

Modified Intertrochantric Valgus Osteotomy as a primary mode of treatment in unstable Pauwels grade 3 fracture neck of femur in young adults

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Abstract

Background: The management of femoral neck fractures in adult population is aimed at preserving the femoral head. Pauwel's type 3 neck femur fracture in particular has a high propensity to develop non union following osteosynthesis owing to dominant shear forces acting at the fracture site. Valgus intertrochanteric osteotomy is a versatile, well established procedure for delayed and nonunion neck of femur neck fracture. We did a prospective analysis of modified valgus intertrochanteric osteotomy as a primary mode of treatment in fresh type 3 Pauwels neck of femur fracture. **Materials and methods:** A total of 5 fresh cases of Pauwel's type 3 femur neck fracture were included in our study and were treated primarily by modified valgus intertrochanteric osteotomy. **Results:** Union was seen in all the 5 cases at an average of 13.2±2.99 weeks. 4 out of the 5 patients showed excellent clinical outcome (Harris hip score ≥ 90) with an average Harris score of 92.8±3.18. **Conclusion:** Modified valgus intertrochanteric osteotomy as a primary procedure in fresh cases of Pauwel's type 3 femur neck fracture has good clinical outcome.

Keywords: modified valgus intertrochanteric osteotomy, Pauwel's type 3 fracture, neck of femur fracture, osteotomy.

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I. Introduction

Neck of femur fractures are seen commonly in the elderly after trivial fall but it is uncommon in younger population of less than 50 years and occur mainly due to high energy trauma⁽¹⁾. In the elderly age group, treatment options include reduction and internal fixation, hemiarthroplasty, total hip replacement and are chosen depending on the age, medical comorbidities, level of activity of the patient⁽²⁾. However, in younger adult population all efforts should be made for preservation of femoral head with the aim of preventing osteonecrosis and avoiding non union⁽³⁾. There are various techniques in use for fixation in head salvage surgeries and for most fresh cases of femoral neck fracture in young adults the technique recommended is use of multiple cancellous screws with Pauwels type 1 and 2 pattern of fractures being most amenable to this type of fixation as the fracture. The fracture geometry in Pauwels type 1 and 2 pattern of fractures allows for placement of three screws in an inverted triangular configuration. Moreover, the perpendicular placement of screws to fracture line allows for optimal compression across the fracture^(3,4). A fourth screw often proves beneficial in femoral neck fractures that exhibit posterior comminution⁽⁵⁾. In Pauwels type 3 fractures, however, the dominant shear forces associated with high angle fracture pattern often results in increased rates of failure and non union^(3,6). Valgus osteotomy is the treatment of choice in these type of cases but in remote areas people with low socio-economic status are not cooperative for more than one surgery and as such often tend to continue with the failed surgery.⁽⁷⁾

This problem can be tackled by valgus osteotomy as primary mode of treatment in cases with unstable fracture pattern, which can be stabilized with various devices. Thus, high grade Pauwels angle is converted into low grade (Type 1 or 2) redirecting the shearing forces to compressible forces. The role of primary valgus osteotomy followed by internal fixation has been described in the management of fresh cases of neck of femur fracture in several studies⁽⁷⁻¹²⁾. The concept of valgus osteotomy was refined by Pauwels⁽¹³⁾ in 1927, showing that nonunion of neck of femur fracture was due to the high shear forces that increased with the vertical orientation of the fracture. The proposed biomechanical solution was to redirect these forces into compression forces via an angulation osteotomy and fixation with a blade plate device. Valgus intertrochanteric osteotomy as described by Pauwels⁽¹³⁾ and subsequently modified by Muller⁽¹⁴⁾ is still in use today, and remains a popular treatment option as it has a high success rate and corrects the common symptoms of coxa vara and associated limb length discrepancy.

We performed a prospective study to evaluate the efficacy of modified valgus intertrochanteric osteotomy as a primary procedure for fresh cases of Pauwel's type 3 fracture neck of femur cases.

II. Materials And Method

The study was conducted in the department of orthopaedic surgery, Gauhati medical college & hospital, Guwahati between June 2018 and May 2019. Institutional ethical clearance was obtained prior to commencement of study and an

informed and written consent was obtained from all the participants prior to inclusion in the study. 5 patients with Pauwels type-3 femoral neck fractures were included in the study. The study group comprised of 4 male and 1 female patient. Radiographs were reviewed and fracture verticality was ascertained using a goniometer by using Pauwel’s method.⁽¹⁵⁾ All the cases were operated within 7 days of admission to our department. The patient characteristics are listed in table 1.

Inclusion criteria:

1. Patients less than 50 years of age
2. Pauwels type 3 fracture neck of femur
3. Fractures less than 3 weeks old.
4. transcervical fractures with $\geq 50^\circ$ of verticality.

Exclusion criteria :

1. Elderly patients (> 50 years)
2. Pauwels type 1 and 2 fracture neck of femur
3. Any prior surgical intervention for fixation of fracture
4. Basicervical fractures.

Table no 1- Patient characteristics included in the study

Case number	Age(years)	Sex	Preoperative Pauwel’s angle	Days elapsed between trauma and surgery
1	45	Male	50°	20
2	47	Female	65°	17
3	40	Male	57°	10
4	49	Male	60°	15
5	35	Male	72°	18
Mean	43.2 ± 5.07		60.8 ± 7.41	16±3.405

Operative techniques

The operative procedure is a modification of method described by Muller⁽¹⁴⁾.

Step 1: Preoperative templating

Templating was performed on the normal hip; it gave information about positioning of implant and size of wedge to be taken out. Thereafter, the angle that the fracture made with horizontal was measured and the angle of correction or wedge angle was calculated as under :

$$\text{Wedge angle (Osteotomy angle)} = \text{Shear angle} - \text{Postoperative desired angle (25°-30°)}$$

Thus, the desired post operative Pauwel’s angle was less than 30°.

Step 2: Reduction and stabilization

Closed reduction was attempted on fracture table with traction/ Leadbetter technique⁽¹⁶⁾ under guidance of image intensifier (figure 1). Open reduction was attempted only when close reduction failed. Reduction was maintained with k wire to avoid rotation during reaming, and the fracture was stabilized with Richard’s screw. The blade or screw was engaged in the inferior quadrant as cut though is observed when it is placed in superior quadrant⁽⁸⁾. As per preoperative templating, osteotomy angle was marked and osteotomy was performed with power saw (figure 2).

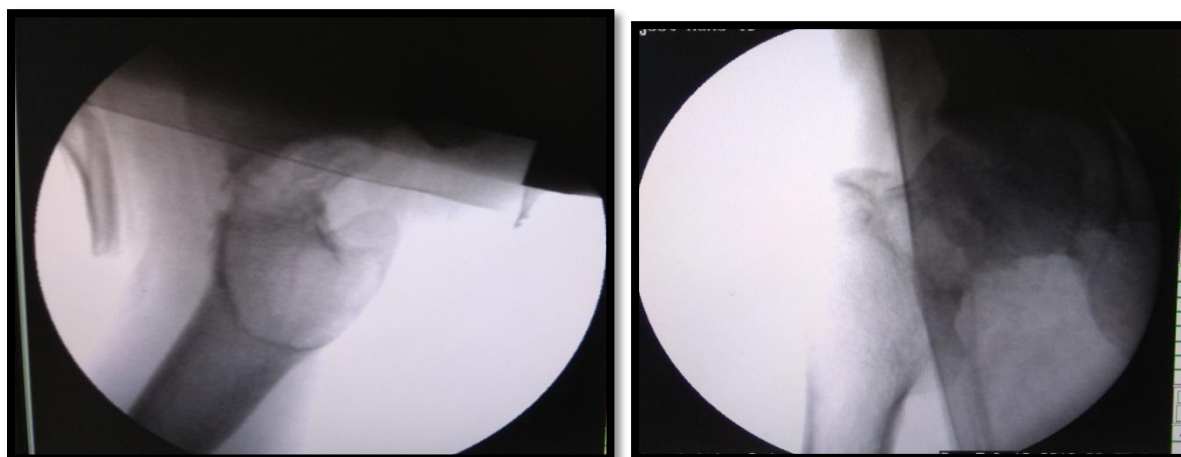


Figure 1: Closed reduction attempted under fluroscopic guidance. Reduction accepted in both anteroposterior and lateral views

Step 3: Osteotomy and fixation

Lateral closing wedge was taken from intertrochanteric region at the upper border of lesser trochanter, after which osteotomy was closed by abducting the limb and clamping the plate to the bone (figure 3).



Figure 2(a) Figure 2(b) Figure 2(c)
Figure 2(a,b,c)- Intraoperative images showing marking of osteotomy site and resection of bone wedge.

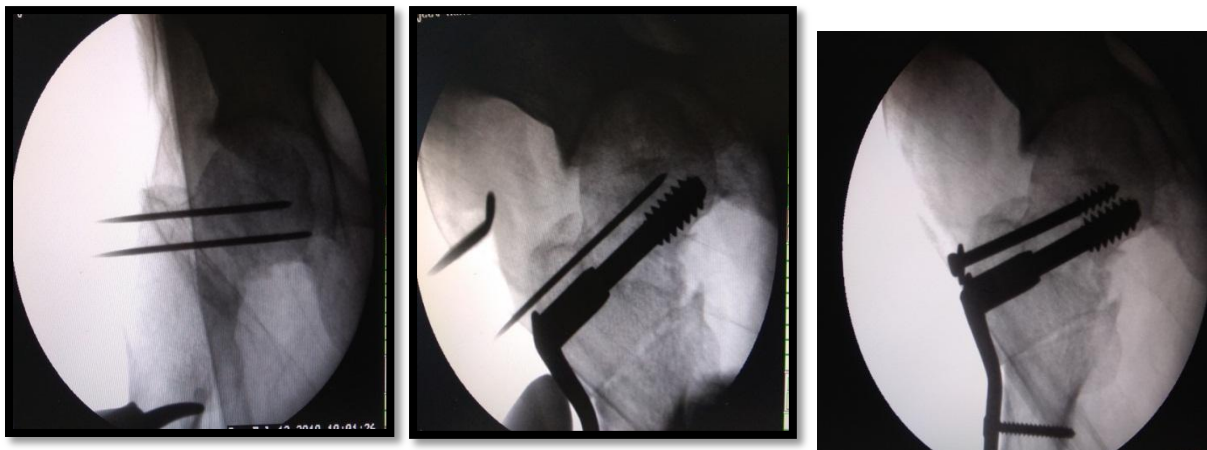


Figure 3: Intraoperative pictures showing various steps of fixation

Postoperative management

Knee and ankle physiotherapy was started on the next day after the operative procedure. Partial weight bearing using crutches was started on the third postoperative day. Full weight bearing was started after complete union of the osteotomy site.

Follow up

The patients were followed up after 2 weeks when the suture removal was done. Thereafter, patients were followed up on a monthly basis and the functional outcome using harris hip scores⁽¹⁷⁾ at 3,6 and 12 months.

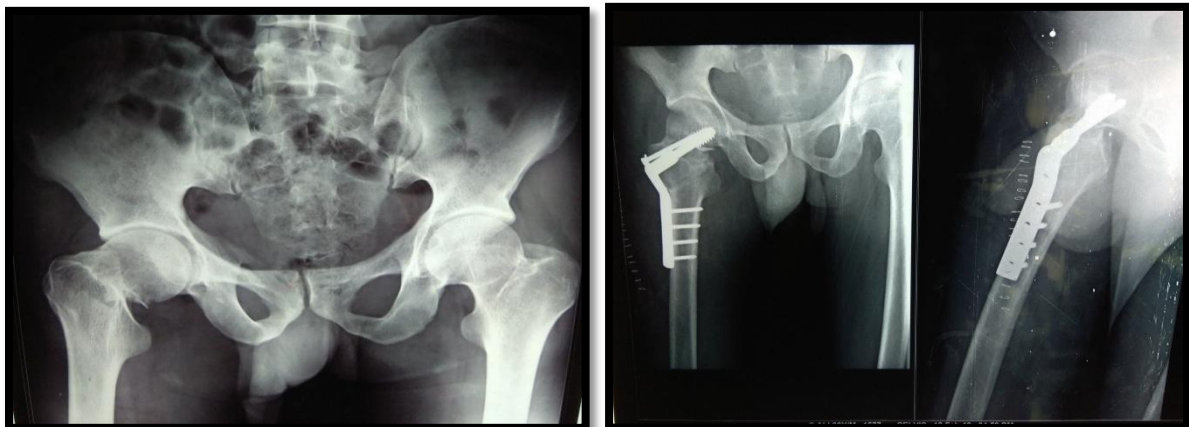


Figure 3(a) Figure 3(b)
Figure 3(a): 35 year old male patient, with type 3 Pauwels neck of femur fracture. **Figure 3(b)-** modified valgus intertrochanteric osteotomy done with 120° double angled DCS

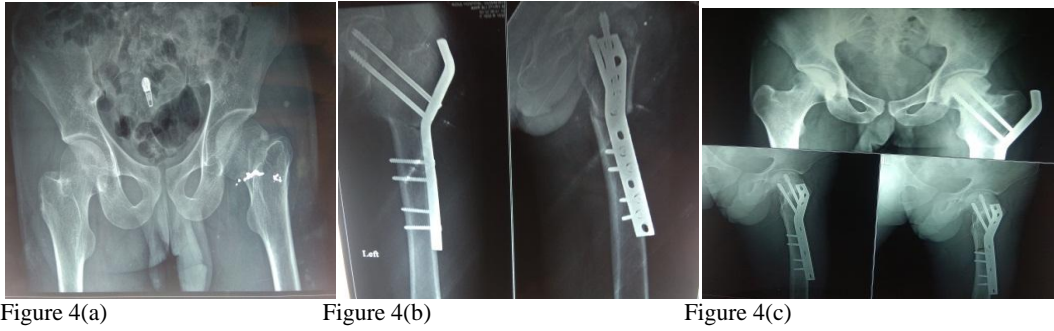


Figure 4(a) 27 year old male patient. **Figure 4(b)** Modified valgus osteotomy was done and fixed with double angled DCP. **Figure 4(c)** Complete union at fracture site and osteotomy site is noted in follow up xray at 6 months.

III. Results

Our study included 5 patients of which there were 4 males and 1 female. The mean age of our study sample was 43.2 ± 5.07 years. All the patients sustained Pauwel's type 3 fracture neck of femur and the average Pauwel's angle after the fracture was 60.8 ± 7.41 degrees. The patients were operated at a mean time of 16 ± 3.405 from the day of trauma.

All the patients were followed up for a minimum period of 1 year .The average Harris hip score at the end of 12 months in the patients was 92.8 ± 3.18 . Excellent results were achieved in 4 of the patients, whereas the result was good in one patient (figure 5).No patient had any serious immediate postoperative complication such as infection or DVT. All the 5 cases achieved clinical and radiological union. Union of fracture site was achieved at an average 13.2 ± 2.99 weeks. A 100% Union at the site of osteotomy was achieved in all the five cases .The average pauwels angle post the operative procedure was 28.4 ± 2.05 degrees and average correction done was 32.4 ± 5.74 degrees. The results are represented in table 2.

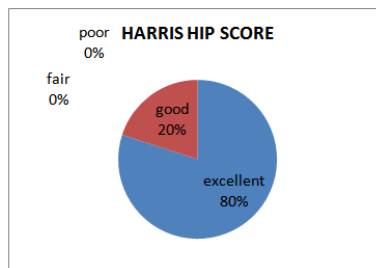


Figure 5- Harris hip score at 12 months follow up

All the patients were able to sit cross legged, squat and do one leg stance (figure 6). No cases of non union or avascular necrosis were recorded upto 1 year follow up. There were no cases of screw cut-outs or limb length discrepancy. One patient however complained of mild knee pain which subsided after physiotherapy.



Figure 6- Clinical photographs showing near normal range of motion and full functional restoration of movements.

Table 2- Results of surgery

Case number	Postoperative Pauwel's angle(degrees)	Wedge correction angle(degrees)	Union at fracture site(weeks)	Harris hip score(1 year)
1	25°	25°	10	96
2	30°	35°	14	95
3	27°	30°	10	92
4	30°	30°	18	94
5	30°	42°	14	87
Mean	28.4 ± 2.05	32.4 ± 5.74	13.2 ± 2.99	92.8 ± 3.18

IV. Discussion

Femoral neck fracture is still regarded as an “unsolved fracture” chiefly owing to the controversies that mar the management protocols⁽¹⁸⁾. In particular, fracture of the femoral neck in young adults poses a daunting task to the orthopaedic surgeons. Fresh cases of femoral neck fractures in the younger population are generally managed by osteosynthesis using cannulated cancellous screw or other devices. However, only Pauwel’s type 1 & 2 fractures are amenable to osteosynthesis with CCS as the high shearing forces in Pauwel’s type 3 fracture often leads to higher rates of failure and non union⁽³⁾. This invariably leads to a second surgery which poses a problem for a developing country like ours where people are apprehensive about undergoing a second operative procedure and often live with a failed surgery⁽⁷⁾. In our study we tried to address this issue by opting for modified valgus intertrochanteric osteotomy as a primary treatment option in patients with Pauwel’s type 3 neck of femur fracture with the aim of converting the shearing stresses at fracture site into compressive forces.

A lateral V-shaped closing wedge osteotomy was preferred by us as this type of osteotomy is technically simpler and provides an equally broad osteotomy surface when compared to Yshaped wedge-closing/open osteotomy^(19,20). We used a double angled DCS/DCP as the implant for fixation after performing valgus intertrochanteric osteotomy. Most of the case series on valgus osteotomy have reported the use of blade plate which is technically more demanding and with an associated risk of splitting of femoral head^(20,21).

In our case series, union was achieved in all the cases (average time- 13.2±2.99 weeks) with 4 out of the 5 patients (80%) having an excellent outcome. Our findings are comparable to results obtained by other authors opting for valgus osteotomy as a primary mode of treatment in neck of femur fractures. Magu et al who reported 94% union rate in their study on 50 cases of fresh intracapsular femoral neck fractures with osteoporosis treated with osteosynthesis and valgus intertrochanteric osteotomy; Excellent to good outcome were reported in 76% of the patients with an average Harris hip score of 92 and the average time of union reported was 12.2 weeks⁽⁸⁾. Ansari et al performed valgus intertrochanteric osteotomy in 15 fresh cases of femoral neck fractures with an initial average Pauwel’s angle of 59° and reported excellent result in 7 cases and good result in 4 cases. The time for union was between 4 to 7 months in all the cases⁽⁷⁾. Rinaldi et al reported bony union in 25 consecutive cases of subcapital fractures of neck of femur treated by primary osteosynthesis and valgus intertrochanteric osteotomy⁽¹²⁾. Fontanesi et al reported excellent to good results in 17 out of 24 cases of femoral neck fractures operated with valgus intertrochanteric osteotomy and sliding compression hip screws⁽¹⁰⁾. Rotolo et al reported 100% union in all cases of subcapital femoral neck fractures treated with primary intertrochanteric osteotomy⁽¹¹⁾.

In our one year follow up of cases, we did not encounter any case of non union, avascular necrosis, limb length discrepancy, screw cut outs although these complications are enlisted at varying rates in literature and have been reported in previous studies mentioned above. As osteotomy was performed at intertrochanteric region, the proximal femoral anatomy was not distorted much which enables us for prosthesis positioning during replacement even if required in future.

V. Conclusion

Modified valgus intertrochanteric osteotomy as a primary mode of treatment in fresh cases of Pauwel type 3 fractures of femoral neck has an encouraging and promising outcome. A large scale study with a longer duration of follow up is necessary to further assess the efficacy of the procedure.

References

- [1]. Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: worldwide geographic variation. *Indian journal of orthopaedics*. 2011 Feb;45:15-22.
- [2]. Roberts KC, Brox WT, Jevsevar DS, Sevarino K. Management of Hip Fractures in the Elderly. *J Am Acad Orthop Surg*. 2015 Feb 6;23(2):131-7.
- [3]. Ly T V., Swiontkowski MF. Management of femoral neck fractures in young adults. *Indian J Orthop*. 2008 Jan 1;42(1):3-12.
- [4]. Holmes CA, Edwards WT, Myers ER, Lewallen DG, White III AA, Hayes WC. Biomechanics of pin and screw fixation of femoral neck fractures. *Journal of orthopaedic trauma*. 1993 Jun 1;7(3):242-7.
- [5]. Kauffman JI, Simon JA, Kummer FJ, Pearlman CJ, Zuckerman JD, Koval KJ. Internal fixation of femoral neck fractures with posterior comminution: a biomechanical study. *Journal of orthopaedic trauma*. 1999 Mar 1;13(3):155-9.
- [6]. Samsami S, Saberi S, Sadighi S, Rouhi G. Comparison of three fixation methods for femoral neck fracture in young adults: Experimental and numerical investigations. *J Med Biol Eng*. 2015;35(5):566-79.
- [7]. Abdul Hameed Ansari S, Assistant Professor S. Valgus osteotomy in fresh fracture neck of femur. *Gokulnath Med J*. 2017;4(4):446-8.
- [8]. Magu NK, Singh R, Mittal R, Garg R, Wokhlu A, Sharma AK. Osteosynthesis and primary valgus intertrochanteric osteotomy in displaced intracapsular fracture neck of femur with osteoporosis in adults. *Injury*. 2005 Jan 1;36(1):110-22.
- [9]. Mishra US. Intertrochanteric displacement osteotomy in the treatment of femoral neck fractures. *Injury*. 1979 Feb 1;10(3):183-9.
- [10]. Fontanesi G, Costa P, Giancetti F, Tartaglia I. Intertrochanteric valgus osteotomy and sliding compression hip screw in fractures of the femoral neck. *Italian journal of orthopaedics and traumatology*. 1991 Sep;17(3):293-304.
- [11]. Rotolo F, Galmarini V, Zanasi L. Osteosynthesis of fractures of the femoral neck by nail-plate, screws and valgus osteotomy. *Ital J Orthop Traumatol*. 1989 Sep 1;15(3):331-7.
- [12]. Rinaldi E, Marengi P, Negri V. Osteosynthesis with valgus osteotomy in the primary treatment of subcapital fractures of the neck of the femur. *Ital J Orthop Traumatol*. 1984 Sep 1;10(3):313-20.
- [13]. Pauwels F. Biomechanics of the normal and diseased hip: theoretical foundation, technique and results of treatment an atlas. Springer Science & Business Media; 2012 Dec 6.
- [14]. Müller ME. Intertrochanteric Osteotomy: Indication, Preoperative Planning, Technique. In: *The Intertrochanteric Osteotomy*. Springer Berlin Heidelberg; 1984. p. 25-66.
- [15]. Bartonicek J. Pauwels' classification of femoral neck fractures: correct interpretation of the original. *Journal of orthopaedic trauma*. 2001 Jun 1;15(5):358-60.
- [16]. LEADBETTER GW. Closed reduction of fractures of the neck of the femur. *JBJS*. 1938 Jan 1;20(1):108-13.
- [17]. Mahomed NN, Arndt DC, McGrory BJ, Harris WH. The Harris hip score: Comparison of patient self-report with surgeon assessment. *J Arthroplasty*. 2001 Aug 1;16(5):575-80.
- [18]. Dickson JA. The “unsolved” fracture: a protest against defeatism. *JBJS*. 1953 Oct 1;35(4):805-22.
- [19]. Marti RK, Schuller HM, Raaymakers ELFB. Intertrochanteric osteotomy for non-union of the femoral neck. *J Bone Jt Surg - Ser B*. 1989;71(5):782-7.
- [20]. Nayak C, Acharyya B, Jain M, Kamboj K. Valgus osteotomy in delayed presentation of femoral neck fractures using fixed angle simple dynamic hip screw and plate. *Chinese J Traumatol - English Ed*. 2019;22(1):29-33.
- [21]. Doppelt S, SH D. The sliding compression screw-today’s best answer for stabilization of intertrochanteric hip fractures. 1980;