DYNAMIZATION IN THE TREATMENT OF DELAYED UNION OF FEMUR FRACTURE

Saeed Ahmed Shaikh, Badaruddin Sahito, Nadeem Ahmed, Qasim Samejo, Allah Rakhiyo Jamali

Jinnah Postgraduate Medical Center Karachi Pakistan

ABSTRACT

Objective: To assess the outcome of dynamization in delayed union of femoral shaft fractures treated initially with static interlocking nailing.

Study Design: The descriptive case series study.

Place and Duration of Study: The study was carried out at the Department of Orthopedic Surgery Jinnah postgraduate medical centre Karachi, from May 2016 to Feb 2017.

Material and Methods: Forty-two patients were included in this study who showed delayed healing of femur fractures from six weeks to six months after initial treatment with static interlocking nailing. Full weight bearing was allowed immediately after dynamization. Rests of the cases were treated with exchange nailing or cancellous bone grafting with or without lengthening and achieved satisfactory outcomes. The patients were followed up for at least 9 months and serial radiographs were taken.

Results: Most of the patients (71.4%) were between 15 to 30 years of age. The average age of the patients was 26.6 ± 9.6 years (both males & females). Out of 42 patients, 30 (71%) patients were male and 12 (29%) were female with 2.5:1 male to female ratio. The mean age for males was 25.05 ± 7.5 years whereas the mean age for females was 28.14 ± 6.4 years. Twenty six patients (62%) achieved a solid union with a union period of 21.67 ± 2.5 weeks after dynamization. 6 of 26 patients who achieved solid union developed femoral shortening of 1 cm to 2cm.

Conclusion: Dynamization is a simple, day case method that can be tried to improve fracture healing in femoral shaft fractures that show delayed healing after interlocking nailing with a less developed problem of 1 to 2 com shortening.

Keywords: Dynamization delayed healing, Femur fracture, Interlocking nailing, Solid union.

INTRODUCTION

Fractures of the shaft of the femur are the result of high-energy trauma and therefore can be both life-threatening injuries and causes of severe permanent disability since femur is one of the principle load bearing bones in lower extremity. Shortening of the limb and malalignment[1] along with contractures of the knee[2,3] due to prolonged immobilization, have traditionally plagued the orthopedist's management of patients. The standard treatment of femoral shaft fractures in adults is an antegrade, reamed, locked intramedullary (IM) nai[4,5]. Intramedullary interlocking nailing is not free of complications that include infection, malunion, delayed union, nonunion and pain from hardware[6]. Delayed union and nonunion can be treated with dynamization, new or different implant, autogenous cancellous bone grafting, and/or bone stimulation {shock wave therapy, low intensity pulsed ultrasound (LIPUS)}[7]. Cyclic compression & distraction technique with the help of additional external fixator and percutaneous autologous bone marrow injection has been employed in some research studies with good results[8]. Exchange nailing has best results when treating a nonunion[9]. Dynamization is a method that can be tried to improve fracture healing in femoral shaft fractures that show delayed healing after static interlocking nailing[10]. The effects of dynamization are to promote the consolidation of fractures where bone callus is deficient, callus remodeling and prevent the fixation device from breaking[10,11]. Dynamization significantly shortens the mean time to union (average 19.2 weeks), though it does not significantly affect the union rate of femoral shaft fractures[12,13]. Biomechanically, dynamization improved stiffness at the fracture

Correspondence: Dr Saeed Ahmed Shaikh, Dept of Orthopedic Jinnah Postgraduate Medical Center Karachi Pakistan
Email:drsashaikh2003@yahoo.com
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site; histologically a denser trabecular callus pattern is seen in the dynamized group[14]. Initially all interlocking nails were routinely dynamized at two to three months to promote fracture healing. Later on it was reported that dynamization was not necessary to achieve a high fracture union rate after interlocking nailing[15]. Dynamization is now used only in cases with delayed union[16]. Although dynamization of a static interlocking is a simple technique and can be performed under local anesthesia as a day case, its effects and complications have rarely been reported. The aim of this study was to supplement this lack and safety of the procedure and to provide local regional data which is sparse regarding this procedure.

MATERIAL AND METHODS

Objective

The objective of the study was to assess the outcome of dynamization in delayed union of femoral shaft fractures after intramedullary interlocking nailing.

Operational Definition

Dynamization: The procedure done in cases of delayed union of femoral and tibial shaft fractures fixed with intramedullary interlocking nail in which screws farthest from the fracture site are removed.

Delayed union: Femoral shaft fractures treated with intramedullary nailing showing persistent fracture line on x-rays and tenderness at fracture site on clinical examination from 6 weeks to 6 months will be labeled as delayed union.

Non probability purposive sampling. Patients between 15 to 50 years of age. Either sex. Delayed union in femur shaft fractures managed with static interlocking nail from 6 weeks to 6 months. Multiple fractures for example involving bones other than femur. Disability of affected limb prior to fracture for example post polio deformity. Pathological fracture: fracture occurring in abnormal or diseased bone. Comorbids like anemia, diabetes, hypertension etc.

Data Collection Procedure

All patients were clerked in orthopedic clinic. The patients who showed delayed healing based on clinical (tenderness at fracture site) and radiological findings (persistent fracture line on x-ray) for at least six weeks after initial treatment with static interlocking nailing and fulfilling other inclusion criteria were recruited after taking the informed consent. Patients were admitted in hospital as day-case. The dynamization procedure was carried out in operating room by researcher himself having one year experience in relevant field under local anesthesia. Follow up of patients was undertaken in outpatient department. The clinical and radiographic healing processes after dynamization were recorded in follow up visits. Radiographs were obtained on admission and at one week, one month, three months and six months interval after dynamization. Final outcome was determined as union achieved as per operational definition.

Data analysis procedure:

Statistical packages for social science (SPSS-10) were used to analyze data. Frequency and percentage were computed for categorical variables like age groups, gender, and outcome of dynamization. Mean with standard deviation, 95% confidence interval, median with Inter-quartile range were computed for quantitative variables like age and union time. Stratification of age and gender were also made to see the effect on outcome of dynamization. Post stratification chi-square test was applied. A p-value<0.05 was taken as statistically significant.

RESULTS

A total of 42 cases of delayed union of femoral and tibial shaft fractures diagnosed on clinical and radiological finding for at least six weeks after initial treatment with static interlocking nailing were selected for dynamization. All patients follow up at least nine month and outcome of dynamization in delayed union of femoral shaft fracture after intramedullary

interlocking nailing. Twenty six patients (62%) achieved a solid union with a union period of 24 ± 2.1 weeks after dynamization. All 16 cases of nonunion were treated with cancellous bone grafting with or without lengthening and achieved satisfactory outcomes. The average age of the patients was 28.5 ± 5.4 years (95%CI: 26.94 to 29.86), ranged in age between 15 years and 50 years as shown in table-I. All patients follow up at least nine month and outcome of dynamization in delayed union of femoral shaft fracture after intramedullary interlocking nailing. Twenty six patients (62%) achieved a solid union with a union period of 24 ± 2.1 weeks after dynamization. All 16 cases of nonunion were treated with cancellous bone grafting with or without lengthening and achieved satisfactory outcomes shown in figure. Effect of dynamization with respect to age were seen and presented in table-II. Twenty of 26 patients (76.9%) were between 15 to 30 years of age achieved solid union with an average time to union of 23.7 ± 2.4 weeks. Patients more than 30 years (n: 6) had a mean time to union of 26.3 ± 2.6 weeks. Out of 42 patients, 30(71%) patients were male and 12 (29%) were female with 2.5:1 male to female ratio. The mean age for males was 26.6 ± 4.8 years whereas the mean age for females was 29.4 ± 3.4 years. Nineteen (73.1%) cases were male to achieved solid union and 7(26.9%) were female patients were achieved solid union with *p*-value >0.05 that is statistically insignificantly and presented in table-III. The time to union in female patients ranged from 13 to 30 weeks, with an average of 21.7 ± 3.1 weeks. The mean time to union in male patients was 26.5 ±6.2 weeks (range, 11-32 weeks).

Procedure of Dynamization

Dynamization is a simple procedure and is performed as a day-case procedure under local anesthesia. X-rays were done before the procedure to determine the screws which were removed that is screw away from the fracture site. Image intensification made the dynamization relatively easier. Patient is placed in supine position and after all aseptic measures whole of the femur was viewed to confirm the screw which is removed away from the fracture site. Local anesthesia was injected at the site of screw on lateral aspect of thigh confirmed by previous scar and image intensifier. Incision made in the skin at the site of local anesthesia. After skin incision, soft tissue is dissected with the help of artery forceps until screw felt. Under image intensifier the position of the screw confirmed and screw removed with the help of hexagonal screw driver. Skin closed and aseptic dressing done.

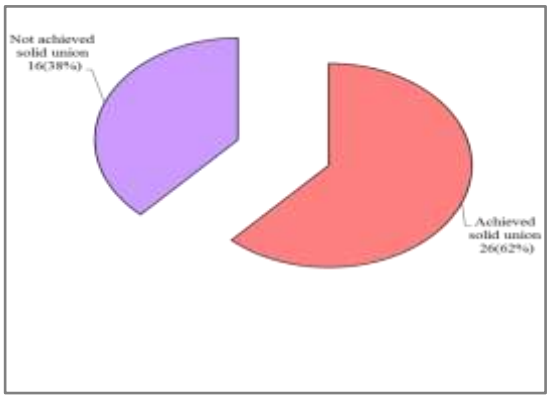

Figure: Outcome of dynamization in delayed union if femoral shaft fracture after intramedullary interlocking nailing (N=42).

Aftertreatment

Patient was mobilized as soon as the pain of wound subsided and encouraged to bear full weight on operated limb with walking aid. Stitches were removed on 10th day of dynamization. Walking aid was removed gradually over an average period of one month.

DISCUSSION

Fracture-healing is a specialized type of wound healing response in which the regeneration of bone leads to a restoration of skeletal integrity. Despite advances in surgical technique, fracture fixation alternatives, and adjuncts to healing, femoral delayed union continues to be a significant clinical problem. Femoral fractures may fail to unite because of the severity of the injury, damage to the surrounding soft tissues, inadequate initial fixation, and demographic

characteristics of the patient, including nicotine use, advanced age, and medical comorbidities. Femoral nonunion and delayed union is a functional and economical challenge for the patient, as well as a treatment dilemma for the surgeon. Literature reveals variable success rate of dynamization. In a comparative study of 50 patients 26 cases which were dynamized went on to union between 13 and 28 weeks (average 19.2 weeks) with two poor results[12]. In another comparative study in animals, dynamization improved stiffness at fracture site[13]. In one study of 160 fractures treated with intramedullary nailing 20 patients had delayed union for which dynamization was performed in 6 patients. All went on to healing without further intervention[17]. In a retrospective study of 28 patients by Chi-chuan Wu, 24 patients were followed for one year. Fourteen patients achieved a solid union (58%) with a union period of 5.2 ± 2.0 months after dynamization[18]. In another retrospective study of M.Umar and colleagues on 89 patients; 7 (7.8%) had delayed union, among them 3 were those which were later dynamized, and they healed after an average of five months period[19]. In a study of 62 patients, 24 patients (14 femurs, 10 tibias) did not show callus formation and complained of vague pain at fracture site 20 weeks after static mode. In these cases, dynamization was tried as an initial treatment modality. The success rate after dynamization was about 87%[20]. Kempf *et al* routinely dynamized all interlocking nails from 8 to 12 weeks to promote fracture healing[14], while Brumback *et al*[20] prefer dynamization after 12 weeks to avoid shortening. In a series of 103 cases of complex femoral fractures, 6 cases were dynamically locked and another 7 patients showed delayed healing. In this study, it appeared that dynamization contributed to the consolidation of the fractures since the nail, in 7 cases, was dynamized by screw withdrawal[11]. Dynamization was performed in 10 patients (17.24%) out of 58 static interlocking nails from 24 to 30 weeks after surgery to achieve union. However 4 patients (5.88%) required further procedure to achieve union[21]. On the other hand studies show that dynamization delays healing process[21]. Brumback *et al*[20] stated that dynamization recommended initially by Wiss *et al*[22] 6 weeks after static

Table-I: Descriptive statistics of age (n=42).

Statistics	Age (years)
Mean ± SD	28.5 ± 5.4
95% confidence interval	26.94 to 29.86
Median (IQR)	29 (9)
Minimum Age	15
Maximum Age	50

Table-II: Stratification of outcome dynamization W.R.T Age

Age Groups	Outcome Dynamization		*p*-value
	Achieved union (n=26)	Not Achieved union (n=16)	
15-20 years	6 (23.1%)	5 (31.3%)	0.554
21-30 years	14 (53.8%)	5 (31.3%)	
31-40 years	4 (15.4%)	4 (25%)	
41-50 years	2 (7.7%)	2 (12.5%)	

With *p*-value>0.05 that is statistically insignificantly showed the higher rate of union with patient treated with dynamization.

Table-III: Stratification of outcome dynamization W.R.T Gender.

Gender	Outcome Dynamization		*p*-value
	Achieved union (n=26)	Not Achieved union (n=16)	
Male	19 (73.1%)	11 (68.8%)	0.763
Female	7 (26.9%)	5 (31.2%)	

osteosynthesis is not an important factor in the consolidation process evolution and can cause risk of instability to the fractures. Chi-chuanwu and wen-jerchen treated 56 consecutive acute segmental fractures and showed poor results of dynamization done in 12 cases[15,22]. The main advantage of this technique is lack of significant complications except limb shortening[18]. The procedure is performed without opening the fracture site. In the present study 62% (26) of the patients achieved solid union with an average union period of 21.67 ± 2.5 weeks. Thirty patients were male (71%), and most belonged to young age group (71.4%), that is between 15 to 30 years of age. In the remaining patients who went on to nonunion, another procedure of either exchange nailing or cancellous bone grafting was done. All patients were followed for at least nine month and outcome of dynamization was observed in delayed union of femoral shaft fracture after intramedullary interlocking nailing. Dynamization was performed between six weeks to six months after initial treatment with interlocking nail. The results of dynamization were better in patients younger than 30 years than in patients older than 30 years. Twenty out of 26 patients achieved solid union who were younger than 30 years in contrast to only 6 patients who were older than 30 years. Male patients achieved union earlier that is 20.78 weeks in comparison to female patients who united at an average period of 22.57 weeks. Femoral shortening of 1 to 2 cm was observed in 6 cases who achieved union. This was tolerated well and compensated with shoe raise. In this study it was observed that although union rate was higher (70%) when dynamization was performed before[10] weeks, these patients developed femoral shortening of 3cm or more. Therefore it is recommended that dynamization be performed between 10 to 20 weeks to avoid complication of femoral shortening.

CONCLUSION

Dynamization is a simple, attractive, day case method that can be tried to achieve solid union in femoral shaft fractures that show delayed healing after interlocking nailing with a less developed problem of 1 to 2 com shortening.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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