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Valgus Inter-trochanteric Osteotomy for Management of Neglected Fracture Neck of Femur in Young Adults: A Simplified Operative Technique

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Abstract

Introduction: Neglected fracture neck of femur in young adults has high rate of non-union, avascular necrosis (AVN) and secondary arthrosis. Only stable fixation is under surgeon`s control as other complications are part & parcel of injury itself. We achieved hip preservation with a simplified operative technique of valgus inter-trochanteric osteotomy fixed with 120 degrees double angled barrel plate and cancellous screws. *Objectives:* To develop an easily reproducible surgical technique with stable fixation to convert high grade pauwel fractures to low grade leading to hip preservation in majority of young adults & delay the need for future arthroplasty. *Materials and Methods:* 18 cases of Neglected fracture neck of femur (>3 weeks) in young adults (<50 yr) were operated using the simplified technique and followed from June 2016 to April 2018. Average presentation was 37 days from injury & average follow-up of 10.4 months. Radiological parameters analyzed were fixation and union at osteotomy and fracture site. Functional outcomes were assessed using modified Askin & Bryan Criteria. *Results:* Out of 18 cases, Good (9) to Excellent (6) results were seen in 15. 3 had fair outcomes necessitating replacement arthroplasty. AVN was seen in 5 cases and non-union at fracture site in 3 cases. Osteotomy united in all cases. No implant failure was encountered. 13 were able to perform activities of daily living satisfactorily and showed no signs of AVN till last follow-up. *Conclusion:* The simplified technique offers good results in majority of young adults with neglected fractures neck of femur with minimal complication rates.

Keywords: Valgus Osteotomy; Fracture Neck of Femur; Hip Preservation; Operative Technique; AVN.

Introduction

Fracture neck of femur is still the unsolved fracture and neglected cases (> 3 wks) in young (< 50) age group are a treatment dilemma. In developing countries, late and neglected presentation is common because of many socio-economic reasons like lack of awareness, manipulation by local bone setters, lack of transport facilities & financial constraints.

Sandhu et al. defined neglected fractures as those which are left untreated for 3 weeks [1]. High incidence of non-union and avascular necrosis (AVN) [2,3] of femoral head are due to poor blood supply, inaccurate reduction, hematoma washout by synovial fluid and lack of cambium in periosteum. Delayed presentation as well as manipulation & massage by local bone setters further jeopardize the final outcome leading to neck resorption, smoothening of fracture margins, sclerosis and eventually unfavorable outcome.

Replacement surgeries [4,5] are unsuitable for rural population in view of financial constraints as well as socio-cultural habits of squatting, sitting

crossed legged & using indian style toilets. Various biological treatment modalities [6-11] have been described for hip preservation such as vascularised bone grafts, muscle pedicle grafts, fibular grafts with or without osteotomy but still the best form of treatment remains inconclusive as these procedures are technically demanding and have not provided consistently reproducible results. Similarly, various fixation methods are described ranging from angled blade plate, 135 degree dynamic hip screw and double angle barrel plate with or without cannulated screws but, till now, no consensus has been reached on the best mode of fixation.

Pauwel [12] postulated that in non-union of femoral neck the problem is both biological and mechanical and by changing the high grade pauwel fracture geometry to a low grade ($\leq 30^0$), the shear forces can be converted to compressive forces, resulting in union. However, stability of fixation and surgical technique plays a major role in final outcome.

In our study, we have used a simplified operative technique of valgus inter-trochanteric osteotomy fixed with 120 degrees double angle barrel plate (DABP) & Cannulated Cancellous Screws (CCS), so as to provide stable fixation and achieve union. Aims of our study were to develop an easily reproducible surgical technique with stable fixation to convert high grade pauwel fractures to low grade leading to hip preservation in majority of young adults & delay the need for future arthroplasty.

Materials & Methods

The observational study done on 18 cases of neglected fracture neck of femur (> 3 weeks) in young adults (< 50yr) by This observational study was done on 18 cases of neglected fracture neck of femur (> 3 weeks) in young adults (<50 yrs) in Department of Orthopedics, Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi, India.

Inclusion Criteria

1. Neglected (>3 weeks old) intra-capsular fracture neck of femur
2. Age <50 yrs
3. Patient Anesthetically fit for surgery
4. Cases with Non-collapse stage of AVN were also included

Exclusion Criteria

1. Fractures <3 weeks old (managed by fixation alone)
2. Age >50 yrs (managed by primary arthroplasty)
3. Neglected Fracture with AVN in Collapse stage
4. Multiple co-morbidities with poor ASA grade

Pre-operatively, all patients were thoroughly evaluated clinically as well as radiologically with X-Rays, MRI (to look for AVN) and pre-anaesthetic check-up. Informed consent was taken from every patient with proper explanation of the procedure and associated complications along with possible need of future hip arthroplasty. Fractures were classified using pauwel classification and shear angle calculated in all cases. Our aim was to achieve correction upto 30 degrees in all the cases to provide compressive forces at fracture site. Hence the osteotomy wedge was calculated by subtracting 30 degrees from shear angle (Osteotomy wedge= Shear Angle-30). Based on the calculated wedge and the nature of our implant (120 degrees DABP), lag screw guide wire positioning angle (the angle at which guide wire needs to be placed in head via trochanter, with the horizontal) was calculated by subtracting wedge angle from implant angle i.e. 120 degrees.

The Simplified Operative Technique (Fig. 1)

All patients were operated on fracture table with C-arm assistance. Maximum possible closed reduction achieved on traction assembly was accepted followed by painting & draping. Using lateral approach, skin & soft tissues were dissected & tensor fascia lata was split. Proximal femur was exposed proximally till greater trochanter. Further step-wise operative technique is as follows-

1. First guide wire for lag screw is inserted from the most prominent part of the trochanter to inferior part of the head of femur at a pre-calculated angle (as described above) to get the best purchase in trochanter as well as to achieve the most desirable post-osteotomy correction with 120 degrees double angle barrel plate.
2. Second guide wire for CCS inserted parallel to the first guide wire 1.5 cm proximal to the first guide wire to superior part of the head for rotational stability, as well as to provide space for lag screw insertion.
3. Cannulated drill passed over second guide wire and appropriate size 6.5 mm CCS passed and partially tightened to align the fracture fragments.

4. Appropriate length lag screw inserted after reaming over first guide wire, so as to allow the coupling screw to give intra-operative compression at fracture site.
5. 120 degrees DABP passed over lag screw and coupling screw tightened to give compression at the fracture site. After that, coupling screw is partially loosened to allow plate rotation.
6. Femur is marked at the angle of plate by multiple drill holes under direct vision as well as C-arm. This will be the mark for proximal horizontal osteotomy site.
7. Based on pre-operative wedge angle calculation to achieve pauwel angle upto 30 degrees (as described above), distal oblique osteotomy site marked with multiple drill holes meeting the proximal osteotomy site, leaving the medial cortical hinge intact.
8. Osteotomy wedge removal is done initially with oscillating saw followed by completion with osteotome & hammer.
9. Lowman's clamp applied between the distal end of plate and femur and after traction loosening, gradual closure done along with manual abduction of the limb to proximate the plate toward femur and closing of wedge verified on c-arm.
10. CCS & Coupling screw tightened & plate secured with screws in dynamic compression mode. A proximal cancellous screw via plate is also applied to give extra stability in the proximal fragment.

Drain was put after thorough wound lavage & closure done in layers. X-Rays were taken post-operatively & compared with pre-operative x-rays to assess the angle of correction. IV antibiotics were given for 5 days post-operatively followed by oral antibiotics for a week till suture removal, depending on wound dressing. Operative time was usually 1-1$^{1/2}$ hrs with 200-300 ml blood loss. Patients were kept non-weight bearing for 6 weeks followed by gradual partial to full weight bearing in 3 months when signs of union were observed.

Initial follow-up was done every 2 weeks till 3 months, followed by monthly visits till 9 months. Radiologically fracture site and osteotomy site were assessed for union, quality of fixation (implant failure), loss of reduction and head collapse/AVN. Functional outcomes were assessed using modified Askin & Bryan Criteria (Table 1).

Results

Total 18 cases (14 males & 4 females) of neglected fracture neck of femur (>3 weeks) in young adults

Table 1: Modified Askin & Bryan Criteria

Clinical Findings	Results
No pain, near normal gait, <20% restriction of ROM, normal activity	Excellent
Mild pain and limp, 2040% restriction of ROM, mild restriction of activity	Good
Continuous pain, marked restriction of ROM and activity, need walking aid	Fair

Table 2: Master chart showing details, follow-up & outcomes

S No.	Age/Sex	Presentation From Date of Injury (Days)	Follow-Up Duration (Months)	Functional Outcome	Complications
1	32/M	23	10	Excellent	-
2	21/M	32	8	Good	-
3	16/M	29	11	Excellent	-
4	48/F	45	12	Good	-
5	40/M	31	6	Fair	NU/AVN
6	36/M	28	14	Good	NU/AVN
7	24/F	36	6	Fair	-
8	29/M	52	8	Good	AVN
9	36/M	22	10	Good	-
10	41/M	38	18	Excellent	-
11	50/M	28	9	Good	-
12	19/M	48	15	Excellent	AVN
13	33/F	37	12	Fair	NU
14	27/M	40	6	Good	-
15	47/F	37	8	Good	-
16	23/M	46	10	Excellent	-
17	29/M	58	8	Good	AVN/Head Collapse
18	46/M	35	16	Excellent	-

(<50 yr) were operated using Simplified Technique and followed from June 2016 to April 2018. Average duration of presentation from injury was 37 days and average duration of follow-up 10.4 months. Parameters assessed during follow-up were:-

1. Passive and active hip range of motion. Any pain during movements & ease of performing activities of daily living
2. Radiological signs of union at fracture site & osteotomy site, associated with any loss of reduction or implant failure
3. Signs of AVN of femoral head
4. Gait analysis & necessity of walking aids

Final outcome was assessed using modified Askin and Bryan's criteria. No implant failures were seen in any of the cases. Osteotomy site united in all the cases (10-12 weeks). Average pre-operative neck shaft angle was 105 degrees. Upto 30 degrees of maximum correction in pauwel angle were achieved post-operatively. Fracture site union (3 cortex contact on AP and Lateral radiograph) was seen in 15 cases (16-18 weeks). Pre-op AVN changes were seen in 3 cases (1 showed reversal during follow-up). Post-op AVN was seen in 5 cases (in 2 of these cases, fracture had already united). Non-union was seen in 3 cases, however, one of these cases (36/M) had good outcome with mild pain with limp and minimal difficulty in performing activities of daily living.

Femoral head collapse was seen in 1 patient; however, he was satisfied with his functional status with mild limp & on/off pain which didn't interfere with his daily activities. Follow-up cases with radiologically persistent/newly diagnosed AVN (5) might require arthroplasty in near future, nevertheless, it was delayed. Preoperatively, 11 cases were pauwel Grade I/II and 7 were pauwel III. During follow-up, all pauwel III had persistent (2)/newly detected (3) AVN changes. Reversal

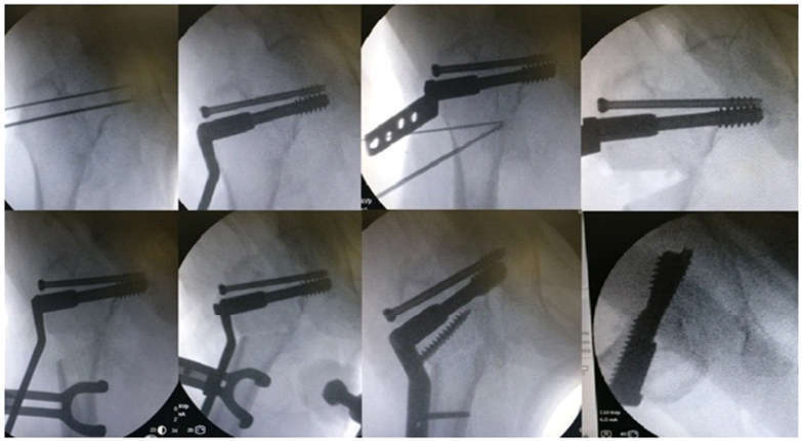

Fig. 1: Intra-operative C-arm images demonstrating the steps of simplified operative technique

Fig. 2: a) Upper half shows x-rays of 16 yr male having Type III pauwel fracture with pre-operative AVN changes. Union was achieved with excellent outcome. b) Lower half shows x-rays of 41 yr male with 38 days old neglected fracture neck of femur operated by simplified technique, leading to union and excellent outcome.

of AVN was seen in 1 case with pauwel III type fracture. Based on modified Askin & Bryan Criteria, out of 18 cases, Good (9) to Excellent (6) results were seen in 15 cases. 3 had Fair outcomes necessitating arthroplasty (Table 2). Two of our operated cases with follow-up x-rays are shown in Figure 2.

Discussion

Femoral neck fractures in young adults must be treated with early closed reduction and internal fixation (CRIF). Despite improvement in the results of internal fixation due to better understanding of fracture morphology, reduction techniques and accurate positioning of implants, non-union results in 4%-30% cases [13-16].

In our country late and neglected presentations are common as initial treatment is usually done by local bone setters. Literature suggests that if neck fracture is more than 2-3 weeks old then primary fixation alone does not give good results [17,18]. Although the vascularized grafts (fibular/ muscle pedicle) appear more biological, they are technically difficult and results are not uniformly predictable. Moreover, there are associated donor site complications as well.

Valgus osteotomy biomechanically converts shearing forces to compressive forces by altering the fracture geometry. It also enhances union by augmenting blood flow through the proximal fragment. Hence it acts both biologically & mechanically. The largest series in literature is that of Marti et al. [19] They presented results of valgus osteotomy in 41 patients of non-union of femoral neck, with union rate of 86% and implant failure in 6 patients, necessicitating re-fixation. Their 7 patients required arthroplasty due to persistent non-union, late collapse and implant failure. Hence, stable and long lasting fixation is one of the most essential factors deciding union in these complicated scenarios. Various fixation methods for osteotomy fixation are mentioned in literature such as traditional double angled blade plate [20,21], fibula grafting with blade plate/screw fixation [11,22], Double Angled Barrel plate with CCS [23-25] and conventional DHS [26].

Studies comparing blade plate with dynamic compression screw for fixation have reported a higher rate of suboptimal implant positioning, cut out and failure with blade plate. [27] While using blade plate, hammering can displace the fragments as well. Advantages with dynamic hip screw include no hammering, compression at fracture site along with some play for fixation as the assembly can be rotated for ease of osteotomy, while doing the same in blade plate is not possible. In our technique, we re-enforced rotational stability to the fixation by using cannulated cancellous screws in all the cases.

In our series, there was no case of implant failure & osteotomy site united in all the cases primarily due to stable fixation & pre-operative wedge calculation, appropriate to the implant as well as fracture morphology.

Pauwel recommended placing the final fracture inclination upto 30^0. This can be explained bio-mechanically for the merit of osteotomy in promoting union [12]. Stromquist and Harrison [28] used tetracycline and isotope studies to show that vascular damage may be increased during overcorrection to more than 30 degrees. Excessive valgus angle or mal-rotation will affect the remaining vessels and increase the chances of AVN.

Pre-collapse avascular necrosis is not a contraindication for valgus osteotomy in non-united fracture neck of femur as revascularization of head is still possible both by artery of ligamentum teres and by vessels crossing the uniting fracture [29]. In our series, 5 cases had AVN changes at the final follow-up out of which, 2 cases already had pre-operative AVN changes & rest 3 developed AVN during due course of time. 1 case (Pauwel III) showed reversal of AVN changes. All previous studies [23-25] showing results of DABP with or without CCS fixation show union rates of around 80-90% but with complications related to implant failure/loosening. Our results were comparable with union rate 83.3% (15/18) with no case of implant failure.

Good (9) to Excellent (6) functional outcomes were seen in majority of the patients (83.3%). Even the patients with fair outcomes were satisfied subjectively with their functional results.

Conclusion

Neglected femoral neck fractures in young adults must always be preserved. The easily reproducible Simplified Operative Technique of valgus inter-trochanteric osteotomy along with stable fixation provides good to excellent results in majority of young adults with minimal complication rates. This technique offers favorable results even in cases with pre-operative AVN changes and delays the need for arthroplasty.

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