Original Article

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Orthopaedics Section

Role of Valgus Osteotomy and Fixation with Double Angle Blade Plate in the Management of Neglected and Ununited Femoral Neck Fracture

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ABSTRACT

Introduction: Femoral neck fracture non union in young patients is a challenging complication as joint replacement is not readily recommended and hip salvageable procedures are relatively unsatisfactory. Valgus intertrochanteric osteotomy described by Pauwels F is one of the treatment options for management of non union of femoral neck in young patients, which was later reciprocated by other surgeons.

Aim: To assess the efficacy of valgus osteotomy and fixation with double angle blade plate in the management of neglected and ununited femoral neck fracture.

Materials and Methods: This was a prospective cohort study, which included 30 patients of femoral neck fracture non union in whom intertrochanteric valgus osteotomy was performed and fixed with 120° double angled blade plate. The preoperative and postoperative neck-shaft angle was compared using the paired t-test. A p-value of <0.05 indicated statistically significant result.

Results: There were 22 males (73.3%) and 8 females (26.7%). Mean age of patients was 35 years. Delay in presentation ranged from 8 weeks to 58 weeks (mean 24 weeks). By Pauwel's classification, there were 13 Type II fractures and 17 Type III fractures. Mean follow-up was 18 months (12 to 36 months). The mean preoperative neck-shaft angle of 95° (range 80-110°) increased to 132° (range 120-140°) after surgery. In all patients, there was improvement in leg length discrepancy after osteotomy. Femoral neck fractures united in 25 patients (83.3%).

Conclusion: Valgus osteotomy and fixation with 120° double angle blade plate is a reliable method for treating non union femoral neck fracture in young adults. It provides rigid internal fixation and good results.

Keywords: Internal fixation, Intertrochanteric osteotomy, Kirschner wires, Neck-shaft angle

INTRODUCTION

Intracapsular femoral neck fracture is one of the most common injury encountered in Orthopaedics with majority being low energy trauma seen in elderly patients [1]. However, rarely these fractures can occur in younger patients as a result of high energy trauma. Despite vast advances in fixation like implants and surgical techniques, about one-third of the cases of displaced femoral neck fractures result into non union [2].

Even after internal fixation of a fracture of the femoral neck the rate of non union described in the literature ranges between 10% and 30% [3-5]. Non union of the femoral neck is associated with a plethora of complications such as osteopenia, osteoporotic changes in the femoral head, failed or unstable implant and infection [3,6-8]. In older patients, due to impaired vascularity, preservation of head is not recommended and in these patients joint replacement surgery is the main modality of treatment [3-8]. In younger patients with physiological age of less than 55 years with no medical comorbidity, good bone stock and preserved joint function, preservation of femoral head is advisable [4].

A number of treatment options for preservation of femoral head have been described e.g. muscle pedicle grafts, vascularised and nonvascularised fibular grafts, proximal femoral osteotomy but none of them is the unanimous choice for management of femoral neck non union; as most of them have a steep learning curve and fair share of complications [9-11]. Meyers MH et al., used muscle pedicle bone grating in 8 patients with non union of femoral neck after failed osteosynthesis and reported a 75% union rate [12].

Pauwels F predicted that the problem in non union of femoral neck, is not only biological but also mechanical [13]. He suggested that by changing the inclination of the fracture, shearing forces can be transformed into compressive forces, resulting in fracture union. He performed a closed lateral wedge valgus intertrochanteric osteotomy resulting in compression at the fracture site. Following the same principles, favorable results have been achieved by various authors [14,15]. Valgus intertrochanteric osteotomy also helps restore limb length discrepancy by gaining length at the osteotomy site.

The study aimed to assess role of valgus osteotomy and fixation with double angle blade plate in the management of neglected and ununited femoral neck fracture in young patients.

MATERIALS AND METHODS

This was a prospective cohort study conducted between January 2014 and July 2018 in the Department of Orthopaedics, Government Medical College, Patiala, Punjab, India. Valgus intertrochanteric osteotomies for neglected and ununited femoral neck fractures were performed in 30 consecutive patients. After getting approval from the Institutional Ethical Committee (INST/2020/997/3398), an informed consent was taken from each patient. The procedures followed were in accordance with the Helsinki Declaration of 1975 that was revised in 2000.

Inclusion criteria: (i) Age less than 60 years; (ii) Fracture of neck of the femur with time since injury more than or equal to 3 weeks; (iii) Fracture of neck of the femur with implant failure (non union with varus collapse).

Exclusion criteria: (i) Patients with advanced Avascular Necrosis (AVN) changes on plain radiography; (ii) Patients with significant

resorption of femoral neck with proximal fragment less than 2.5 cm; (iii) patients with pathological fractures.

Functional Outcome

Functional outcome was judged according to Askin SR and Bryan RS criteria [15]:

Excellent- Full range of movements and strength, little or no pain and essentially normal appearing radiographs.

Good- Some limitation of motion, mild discomfort and mild joint space narrowing.

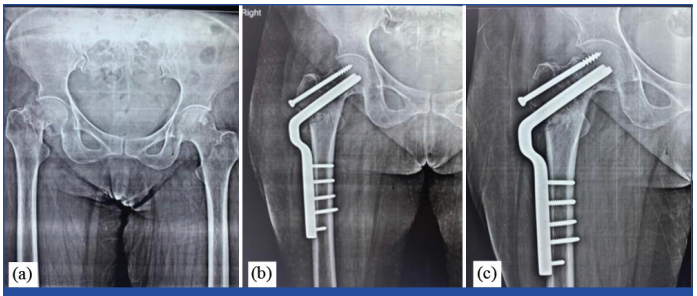
Fair- Some limitation of motion and moderate pain with degenerative changes or aseptic necrosis.

Poor- Severe restriction of function and pain requiring salvage procedure.

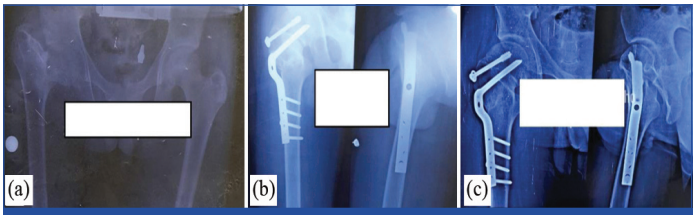
Surgical Technique

From January 2014 to July 2018, 30 cases of non union of femoral neck fractures in young patients (less than 60-year-old) were taken up for valgus osteotomy and fixed using 120° double angled condylar blade plate, by the same team of orthopaedic surgeons lead by the first author. Preoperative radiographs [Table/Fig-1a] of the hip joint were taken and fracture was classified according to Pauwels' criteria [16]. No preoperative MRI scans were done and patients with advanced AVN changes on radiographs were excluded. The preoperative Pauwel's angle was calculated for each fracture and the osteotomy was planned in such a manner so as to achieve a Pauwel's angle of 30° or less. The goal of osteotomy was to achieve compression at the fracture site. The site of osteotomy was at the level of lesser trochanter and desired wedge was resected depending on Pauwel's angle as described by Pauwels F and later modified by Mueller ME [16,17]. The surgery was performed under spinal plus epidural anaesthesia, patient was placed on standard fracture table with image intensifier guide. Direct lateral skin incision was given, centered over and in line with greater trochanter proximally to femoral shaft distally. Underlying fascia was incised in line with skin incision and the vastus lateralis muscle was split open to expose the proximal femur. All previous surgical implants were removed. Two 2.5 mm Kirschner wires were passed through the lateral cortex into the femoral head and fracture was provisionally stabilized. Open reduction of the fracture site was not done, as it further compromises the blood supply to the femoral head. Interfragmentary compression at the fracture site is now achieved with the help of single 6.5 mm partially threaded cancellous cannulated screw placed in the proximal part of the neck of the femur. Provisional kirschner wires were removed after appropriate length screw placement. Under image intensifier appropriate entry point for the chisel was marked on the greater trochanter in both the anteroposterior and lateral views. A chisel was then introduced into the femoral head and a track was created for the blade of the 120° double-angled osteotomy blade plate (Stainless Steel 316L, Kaushik). The intertrochanteric osteotomy was carried out 2 cm distal to the blade entry point and desired wedge of bone was removed. The lower limb was abducted to close the osteotomy site and to align the plate to the femur which was stabilised with cortical screws.

Postoperatively, patients were mobilised with crutches and non weight bearing was allowed for initial six weeks. After six weeks partial weight bearing was allowed as tolerated by the patient. Full weight bearing was allowed only after union. Clinical signs of union were defined as absence of pain and tenderness at the fracture site on weight bearing. Radiological healing was determined by evidence of bridging callus across the fracture site on plain radiographs as seen in [Table/Fig-1,2].



[Table/Fig-1]: a) Preoperative radiograph showing femoral neck fracture non union; b) Immediate postoperative radiograph after valgus osteotomy and fixation with double angle blade plate; c) Final follow-up radiograph at 24 weeks shows union at fracture and osteotomy site.



[Table/Fig-2]: a) Preoperative radiograph showing femoral neck fracture non union; b) Immediate postoperative antero-posterior and lateral views shows valgus osteotomy and fixation with double angle blade plate; c) Final follow-up radiograph at 32 weeks shows union at fracture and osteotomy site.

STATISTICAL ANALYSIS

This was performed using the IBM Statistical Package for the Social Sciences (SPSS) version 25.0 software (Armonk, New York). The preoperative and postoperative neck-shaft angle was compared using the paired t-test. A p-value of <0.05 indicated statistically significant result.

RESULTS

Mean age of patients was 35 years (range 18 years to 58 years). Delay in presentation ranged from 8 to 58 weeks (mean 24 weeks). Right hip was affected in 18 cases (60%) and left hip was affected in 12 cases (40%). There were 22 males (73.3%) and 8 females (26.7%). There were 13 (43.3%) Pauwels' type II and 17 (56.7%) Pauwels' type III fractures.

Mean follow-up was 18 months (12 months-36 months). The fracture showed a satisfactory union in 83.3% of cases (25 out of 30) at mean interval of 18 weeks (12-32 weeks). The osteotomy site went into union in all the cases, one patient was lost to follow-up.

The mean preoperative neck-shaft angle of 95° (range 80-110°) increased to 132° (range 120-140°) after surgery [Table/Fig-1,2]. In all patients, there was improvement in leg length discrepancy after osteotomy which was statistically significant. The mean limb length discrepancy preoperative was 2.7 cm (range 1.5-4) postoperatively was 1.8 cm (range 1-2.5 cm) [Table/Fig-3]. There were no deep infections or deep vein thrombosis in the immediate postoperative period and no coxa vara deformity in any patient.

Variables	Pre-operative	Final follow-up	p-value
Neck-shaft angle (°)	95 (80 to 110)	132 (120 to 140)	0.001
Limb length discrepancy (cm)	2.7 (1.5-4)	1.8 (1-2.5)	0.001

[Table/Fig-3]: The mean (range) measures of the neck-shaft angle. p<0.05 was considered as statistically significant

According to Askin SR and Bryan RS criteria, 15 (50%) patients had excellent outcome, 7 (23.3%) patients had good outcome patients and 3 (10%) patients had fair outcome. 4 (13.3%) patients had poor outcome, out of which two had avascular necrosis with collapse of femoral head. In one case, the position of blade was not central, (inappropriate surgical technique) this led to cut through of blade out of the head after 12 weeks of surgery and implant penetration into the joint was observed in one case after 12 weeks (inappropriate length of the blade). Bipolar hemiarthroplasty was done in all the

patients who had poor outcome. All the patients with fracture union were able to perform routine daily life activities such squatting and sitting cross-legged.

DISCUSSION

Management of Femoral neck fractures in young active adult patients is by early reduction and stable osteosynthesis. Despite advancement in reduction and internal fixation techniques and better understanding of fracture morphology the non union rate of femoral neck fracture reported ranges from 4%-30% of cases. [7,8]. Various surgical treatment options have been described to treat femoral neck fractures non union so as to preserve the femoral head. However, all have a significant rate of complications [3,6,18]. This study aimed to assess whether valgus osteotomy and fixation with double angle blade plate reliably achieved union and restored function. Pauwels F recognized that non-union of femoral neck fracture is due to high shear stress across fracture site and by changing the inclination of the fracture, shearing forces can be transformed into compressive forces and this would result in consolidation of fracture within few months [16]. He showed that a laterally based closed wedge valgus osteotomy would lead to compression at the non union site and thus union at fracture. For immobilization of the fracture, postoperatively hip spica was applied. Later, Mueller ME suggested fixation of fracture and osteotomy with the help of condylar blade plate for early mobilization of the patients [17].

Angelen JO achieved 100 % union rate in 13 patients with failed osteosynthesis of femoral neck treated with valgus osteotomy [19]. Wu CC et al., reported a union rate of 95% using a sliding hip screw to achieve compression at non union and to realign the proximal femur [20]. As previously considered to be a contraindication, valgus osteotomy in avascular necrosis without collapse of the femoral head has also been reported with successful outcome [21]. Sen RK et al., treated 22 patients of failed internal fixation using an angle blade plate and autogenous nonvascularised fibular graft and achieved union in 91% patients [22]. Gadegone WM et al., treated forty-one patients of neglected femoral neck fractures with Valgus intertrochanteric osteotomy and fibular strut graft and achieved union in 95% patients [23]. Kulkarni SG et al., operated 44 cases of neck femur non union with delayed presentations (more than 3 weeks), with Dynamic Hip Screw (DHS) and compression screw and reported complete union in most (93%) of the cases [24].

In most of case series of valgus osteotomy reported in literature [Table/Fig-4], fixation has been done by angle blade plate, thus for comparison the index authors have also used blade plate for fixation in this study. The blade plate has a U-cross-section that provides high strength with minimum bone displacement. The advantage of double angle blade plate over angle blade plate is that it provides better control of fracture fragments. This technique resulted in union in 25 (83.3%) of 30 patients in this study. Valgus osteotomy is believed to promote osteogenesis by acting as a biomechanical stimulus. It helps convert shearing forces at fracture site into compressive forces and improves stability as it is an angle fixed device and provide rigid fixation [18]. The surgery is a definitive, minimal learning curve and cost-effective option in young patients with neglected or ununited femoral neck fracture.

Author	Year of publication	Method of fixation	Number of cases	% union
Angelen JO [19]	1997	Valgus osteotomy with condylar screw fixation	13	13 (100%)
Wu CC et al., [20]	1999	Sliding hip screw±valgus osteotomy	26	23 (88%)
Sen RK et al., [22]	2012	Angle blade plate with autogenous non vascularised fibula graft	22	20 (91%)
Gadegone WM et al., [23]	2013	Valgus osteotomy +DHS with custom made double angle side plate	41	39 (95%)
Kulkarni SG et al., [24]	2017	DHS and Compression Screw	44	41 (93%)

[Table/Fig-4]: Comparison of the present study with literature on fixation of femoral neck non union.

Limitation(s)

Limitation of this study is that no preoperative MRI scan was done to assess the early AVN changes in the femoral head.

CONCLUSION(S)

In the present study, union was achieved in 25 patients (83.3%) undergoing Pauwel's osteotomy, which is remarkable as this procedure helps preserve the femoral head in young patients. It can be concluded that valgus osteotomy and internal fixation with 120° double angle blade plate is a simple and reproducible procedure which has high success rate of union of fracture in young patients with neglected and ununited intracapsular fracture neck of femur. The potential benefit of this procedure is salvaging a viable biologic and functional joint. This study recommends this procedure for neglected femoral neck fractures in young patients.

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