

Outcome of Treatment of Nonunion Tibial Shaft Fracture by Intramedullary Interlocking Nail augmented with Autogenous Cancellous Bone Graft.

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ABSTRACT

To assess results of operative treatment of non union fracture shaft of Tibia by intramedullary interlocking nail augmented with autogenous cancellous bone graft in our setup.

A total of 25 nonunion tibial shaft fractures were evaluated among which 20 cases were male and 5 female with the mean age 31.84 years. Hypertrophic non-union were 14 and atrophic non-union were 11. Upper one third of tibial diaphysis was involved in 4 cases, middle one third in 14 cases and lower one third in 7 cases. In all cases open reduction, interlocking nailing and autogenous cancellous bone graft was applied.

The mean follow up was one year. Mean time for healing was 8.08 months. Mean operation time was 110 minutes (range 70 to 160 minutes). Satisfactory results (excellent and good) were achieved in 88% cases and unsatisfactory (fair and poor) results in 12% cases.

This operative treatment option appears to have a high success rate and should be considered in nonunion of tibial diaphysis.

INTRODUCTION

Fracture of tibial shaft is important for two reasons, first is that they are more common; the second is that they are controversial and anything that is both common and controversial must be important¹. Because of subcutaneous position, the tibia is more commonly fractured and more commonly sustain open fracture than any other long bone². The incidence of tibial non-union is estimated to range from 2 to 10% of all tibial fracture and is greater with high energy injuries and open fractures³.

Several factors may predispose to non-union. Many of these are related to the fracture characteristics such as degree of fracture comminution and bone loss, whether the fracture is open or closed and degree of soft tissue injury. Subsequent complication such as infection or compartment syndrome may also play a role.

The patient related factors such as cigarette smoking, use of NSAIDs, steroid, poor nutritional status, systemic diseases like uraemia, jaundice etc and non-compliance to post operative regimes also contributes to the incidence of non-unions. Iatrogenic injury to soft tissue envelope, distraction across fracture site, inadequate immobilization or fixation and splinting effect of an intact fibula may contribute to the development of a non-union¹.

Historically, the definition of nonunion has been based on time frame from the onset of injury. More recently the exact time frame is considered to be less important. Fracture healing is a dynamic progressive process and

intervention is warranted by 3 to 5 months following injury if monthly radiographic studies do not show progression of fracture healing³.

Several non-operative options have been described for the treatment of this complication such as immobilization in a cast, use of functional brace, electrical stimulation and pulsed ultrasound. Surgical treatment includes fibular osteotomy, Posterolateral, subcortical or open cancellous bone grafting and a variety of methods of stabilization like external fixation, plate and screws, intramedullary nailing and intramedullary nailing supplemented with plate and screws. Every treatment option mentioned above had its own advantage and disadvantages.

In this series, the effectiveness of interlocking nailing augmented with autologous cancellous bone graft in the treatment of tibial diaphyseal fracture non-union has been evaluated.

MATERIALS AND METHODS

All 25 patients who underwent open reduction and intramedullary interlocking nailing with autogenous cancellous bone graft during 2009 to 2011 and all were followed for one Year. The inclusion criteria were non-union tibial shaft fracture, age >18 years, both male and female were taken. Exclusion criteria were infected non-union tibial shaft fracture, gap and delayed non-union, pathological and children's fracture.

Fracture site was opened through antero-lateral approach and nail was introduced through patellar tendon

splitting approach which was followed by placement of autogenous cancellous bone graft at the fracture site. In all cases reaming was done.

Postoperatively both active and passive toe movements started immediately after anesthesia. Static quadriceps exercise began as soon as pain allowed, followed by movement of knee and ankle. Patients were allowed partial to full weight bearing as pain allowed; with the help of crutch. Patients were discharged on 4th to 12th postoperative day. In cases of wound infection, patients needed longer stay.

The first follow up was on three weeks interval and thereafter at monthly intervals till the fracture united. The last follow up was at one year.

The criteria for assessing the outcome after intramedullary nailing have been set by different workers. In this series, Tucker criteria was used for evaluation of the results. The results were expressed as excellent, good, fair, and poor according to the criteria followed by Tucker et al 4.

Grading

Excellent: - the results were graded as excellent when the following criteria were fulfilled.

Fracture union

Full knee extension and 125 degree flexion

Ankle motion 75% of normal side (in bilateral fracture, ankle motion should be above neutral and have 30 degree flexion)

No leg length discrepancy of more than 1 cm

No angulations greater than 7 degree in any plane

No infection

No pain on weight bearing

Good: - Fracture union and one criterion above missing

Fair: - Fracture union and two of the above criterion missing

Poor: - Fracture union with three criteria missing

Results

Table 1. Age distribution of patients

Age (Years)	No of patients
11-20	2
21-30	10
31-40	8
41-50	5

Table 2. Sex distribution of patients

Sex	No. of patients
Male	20
female	5

The total number of patients was 25 with 80% male. All patients had one year follow up. The mean operative time was 110 minutes (range 70-160 mins). Full weight bearing was achieved within 2 days of operation. Bony union was achieved in all nonunions (100%). The mean time of union was 8.08 months. Fifteen cases required fibular osteotomy that allowed transfer of stress from intact fibula back to tibia and aided in realignment of tibia.

Regarding time to union; Hypertrophic non union required an average of 6.79 months and atrophic non union at 9.73 months. In this study, 4 cases (16%) had superficial wound infection, 5 cases (20%) had limb shortening (three cases-1.5 cm ; two cases- 2cm) and 2 cases had knee pain(8%), 4 cases had ankle stiffness(16%), significant restriction of knee movement more than 15° were found in 4 (16%) cases, one case each (4%) had ankle pain and valgus deformity. Functional range of motion of both the knee and ankle were maintained. In this series, final result was considered on the basis of tucker's criteria. According to which, 9 cases (36%) had excellent result, 13 cases (52%) had good result, 2 cases had (8%) had fair result and 1 case (04%) had poor result.

Table 3: Complications

Complications	Number of cases	Percentage
Superficial wound infection	4	16
Shortening	5	20
Knee pain	2	8
Valgus deformity	1	4
Ankle stiffness	4	16
Knee joint movement deficit >15°	4	16
Ankle pain	1	4

DISCUSSION

Many factors have to be considered to select optimal treatment for a patient with tibial

non union to achieve speedy recovery and return to function. Bone quality, bony defects, soft tissue coverage, potential occult infections, insufficient primary stabilization and mal-union are essential determinants 5.

It must be taken in consideration that numerous investigators have reported result of treatment of same type of non union by using different operative techniques and implants used in many recent series 6,7,8,9. Comparison among those studies i

s often difficult and wide variation frequently exists. Some of these discrepancies may be

attributed to factors including patient selection, various methods of rehabilitation, and difference in length of follow-up. Patient in various clinical series also differ not only with respect to type of non union, but with regard to age, sex, lifestyle and level of activity.

The tibial diaphyseal fracture non union is the commonest among all long bone fracture nonunion. An orthopaedist must consider many factors in choosing the best treatment for patient who has non union of the tibia. In spite of vast experience gained over the last few decades, at present, no single method is universally accepted, and many methods appear to result in an acceptable rate of union. One of the most important differences among those methods is the duration of disability to be expected. Most patient who have non union of tibia have been incapacitated for six to twelve months and any methods that encourages early return to function is appreciated.

With these shortcomings in mind, the present study has been undertaken in NMCTH, Kathmandu to evaluate the result of treatment of the tibial diaphyseal fracture non-union by interlocking nail augmented with autogenous cancellous bone graft.

A prospective study was carried out from 2009 to 2011 at NMCTH. A total of 28 patients satisfying the inclusion and exclusion criteria were selected for this study and three patients were lost for follow up. So this study comprised of 25 patients.

In this series, the age range of patient was from 18- 50 years, with mean of 31.84 years. Similar findings were also noted by Johnson and Marder (1987) in the study where the average age was 43.4 years¹⁰. Majority of the patients in this series were in the age group of 21-30(40%) years.

Male population in the series constituted 80% of cases, while the female made up the remaining 20%. Male being the major working force of a society and are thus more consistently exposed to external environment, which probably accounts for this discrepancy.

The major cause of initial injury was road traffic accident (RTA). Thirteen (52%) patients developed fracture following RTA. RTA was the initial cause of fracture in other previous studies too¹⁰.

Most non union occurred in middle third of the diaphysis of tibia (56%), followed by distal third(28%) and then proximal third(16%) in this series. This was consistent with the observation of Johnson and Marder(1987)¹⁰.

In this series, hypertrophic non union were 14 cases(56%), atrophic type were 11 cases(44%). Similar result observed by Johnson and Marder (1987), hypertrophic type were 55% cases, atrophic type were 45% cases. Whereas Rosson et al. (1992) reported hypertrophic type 54.16% cases, atrophic type 45.84% cases¹⁰, 11.

In this series, 15(60%) cases were initially treated by plaster immobilization after initial injury, 8(32%) cases were treated by external fixation, and 2(8%) cases was internally fixed by plate and screw. All were without evidence of infection for at least six months before the intramedullary nailing.

The time elapsed from injury to treatment for non union varied from 6 months to 19 months with mean of 10.08 months. Johnson and Marder (1987) reported time from injury to nailing from 9 months to 36 months with mean of 17.43 months. Rosson et al (1992) reported time from injury to nailing varied from 10 months to 54 months with mean of 21.37 months¹⁰, 11. This variation in time is due to the change in definition of non union itself. Previously when 9 months had elapsed after the initial injury and no progressive signs of healing were visible, then only it was called non union¹². But according to the newer definition a fracture can be called non united when it shows no signs of union after 6 months of initial injury³.

Fibular osteotomy was done in 15 cases, because this osteotomy allows transfer of stress from the intact fibula back to the tibia and aids in realignment of tibia. Osteotomy was performed 6 to 8 cm away from non union. An osteotomy at this distance allowed correction of alignment but left some interosseous membrane intact and prevented excessive shortening and instability⁶. Static interlocking was done in all cases. Autogenous cancellous bone graft taken from iliac crest was given in all cases. No external immobilization was used post operatively.

Post operative hospital stay ranged from 3 to 12 days with mean of 5.08 days. Hospital stay was comparatively much longer in cases where external fixators were used.

Assessment of union at follow up was made radiographically and clinically. The follow up period was 12 months. A non union was considered to be healed clinically when the patients could walk with full weight bearing without assistance and had no pain even with provocation test. A non union was considered to be healed radiographically when the radiolucent fracture line was obliterated or when callus bridged the site of non union.

Mean union time in this study was 8.08 ± 2.53 months (range 4 to 12 months). In the study of Waren et al. (1992) mean time of union was 8 months (range- 2 months to 15 months), Rosson et al (1992) showed a mean union time of 9 months (range- 2 to 15 months) 11, 13.

In this series, union occurred in all (100%) cases. Johnson and Marder (1987) achieved union 100% cases. In the study by Meargo et al (2007, union occurred in 99% of cases within 5.2 months with the use of intramedullary nail 10, 14.

Hypertrophic non union showed union at an average of 6.79 months (ranging from 4 to 10 months) and atrophic non union had union at an average of 9.73 months (ranging from 6 to 12 months). This difference is statistically significant ($P < 0.05$). In Johnson and Marder study (1987) also showed statistically significant difference between union time of hypertrophic and atrophic non union. Similar findings were also found in the study of Rosson et al (1992) 10, 11.

In this series, the mean union time taken for union at proximal third was 6.75 months, at the middle third it was 7.5 months and lower third it was 10 months. This finding is similar to the study of Rosson et al (1992), which showed longer time for union of distal third but contrary to the study of Johnson and Marder (1987) which showed no difference in union time according to the site involved 10, 11.

In this series, non united fracture that were open initially needed multiple surgical debridement and took longer time for union (mean- 9.09 months) and non united fracture that were initially closed achieved union at a mean of 7.28 months. This difference is statistically significant ($P < .001$). In Johnson and Marder (1987) also found that non united closed fracture united earlier than non united open fracture which was statistically significant. In the critical analysis of 705 cases, Nicoll (1964) also found that there was statistically significant difference between mean union time of closed and open fracture. This supports the theory that severe damage to soft tissues at the time of fracture or from repeated stripping of soft tissues is detrimental to the healing fracture 10, 15.

In this series, 4 patients (16%) had a post operative superficial infection which healed with regular dressing and antibiotics. Rosson et al (1992) reported infection rate in 16 % cases in their series. Johnson and Marder (1987) found infection rate in 10% cases and Waren et al (1982) reported infection rate 0% 10, 11, 13.

In the present series significant restriction of knee movement more than 15° were found in 4 (16%) cases but mild degree of knee stiffness ($< 15^\circ$) was present in 14 (56%) cases. Restriction of ankle movement was

found in 4 (16%) cases. These were probably due to inadequate physiotherapy.

Anatomical alignment of the fragments to a neutral position in all cases except 1 who developed valgus deformity of 10° .

Limb length discrepancy is an important problem of treatment. Two patients in this series had shortening of 2 cms and another 3 had shortening of 1.5 cm. No patients in this series had an unacceptable shortening. Two patients had knee pain and 1 had incidence of ankle pain on weight bearing. The final outcome was in excellent in 09 (36%) cases, good in 13 (52) cases, fair in 2 (08%) cases and poor in 1 (04%) cases, as shown in figure 1. In final follow up the satisfactory result (excellent and good) was obtained in 22 (88%) cases. In the study of Johnson and Marder, satisfactory result was in 100% cases 10.

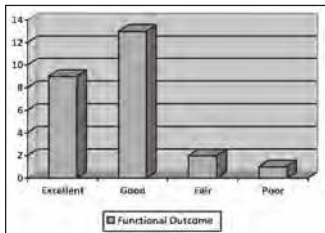


Fig.1: Functional outcome

Intramedullary interlocking nail augmented with autogenous cancellous bone graft is a good option for the patients of tibial diaphyseal fracture non union with high rate of union and early mobilization with a low complication rate and early return to function.

In conclusion, this technique should be considered a viable option for refractory non union of tibial diaphysis.

This study was conducted on small sample size (25 patients), sampling was not done randomly and follow up period was 12 months. So, further prospective study with larger sample size is required to delineate outcomes.

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