figure 2. Correct position on table for traction and reduction

At first, the closed reduction can be undertaken by traction, internal rotation of the leg in a gentle manner. Awareness of excessive traction with forceful rotation to the leg can lead to valgus. Then, the quality of reduction was evaluated by the radiographic study. If it was not satisfying, small traction and internal rotation could be helpful. In Pauwels type 3 femoral fracture, an open reduction is usually preferred since the closed reduction cannot be achieved in many cases. This type of fracture usually has an apical fracture spike which may increase the stability of fixation if anatomically reduced. The open approach helps to apply fixation device into the neck area and provides decompression of the intra-capsular hematoma, which decreases the risk of AVN (14-17).

Surgical Approach: There are two commonly used surgical approaches for Pauwels type 3 fractures: the direct anterior approach (Smith Petersen or Heuter) and the anterolateral approach (Watson-Jones). The Smith-Petersen approach provides direct visualization of the vertical fracture line in the anteroinferior region of the femoral neck. As a disadvantage, we need a second approach for fixation of Dynamic Hip Screw (DHS) or screws (Figure 3). On the other hand, by the Watson-Jones approach, the whole operation can be performed in one anterolateral window which has a limited visualization, especially in obese patients (18). We preferred the Watson-Jones approach.

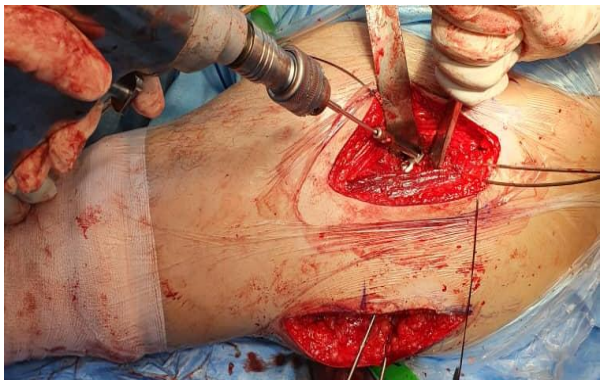

Figure 3. Intra-operative photo of Smith-Petersen approach

The incision started about 6 cm proximal to the greater trochanter, arcing to the iliac crest nodules and continued to 7 cm distal to lesser trochanter, in a line with femoral axis. Then, a sharp incision was made on the fascia lata, gluteus medius muscle, and greater trochanter was exposed. The Hoffman retractors were placed anterior to medius gluteus and acetabulum. Then we pulled the tensor fascia lata anteriorly and gluteus muscle posteriorly to expose the proximal hip capsule. Distally, the lateral femoral muscle was pushed under the periosteum and the fracture site was exposed through the T-shaped incision of the hip joint capsule (Figure 4) (19, 20).

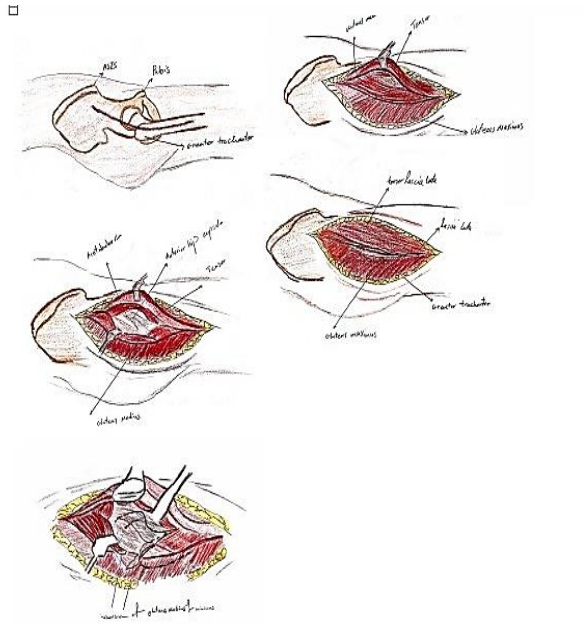

Figure 4. Schematic drawings of Watson-Jones surgical approach

Fixation Technique: The reduction could be achieved with direct visualization by changing the position of the leg and using stout K-wires or 3-4 mm Schantz pins as joysticks for fragment manipulation. A Weber clamp or modified small-pointed clamp was used for maintaining the reduction. For provisional fixation, we could use extra K-wires. For better visualization and exposure of medial aspect of femoral neck, it was beneficial to perform an external rotation of hip with a mild flexion (Figure 5).

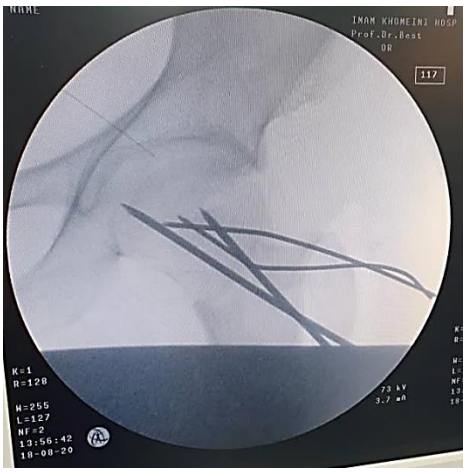

Figure 5. C-arm anteroposterior view open reduction of femoral neck fracture using k-wires

A 4-hole reconstruction plate was formed to fit femoral neck medial arch and secured with 3.5-mm cortical screws. The more the plate was in the shape of the femoral neck, the better it could provide buttress force. For fixation, the first screw was placed in the middle of the plate for adjusting the position. The ideal position of the plate was medial to the femoral neck. On the lateral view, it could sometimes appear in a more anteromedial position due to the anteversion of the femoral neck. Iatrogenic impingement might happen because of placing the plate too superiorly or too anteriorly. The second screw was placed proximal to the fracture line and had to be directed cephalad into the femoral head to avoid violating the fracture line (Figure 6). Then, one or two screws were fixed in the distal aspect of the plate (21).

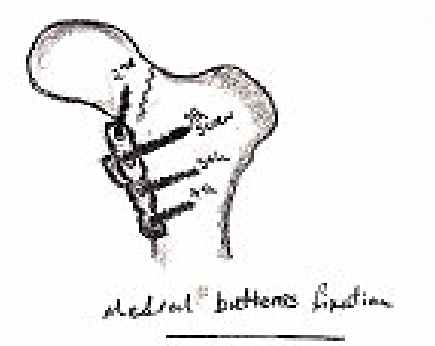

Figure 6. Schematic drawing of placing medial buttress plate

Which is Better for Combination with Medial Buttress Plate, DHS or Cannulated Screws?

Medial buttress plate can be used in combination with cannulated screws or DHS. Ye et al. in a review article reported an improved fracture union rate using cannulated screws (22). Li et al. attempted to combine the medial anatomical buttress plate with cannulated screws in a biomechanical study. They found that addition of the buttress plate enhances the stability significantly (13).

A combination of the DHS or cannulated screws with fibular bone graft were compared with the study by Li et al., in which the DHS and fibular bone graft showed to speed up the healing, decrease the nonunion and AVN, and provide a better Pauwels type 3 fixation (23).

We preferred DHS over the screws because we believed it provided less failure and more resistance and strength. Additionally, we use AP/lateral radiographs for placing the sliding-screw to avoid interaction with plate screws (Figure 7).

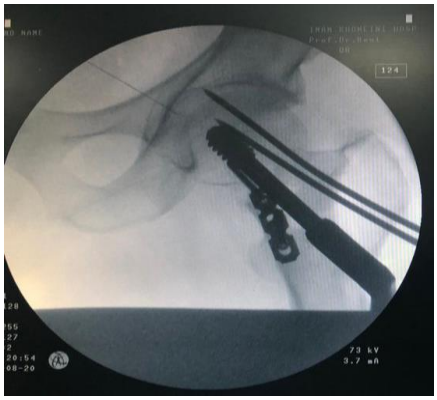

Figure 7. C-arm anteroposterior view of completing the fixation by placing Dynamic Hip Screw (DHS)

Some studies prefer fixing the femoral neck with an initial DHS or screw placement, and a secondary medial buttress plate as an anti-glider (21, 24). We preferred the primary placement of the medial buttress plate.

The Best Options for Medial Buttress Plates

Ye et al. preferred to use a 2.7-mm or 3.5-mm third tubular plate because they could provide effective buttress and reduce the possible irritation to the medial femoral neck structures. Moreover, they recommended not to use a reconstruction locking plate, since the locked screws might prevent dynamic compression and increase the nonunion rate (24).

We placed reconstruction plates for more compression effect on the medial side of the femoral neck.

Outcome

In a biomechanical analysis, Kunapuli et al. compared the strength of 2.7-mm locking plate as medial buttress fixation method with nonaugmented one (DHS and cannulated screws). Both the cannulated screw and DHS constructs augmented had a significant stronger stiffness (25).

Tianye et al. recommended "F" shaped cannulated screws in combination with medial plate among 4 groups of fixation methods in a biomechanical study: F shaped cannulated screws or traditional cannulated screws with or without medial buttress plate (26).

Ye et al. combined cannulated screws with a medial-buttress 1/3 tubular plate, contoured based on patient medial femoral neck anatomy in 28 patients with a Pauwels type 3 fracture. This procedure increased the rate of union compared to cannulated screws alone, and also, there was no increase in the rate of AVN (24).

Putnam et al., using eight fresh hip cadavers, demonstrated that medial buttress plate has the biomechanical advantage in Pauwel type 3 fracture. Furthermore, it was a safe method of fixation that did not compromise the inferior retinacular artery which supplies femoral head (27).

Yousrya et al. reviewed the different methods of fixations for this type of fracture, including cannulated screws, DHS, dynamic condylar screw (DCS), cephalomedullary nails, medial buttress plate augmentation, cement augmentation, fixed angle blades, and primary valgus osteotomy. The AVN rate was highest with the fixed angle device (16%) and lowest with the medial buttress plate augmentation (0.0%). Similarly, the reoperation rate was highest with the fixed angle device (32.0%) and lowest with medial buttress plate augmentation (0.0%). The 130° angled blade plate achieved the highest union rate (96.6%), while DCS achieved the lowest union rate (50.0%) (2).

Currently, there is no "gold standard" treatment for Pauwels type 3 femoral neck fractures. The medial buttress plate has shown great potentials in biomechanical testing and short time clinical follow-up. Further randomized trials are needed to compare the new combined fixation methods with the traditional fixation.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgments

None.

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