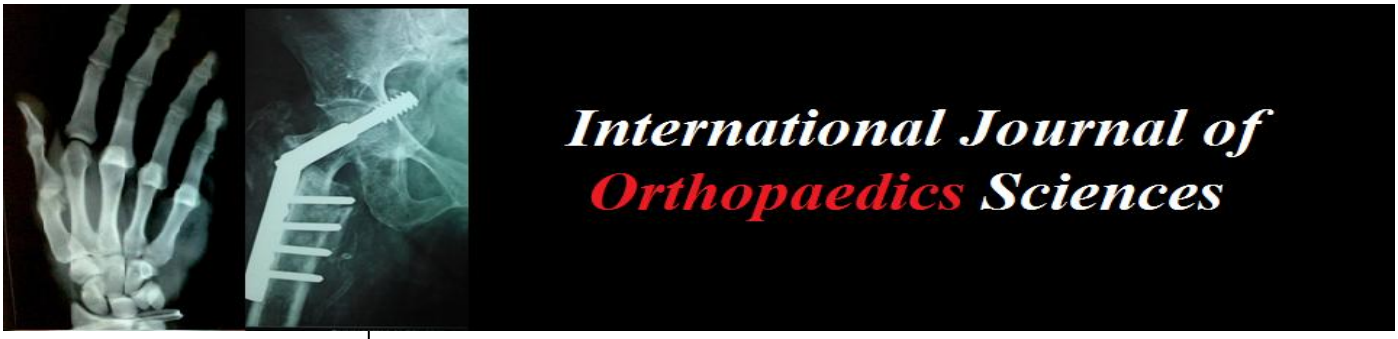

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A study of outcome of reamed intramedullary interlocking nailing in type I and type II open fractures of shaft of tibia

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Abstract
Background: Open fractures of tibial shaft are important for the reason that they are most commonly fractured long bone in the body & subcutaneous location of the anteromedial surface of the tibia makes their management controversial. The precarious blood supply and lack of soft tissue cover of the shaft of the tibia make these fractures vulnerable to delayed union, nonunion, malunion and infection. The treatment of tibial fractures has developed from a strictly non-operative to a variety of operative techniques. While reamed Intramedullary nailing offer improved stability of the fracture, their use carries a theoretical risk of infection and nonunion as a consequence of disturbing endosteal blood supply. Recent reports suggest that the reaming is safe for grade I, II and IIIA open fractures of tibia.
Material & Method: A total of 25 patients presented to Father Muller Hospital, Mangalore from Jan'06 to July'07 with type I and II open tibial shaft fractures were included in the study and all cases underwent debridement within 6 hours of admission and treated with reamed intramedullary interlocking nailing. They were reviewed at every 2 weeks for 6 weeks and then monthly post operatively and x-rays were repeated at 6,12,24 weeks to check for fracture healing. The average duration of follow-up was 32 weeks. Functional results were graded according to criteria by klemm & borner.
Result: The average time to union was 19.68 weeks. Type I united in 18.86 weeks as compared to 20.5 weeks for Type II fractures. The average range of motion in the knee joint was 135.6 degrees. Full ankle motion was observed in 19 patients. One patient showed a loss >25° of motion at ankle compared to normal side while 5 patients showed < 25^0 loss of joint motion. 92% patients achieved good or excellent results, fair results were obtained in one patient & in one patient functional results were poor.
Conclusion: Anatomical & functional outcome of open tibial fractures type I and type II treated with reamed intramedullary interlocking nailing is excellent to good and it is safe and effective technique for the management of Gustilo type I and type II.

Keywords: Gustilo type I & II open fracture, reamed intramedullary nailing, Klemm & Borner criteria

1. Introduction
The tibia is the most commonly fractured long bone in the body. Open fractures of tibial shaft are important for the reason that they are common and their management is controversial. The subcutaneous location of the anteromedial surface of the tibia means that there is a high incidence of open fractures compared to any other long bone, with significant loss of skin and soft tissues.
The treatment of tibial fractures has developed from a strictly nonoperative to a variety of operative techniques. Various modalities of treatment have been used such as short leg or long leg cast, open reduction and internal fixation with plates and screws, closed unlocked or locked intramedullary nails and external fixation techniques. Each method has specific advantages and disadvantages and controversy continues to exist regarding which method of treatment is warranted for a specific clinical situation.
The goal of open tibial fracture management is to obtain an anatomic, functional limb, and return of the patient to their preinjury level of function as quickly as possible. The optimal treatment method should assist in meeting this goal while minimizing the complications.
Immobilization in a plaster cast has been used most commonly in the past, but it does not always maintain the length of the tibia and it leaves the wound relatively inaccessible.
Plate fixation has an unacceptable rate of deep infection, and plate breakage and nonunion are frequent problems.

External fixation has been popular because of the relative ease of application and the limited effect on the blood supply of the tibia, but these advantages have been outweighed by the high incidence of pin track infection, difficulties relating to soft tissue management, bulky frames and the potential for malunion and nonunion.

Nail is a load sharing device and is stiff to both axial and torsional force and offers reliable bone stabilization. Closed nailing involves least disturbances of soft tissue, fracture haematoma and natural process of bone healing as compared to other forms of internal fixation.

Reports of unreamed nails in open tibial fractures have revealed high rate of failure of screws and nonunion. The use of reamed intramedullary nails in the management of open tibial fractures is contentious. More recent reports suggest that the reaming is, in fact, safe for grades I, II and IIIA open fractures of tibia. Recent studies show no statistically significant difference in the results of treatment of open tibial fractures with reamed nailing and with unreamed nailing except for the higher incidence of screw failure in unreamed nails. It will be left to clinical trials to demonstrate usefulness, or otherwise, of reaming.

Hence we have done a study of outcome of reamed intramedullary interlocking nailing in type I and type II open fractures of shaft of tibia.

2. Material and Methods

The study was conducted in Father Muller Hospital, Mangalore from Jan 2006 to July 2007, 25 open fractures of shaft of tibia type I and type II were included in the study who were treated with reamed intramedullary interlocking nailing.

2.1 Inclusion criteria: Age more than 20 years, Fractures of shaft of tibia involving up to 4cm from ankle joint, Gustilo and Anderson Type I and Type II open fractures.

2.2 Exclusion criteria: Intraarticular fractures extending into upper or lower end of tibia, Closed fractures, pathological fractures and Gustilo and Anderson Type III open fractures.

All the patients were explained about the aims and methods of the study and an informed written consent was obtained before being included in the study.

There were 21 male and 4 female patients. The age of the patients ranged from 20 years to 60 years with a mean of 34.64 years. The fractures were classified according to Gustilo and Anderson classification for open fractures based on the initial appearance of the wound and the findings during debridement, and according to the location of fractures in the bone, whether involving upper, middle or lower thirds.

A standard management protocol was used in all cases. On admission, general condition of the patient was assessed including the respiratory and cardiovascular systems and resuscitative measures taken accordingly. Other systemic injuries were ruled out. Associated orthopaedic injuries were noted.

All patients received prophylaxis against tetanus. Antibiotics, a third generation cephalosporin for type I fractures, and a combination of cephalosporin and aminoglycoside, for type II fractures were administered at the time of admission. Parenteral analgesics were given. The wound was covered with sterile dressing. The fracture was immobilized above knee plaster slab.

The cases were taken to the operating room for emergency debridement. All devitalized tissues were removed and wound irrigated with copious amounts of saline. All cases underwent debridement within 6 hours of admission. Repeat debridements were done as dictated by the status of the wound. Operative stabilization of the fractures was carried out as early as possible once general condition of the patient was stable and the patient was fit for surgery.

2.3 Surgical procedure

Patients were operated under spinal/epidural/general anaesthesia. Patient was placed in supine position over a radiolucent operating table. The limb was painted and draped so that full access was available from the knee joint to the ankle joint.

Patellar tendon splitting approach used. The entry point was about 1.5 cm distal to the knee joint and in line with the centre of the medullary canal. Medullary cavity was entered by penetrating the cancellous bone of metaphysis with the awl.

A ball-tipped guide pin passed while reducing the fracture into the distal fragment to within 1cm of ankle joint. The position of the guide wire was confirmed in central position within the distal fragment under C-ARM on both AP and lateral views.

The canal was reamed with the help of a cannulated flexible power reamer, in 0.5mm increments. The reaming was performed until cortical contact (chatter) was obtained. The ball-tipped guide rod was exchanged with a smooth tip for nail insertion. The length of the nail was determined. The diameter of the nail inserted was 1 to 1.5cm smaller than the last reamer used.

Distal locking was performed with a freehand technique. Two bolts were inserted in most fractures. Proximal locking was done with the help of the jig attached to the nail insertion device. The bolt should protrude approximately 5 mm beyond the far cortex. The second bolt was inserted in more unstable fractures. Dynamic interlocking was performed in fractures deemed to be stable.

The traumatic wound at fracture site was left open and allowed to either heal by secondary intention, closed by delayed primary sutures or covered with a split skin graft at a later date.

Postoperatively active movements of toes, ankle and knee joints were encouraged from first postoperative day. Post-operative X-rays were taken. Non weight bearing crutch walking was allowed till 6 weeks. Partial weight bearing was started at 6 weeks postoperatively. Full weight bearing was allowed based on the assessment of fracture healing at follow-up. Patients were regularly followed up every 2 weeks up to 6 weeks and then monthly. X-rays were repeated at 6, 12 and 24 weeks.

Patients were enquired about any pain at the fracture site or the knee joint at each follow up.

A fracture was deemed to be united when the patient could fully bear weight with no pain at the fracture site and there was radiographic evidence of bridging of 3 of 4 cortices on standard AP and lateral views. Deep infection was diagnosed in the presence of a purulent wound discharge from which organisms were cultured necessitating further surgical debridement of infected bone or soft tissue.

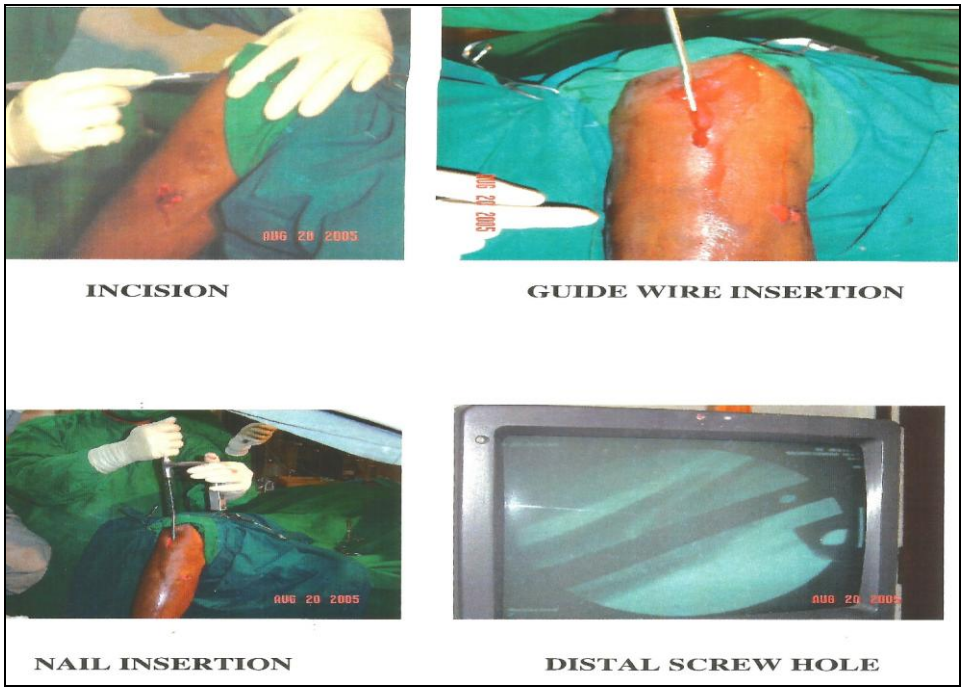


Fig 1

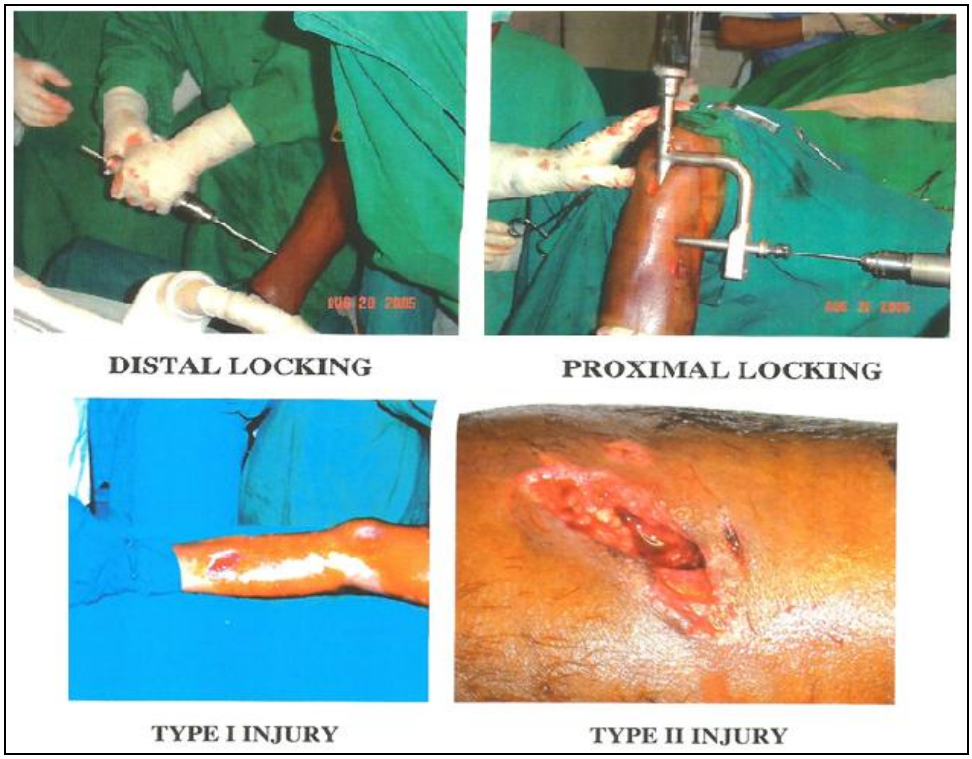


Fig 2

3. Results

25 cases of open fractures of shaft of tibia Type I and Type II were part of the study group.

The minimum follow-up period was 6 months in all patients and the average duration of follow-up was 32 weeks, ranging from 6 months to 22 months. The mean age of the patients forming the study group was 34.64 years. Majority of patients were in the age range of 20-35 years. The youngest patient was 20 years old and the oldest was 60 years. Majority of of patients were males accounting for 21(84%) cases. The leading cause of the injuries was road traffic accident accounting for 64% of cases whereas fall from a height constituted 24%. 14 cases occurred on the right side and 11 on the left side. Majority of the fractures involved middle third of the tibia (48%). 8 cases were seen in lower third and 5 in upper third of tibia.

64% of the fractures showed transverse pattern, 7 cases were of oblique and 3 were of spiral pattern. 2 cases (8%) were comminuted fractures. There were 14 cases (56%) belonging to Type I and 11 cases (44%) belonging to Type II variety. The average duration of time interval between injury and intramedullary nailing was 3.36 days.

The average time taken for union was 19.68 weeks. Type I fracture united earlier (18.86 weeks) compared to Type II fractures (20.5 weeks). 96% of the fractures united with 2 fractures showing a delayed union and 1 (4%) fracture going for nonunion.

The average range of motion in the knee joint was 135.6 degrees. Full ankle motion was observed in 19 patients. One patient showed a loss 25° of motion at ankle compared to the normal side while 5 patients showed <25° loss of joint motion.

One case (4%) of deep infection was noted in the present study, patients showed a superficial soft tissue infection. One case of malunion was found with an anteroposterior angulation of 10 degrees

One case (4%) of failure of the distal bolt was seen in a lower third tibia fracture. It did not affect the fracture healing. *6* cases (24%) complained pain in the knee joint at final follow-up. All were mild variety and occurred on kneeling down.

Functional results were graded according to the criteria by Klemm and Borner (1986). 92% of patients achieved good or excellent results, fair results were obtained in one patient and in one patient, the functional results were poor.

Case 1

Preoperative X-ray

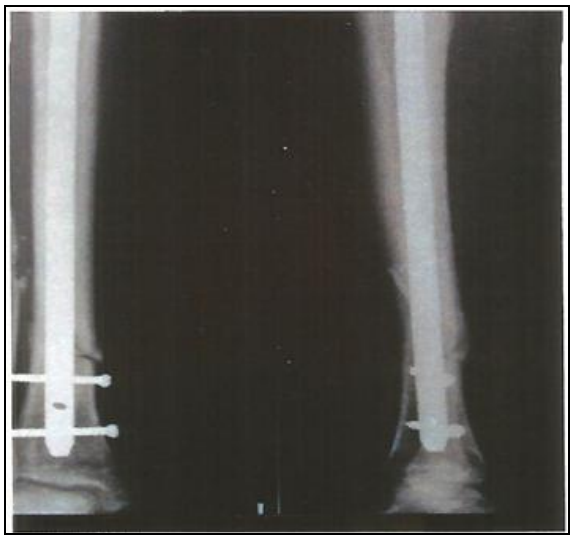
Postoperative X-ray

Dynamization – at

12 Radiological union

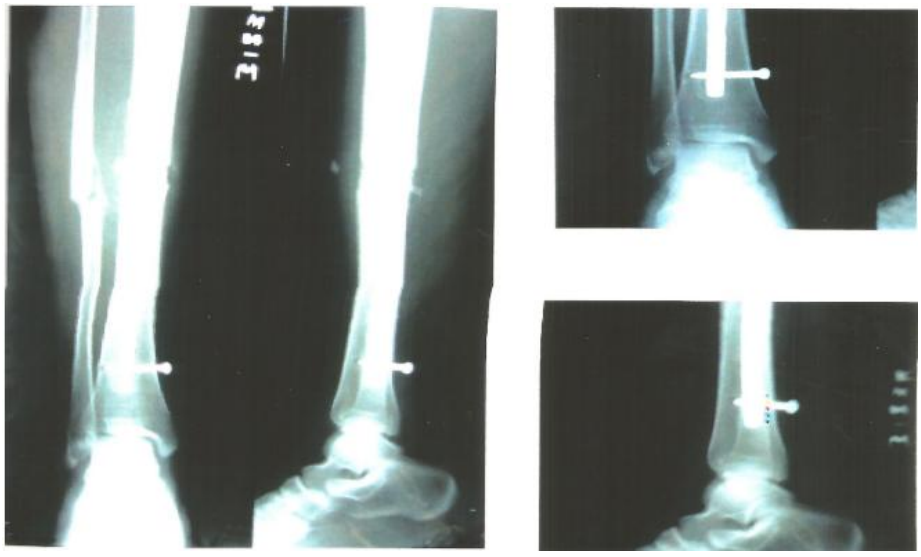
Case 2

Preoperative X-ray



After 6 Weeks

Radiological Union



Deep Infection backing out of distal bolt

Malunion Anteroposterior

Distal Screw Failure

4. Discussion

Our study consisted of 25 patients. The mean age of the patients in the present study was 34.64 years. Majority of patients were males accounting for (84%) cases. The average age of the patients was 37.2 years in a study of epidemiology of tibial fractures by Court-Brown *et al.* [1]. The average age in a study of 50 open fractures of tibia conducted by Whittle *et al.* [2] was 34 years. The worldwide incidence of tibial fractures in males is 41 per 100,000 per year compared with female incidence about 12 per 100,000 per year [3]. The increased incidence of open tibia fractures in young males corresponds with their activity level whereas the incidence again increases in elderly individuals due to osteoporosis.

The leading cause of the injuries was road traffic accident in the present study accounting for 68% of cases. The commonest cause of tibial diaphyseal fractures was road-traffic accidents (40.7% of open fractures) in Court-Brown *et al.* [1] study. Whereas Bonatus *et al.* [4]. Reported that 54.16% of their cases were due to road traffic accidents. This indicates the incidence of open fractures can be brought down by road

Numerous studies have stressed on early debridement and stabilization of open fractures of tibia. Some recent reports have questioned this belief. Shanker *et al.* [5] stated that their experience indicates the incidence of complications correlates more with the severity of the injury rather than with time from injury to treatment. Delays of 6 to 18 hours did not reflect a proportional increase in incidence of complications. Henley et al[6] opined that the risk of developing an adverse outcome was not increased by aggressive debridement/lavage and definitive fixation up to thirteen hours from the time of injury when early prophylactic antibiotic administration and open fracture first aid were instituted. In the present study, all cases were administered antibiotics on admission and irrigation and through debridement were carried out within 6 hours of admission. The average duration of time interval between injury and intramedullary nailing was 3.36 days.

Keating O' Brien and Blachut [7] in their study advised the patients to remain non-weight bearing for the first 6 weeks after injury whereas Larsen Madsen and Hoiness [8] allowed partial weight bearing of 15 kg for 6 weeks in early postoperative period.

There were no cases of compartment syndrome, fat embolism or peroneal nerve palsy in the present study. McQueen, Christie and Browne [9] reported that there is no evidence of an increased incidence of compartment syndrome with reamed intramedullary nailing. They opined that the increase in compartment pressure associated with nailing is produced by reduction of the fracture and stretching of the adjacent muscles. Christie [10] also noted that tibial reaming and nailing did not result in respiratory problems due to fat embolism.

Court-Brown [11] reported a union rate of 87.9% in Gustilo type I fracture and 83.6% in type II fractures with an average time to union of 21.7 weeks and 23.7 weeks respectively. Whereas Keating O' Brien and Blachut[7] reported union in 97% of type I fractures and 95% of type II fractures with a time to union of 29 weeks and 32 weeks respectively. Blachut *et al.* [12] reported a 12.8% of nonunion rate in reamed nailing open fractures. Whereas Cole and colleagues [13] reported a 100% union rate in open fractures treated by reamed nailing.

Finkemier *et al.* [14] reported an 83% union rate in open fractures treated by reamed nailing at the end of 12 months whereas Hooper and colleagues [43] reported a union time of 15.7 weeks in closed and open type I fractures. Puno, Teynor and Nagano [15] reported an average union time of 15.19 weeks in type I and II open fractures treated by reamed intramedullary nailing with a 94% union rate.

The results of the present study are comparable with those other studies. 96% of the fractures united in the present study with a mean union time of 19.68 weeks. Type I fracture united earlier (average 18.86 weeks) compared to type II fractures (average 20.5 weeks). One case of type II fracture involving distal third of tibia went for nonunion despite dynamizing the nail at 20 weeks. The patient refused for further intervention. Delayed union was seen in two cases. First case was a comminuted type II fracture in a 54-year-old male which united in 25th week, after dynamization. The second case was associated with a deep infection at the distal screw site and took 26 weeks to show union.

Templeman, Gull and Gustilo [14] in their study, performed dynamization between 6 and 12 weeks whereas Singer and Kellam [16] recommended dynamization between 8 and 12 weeks if the healing is delayed.

Larsen and Madsen [8] reported a malunion in 2 out of 22 patients treated by reamed nailing. Keating O'Brien and Blachut [7] reported a 6% rate of malunion in type I fractures and 3% rate in type II fractures.

One case (4%) of fracture of upper third of tibia showed a 10-degree angulation in the anteroposterior plane.

Court-Brown [11] reported an infection rate of 6.9% in Gustilo type I fractures and 6.6% in type II fractures with reamed intramedullary nailing. Keating, O'Brien and Blachut [7] reported a 10% infection rate in type II fractures. Finkemeier and colleagues [14] reported 5% infection rate in open fractures in their study.

Puno, Taynor and Nagano [15] reported an incidence of 5.9% infection after reamed nailing of type I and II open fractures.

The current study had only one case (4%) of deep infection. A small swelling developed in the region of distal screw which opened leading to a purulent discharge in a patient with a type II fracture 6 weeks after the surgery. The screw was removed and the wound was debrided. Appropriate antibiotics were started. The infection subsided with regular dressing of the wound and the fracture went for a delayed union at 26 weeks.

Two cases developed superficial soft tissue infection, one at the traumatic wound site and the other, in a diabetic patient, at the incision site. They were treated by antibiotics and dressing.

Singer and Kellem [16] recommended use of antibiotics for 2 to 6 weeks in case of infection associated with intramedullary nailing. Keating, O'Brien and Blachut [7] opined that adequate soft tissue and bony debridement followed by sound soft tissue coverage is the key to minimizing deep infection in open fractures of tibia irrespective of the type of fixation used. The use of antibiotic bead pouches reduces the incidence of infection further. If infection occurs, it is not necessarily a catastrophic complication and usually can be eradicated with prompt measures.

5. Conclusion

Open fractures of tibia represent a severe and complex problem and optimal management is essential if the patient is to regain significant preinjury level of functions.

Soft tissue management including emergent irrigation and debridement of the wound and administration of antibiotics are of utmost importance in the treatment of open fractures of tibia.

High union rates, low incidence of complications including infection and good functional results suggest that reamed interlocking nailing technique is a satisfactory method of treating open tibial fractures.

Careful preoperative planning and respecting the principles of reamed interlocking nailing technique are essential for obtaining good results.

We conclude that anatomical functional outcome of open tibial fractures type I and type II treated with reamed intramedullary interlocking nailing is excellent to good and it is safe and effective technique for the management of Gustilo type I and type II open fractures.

6. References

1. Court-Brown CM, McBirnie J. The epidemiology of tibial fractures. J Bone Joint Surg. 1995; 77:417-421.
2. Whittle AP, Russell TA, Taylor JC, Lavelle DG. Treatment of open fractures of tibial shaft with the use of interlocking nailing without reaming. J Bone Joint Surg. 1992; 74A:1162-1171.
3. Bucholz RW, James DH. Rockwood and Green's Fractures in adults. 5th ed. Philadelphia: Lippincott Williams and Wilkins, 2001.
4. Bonatus TDO, Olson SA, Lee S, Chapman MW. Non-reamed locking intramedullary nailing for open fractures of the tibia. Clin Orthop. 1997; 339:58-64.
5. Shanker HK, Canaven B, Wong J, McGee H. How does delay in management of open tibial fractures affect outcome J Bone Joint Surg. 2004; 86B:125.
6. Henley MB, Chapman JR, Agel J. Treatment of II, IIIA and IIIB open fractures of the tibial shaft: a prospective comparison of unreamed interlocking intramedullary nails and half-pin external fixators. J Orthop Trauma 1998; 12:1-7.
7. Keating JF, O'Brien PI, Blachut PA, Meek RN, Broekhuyse HM. Reamed interlocking intramedullary nailing of open fractures of the tibia. Clin Orthop. 1997; 338:182-191.
8. Larsen LB, Madsen JE, Hoiness PR, Ovre S. Should insertion of intramedullary nails for tibial fractures be with or without reaming? A prospective, randomized study with 3.8 years follow-up. J Orthop Trauma. 2004; 18:144-149.
9. McQueen MM, Christie J, Court-Brown CM. Compartment pressures after intramedullary nailing of the tibia. J Bone Joint Surg Br, 1990.
10. Christie J. The coagulative effects of fat embolisation during intramedullary manipulative procedures. Tech Orthop. 1996; 11:14-17.
11. Court-Brown CM. Reamed intramedullary tibial nailing: An averview and analysis of 1106 cases. J Orthop Trauma. 2004; 18:96-101.
12. Blachut PA, Keating JF, Ricard S, O'Brien PJ, Meek RN, Broekhuyse HM. Reamed versus unreamed locked intramedullary nailing of open tibial shaft fractures: A prospective randomized study. J Bone Joint Surg. 2000; 82B:149.
13. Cole AS, Williams JR, Gibbons CLMH, Trundle HR, Worlock PH. Reamed and undreamed intramedullary nailing for the treatment of open tibial fractures. J Bone Joint Surg. 1998; 80B(1S):52.
14. Finkemeier CG, Schmidt AH, Kyle RF, Templeman DC, Varecka TF. A prospective, randomized study of intramedullary nails inserted with and without reaming for the treatment of open and closed fractures of the tibial shaft. J Orthop Trauma. 2000; 14:187-93.
15. Puno RM, Teynor JT, Nagano J, Gustilo RB. Critical analysis of results of treatment of 201 tibial shaft fractures. Clin Orthop. 1986; 212:113-121.
16. Singer RW, Kellam JF. Open tibial diaphyseal fractures: Results of unreamed locked intramedullary nailing. Clin Orthop. 1995; 315:114.