



External Fixation versus Unreamed Interlocking Intramedullary Nailing for Open Tibia Fracture

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Abstract

Open fractures of tibia are more common in active adults due to direct trauma, and they pose a major therapeutic challenge due to high incidence of postoperative complications. Although locked unreamed intramedullary nail (IMN) and external fixator (EF) are the most common treatment modalities, the superior mode of management remains controversial. The purpose of this study was to compare the outcome of open tibial shaft fractures in adults treated with locked unreamed conducted in orthopaedic department at Almarj Teaching Hospital for a period of twenty four months from June 2014 to June 2016. In this study, fifty-six open tibia shaft fractures in fifty-four patients were divided into two groups, twenty five fractures were treated by unreamed locked IMN, and thirty one fractures were treated by EF. Thirty six fractures were due to gunshot wound and explosive injury, ten were due to RTA, and ten were due to indirect trauma. According to Anderson Gustilo classification eleven fractures were type I, sixteen were type II, and twenty nine were type III. All cases were prospectively followed for twenty four months. The rate of union, soft tissues healing, and any complication were recorded. To analyze the results a chi square test and an SPSS software were used to study the significant relation and association between multiple variables of these two groups. Nineteen fractures healed uneventfully seven of EF group and twelve of IMN group, ten fractures had superficial infection seven of EF group and three of IMN group, four fractures developed deep infection all were EF group, four fractures had malunion two of EF group and two of IMN, six fractures had delayed union two of EF group and four of IMN group, five fractures had nonunion three of EF group and two of IMN group, three fractures ended with amputation all were EF group, two fractures had broken distal locking screws, and three fractures were exchanged from EF into IMN.

Locked unreamed intramedullary nail (IMN) appears to be a better option for the treatment of Gustilo type I, II, and IIIA open tibial shaft fractures compared to external fixator as it shows less complication rate.

Keywords: *Tibia fractures, Intramedullary nails, External fixator.*

Introduction

Open fractures of the tibia are among the most difficult to treat, due to poor soft tissue cover and blood supply of the tibial shaft. The extent of the soft tissue injury and the amount of comminution are directly related to the level of energy causing

the fracture. Once quantified, the importance of soft tissue damage as an important predictor of infection and poor outcome, has since been confirmed^[1-7] Tibia is the most common long bone to sustain an open fracture, which is significant given the precarious superficial position of its

blood supply^[8-11]. These fractures are showing an increasing trend due to road traffic accidents and firearm (war) injuries^[12], these injuries are on the rise in last few years in Libya due to increasing incidence of gunshot, shotgun, and road traffic accident, and their management is a common problem in trauma centers. The soft tissue management is the most important factor in determining the outcome of open tibia fractures with the optimal method of fixation is still debated. Sufficient stability of the fracture fragments and soft tissues usually can be obtained only by locked intramedullary nail or external fixator^[13], and this continues to be a major therapeutic problem because of poor soft tissue cover and blood supply of the tibial shaft which make these fractures vulnerable to nonunion and infection^[14].

Preventing tibia from postoperative infection, obtaining union, and returning the involved limb to normal function always remain elusive goals. External fixation and locked unreamed intramedullary nailing are two common approaches for fixation of open tibia fractures. Initially, the management by EF is well established as it allows immediate stabilization with access for management of the soft tissues. However, its use is also associated with significant rates of malunion and pin tract infection often necessitating premature removal and conversion to alternate forms of stabilization^[15-19].

In most large series of grade-III fractures treated in this way, external fixation has been used to stabilize the fracture, relatively to avoid further damage to the blood supply of bone which would be caused by reaming. Most of these severe injuries are too comminuted to allow use of unlocked intramedullary nails. However small diameter interlocking intramedullary tibial nail which can be placed without reaming, has provided a new method for stabilization of these fractures^[20].

Currently, many traumatologists prefer intramedullary nailing for Gustilo type I, type II

and type IIIA open fractures, although equipment for nailing in resource-limited environments may make it difficult to perform^[21].

External fixation has been popular because of ease of application and limited effect on blood supply of the tibia, but these advantages have been outweighed by the high incidence of pin-track infection, difficulties related to soft tissue management and the potential for malunion, delayed union and nonunion^[22,23]. Thus, the current recommended treatment for type IIIA open tibia shaft fracture can be either; surgical debridement and fixation by interlocking intramedullary nail or surgical debridement and fixation by external fixation. With respect to recovery from tibial shaft fractures, the most salient outcomes include callus formation, infection, and malalignment and shortening. Existing literature suggests that IM nailing can lead to bridging callus at the fracture as early as three months^[24]. Although EF and IMN have been used as treatments of choice for tibia fractures, which of them can be served as an optimal approach still uncertain. There were some previous analyses which supported the use of unreamed IMN for open tibia fractures. However, the outcomes in recently published articles still remain controversial^[25-29]. Type III open tibia fractures are associated with high rates of infection, nonunion, malunion, and amputation. Infection rates in these fractures are reported to be much higher than those for type-I and type-II fractures. Infection rates for types I, II and III of 0- 2%, 2-7%, and 10-50% have been recorded respectively^[30-32].

The increasing use of immediate antibiotics, aggressive and repeated debridement, fracture stabilization, early bony coverage, and prophylactic bone grafting has greatly reduced the rates of infection and nonunion^[33-73]. In addition, there have been reports that IM nailing for type IIIA open tibia fractures can lead to an infection rate as low as 5.5%, while other reports show that EF infection rate may be as high as 26.4%^[38, 39]. Finally, open tibia patients are at risk of a

shortened and malaligned leg after recovery^[40]. In addition, IMN allows stable fixation with minimal additional violation of the soft tissues in the region of the fracture via placement of unreamed or reamed interlocking nails. The use of IMN in treating open tibial shaft fractures results in a high rate of union and a low rate of infection and malunion^[41-45].

Meanwhile, great benefits of EF for the fixation of open tibia fractures have been observed in shortening operation time, reducing blood loss and soft tissue injury, and improving blood supply at the broken ends and fracture healing rate^[41-45].

In this study a comparison has been done between external fixation and unreamed interlocked intramedullary tibial nailing for management of open fracture types I, II, and IIIA of tibia in adults. We conducted an updated meta-analysis with all the relevant studies to provide reliable evidence for the better efficacy of IMN approach than EF in the fixation of open tibia fractures.

Materials and Methods

This study was conducted in orthopedic department at Almarj Teaching Hospital for a period of twenty four months from June 2014 to June 2016. In this study, fifty-six open tibia shaft fractures in fifty-four patients were divided into two groups, twenty five fractures were treated by unreamed locked IMN, and thirty one fractures were treated by EF. All cases were prospectively followed for twenty four months. The rate of union, malunion, delayed union, nonunion, soft tissues healing, hardware failure, and any other complication were recorded. To analyze the results a chi square test and an SPSS software were used to study the significant relation and association between multiple variables of these two groups.

Inclusion criteria

- 1) Patients with open tibia fractures, and the diagnosis was clearly defined.
- 2) Treatment by IMN and EF, and no other method of treatment.

- 3) Outcomes were accessed by at least one of the following indicators including postoperative infection, malunion, nonunion, amputation, and hardware failure.
- 4) Follow-up duration was more than eighteen months.
- 5) One surgeon performed all the operations.

Exclusion Criteria: Fractures located within 5cm of the proximal or distal articular surface, fractures extending into a joint, and patients less than 16 years old. Data was extracted from patients' admission files and follow up data. The detailed data included sample size, gender and age of patients, mechanism of fracture, type of tibia fracture, and method of fixation. The indicators including postoperative infection, malunion, nonunion, amputation, and hardware failure were used for quantitative outcome assessment. To analyze results a chi square test and SPSS software were used to study significant relation and association between multiple variables of the two study groups.

Results

Out of fifty six fractures in fifty four patients forty eight were males and eight were females, twenty five were treated by IMN (M=22 ; F=3), and thirty one by EF (M=26; F=5), forty six were due to direct trauma (M=38; F=8) with nine Gustilo type I, fourteen Gustilo type II, and twenty three Gustilo type III (EF=26 ; IMN=20), and ten fractures were due to indirect trauma (all males) with two Gustilo type I, two Gustilo type II, and six Gustilo type III (EF=5; IMN=5). Nineteen fractures developed no complications (EF=7; IMN=12), ten fractures developed superficial infection (EF=7; IMN=3), four fractures developed deep infection (EF=4; IMN=0), four fractures developed malunion (EF=2; IMN=2), six fractures developed delayed union (EF=2; IMN=4), five fractures developed nonunion (EF=3; IMN=2), three fractures had amputation (EF=3; IMN=0), two fractures developed hardware failure as broken screw (EF=0;

IMN=2), and three fractures were revised (EF=3;IMN=0). The incidence of postoperative infection (deep and superficial) was reported in fourteen fractures (EF=11; IMN = 3).Four fractures had malunion (EF= 2; IMN = 2), delayed union was seen in six fractures (EF = 2; IMN = 4), nonunion was noticed in five fractures (EF = 3; IMN = 2), three fractures ended with amputation (EF = 3; IMN = 0), and hardware failure was seen in two fractures (EF = 0; IMN = 2).The frequencies variables of our study included: I-Age: The most common affected age of open tibia fractures is 25years (17.9%).II-Sex: The most common affected sex is the male (85.7%).III-Treatment protocol: Most of open tibia fractures are treated by EF(55.4%). IV-Complications: Most cases of open tibia fracture developed no complication (33.9%).V- Fracture type: The most common type of open tibia fractures is Gustilo III A (51.8%).

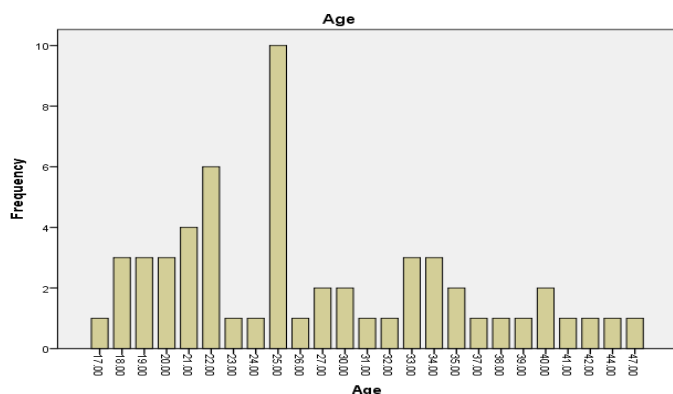


Fig. (9) Age frequency, the most common affected age of open tibia fractures is 25years (17.9%).

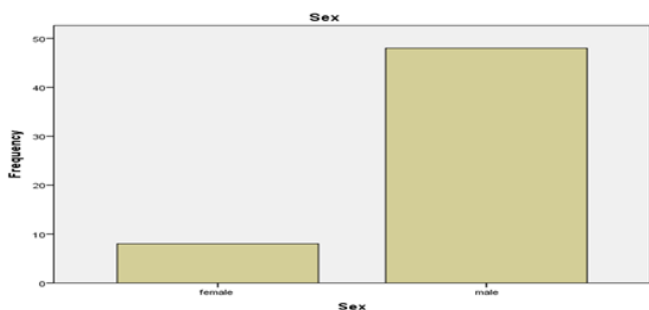


Fig. (10) Sex frequency, the most common affected sex by open tibia fractures is the male (85.7%).

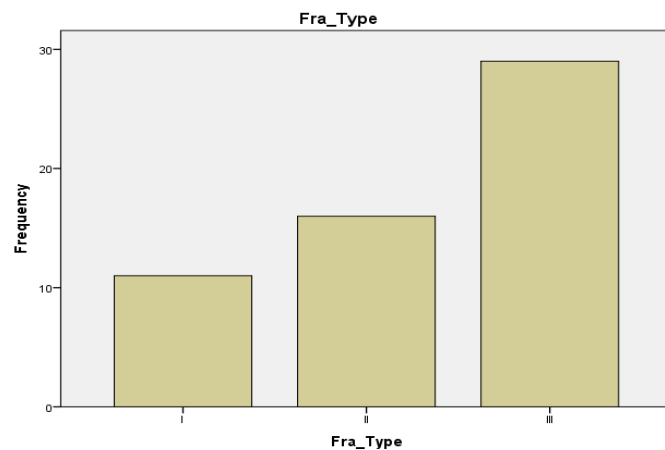


Fig. (11) Fracture types frequency, the most common type of open tibia fractures is IIIA (51.8%).

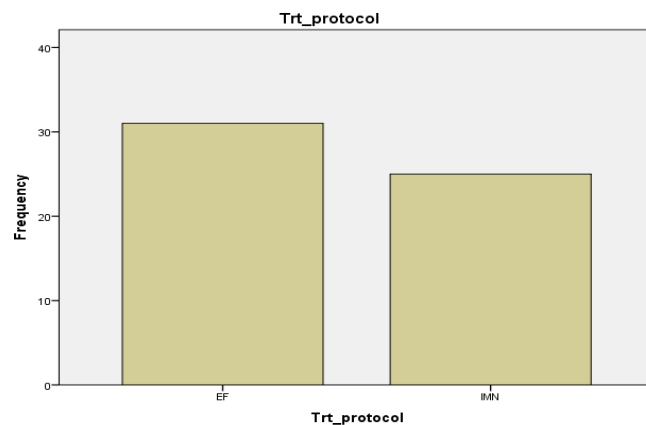


Fig. (12) Treatment frequency, the most of open tibia fractures is treated by EF (55.4%).

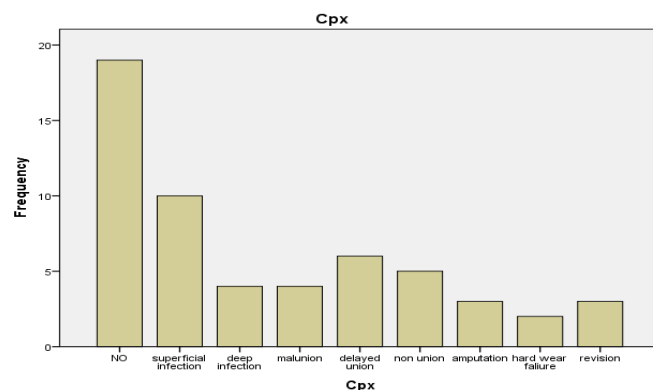


Fig. (13) Complications frequency, the most cases of open tibia fracture developed no complication (33.9%).

Discussion

The accepted protocols for managing open tibia fractures include immediate debridement and

irrigation, administration of antibiotics, skeletal stabilization, delayed wound closure, and early soft tissue coverage. Postoperative infection is an important factor for predicting patient prognosis in terms of limb salvage and preservation of function. One of the basic goals in the treatment of open tibia fractures is to prevent infection. Previous studies have indicated that IMN may increase the risk of deep infections and even the risk of amputation. However, in this study the results indicate that the incidence of postoperative infection in patients treated with EF approach was significantly higher than that in patients treated with IMN approach ($P = .0530$). "Kaftandziev et al. have noted that sterile metal does not cause infection but that sterile metal combined with inadequate debridement or absent soft tissue coverage does lead to infection in devitalized soft tissue and bone. An important factor in the body's ability to resist infection is the viability of surrounding soft tissue. Consequently, adequate debridement and early soft tissue coverage may be the keys to preventing deep infections and producing favorable results."^[50]

Four fractures had malunion (EF=2; IMN =2), indicating that occurrence of malunion was not different between IMN and EF. Some published studies have reported that open tibia fracture patients treated with EF may experience malunion, with an incidence of up to 20%^[51,52]. In contrast, the IMN is much closer to the fracture site, it can provide robust stability and therefore effectively maintain alignment, which could contribute to the lower incidence of malunion. Delayed union was evaluated in six fractures (EF = 2; IMN = 4), indicating that the incidence of delayed union was reduced by EF more than by IMN. "However, in some other previous studies, the healing bone cannot distinguish between correct and incorrect alignment patterns. Once the healing process begins, final bone healing can be achieved in both groups despite the alignment condition"^[53]. Clinically nonunion was seen in five fractures (EF = 3; IMN = 2), indicating that the

incidence of nonunion was reduced by IMN compared to EF.

Three fractures ended with amputation (EF = 3; IMN = 0), indicating that the incidence of amputation was reduced by IMN compared to EF. Hardware failure was evaluated in two fractures (EF = 0; IMN = 2), indicating that the incidence of hardware failure was reduced by EF compared to IMN. "Hardware failure remains the most reported complication of IMN, with an incidence of up to 3–16%. The most common hardware failure is the breakage of locking screws. However, Alberts et al.'s research showed that locking screw failure's long-term effect is minor because in most cases this complication could not be noticed in the first eight weeks and did not result in more than 5 mm of shortening. Generally speaking, these failures are related to fracture patterns, fracture locations and the patients' weight bearing statuses. Unlike the compound system of nail and bone in reamed nails, IMN functions as a splint in the medullary cavity. The load is transmitted directly to the locking screws. Awareness of this function and adherence to a strict protocol concerning patient mobilization and weight-bearing status appear to be the most important factors for avoiding this kind of failure."^[54-56] However, there is no consensus on the best method of bony stabilization. EF and IMN are two well-accepted techniques, and they are also associated with the most controversy over which is the optimal treatment. The functional outcome is also a focus after fracture surgery. An obvious advantage of IMN is that it can allow for early range of motion after surgical intervention. In contrast the EF technique where passing of wires and pins through muscles may limit motion and lead to joint contracture^[57,58].

According to our study, IMN reduced the incidence of superficial infection, nonunion, and malunion compared to EF. However, EF had a significantly lower rate of hardware failure, postoperative deep infection, and delayed union. Our study has some limitations, such as small number of cases, lack of regular follow up, lack of

treatment cost evaluation, lack of enough data and the surgeons' experience, all of these may have influenced the results. The results indicated that the patients treated by IMN had lower incidence of postoperative complications compared to those treated by EF. The superiority of IMN was more comprehensively proved by this analysis. For the most clinical endpoints studied in this analysis, IMN group has considerably higher efficacy for treatment of open tibia fractures compared to EF group. The IMN can offer stability and anatomic alignment of the affected bone, even in the presence of bone loss or comminution.

Conclusion

Locked unreamed intramedullary nail (IMN) approach appears to be a better option for the treatment of Gustilo type I, II, and IIIA open tibial shaft fractures as compared to external fixator. Advantages of the IMN include less rate of complications like nonunion, infection, amputation, and revision.

We recommend to use it as a first-line treatment for patients with open type I, II, and IIIA tibia fractures.

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