

Original Research Article

Primary interlocking nailing for open fractures of tibial shaft: a clinical study

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ABSTRACT

Background: The excellent method for treating fractures of the tibial shaft was the closed intramedullary nailing technique. But because of limited references related to the results, incidence of infection, non-union of open injury. Hence, it was decided to analyse open tibial fractures treatment by primary interlocking nailing.

Methods: 50 Patients with open fractures of the tibial shaft which were treated with primary interlocking nail were studied in the period of 14 months.

Results: In present study 18 (36%) type I, 22 (44%) type II and 10 (20%) type IIIA Gustilo open fractures were treated. The average duration of time between injury and nailing was 3.5 hours (range was 1.5 hours to 4 hours). After reaming, 40 (80%) fractures were fixed, without reaming, 10 (20%) of fractures were fixed. The average time to union was 27 weeks for type I fractures, 30 weeks for type II fractures and 33 weeks for type IIIA fractures. There was 1 non-union. There were 4 deep infections.

Conclusions: The best mode of therapy was primary interlocking intramedullary nailing for open fractures.

Keywords: Open nailing, Tibial shaft, Gustilo open fractures

INTRODUCTION

The most common sites for open fractures are the tibial shaft. 63% of the open fractures are observed in tibial shaft.¹ Technique of interlocking was used to treat tibial fractures which are 4 cm distal to the tibial tuberosity to 4 cm proximal to the ankle. This technique results are proven to be excellent for treatment of the tibial shaft.²⁻⁵ The tibial fractures are vulnerable to non-unions and infections as the blood supply and the lack of soft tissue cover of the shaft. Infection rate may be as high as 50% in the grade III-B open fractures. These complications were attempted to be reduced and have led to developing aggressive protocols which included immediate intravenous antibiotics, repeated soft tissue debridement, fracture stabilization, early soft tissue covers and bone grafting. The advantages of external fixators were

popular as their relative application was easy and limited effect on the blood supply of the tibia, but these were masked by high incidences of pin tract infections, the difficulties of soft tissue management and the mal-unions or non-unions. In management of open tibial fractures, use of intramedullary nails is contentious. Improved fracture stability is offered by reamed nails and their use carries risks of increasing infections and non-unions.⁶ The stability at the fracture site is compromised by use of unreamed intramedullary nails. Hence the primary interlocking nailing for open fractures of tibial shaft was analysed.

METHODS

This study was a prospective study which was performed in Department of Orthopaedics at Medciti Institute of

Medical Sciences in Patients with open fractures of the tibial shaft which were treated with primary interlocking nail. Study done for a period of 14 months from September 2009 to October 2010. Before the study started, institutional ethics committee was obtained. Informed consent was collected from all the patients.

Inclusion criteria

Open fractures of all grades of the tibial shaft were considered except for Type III B and C and all patients who had a follow up of one year.

Proximal end of the tibia fracture or a fracture within 4 cms of the ankle and patients who had medical or surgical disorders to reduce their influence on fracture healing and if open growth plates were observed. All patients were given cefotaxime and amikacin after initial clinical assessment. Under direct supervision of consultants, all the operative procedures were performed. After admitting to the hospital, wound debridement and nailing were performed. If there was no contamination or soft tissue injury, the wound would have been closed. Superficial split thickness grafting was the option, if the wound was open after one or two weeks and if the bone or tendons were exposed, flap coverage was done. The management sequence was wound debridement with or without closure, fracture fixation by primary interlocking nailing, wound management with SSG, delayed primary closure, flap. The operative technique used was interlocking nailing. For debridement, a separate trolley was used. The limb was repainted and redraped after debridement. On an operating table, the patient was positioned and with knee in neutral position. A midline longitudinal incision over the patellar ligament of 3 cm was done. To gain access to the intramedullary canal, a medial paratendinous approach was used. The entry point being the proximal to the insertion of the ligamentum patellae, the canal was broached with a large bone awl and below the joint line. Fracture displacement was prevented and maintained by applying sterile esmarch tourniquet at the fracture site and closed reduction was done. To reach the distal end, guide rod was passed, and negotiated through fracture site. This was done with the knee in neutral position. It was done with conventional knee in flexed position, if it was difficult. Using C-arm images, intramedullary position was assessed. Electric reamer was used for reaming. The size of the diameter of the nail was decided intra-operatively on the basis of size of the reamer that made cortical contact at the isthmus of the medullary canal. Standard interlocking nail was used to stabilize all the fractures. The nail was inserted by pushing with or without gentle hammering, that has the correct length and diameter. Depending upon fracture stability, the decision to perform static or dynamic was made. With the help of the jig, the proximal locking was done. Depending on the fracture stability, single or double distal locking was done. Patients were suggested to be on partial weight bearing for 1st six weeks irrespective of configuration of fracture. The patients

were examined at 6 weeks, 12 weeks, 18 weeks, 6 months, 9 months, 1 year after discharge. The patient assessment was recorded in four groups namely excellent, good, fair and poor based on final functional outcome, duration to return to occupation, pain persistence.

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented as mean±SD and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Significance levels are considered if $p < 0.05$.

RESULTS

50 patients with 50 fractures were taken into the study. Table 1 shows that males were 40% and females were 10%. The average age was 35 years (20 to 85 years).

Table 1: Distribution based on age and sex.

| | Males | Females |
|----------------------|------------------------|---------|
| Sex distribution (%) | 40 | 10 |
| Average age (years) | 35 years (20-85 years) | |

Table 2: Distribution based on fracture side and mechanism of injury.

| Variable | Number (%) |
|----------------------------|------------|
| Fracture side | |
| Right | 25 (50) |
| Left | 25 (50) |
| Mechanism of injury | |
| RTA | 35 (70) |
| Domestic | 10 (20) |
| Industrial | 5 (10) |

Table 3: Details of fractures and surgery in present study.

| Parts of body | Number (%) |
|---|------------|
| Proximal third of tibia | |
| Middle third | 25 (50) |
| Lower third | 8 (16) |
| Segmental fractures | 7 (14) |
| Type of fracture | |
| Type-I | 18 (36) |
| Type-II | 22 (44) |
| Type-III A | 10 (20) |
| Average duration of time between injury and nailing (mean and range) | |
| After reaming are fixed | 40 (80) |
| Without reaming fixed | 10 (20) |

Table 2 shows that RTA mechanism of injury was 35 (70%), domestic was in 10 (20%) and industrial was in 5

(10%) of the patients. 50% of the patients had right sided fractures.

Table 3 shows that fractures involved 20% of proximal third of tibia, 50% in middle third, 16% in lower third and 14% in segmental fractures.

18 (36%) type I, 22 (44%) type II and 10 (20%) type IIIA Gustilo open fractures were treated. The average duration of time between injury and nailing was 3.5 hours (range was 1.5 hours to 4 hours). After reaming, 40 (80%) fractures were fixed, without reaming, 10 (20%) of fractures were fixed.

Table 4: Distribution based on nails and closure of wound.

| Size of nails | Number (%) |
|----------------------------|------------|
| 9 mm | 8 (16) |
| 10 mm | 35 (70) |
| 11 mm | 7 (14) |
| Split thickness skin graft | 3 (6) |
| primary delayed closure | 2 (4) |

Table 6: Functional results by criteria modified by Yokoyama et al.¹³

| Criteria | Gustilo and Anderson grading | | | Total | % |
|--|------------------------------|----|-------|-------|----|
| | I | II | III A | | |
| Excellent (normal) | 15 | 13 | 4 | 32 | 64 |
| Good (occasional pain with prolonged use, joint motion, 75% normal, trivial swelling, normal gait) | 6 | 3 | 2 | 11 | 22 |
| Fair (Pain on ordinary activity, Joint motion, 50% normal, Small amount of swelling, Slight limp) | 0 | 2 | 2 | 4 | 8 |
| Poor (Constant pain, Joint motion, <50% normal, Any visible deformity, Limp, gait on cane or crutch) | 0 | 1 | 2 | 3 | 6 |

Based on the functional grading scale which was produced by Yokoyama et al.¹³ We recorded excellent results in 32 cases (64%); good results in 11 cases (22%); fair results in 4 cases (8%); and poor results in 3 cases (6%). There was 1 non-union. There were 4 deep infections (Table 6).

DISCUSSION

In present study, males were 40% and females were 10%. The average age was 35 years (20 to 85 years), total number of patients were 50 whereas in Keating et al study, average age was 37 years, age ranged from 16 to 88 years, males and females ratio was 77:14, total number of patients were 91.⁷ In Singer et al study, average age was 36 years, males and females ratio was 30:11, total number of patients were 41.⁸ In Whittle et al study, average age was 34 years, age ranged from 17 to 69 years, males and females ratio was 34:13, total number of patients were 47.⁹ In Court Brown et al study,

Table 5: Distribution based on average union time.

| Type of fractures | Average time of union |
|-------------------|-----------------------|
| I | 27 weeks |
| II | 30 weeks |
| IIIA | 33 weeks |

Table 4 shows that 8 (16%) nine mm nails, 35 (70%) 10 mm nails, 7 (14%) 11 mm nails were used. 10 (20%) nails were locked dynamically. 5 (10%) wounds were not closed by primary suturing. Local flap cover was used in 2 (4%) patients. Split thickness skin graft was used for 3 (6%) of patients. 2 (4%) was treated by using primary delayed closure. The average hospitalisation duration was 12.5 days.

Table 5 shows that the average time to union was 27 weeks for type I fractures, 30 weeks for type II fractures and 33 weeks for type IIIA fractures. The p value was 0.0189 being significant. Type I fractures having early union is statistically significant. There was 1 non-union. There were 4 deep infections. 2 developed in type II fractures and 2 developed in type IIIA fractures.

average age was 39.1 years, age ranged from 17 to 89 years, males and females ratio was 31:8, total number of patients were 39.¹⁰ In Bone et al study, average age was 31 years, age ranged from 14 to 77 years, males and females ratio was 90:20, total number of patients were 110.¹¹ In present study, RTA mechanism of injury was 35 (70%), domestic was in 10 (20%) and industrial was in 5 (10%) of the patients, whereas in Keating et al study, RTA mechanism of injury was 63 (69%), in Singer et al study, RTA mechanism of injury was 32 (78%).^{7,8} In Whittle et al study, RTA mechanism of injury was 41 (87%). In Court Brown et al study, RTA mechanism of injury was 26 (67%) and in Bone and Johnson et al study, RTA mechanism of injury was 99 (90%).^{9,10,11} In the present study, the average duration of time between injury and nailing was 3.5 hours (range was 1.5 hours to 4 hours), whereas in Keating et al study, the average duration of time between injury and nailing was 9.5 hours (3.43 to 28.75 hours).⁷ In Singer et al study, the average duration of time between injury and nailing was 5.6

hours.⁸ In present study, after reaming, 40 (80%) fractures were fixed, without reaming, 10 (20%) of fractures were fixed. In Keating et al study, 50 (55%) were reamed, 91(100%) were static, SSG were 9 and 1 flap was observed.⁷ In Singer et al study, 41(100%) were static.⁸ In Whittle et al study, 46(98%) were static, SSG were 4 and 1 flap was observed.⁹

In Brown et al study, 39 (100%) were reamed, 39 (100%) were static. In Bone and Johnson et al study, 82 (75%) were static.^{10,11}

In the present study, 18 (36%) type I, 22 (44%) type II and 10 (20%) type III A Gustilo open fractures were treated. In Keating et al study, 14 (15%) type I, 34 (37%) type II, 35 (38%) type III A Gustilo open fractures were treated.⁷ In Singer et al study, 6 (15%) type I, 11 (27%) type II, 16 (39%) type IIIA, 8 (19%) type III B Gustilo open fractures were treated.⁸ In Whittle et al study, 3 (7%) type I, 13 (28%) type II, 22 (47%) type IIIA, 9 (18%) type III B Gustilo open fractures were treated.⁹ In Court Brown et al study, 14 (36%) type II, 14 (36%) type IIIA, 11 (28%) type III B Gustilo open fractures were treated.¹⁰ In Bone and Johnson et al study, 25 (96%) type I and type II and 1 (4%) type IIIA Gustilo open fractures were treated.¹¹

In the present study, the average time to union was 27 weeks for type I fractures, 30 weeks for type II fractures and 33 weeks for type IIIA fractures. In Keating et al; for type I, the duration of time of union for reamed union was 28, unreamed union was 21.⁷ For type II, the duration of union time for reamed union was 28, unreamed union was 27. For type IIIA, the duration of union time for reamed union was 34, unreamed union was 31. In Singer et al study; duration of union time for type I was 19, duration of union time for type II was 28, duration of union time for type IIIA was 31.⁸ In Whittle et al study; duration of union time for type I, II, IIIA was average of 7 months.⁹ In Court Brown et al study; duration of union time for type II was 23.5 weeks, type III A was 27.2 weeks.¹⁰ In Bone et al study, 110 cases included closed and open fractures, average time to union was 19 weeks.¹¹ There was 1 non-union in present study. 9 non-unions were present in Keating et al study.⁷ 2 non-unions were present in Singer et al study.⁸ 8 non-unions were present in Whittle et al study. In present study, there were 4 deep infections. 2 developed in type II fractures and 2 developed in type IIIA fractures. In Keating et al study, 2 infections were observed, 1 in type II.⁷ In Singer et al study, 5 infections were observed.⁸ In Whittle et al study, 4 infections were observed, in Court Brown et al study, 4 infections were observed and in Bone and Johnson et al study, 7 infections were observed.⁹⁻¹¹

Based on the functional scale of Ketenjian and Shelton, which was modified by Yokoyama et al, we encountered 1 poor result in a case of type I injury.^{12,13} This patient had an associated ipsilateral fracture at the lower end of the femur (closed). In this case, the tibial fracture was

found to be united at 18 weeks of follow up, but the femoral fracture went into a delayed union. This patient could not do knee mobilization early, resulting in a decreased range of motion at the knee (less than 50% of the normal). 2 patients among these had continued anterior knee pain and subsequently, he developed a decreased range of motion at the knee (75-50% range of the normal range of motion).

Joshi et al, reported 85.8% overall good to excellent functional results in a similar study by using the same criteria.¹⁴ Yokoyama et al, reported 89% good to excellent results.¹³ Agrawal et al showed 83.4% good to excellent results.¹⁵ These results are comparable to our results as good to excellent results in 86% of the cases.

CONCLUSION

The best mode of therapy was primary interlocking intramedullary nailing for open fractures. As average time to union was 27 weeks for type I fractures, 30 weeks for type II fractures and 33 weeks for type IIIA fractures. Results are good to excellent about in 86% of the cases. Hence, primary interlocking nailing is preferred method for open fractures of the tibial shaft.

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