



Valgus inter-trochanteric osteotomy and fixation with double angle barrel plate and Richard screw for neglected fracture neck femur in young adults – A prospective clinico-radiological cohort study

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Submission: 10-02-2022

Revision: 22-05-2022

Publication: 01-07-2022

ABSTRACT

Background: Saving natural head is the primary aim of management in delayed presented intracapsular fracture neck of femur, especially in young population. Anatomical reduction of these fractures is a difficult task. Rather more difficult is to decide the method of fixation which might require additive procedure(s) and one such method is valgus osteotomy and fixation devices which are technically demanding. **Aims and Objectives:** Our aim is to evaluate the practicality and validity of valgus osteotomy and fixation with Richard screw and double angle barrel plate in delayed presented (more than 3 weeks) fracture neck of femur in young adults. **Materials and Methods:** We treated 18 patients with mean age of 39 years who presented late with valgus inter-trochanteric osteotomy and fixed with Richard screw and double angle barrel plate. The cases were evaluated radiologically and clinically for Harris hip score, limb length discrepancy, union time, neck-shaft angle and complications such as avascular necrosis and implant cut through. **Results:** 15 out of 18 patients (83%) united in an average period of 15 weeks (12–28 weeks) clinically as well as radiologically. In more than 70% of patients, the average Harris hip score was “Excellent to Good” (Harris hip score >80). Pre-operative Pauwel’s angle has been corrected from 72.5 to 33. All the patients with united fracture were able to walk with full weight bearing, sit cross legged, squat, and perform SLR and do one-leg stance. **Conclusion:** Fixation with Richard screw and 120° double angle barrel plate provides rigid bony fixation and restore the limb length after valgus inter-trochanteric osteotomy. Valgus inter-trochanteric osteotomy is an effective method to achieve union in neglected fracture neck of femur, as it facilitates added compression at fracture site and stable internal fixation.

Key words: Avascular necrosis; Harris hip score; Neglected fracture neck femur; Pauwel’s angle; Valgus inter-trochanteric osteotomy

INTRODUCTION

Among many mysteries in orthopedics, femoral neck fracture is one of them and commonly known as “unsolved fracture.”¹ Intracapsular femoral neck fractures are very common injuries that come cross in orthopedics. It is

very common in elderly population as it can happen with trivial trauma whereas it accounts for only 2–3% in patients younger than 50 years.² Young and active patients are usually treated by anatomical reduction and internal fixation with most suitable method in order to save natural femoral head. According to Manninger et al.,³ decreased

Access this article online

Website:

<http://nepjol.info/index.php/AJMS>

DOI: 10.3126/ajms.v13i7.34595

E-ISSN: 2091-0576

P-ISSN: 2467-9100

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incidence of femoral head collapse, were reported when reduction and internal fixation was carried out within 6 h of injury.³ Whereas in developing countries these fractures often remain untreated for long period of time (weeks to months) due to financial constraints, lack of awareness and bone-setting done by osteopaths. In spite of all the progress in surgical techniques and treatment options, understanding anatomy and fracture morphology, nonunion is still reported in one third of cases of femoral neck fracture with displacement.^{4,5}

Nonunion and avascular necrosis (AVN) of the femoral head are the main complications following femoral neck fractures and incidences are even higher when presentation is delayed. There are multiple treatment options for head saving procedures described like fixation with muscle pedicle bone grafting, internal fixation with vascularized or free fibular grafting and valgus osteotomy and internal fixation, but best option is still a matter of debate.⁶ Pauwels was the first to treat a pseudo-arthritis of the femoral neck with a valgus repositioning osteotomy resulting in alteration of the biomechanics of hip converting the shear stress to compression stress.⁷ Valgus inter-trochanteric osteotomy changes geometry and biochemical milieu of the fracture site and restores limb length.

We conducted a prospective study for young adults presented late to our institution treated with Valgus intertrochanteric osteotomy and fixation with double angle barrel plate and Richard screw, and evaluated clinical and radiological results.

Aims and objectives

Our aim is to evaluate the practicality and validity of valgus osteotomy and fixation with Richard screw and double angle barrel plate in delayed presented (more than 3 weeks) fracture neck of femur in young adults.

MATERIALS AND METHODS

This study was conducted in a tertiary care teaching hospital after obtaining ethical approval from competent authority. This study was conducted between January 2018 and July 2020 in department of orthopedic surgery where we enrolled 18 young patients who presented to us late (after 3 weeks of fracture) with fracture neck of femur. Patients with age between 18 and 55 years and with neglected fracture neck of femur were included in the study. All patients with history of any previous surgery for the fracture or with radiological signs of AVN and patients not willing to participate in the study were excluded from the study.

After the appropriate written informed consent from all participants, detailed history was taken and patients were examined clinically and radiologically to obtain the data in terms of time from fracture, Pauwels angle, and Harris hip score. All the patients were planned for Valgus intertrochanteric osteotomy and fixation with double angle barrel plate and Richard screw under regional anesthesia. Intraoperative data were collected for time taken to perform surgery and also for blood loss.

Post-operative rehabilitation was done as per standard protocol and patients were allowed walk with toe touch immediately after surgery and were allowed to bear full weight only after radiological union. Data regarding union time, Harris hip score and signs of AVN were collected at every follow-up that was at 6, 12 weeks, 6 months, and 1 year.

Surgical technique

Osteotomy planning

The inclination of fracture line to horizontal (line touching the roofs of acetabulum) is the Pauwels' angle or "shear angle." Our goal was to achieve "Pauwels' optimal angle" which is usually between 20 and 25, it is the angle where the compressive force will be at a right angle.⁷ The desired wedge for osteotomy is planned in such a manner that after closure of osteotomy it results into more horizontal fracture plane i.e. 30° or less. Wedge thickness depends on the Angle of correction of Pauwels' angle to 30°. It is nearly 1 cm for 10°, but depends on thickness of femur at the level of osteotomy.

Pin placement and Richard screw insertion

Richard screw pin is to be inserted at a particular angle, measured when patient was mounted on traction table, as fracture alignment gets improved and requirement of wedge to be taken out was correctly measured. Pin insertion angle is the angle formed between the borders of the pin within the femoral neck and lateral femoral cortex. Angle of Richard screw pin is calculated by subtracting wedge osteotomy angle from the angle of implant.

Steps of procedure

All patients positioned supine and reduction tried when required by Leadbetter/Whitman method, open reduction not done in any of the patient. Richard screw guide wire inserted under fluoroscopic view at an angle guided toward center or inferomedial quadrant of femoral head. Antirotation guide wire or cancellous screw was inserted to prevent rotation of proximal fragment which occurs at the time of reaming to prevent further damage the blood supply of femoral head which was already jeopardized.

Suitable length Richard screw inserted after triple reaming and double angle barrel plate applied which stands away at

an angle which is required to be osteotomized. Osteotomy: “V shaped” lateral closing wedge osteotomy just above lesser trochanter was performed over guide pins. Upper pin recommended to be horizontal and lower pin is to be angled with upper pin as the wedge is required.

This particular configuration is advisable so as to match the maximum surface area at the osteotomy site which decreases chances of “ostetomy nonunion,” to prevent lateralization of distal shaft, better plate seating. Wedge removed and cancellous bone in it can be used as graft at osteotomy site. Distal shaft and plate approximated by abduction and held by Lowman bone holding clamp and fixation done.

RESULTS

All patients were monitored for an average of 19 months (range 11–36 months). The average Harris hip score increased from 66.6 points (range 55–75 points) before surgery to 88 points (range 75–95 points). Excellent results were achieved for 18 patients; two patients had poor results due to AVN and one due to cut-out of implant. In 15 of the 18 patients, the fracture went on to satisfactory union after an average of 14.7 weeks (10–26.7 weeks). No patient was lost to follow-up. The average preoperative neck-shaft angle of 102 (range 80–120) increased to 132 (range 120–145) after surgery. The average limb length discrepancy (shortening) post-operatively was 1.2 cm (range 0–1.6 cm). Out of 18 patients (12 male, 6 female, 10 right sided, and 8 left sided) were operated. Among operated patients, 3 had subcapital, 1 had basal, and 14 had transcervical fracture geometry. Ten patients who were operated had more than 50 degree of Pauwels’ angle, rest 8 patients had Pauwels grade 2. Earliest time to presentation was 4 weeks and the most late was 24 weeks with average time period of 15 weeks. (Figures 1 and 2).

15 out of 18 patients went in to bony union, with average time of union was 13 weeks ranging from 10 to 20 weeks. Osteotomy site also healed side by side without any complication (average time of union was 13 weeks). Fracture united in all but three patients, one was subcapital and 2 were transcervical fracture. Two patients in whom fracture united went in to AVN. Both patients have positive history of smoking and central cut through happened in 1 patient and the other patient was diabetic who was presented 6 weeks post injury. Pauwels’ angle corrected from 72.5° to 33°, average wedge correction angle was 27.5°. Equal limb length was achieved in 12 patients, shortening approximately 1 cm in 4 patients and 2 patients limb were lengthened which was approximately 1 cm. Functional outcome was good to excellent (Harris hip score >80) were seen in 13 patients (72%). Patients were

able to perform daily routine activities such as squatting, palthi position, and sitting cross legged, discontinued crutches after 5 months of surgery.

DISCUSSION

Main arterial supply of femoral head comprises Medial circumflex femoral artery (MCFA), Lateral circumflex femoral artery and the obturator artery.⁸ These terminal branches supplying the femoral head are intra-capsular. The largest and most important supply to the femoral head, especially the superolateral aspect is the MCFA.⁸ Fracture displacement disrupts the terminal branches to the femoral head which may progress to AVN.⁹

According to Barnes et al.,¹⁰ if fracture neck of femur remains untreated for more than 3 weeks, with internal fixation alone it is unlikely to unite the fracture. In their series, non-union rates were as high as 50% when fractures older than 1 week were treated.

King,¹¹ in 1939, in his comprehensive review of both recent and old case of fracture neck femur, emphasized that 3-weeks-old can be arbitrarily called old and un-united, as it can be assumed that the head of the femur is devoid of its blood supply, has less chances of osseous union and that secondary changes are more probable than in earlier operated cases. Plain X-rays are adequate to make a clinical diagnosis and stage the neglected femoral neck fracture. Bone scan may be indicative of AVN, but MRI is most sensitive modality to diagnose AVN.¹² Nonunion may occur in one-third of patients, with higher rate in vertical or displaced fractures.¹³

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.⁷ Marti et al.,¹⁴ reported 86% union rate at an average of 3.6 months, treated by this method alone. The goal of treatment in neglected fracture NOF is to achieve a painless, mobile and stable hip.¹⁵ The treatment depends on the age and physical status of the patient, duration of non-union, viability and sphericity of the femoral head, amount of resorption of the femoral neck and potential limb length inequality. Various options of management are described in the literature, all with variable outcomes in various series (a) osteosynthesis with or without vascularized or non-vascularized bone grafting (b) osteotomy, displacement or angulation type, (c) osteosynthesis with muscle pedicle bone grafting, (d) replacement (hemiarthroplasty or total hip replacement [THR]).¹⁶⁻²¹



Figure 1: Pre-operative X-ray (a), Intra-operative C-arm images (b), Post-operative images (c) and follow up X-rays showing union (d)

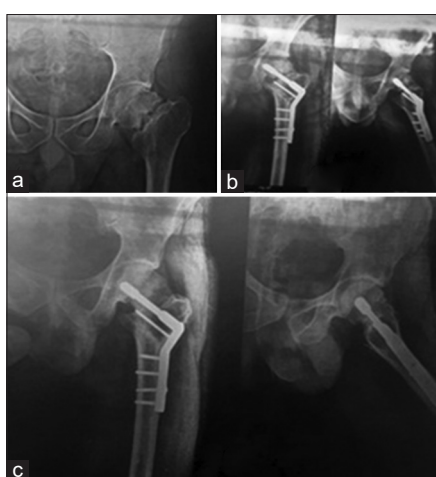


Figure 2: Pre-operative X-ray (a), post-operative X-ray (b), and X-ray showing union at final follow-up

In 2005, Magu et al.²² 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%.

Final results found to be affected by multiple factors such as age and sex of patient, osteoporosis, and time elapsed after injury, first aid, degree of displacement and quality of fracture reduction.²³ In patients younger than 55 years with good general medical condition, with no osteoporosis, with a reasonable size of femoral neck and normal joint space, it is desirable to preserve the femoral head, particularly if the patient's lifestyle and social and religious customs require squatting and sitting in a cross-legged position.²⁴

Fibular strut grafts have been associated with breakage, disimpaction or angulations of the head leading to failure.¹⁶⁻²¹ Arthrodesis can be considered in very young patients, but has a high failure rate, limb length discrepancies but, when successful it leads to a functional hip. Different techniques of vascularized bone grafting have been introduced, often with excellent results^{17,21} but the usefulness of these techniques is limited because of donor-site morbidity and limb length discrepancy with residual varus deformity.

Authors namely Pauwels, Muller and Sharma et al. used the Y shaped Wedge-closing/open inter-trochanteric osteotomy^{7,25,26} and Pauwels recognized that non-union of femoral neck fracture would unite within few months if shearing forces were transformed into compression forces at non-union fracture site.⁷ Most of the studies reported in the literature on valgus osteotomy, blade plate fixation has been used, which needs perfection and technically demanding.^{6,27,28} There is always a risk of splitting of femoral head in less experienced hands.^{29,30}

Marti et al.¹⁴ reported 86% union in 50 patients at an average of 3.6 months, treated by this method alone. Twenty-two hips preoperatively had avascular necrosis, with three of these cases progressed to collapse, necessitating THR. Anglen³¹ reported a series of 13 patients, all of whose femoral neck fractures united. Khan et al.³² treated 16 patients with valgus osteotomy and fixation with double angle barrel plate out of which 14 united satisfactorily, at an average of 14 weeks.

In our study of 18 patients, two patients ended up in to AVN and cut out of screw in 1 patient, which later were managed by THR. We aimed to get a final fracture plane of less than 30° postoperatively, but average we achieved was 33°. This technique resulted in union in 15 out of 18 patients. The rate of fracture union (83%) in our study is comparable to other studies where conventional double angle blade plate with valgus osteotomy has been done.^{27,28,31,32} Limb shortening had been corrected to pre-injury level in 13 pts, lengthening occur in 2 patients.

Valgus osteotomy changes bio-mechanical milieu and provide favorable environment for fracture healing, promoting osteosynthesis as it transforms shearing forces in to compressive one by placing fracture site at 90 degrees to the resultant forces of body weight. It buttresses the head of femur from below to improve stability provided by the internal fixation.^{24,25}

Following osteotomy, acute orientation of the proximal femur decreases the lever arm and therefore increases joint reaction force and contact pressure on the head. This may, in turn, lead to degenerative disease or progression of osteonecrosis.⁷ Progression of AVN of femoral head had been reported after osteotomy by many authors, several theories in favor but most likely its multifactorial which acted simultaneously. Walcher and Wiesinger³³ considered radiographic degenerative changes of joints in patients over 30 years of age as a contra-indication for an osteotomy. Therefore, we have excluded those patients from our study. Catto²⁹ believed that a neck fracture can unite and a necrotic head can be revascularized, although it may take long time and adequate fixation of the fracture. There are studies reporting that preoperative AVN is no contraindication for osteotomy for delayed fracture neck of femur. According to Marti et al.,¹⁴ collapse of femoral head may occur even 3–4 years after osteotomy. In our study, we did not find any late collapse of femoral head.

Raaymakers and Marti³⁰ also reported that collapse can occur 3–4 years later following osteotomy. Follow-up period of 3 years in our study was a limitation in this regard and longer follow-up is required for evaluation of collapse in femoral head. Kirby³⁴ reported no significant difficulty in doing THR later on even with standard implants, contrary to the apprehension. We have done MRI in only one patient in which osteotomy was done after 18 months of fracture, in others AVN was excluded on X-ray.

Limitations of the study

Small sample size and not able to get pre-operative MRI of affected head of femur to assess the viability of the head of femur due to financial constrains are the two limitations of our study.

CONCLUSION

We on the basis of our study and supporting previous studies concluded that management of fracture neck of femur in young adults in developing countries like ours is a challenging task considering various mal-practicing elements, economic constrains, and lack of awareness in general public. Valgus inter-trochanteric osteotomy is an effective method to achieve union in neglected fracture neck of femur, as it facilitates added compression at fracture site and stable internal fixation.

ACKNOWLEDGMENT

We acknowledge all the individuals participated in this study.

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RM - Concept and design of the study, prepared first draft of manuscript; SS, AS - Interpreted the results; reviewed the literature and manuscript preparation; SK, NSK, DK - Concept, coordination, statistical analysis and interpretation, preparation of manuscript, and revision of the manuscript.

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Source of Support: Nil, **Conflict of Interest:** None declared.