

Original Article

Valgus osteotomy in delayed presentation of femoral neck fractures using fixed angle simple dynamic hip screw and plate

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ABSTRACT

Purpose: Reduction and fixation in femoral neck fracture in young patients have a problem of nonunion, requiring additional procedures like valgus osteotomy; but fixation devices are technically difficult for inexperienced surgeons. We aim to assess the results of valgus osteotomy in femoral neck fracture in our setup.

Methods: We reported a series of 20 patients of higher Pauwel's angled fracture of femoral neck fracture presenting late wherein valgus osteotomy was added to reduction fixation which was secured with a commonly available 135° dynamic hip screw and plate.

Results: Femoral neck fractures united in 16 patients (80%). Excellent to good results (Harris hip score >80) were seen in 70% patients. Angle of correction of preoperative Pauwels has been changed from 68.3 to 34.3.

Conclusion: The 135° dynamic hip screw and plate provides rigid internal fixation after valgus osteotomy and being a more familiar fixation device simplifies the procedure with good results.

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Introduction

Femoral neck fracture continues to be regarded as the “unsolved fracture”.¹ Young and active patients are generally treated by anatomical reduction and internal fixation to preserve one's own hip as much as possible. Maninger et al.² reported a lower incidence of femoral head collapse when surgery was carried out within 6 h of injury; however patients are often reported after few weeks and some even months of trauma. Despite modern treatment modalities and good understanding of anatomy of femoral neck, nonunion is still reported in one third of cases of femoral neck fracture with displacement.^{3,4} Operative methods to use to enhance vascularity and achieve healing at fracture site in lately presenting fractures are either by fixation with bone grafting, pedicle graft to provide blood supply or valgus intertrochanteric osteotomy.^{5–8} Pauwels⁹ was the first to treat a pseudoarthrosis of the femoral neck with a valgus repositioning osteotomy resulting in alteration of the biomechanics of hip converting the shear stress to compression stress. Subsequently many authors have added some type of internal fixation devices like blade plate, double angled

blade plate and also double angled dynamic hip screw (DHS). The fixation with blade plate remains a technical challenge requiring a learning curve and expertise before execution as a poorly performed procedure may displace the fracture fragment. Moreover, in many areas the double angle blade plate or the modified double angled DHS may not be readily available. Hence many surgeons are giving up this “salvageable” procedure to the “substituting” procedures which are simpler to perform.

Fixed angle DHS (used for intertrochanteric fractures) is a commonly used implant and familiar to all practising orthoped. We planned the osteotomy fixation using this readily available implant in our study. We share the outcomes of our valgus intertrochanteric osteotomy and fixation by DHS & plate in late presenting femoral neck fracture. Ours is a pilot project as part of large study in order to assess the results of valgus osteotomy in femoral neck fracture in our setup.

Methods

This study was carried out at a tertiary teaching hospital from June 2010 to June 2012. The study was approved by the ethical committee of our institution, and all patients gave informed consent. Patients with intra capsular femoral neck fracture >3 weeks old, Garden type III/IV fractures, Pauwels type II/III fracture line and those with acceptable reduction (closed/open) on fracture table were

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selected for the procedure. Elderly patients (age >60), patients having preexisting diseases in same/opposite hip or having medical co-morbidities, those failing to get acceptable reduction and those having signs of avascularity on X-ray were excluded from the study.

Preoperative evaluation

A detailed history was taken. Assessment of the patient's pre-injury ambulatory status and cognitive function was done. The degree of shortening and deformity of lower extremity was noted. An anteroposterior radiograph of the pelvis with 20° internal rotation at hips and a lateral view of the involved side were taken to assess angulations, displacement of fragments, to note posterior comminution and avascularity of femur head. All fractures were classified based on fracture location, Pauwels and Garden's classification.

Plan of osteotomy

The inclination of fracture line to horizontal (line touching the roofs of acetabulum) is the Pauwels' angle or "shear angle". Pauwels' optimal angle is usually between 20° and 25° which is the angle where the compressive force will be at a right angle. Thus the goal of osteotomy was to achieve a final Pauwels angle of 20° to 25° (Fig. 1). We planned a wedge of 0°–40° on case to case basis depending upon the fracture angulations. The height of the base of the wedge is calculated on simple circle geometry of $360^\circ = 2\pi r$. It is nearly 10 mm for 10° depending on femur thickness in an adult male. Pin insertion angle is the angle created between the borders of the pin within the femoral neck and lateral femoral cortex. The sliding hip screw is placed towards the centre of head at the pre-determined pin insertion angle. For 135° DHS and 40° wedge, the angle is 95° and will increase if fewer angles are required.

DHS screw insertion

Under spinal anesthesia patient was laid supine on orthopedic fracture. An attempt of closed reduction of fracture tried by Whitman's method or Leadbetter's method was made failing which a formal open reduction through Watson Jones approach was done. Under fluoroscopy DHS guide wire was inserted at predetermined angle approximately 2 cm above the proposed osteotomy level

aiming the centre or infero-medial quadrant of femoral head. A 6.5 cancellous screw was inserted over another wire placed superiorly in the femoral head after placement of first guide wire for hip screw. Appropriate DHS was inserted. The side plate now stands away from the femoral shaft, making an angle equal to the desired osteotomy.

Osteotomy

A lateral closed wedge osteotomy is performed. The upper cut of the osteotomy is transverse 2 cm below the hip screw (Fig. 2). Then the lower cut is made, subtending the wedge angle with the upper cut and meeting it at the medial surface of the femoral shaft. The wedge of bone is removed and can be used as bone graft at the osteotomy site. In cases where no correction of angle was required, only an osteotomy was made and no wedge is removed. Subsequently distal fragment is displaced laterally and valgusised and fixed with 135° barrel plate and cortical screws. Wound was closed in layer after leaving suction drain. The drain was taken out after 48 h and skin stitches were removed at 14th postoperative day.

Postoperative management

Quadriceps drill & ankle pump exercises were initiated as soon as patients tolerated. Patients were allowed to sit up and gradual mobilization as partial weight bearing begun. Full weight bearing was allowed after complete union of osteotomy site.

Follow-up

Functions were evaluated using modified Harris hip score four weeks, 3 months, 6 months and final at 12 months. Union, viability of the head and implant cut-out was studied in the radiographs. Union was defined as trabeculations across fracture or osteotomy site.

Results

We got 20 patients, of which there were 15 males and 5 female. Out of the 20 patients, there were 2 sub-capitals, 13 trans-cervical and 5 basal neck fractures. Pauwels III was measured in 9 patients (45%) and II in 11 (55%). The average time interval between trauma and operation was 12.2 weeks with a minimum of 6 weeks

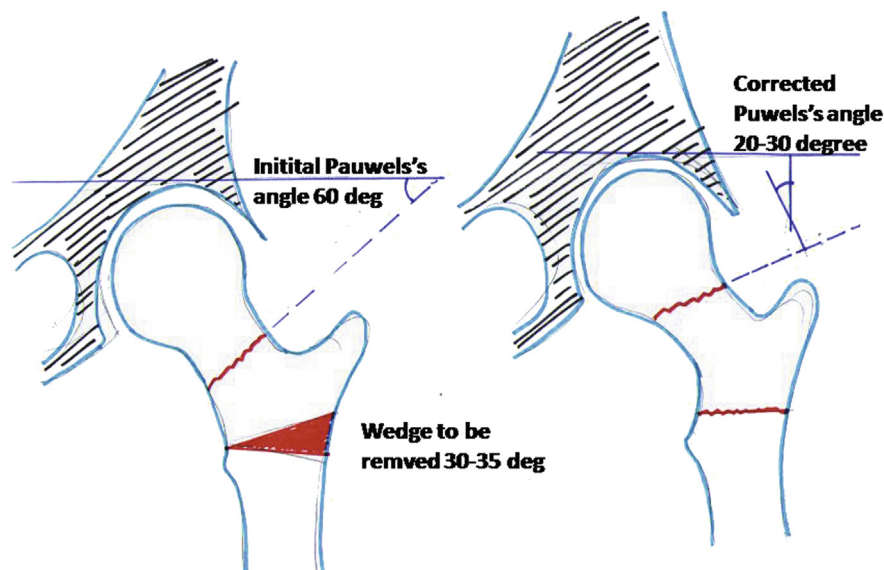


Fig. 1. Drawing showing the lateral wedge osteotomy with aiming Pauwels angle to 25°.

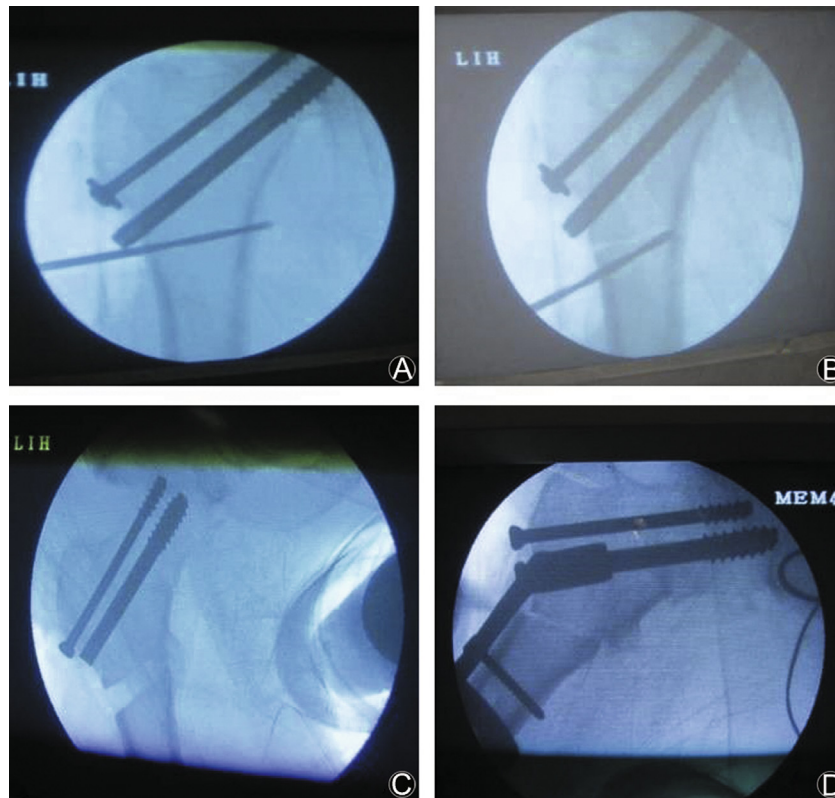


Fig. 2. The steps of osteotomy showing final valgus displacement (A–C) and closure of osteotomy site (D).

and maximum of 20 weeks (<10 weeks in 6, 10–15 weeks in 9 and 15–20 weeks in 5 patients). 17 (85%) were operated within 2 h and only 3 (15%) took more than 2 h for surgery. Fracture union was achieved in all but 4 patients (80%). Time to fracture union ranged from 16 to 28 weeks with mean of 19.94 weeks. Healing of the osteotomy site was also complete (100%) from 8 to 12 weeks with mean of 10.35 weeks without any significant correlation between them (spearman's RHO value 0.484). The average correction of Pauwels changed was from 68.3 to 34.3. Limb length was regained in 15 patients (75%) and 5 had more than 1 cm of shortening. Functional outcome was good to excellent (Harris hip score >80) were seen in 70% patients.

We got 4 nonunions, mild knee pain in 2 and persistent limp in 5 patients. However there was no case of screw cut-outs. One patient of the nonunion and 2 other patients post-union developed avascular necrosis (15%) and all six patients (30%) were scheduled for total hip arthroplasty at later date. We had no case of screw migration into the joint or implant cut-out. Fig. 3 shows the final outcome of four patients.

Discussion

Nonunion of femoral neck fractures particularly in the younger age group has always been challenging to manage.^{3,9} Arthrodesis is not accepted in our country particularly for the desire to squat or sit cross legged. Total hip arthroplasty (THA) is a “substituting” procedure and reserved for the elderly patient. Even in the elderly with femoral neck fracture Magu et al.¹⁰ have suggested osteotomy provides comparable results with THA.

The most common cause for nonunion remains a high shearing Pauwels angle at the fracture site and Pauwel recognized that nonunion of femoral neck fracture would consolidate within few months if shearing force acting on fracture site was transformed

into compression forces.⁹ Marti et al.¹¹ reported 86% union rate at an average of 3.6 months, treated by this method alone. In 2005 Magu et al.¹² reported 50 patients with fresh intracapsular fractures of the femoral neck with osteoporosis treated by osteosynthesis with valgus intertrochanteric osteotomy with union rate of 94%.

In the developing countries like ours late presentation is common as the fracture often remains untreated, sometimes patient's unwillingness to seek treatment but mainly due to treatment primarily by osteopaths.¹³ Avascular necrosis remains a potential threat with the rate reported in the literature ranging from 12% to 86%.¹⁴ The risk is directly proportional to the severity of trauma and displacement of the fracture.¹⁵ MRI can detect this early than the conventional X-ray, but we did not include this special study as precollapse avascular necrosis of femoral head is not considered to be a contraindication for valgus osteotomy.^{13,16}

Some authors namely Pauwel, Muller and Sharma used the Y-shaped wedge-closing/open osteotomy^{9,13,17} but V-shaped lateral closed wedge osteotomy is technically simpler and provides equally broad osteotomy surface that ensures good bony contact on closure of the osteotomy.¹¹ This osteotomy also results in rotation of the upper segment of the femur making the osteotomy line oblique (Fig. 2D).

In most of the case series reported in the literature on valgus osteotomy, blade plate fixation has been used, which is more technically demanding.^{18–21} There is always a risk of splitting of femoral head by the sitting chisel in new hands.^{22,23} The correct length of blade plate is also crucial as shorter one can lead to secondary instability and longer can penetrate hip joint and also lead to distraction nonunion.²³ Sometimes during surgery, blade may displace the fracture fragments and minimal change in the direction of blade may change the direction of plate anterior or posterior to the shaft of femur. Most orthopedic surgeons are accustomed to the use of the conventional fixed angle (single barrel) DHS, which is more



Fig. 3. Radiological union shown in four cases (A–D). Case 3C showing squatting and Case 3D showing active straight leg raising test.

commonly used in the treatment of intertrochanteric fractures, and is technically much simpler than the blade plate fixation. In DHS fixation, powered instruments could be used, which saves time and reduces blood loss. Osteosynthesis with DHS in its optimum position in the femoral head, supplemented by the buttressing effect of the distal osteotomy fragment, maintains coaptation and immobilization of the fragments and provides a high degree of stability. When double angled implants are used the femoral shaft is displaced medially and becomes vertically oriented after the osteotomy becomes fixed in this deformed position (Fig. 4). On the contrary, fixation with a single-angled blade plate or a simple DHS will pull the femoral shaft laterally correcting the medialisation of the femoral shaft, restoring the normal inclination of the femur to the sagittal plane and resulting in desirable lengthening.²² These effects also have a positive impact on the knee joint per se preventing valgus strain and overloading commonly seen with double angled implants. The weight bearing compressive forces at the hip subtend an angle of 20° – 25° and the fracture plane is reclined to subtend near this value for optimum output. The drawbacks of this procedure are lengthening of acetabulo-trochanteric distance (which may stretch the abductor muscles and capsule hampering their circulation⁹) but are desirable in our situation of late presentation with shortening.

When blade plate is compared to the DHS, there is a theoretical risk of greater chances of avascular necrosis with DHS as there is thermal necrosis and rotatory motion during reaming and intraosseous vascularity disruption due to large screw placement.²⁴ Yet the procedure is much simpler and the purchase is good particularly in the younger age patients. Blade plate is advantageous in the older and the osteopenic bone, without the risk of cutting through the femoral head.¹² We had excluded the patients with more than 60 years of age due to same reasons.

The rate of fracture union (80%) in our patients is comparable to rates achieved by others by valgusization osteotomy using the conventional double angled blade plates.^{11,17,20,25} Limb-length equalization was achieved in 75%, and no coxa vara was seen in our patients. The functional outcome in our patients is also comparable with reported outcomes. Seventy percent of patients could squat on floor or sit in the crossed-leg position which is the most

satisfying functional gain besides a near normal gait. The causes of limping in our patients were residual shortening of 2 cm (3 patients who were habituated to bare foot walking and refused a sole raise, and painful avascular necrosis in 2 patients).

Avascular necrosis (AVN) and nonunion are the most notorious complications in the late neck fractures, and although great efforts have been made in past decades, the real prognosis of the young femoral neck fractures has not been improved dramatically. Valgusization osteotomy does not increase the chances of nonunion or AVN and there are enough studies that prove it is the temporary instability after fracture which is more detrimental for vascularity of head.¹⁵ Magu et al.¹⁸ had 5 nonunions and 2 AVN in their series of 49 patients however they classified using Pauwels angle only. We had 2 sub-capital fractures both went to AVN (one had nonunion and AVN, and other united with AVN). They also mentioned two cases of implant penetration into joint and 2 cases of inadequate valgization (blade plate needs more accurate execution). They have not encountered implant cut-out but we have burnt fingers in our initial days when we have used double angle blade plate. This had prompted us to use a more surgeon friendly device. Gupta et al.¹⁶ did their study in failed & un-united as well as neglected fractures using the conventional 120 DHS and found to have a radiological outcome of 93% and functional outcome of 90% (good to excellent). They did have 2 cases of implant cut-out (3%) in their series which we did not have.

The limitations of this study are small sample size and short term follow-up. We have not done MRI preoperatively to access the vascularity of femoral head in planning but excluded avascularity on X-ray. Comparing studies with blade plate fixation may be helpful in finding out any significant outcome differences.

In conclusion, the results are encouraging for the use of universally available simple DHS for valgus intertrochanteric osteotomy fixation in femoral neck fractures with high Pauwels angle in relatively young adult patients.

Funding

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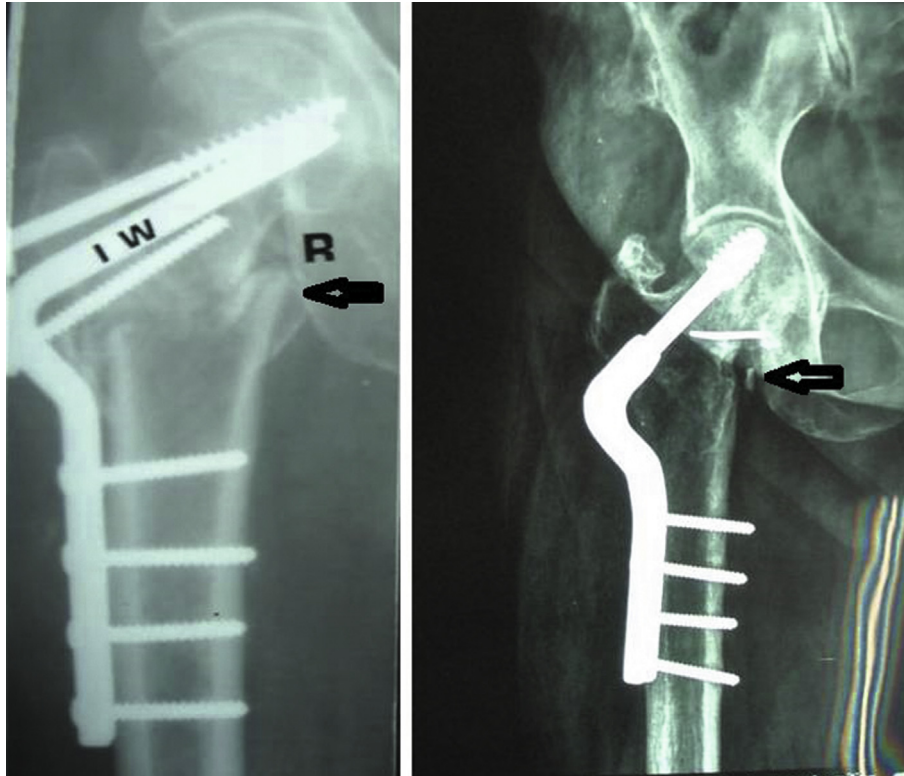


Fig. 4. Fixation with double angled implants (blade plate in A, DHS in B) showing medial displacement of shaft (arrow marked).

Ethical statement

The study was approved by the ethical committee of our institution, and all patients gave informed consent.

Conflict of interest

The authors declare that they have no competing interests.

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