EVALUATION OF RESULT OF PLATE AUGMENTATION AND AUTOGENOUS BONE GRAFTING FOR FEMORAL SHAFT NONUNION AFTER LOCKING NAIL

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DOI: 10.38103/jcmhch.2020.62.4

ABSTRACT

Introduction: *Method of treatment for nonunion of the femoral shaft fracture after locked intramedullary nail fixation are challenging. The methods of exchanging an existing nail with a larger-sized nail, dynamization, removal of the nail followed by locking plating, and bone grafting have all been reported. In our study, we used plate augmentation and iliac bone grafting with retention of the nail.*

Objectives: *The purpose of our study was to evaluate the effectiveness of this method in treating femoral shaft nonunion after open reduction and internal fixation with locked intramedullary nail fixation.*

Methods: *Our study is retrospective descriptive study and longitudinal research. Between January 2017 and January 2019, 32 patients who had nonunion after open reduction and internal fixation with locked intramedullary nail for femoral shaft fracture were included in our study. There were 23 men and 9 women participants, with a mean age of 32 years (range, 16-60 years old). The mean period of follow-up after surgery was 13 months. The patients were classified into three groups, atrophic, oligotrophic, and hypertrophic. We retained the nail and performed plate augmentation for all patients, with simultaneous autologous bone grafting harvesting from iliac crest. We followed up on all patients with plain X Ray film examination, and to assess functional recovery status to determine osseous union condition. SPSS 20.0 sofware is used for this descriptive statistical analysis.*

Results: *All 32 of the patients achieved postoperative bony union uneventfully at a mean time of 13 months (range, 10 -20 months). The mean operative time was 65 minutes, and the mean blood loss was 150ml. All of the patients could walk bearing full weight without pain within 3 months. There were no significant complications such as broken hardware, implant back-out, axial or rotational malalignment, or deep infections.*

Conclusion: *Plate augmentation with retention of the nail with autologous bone grafting may be an effective and reliable alternative in treating nonunion of the femoral shaft fracture after open reduction and internal fixation with locked intramedullary nail.*

Keywords: *nonunion, plate augmentation, autogenous bone grafting.*

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Received: 5/5/2020; **Revised:** 17/5/2020
Accepted: 20/6/2020

I. INTRODUCTION

The fracture of femoral shaft is a commonly seen injury in Orthopaedic Traumatology after high energy trauma. The treatment of choice for these fractures is osteosynthesis as they have shown excellent union results in locked intramedullary nailing. The statistic results of Winquist with this technique are succesful in 95% [1]. Non-union after intramedullary locked nail fixation of femur shaft fractures is infrequent but this problem is challenged to treat. Heun GJ suggested the challenging treatment options available to deal with such situation include simplicity, effectiveness, economy to restore bone healing and limb function in daily working [2]. Some authors suggested the treatment of choice for non-union after locked intramedullary nail fixation of femur shaft fractures depending on the classification of non-union, location, nailing osteosynthesis, bone graft, characteristics of patients [3,4]. Indications for surgical intervention include three following principles: anatomic reduction of fracture, stable immobilization, supply of biologic environment for bone healing such as protecting of soft tissue, auto bone grafting, allo graft, synthetic bone graft, stem cell treatment [5]. We present our technique of plate augmentation retaining the nail in situ and iliac autobone graft for nonunion of femoral shaft fracture. It is an efficient technique, which provides bone healing results, allows early rehabilitation of the patient and carries lesser complications.

Objectives: The purpose of our study was to evaluate the results of bone healing and restore of rehabilitation of plate augmentation leaving the nail in situ and iliac autobone graft for treating femoral shaft nonunion after open reduction and internal fixation with locked intramedullary nail .

II. MATERIALS AND METHODS

This study is retrospective, descriptive. Thoses patients were diagnosed femoral shaft aseptic nonunion after open reduction and internal fixation with locked intramedullary nail. They were from 16 yrs to old and were operated in Lower Limb Department, Hospital for Traumatology and Orthopedics Ho Chi Minh City from August 2017 to August 2019.

Description of Population and Sample

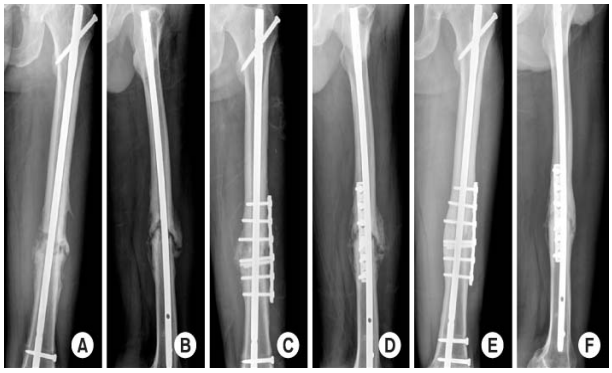
$$n = \frac{Z^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

If α=5%, Z=1,96, p=0,98, d= 0,05 → n=30.1. N >31 cases

Table 1: Classification of non - union (from Weber & Cech 1976) (8)

Type non union	Clinical symtom	X Ray
hypertrophic non-union	Mass of calcaneus, pain in walking	rich in callus and are a result of inadequate immobilisation
Atrophic non-union	Pain in walking radiating to knee	poor in callus and is due to unstable fixation.
oligotrophic non-union	Pain in walking radiating to knee	no callus seen and is due to severely displaced fracture or fixation without accurate apposition of fragments.

Evaluating of bone healing after operation is quality results based on chinical manifestations and X ray sign. The average duration of bone healing was 7 months. Clinical manifestations are no pain, total weight bearing mobilisation with a normal walking without crutches. Bone healing sign in X ray is continuous callus.



Picture 1: Non union of femoal shaft, bone healing after plate augmentation and iliac autobone graft.

Results of functional recovery of Binkley: Evaluating of lower limb function post-operation [6]. LEFS scores evaluate the ability of daily activity of the patient incliding 20 question test. This scores evaluate functional outcome according the effect of operation: Excellent: pointing result > 90% x 80:> 72 points. Good: pointing result 80-90% x 80 : 64 - 72 points. Average: pointing result 70 - 80% x 80: 56 - 64 points. Poor: < 70% x 80: < 56 points.

Evaluating of the last results in treating non union is followed on Thoresen scores: there are 4 quality values (excellent, good, average, poor) based on invidual patient score of Thorsen. Then we have the last total functional scores [7].

III. RESULTS

There were 32 patients in the present study in two years (2017 - 2019) in The Lower Limb department HTO Ho Chi Minh City. The average time of follow - up is 16 months.

There were 23 males (71.9%) and 09 females (28.1%) in the present study with the average age of 30 years (range 16 - 60 years), 21 yrs to 40 yrs of 59.4%. 54 % of patients in working ages, the left in 18 cases (56.5%), the right in 14 cases (43.5%). The location of non union fractures is in the 1/3 lower femoral shaft of 92%.

The average time of surgery between the primary surgery of interlocking nail fixation and the plate augmentation was 13 months (range 12 - 15 months).

Classification of the non union (Weber & Cech) [8]: hypertrophic non union is 95%, Atrophic non union is 5%.

The factors of non union were significant displacement of fragments (53.1%) and mechanical factors (like small diameter of the nail, unstable locking, ruptured wiring). In the present study, we found that rotational instability at the fracture site and rotation of fracture were the leading causes of non - union.

Bone healing results:

The rate of treatment in plate augmentation with retention of intramedullary nail and iliac auto bone graft is 100%. Hypertrophic non-union is easier in

Table 2: Crosstab statistics between the time of beginning of callus and type of non union

	Week 10	Week 14	Week 18	Week 22	Week 26
Hypertrophic	11 cases	15	2	0	0
Atrophic	0	0	0	2	2
N = 32	11	15	02	02	02

Chi-Square Test for Association using SPSS Statistics (n=32, p value Chi-square = 32,000a, df = 1) hypertrophic non union requires more time to have bridge callus than atrophic non union

Table 3: Crosstab statistics between the time of bone healing and type of non union

	12 months	16 months	20 months	24 months
Hypertrophic	17	09	2	0
Atrophic	0	0	4	0
N = 32	17	09	04	0 ca

healing than atrophic non - union.

Chi - Square Test for Association using SPSS Statistics (n = 32, p value Chi-square = 3,829a, df = 1) hypertrophic non union requires more time to totally heal than atrophic non union

Results of funtional recovery: there are 29 cases (90,6%) of good to excellent in Binkley but theses excellent cases is 66,7%.

Table 4: Results of functional recovery of Binkley

Excellent	Good	Average	Poor	Total
21	*8*	*3*	*0*	*N = 32*

Results of Thoresen functonal recovery (from Thoresen 1985): there are 28 cases(87,5%) of good to excellent in Binkley but theses excellent cases is 56.25%.

Table 5: Results of functional recovery of Thoresen

Excellent	Good	Average	Poor	Total
18	*10*	*4*	*0*	*N = 32*

Complications post operation

Limb shortening was less than 2 cm after treatment, thoses results were acceptable

*Table 6: **r**esults of limb shortening post operation*

Shortening 2-3cm	Shortening 1-2cm	Shortening <1cm	Total
0 (0,0)	*10 (31,25)*	*22 (68,75)*	*32 (100)*

Limitation of range of motion of knee in post operation: all the patients were restored clinically the ange of motion of knee in post operation

IV. DISCUSSION

The patient age ranges from 21 to 40 years old and people of all age groups regard the juvenile years and the early 30's as a working time in life. Then the results of femoral bone healing is necessary in this study. Einhorn found that The known causes of failure of internal fixation was difficult [9]. In this study, somes cases had causes of non union based on clinical records, history of patient, clinical manifestations, X ray of pre and post operation. In majority of cases, the non union were resulted from the comminuted fractures, the heavy trauma of the soft tissue and bood supply, non anatomic reduction of fractures, unstable osteosynthesis, visible unstable fixation while operating fracture. Julius reported the risk factors of non union composing two main factors: the host factors and the external factors. The external factors composed of trauma and procedure of treatment. The host factors composed of medical history, smoker, corticosteroid, malnutrition. Mark classified into three causes: unstable osteosynthesis, decreasing of blood supply and fair contact of fractures [10]. Bellabarba said that non anatomic reduction of fractures, unstable fixation led to majority of non union of femoral fractures after locked nailing [11]. So principles of internal fixation must be standard. The biologic of factors such as decreasing of blood supply and the soft tissue injuries are problems.

In this study, there are 32 cases of the combination of plate augmentation and bone auto graft over retained intramedullary nail. The union rate is 100%. Plate augmentation and bone auto graft over retained intramedullary nail

Is current procedure indicated that is an effective and safe treatment option for femoral nonunion. favorable procedure composed of two objects such as augmentation of fractue fixation and bone graft suitable for biologic environment in bone healing. Judet said that the technique of onlay

for auto bonegraft was effective in non union of diaphysis [12]. In the study of Birjandinejad. using a plate over intramedullary nailing associated with bone graft resulted in satisfactory outcome and he concluded that this procedure appears to be effective in reducing pain and improving function, and predictably leads to radiographic consolidation of the nonunion. He additionally applied plate augmentation in hypertrophic nonunion patients to stimulate further callus formation without changing locking nail. In his study, this method was performed in 121 cases in plate augmentation . 96% of patients had bony union in avarage of 6 months without complications, this method is favorable [13].

In Boyd's opinion, exchange larger nailing with or without bone graft is the standard of care for femoral nonunion. Locking nail fixation is effective in rotation control of the fracture. The causes of non union of femoral fractures composed of many factors [14]. Somes ideas for treatment non union of femoral fractures were suggested exchange nailing, dynamization, nail removal followed by plating, stable fixation with plate and bonegrafting. Exchange locked nailing and auto bone graft was treatment of choice for the femoral shaft nonunion with incarcerated broken femoral nail. Nonunion of femoral shaft fracture after locked intramedullary nailing without nail breakage is still discussed problem. Somes authors said: Jhunjhunwala reported 40 patients had been diagnosed with the femoral shaft nonunion with locked femoral nail . They composed of average age of 35 with 14 cases of hypertrophic non union, 24 cases of oligotrophic non union, 2 cases of atrofic non union [15]. The last results were 39 patients of bone healing, 1 patient of deep infection with treatment of Vancomycin nail exchange and being bone healing later. Birjandinejad reported 55 patients had been diagnosed the nonunion of communited femoral fractures with locked femoral nail. They were idicated the combination of plate augmentation and bone auto graft over retained intramedullary nail. The results were 54 cases of bone healing in average time 6 months [13]. Heun reported 31 cases of nonunion of femoral fractures with locked femoral nail. Somes methods were suggested 14 cases of bone healing, 13 cases of nail exchange, 14 cases of plate augmentation and bone auto graft and 4 cases of dynamization. The results were 4 nail dynamization fail, 7 cases of 13 cases nail exchange healing (54%), all cases of healing in plate augmentation and bone auto graft (100%) [2].

Evaluation of Thoresen functional restoration in method of plate augmentation and bone auto graft were from good to excellent. The femoral non union is the only bone broke in the thigh and still serves for an attachment site for the largest muscles of the body in the thigh without injury of surrounding articulations such as knee and hip. This anatomic characteristic help the femoral non union with bone healing and good funtional restoration. The plate augmentation and bone auto graft help the fracture stable to exercise early and to restore the lower limb function satisfactory.

V. CONCLUSION

Plating augmentation and auto bone graft in femoral nail non union is an effective and safe treatment option for nonunion of femoral shaft fractures.

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