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Tibial Intramedullary Interlocking Nail Without Imaging

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Abstract

Tibia is one of the most common fractured long bone, which occurs most often in young people following high-energy trauma. Gold standard treatment of tibial diaphysis fractures is currently intramedullary nailing. In this study, we intend to examine the results of treatment of tibia diaphysis fractures with intramedullary interlocking nail without use of imaging (C-Arm) during surgery. In this cross-sectional study, 43 patients (36 males and 7 females with an average age of 31 years) were included, 40% were open fractures and 60% were closed. Just postoperatively, 12% of the cases had a problem with length and placement of nail and screws. A total of 18% had rotational deformity (78% less than 5 degrees) and 5% had only mild varus or apex anterior deformity. In cases where imaging during surgery is not possible for any reason, the use of intramedullary nailing along with distal jig could be performed for tibial shaft fractures.

Keywords: Intramedullary Nailing, Interlocking, Tibia, Radiography Imaging

1. Background

Intramedullary (IM) nailing is accounted as the treatment of choice for most of the tibial shaft fractures. The main technique of nailing includes application of intraoperative radiography by image intensifier (C-arm). Steps of operation that may need check by C-arm consists of finding entry point, reduction and intramedullary passage of guide wire, conforming the center position of guide wire in distal segment, and ensuring the length of the nail and position interlocking screws. Stage that obligates the presence of the image intensifier is insertion of distal screws, while all insertion sets have a proximal jig for proximal screws insertion. Especially in developing countries, the majority of insertion sets has a design that assemble on the proximal jig to insert distal screws (1). By putting the guide wire and measuring its length, it is possible to be sure that distal screws pass through their related hole in the nail, sequentially. Therefore, this completely dependent step on the C-arm could be bypassed if other relatively dependent steps are performed in a right way (2-4). In this study we intended to assess the results of IM nailing of tibial shaft fracture without intraoperative X-ray, which may permit orthopedic surgeons to treat this common fracture by the best choice of treatment in centers deprived from some routine equipment like C-arm.

2. Methods

As the image intensifier of our operating room was out of order for about six months and portable radiology device was absent, there was no equipped hospital in proximity to transfer the patient; tibial IM nailing was performed without C-arm for a period. This study is a cross sectional study in which 43 patients with acute fractures of tibial shaft, closed or Gustilo open type 1 and 2 were subjected to IM nailing during a six-month period at the Persian Gulf Hospital of Bushehr. The problem of the operating room was explained for each patient and if non-consented, facilities to transfer the patients to other centers were provided. Informed consent was signed by the patient or by the family for unconscious patients. The ethical committee of Bushehr University of Medical Sciences approved this study.

At arrival of the patient to our emergency department, parallel to respecting advanced trauma life support principles, anteroposterior and lateral radiographs of the affected leg, knee, and ankle were obtained. After stabilization of the general condition and assessment of other possible injuries, the patient was admitted to the ward and scheduled for operation. Exclusion criteria were age < 18, open fracture of Gustilo type 3, those fractured due to proximity or extension to knee or ankle, IM nailing was not possible, and neurovascular or soft tissue compromise that precluded internal fixation.

2.1. Surgical Technique

In the operating room, anesthesia was induced two ways either general or spinal. A half hour before surgery, an intravenous dose of cephazolin was given to all patients. The length and diameter of the nail was estimated preoperatively by measuring the distance between tibial tuberosity and tip of medial malleolus and the dimeter of the narrowest part of tibia in lateral X-ray, respectively. All patients were surgically treated by a single surgeon (A.R.F). If a fibular fracture was present and indicated to be fixed it was reduced openly and fixed first. Patellar tendon splitting method was used for nail insertion. Closed reduction was achieved by help of an assistant without the use of imaging. Alignment and rotation was restored clinically by appearance and alignment of midline of patella and 2th metatarsal. If closed, reduction cannot be achieved and in cases of open fractures, open reduction was done. Reaming of medullary canal was performed and a nail (of Osveh Asian Medical Instrument Company, Mashad, Iran), 1 mm smaller than last reamer diameter, was selected. The nail was seated at about tangent or 5 mm below the surface of insertion site. Based on site and the presence of comminution, using proximal and distal jigs and by using a non-ball tip guide wire, up to two interlocking screws were inserted at the distal and proximal holes, sequentially. The length of screw was sized by depth gauge, in addition, by adding 5 to 10 mm the proper size was selected. By palpating the far cortex side during and after screw placement, full seating and preventing of a long protruded screw were double-checked. Clinical appearance and alignment (angular and rotational) of the leg was ensured finally. The length of the leg was also roughly controlled by measuring distance between tibial tuberosity and the medial malleolus of the operated side with the contra-lateral normal leg. A hemovac drain was inserted and the patella tendon was sutured with absorbable suture. Subcutaneous tissue and skin were closed in routine way and sterile dressing was applied. The day after operation (or when the bleeding is less than 30cc/day) the drain was removed, knee and ankle range of motion was started, and the patient was mobilized.

2.2. Evaluation

Preoperatively and intraoperatively, type of open fractures in term of Gustilo classification and amount of comminution (no, $0 \leq$ mild < 20, $20 \leq$ moderate < 50, severe $\geq 50\%$ of periphery of the bone) were recorded. Clinical examination was performed, just postoperatively. The length and rotation was assessed clinically 2 days after surgery, when the patient was to be discharged and/or knee flexion was possible to 90°. The length was compared with contralateral side (measured by length of leg from tibial tuberosity to medial malleolus) and rotation was measured by foot thigh angle in a prone position and knee flexed 90 degrees. Postoperative X-rays were performed in the department of radiology and were evaluated for the length of the nail (standard: parallel to fibular head tip to 2 cm above distal tibia articular surface). Intramedullary position of locking screws, length of locking screws was checked (so that the screw head attached to near cortex and not more than 10 mm extruded of far cortex). Accuracy of reduction, angulation, and gap was as well assessed. Data were then analyzed using SPSS version 21 software.

3. Results

In this study included were, 43 tibial fractures in 43 patients who underwent IM nail surgery and returned for follow-up, 84% were male and 16% were female. The mean age of patients was 31 years (18 - 75 years). The type of fracture and the amount of comminution is shown in Table 1. There were 38 fibular fractures, 14 needs fixation due to involving lateral malleolar area. A total of 43 nails and 157 locking screws were inserted; 12 nails had one screw proximally and 3 nails were fitted with one screw distally. In all others, 2 screws were inserted both proximally and in distal holes.

Immediate postoperative radiographies demonstrated that 3 nails (7%) were short (distal tip of one nail located distally 5 cm higher than distal articular surface and of two nails was 3 and 2.5 cm), 5 (3%) long screw (protrudes > 10 mm), and 3 screws (2%) were not seated on the near cortex fully. All screws were in the nail. The rate of problems about nail length, screw positioning assessed

Table 1. Types and Amount of Comminution (No = 0; minimal $\leq$ 10%; 10 < Moderate $\leq$ 50% and Sever > 50% Comminution of Cortex) of Fractures

Fracture type	%
Clinical	
Close	60
Open type 1 Gustilo	22.8
Open type 2 Gustilo	17.2
Radiographic	
No comminution	48
Minimal comminution	17
Moderate comminution	33
Severe comminution	2

Table 2. Problems Detected by IM Nailing Without Image Intensifier in Just Postoperative Clinical and Radiological Assessment

Problem	Frequency %
Short nail length	7
Long screw (10 mm)	3
Not fully seated screw head	2
Leg length discrepancy (LLD), cm	28
> 1.5	0
0.5 < LLD ≤ 1.5	7
0.5 ≤	11
Angulation	5
Varus	2.5 (1 case = 4°)
Apex anterior	2.5 (one case = 6°)
Rotation	18
Foot thigh angle difference in relation to contralateral side	
15 - 30	4
≤ 15	14

Abbreviations: cm, centimeter; LLD, Leg length discrepancy; mm, millimeter.

at postoperative X-rays, and malalignment assessed clinically and radiologically at last follow up were shown in Table 2).

4. Discussion

Intra medullary-interlocking nailing is considered to be more appropriate surgical option in the fractures of tibia due to the biomechanical benefits, including rotation control, leg length preservation, and early weight bearing capability (5). Before the invention of the C-ARM, Tibial nailing was done openly. Since the late 1970s, C-ARM has been in extensive use for IM nailing procedures and has become an essential tool for surgeons. C-ARM is an expensive equipment and is not available in some health centers, particularly in some developing countries. In addition, inaccessibility, or difficulty of XRAY preparation in two directions using portable radiography devices makes it not so helpful (2, 6). In the study of Bari et al. 35 patients with tibia fractures were treated by minimum open restoration and fixation with intramedullary interlocking nail without image intensifier; the outcome was analyzed for severity and complications. The mean union time of fracture site was 16 weeks. Functional outcome was reported in 48.57% as excellent, in 31.43% as good, in 14.28% as fair, and in 5.72% patients as poor (6). A completely related study by Orfi et al. (4) compared the results of intramedullary interlocking nailing with and without imaging during the surgery. The duration of surgery was half without C-arm application, however, the rate of infection was 2.4% compared to 1.4% of C-arm assisted group. In the study by Cuin et al. in 2008 (7), 55 patients were studied for complications after tibia nailing surgery. Surgery was performed without imaging during surgery. The study of Cuin reported that, in the follow up after 3 months, only 21.8% of patients had complete union. Finally, 96.4% of patients developed Union after 6 months. While in our study, 91% of patients had union after 6 months.

Non-union rates have been reported as 2% - 13% in other studies (8-10). This difference is not significantly different from that of imaging during surgery. This study aimed at examining the just postoperative results about the precision of nail and screw length, screw placement and quality of reduction in tibial IM nailing without using intraoperative image intensifier. The results of this study showed that there is a rate of 40% for problems in the screw and nail placement and 23% for inevitable problems of the quality of reduction. Table 2 shows the rate of complication that seems clinically insignificant and it is not obvious that by using C-arm, the rate of complications can actually be decreased (about minimal malrotation for example). This is more meaningful especially when anatomic alignment, not anatomic reduction, is the purpose of treatment of long bone like tibia. Using a distal and proximal Jig system, performing tibia nailing surgery is still logically more appropriate than other therapies (2, 6, 7, 11, 12). Our results and results of similar studies show that IM nailing, without intraoperative X-ray, could result in acceptable results, if distal jig is present and precise.

4.1. Conclusion

Intramedullary interlocking nailing is known as the preferred method for the treatment of tibia diaphyseal fractures. If the surgery is performed by an experienced surgeon with the help of a distal and proximal Jig system, the lack of imaging during the surgery may not have a significant effect on the outcome of the patients. In addition, the lack of access to imaging during surgery should not always lead us to use other interventions such as plates.

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