SECONDARY INTERNAL OSTEOSYNTHESIS WITH LOCKING PLATES FOR RECENT OR OLD OPEN FRACTURE OF THE TIBIA, OVERLAPPING PROVISIONAL EXTERNAL FIXATOR PIN SITES: IS THE INFECTION RISK INCREASED?

Orthopaedics

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ABSTRACT

Twenty-two patients had a severe open fracture of the tibia that was initially treated by external fixation and subsequently by locking plate. The external fixation had been maintained for an average of fifty-nine days (range, 15 to 240 days). The mean interval between removal of the external fixator and plating was twenty-six days (range, 10 to 44 days). Five out of twelve patients who had an infection at one or more of the pin sites, developed one superficial and four deep infection. In comparison, only one of the ten patients who had not had a pin-site infection had a superficial infection. An analysis of other variables, including the duration of external fixation, wound coverage, other injuries, and the type of fracture, showed that none was a predictor of infection either at the pin sites or around the plate. We concluded that a pin-site infection that develops during external fixation is a contraindication to the subsequent plating in patients who have a fracture of the tibia.

Background: Compound fractures of the shaft of tibia represent one of the most common lower extremity fractures. Definitive internal fixation of tibial shaft fracture after external fixation (EF) is controversial due to more infection risk. On the other hand, isolated EF management is also problematic. It also improves patient comfort (healing care, ankle rehabilitation) and may enable earlier return to work, if sedentary. It may be performed early (within 2 months of fracture), after a "damage control" phase, or later with a view to facilitating fusion. It remains a subject of debate, with varying reported rates of fusion and of infection. The present continuous retrospective series was therefore analyzed to determine:

Materials and Methods: We retrospectively reviewed 22 cases, which includes 18 males and 4 females, of open diaphyseal fractures of the tibia of varying severity that were managed at our institute from 2013 to 2019 with primary stabilization with external fixator either rail or Ilizarov fixator. On debridement, 8 patients had Gustilo type II injury, 6 patients had Gustilo type I, and 8 patients had Gustilo type III injury. All the cases included in the study had a staged treatment (primary external fixation followed by internal) because of either delayed presentation or multiple associated injuries. Cases that had less than two-year follow-up were not included in the study.

Once there were no signs of local wound infection (no swelling, erythema, or discharge), patients were allowed for definitive internal fixation with locking plate. The present study therefore analyzed definite internal fixation, to determine infection and union rates, and whether locking plates subsequent to external fixator ablation increased the risk of infection.

Results: 4 patients (18.2%) in which one (12.5%) from Gustilo type II and three (37.5%) from Gustilo IIIB injuries were developed infection. Other two patients having superficial infections were cured by debridement and implant retention.

In Gustilo type I fractures, the average time to union was 21 weeks, whereas for Gustilo types II and III, it was 28 and 46 weeks, respectively. There was one case of frank nonunion (4.5%), followed by infection of the fracture site and loosening of the implant. This was treated with Ilizarov external ring fixator.

Conclusion: Definite internal fixation with locking plate after external fixator is a controversial treatment option. Statistically, the sole factor significantly increasing infection risk was skin wound severity on the Gustilo classification. In Gustilo type IIIB and IIIC fracture, there are high rates of EF pin site infection. We concluded that a pin-site infection that develops during external fixation is a contraindication to the subsequent use of plating in patients who have a fracture of the tibia.

KEYWORDS

Open tibial fracture, external fixator, internal fixation, locking plates

INTRODUCTION

Tibia is the commonest site for open fractures.^[1] These injuries often result in extensive damage to the soft tissue and bone. With high rates of infection and frequent injury to neurovascular structures, they have a high incidence of complications and poor treatment outcome.^[2] Treating these injuries requires experience and judgment.^[3] It remains one of the most challenging problems facing the orthopedic surgeon.^[4] Modern-day management of these injuries has focused on thorough debridement, immediate bony stabilization, and tissue cover to enable early mobility and restoration of optimum function.^{[5],[6],[7]} Current practice by most orthopedic surgeons is to avoid placement of external fixation pins within anticipated surgical incision sites in order to prevent potential deep infections after definitive fixation. However, with the recent popularity of less invasive or submuscular plate applications, as well as the biomechanical advantage of long plates for metaphyseal fracture components, this overlap may be unavoidable. Staged treatment with primary external fixation is preferred only for patients who either present late^{[11],[12]} or have multiple injuries. Pin tract infection is seen in more than 40% cases.^{[13],[14],[15]} Maurer and Gustilo^[16] in their study showed that internal fixation after external fixator using pin fixator had 25% chance of deep infection, and the same was as high as 71% when nailing was done after there was an evidence of pin tract infection. Most of the studies have shown a high risk of deep infection (more than 20%) when definite fixation is done after pin external

fixator.^{[17],[18]} The primary objective of this study was to analyze the incidence of deep infection on conversion to definite internal fixation.

MATERIALS AND METHODS:

We retrospectively reviewed 22 cases which includes 18 males and 4 females, of open diaphyseal fractures of the tibia of varying severity that were managed at our institute from 2013 to 2019 with primary stabilization with tubular external fixators, rail or Ilizarov external fixator. All the cases included in the study had a staged treatment (primary external fixator followed by internal fixation with locking plate) because of either delayed presentation or multiple associated injuries. Cases that had less than two-year follow-up were not included in the study.

Once there were no signs of local wound infection (no swelling, erythema, or discharge), patients were allowed for definitive internal fixation with locking plate. The present study therefore analyzed definite internal fixation, to determine infection and union rates, and whether locking plates subsequent to external fixator ablation increased the risk of infection.

All the fractures were classified as per AO fracture classification for fracture anatomy and Gustilo and Anderson classification for nature of open injury. All the fractures selected were of the diaphyseal segment.

The fixator was applied under spinal anesthesia. Attempt was made to achieve soft tissue cover by loose closure of soft tissue or by immediate flap cover done by the plastic surgeon. However, in one case of Gustilo type III injuries, adequate soft tissue cover could not be achieved in the first sitting. This was managed by immediate vac dressing and later on by flap cover.

In all cases, intravenous antibiotics were used. Choice of antibiotic to use depends on the local antibiotic sensitivity patterns. Pin site care was given in the form of removal of crust, gentle massage of soft tissue around the pin site, and simple dressing with saline and betadine. Once there were no signs of local wound infection (no swelling, erythema, or discharge), patients were allowed for definitive internal fixation with locking plate. The limb was put on plaster slab till the definite fixation after the removal of external fixator. The mean interval between removal of the external fixator and plating was twenty-six days (range, 10 to 44 days). The average time between injury and plating is twelve weeks. All patients were followed until either the fracture had united or there was an established non-union or infection.

All cases were closely followed in the postoperative period for evidence of superficial or deep infection at the fracture site including pin-site infection. Cases with local pain, swelling, erythema, and serous discharge (culture positive for pathogen) from the fracture site were labeled as superficial infection and were managed with elevation, drainage, and additional course of antibiotics as dictated by culture sensitivity. Patients were also monitored for evidence of deep infection in the form of wound abscess and systemic features of infection including radiological evidence of periostitis or osteomyelitis. Pin-site infection was considered to be present when there was culture-positive purulent discharge from one or more pin sites when the fixator was removed.

All the cases were followed up for 6 months to 2 years for union and other complications like secondary osteomyelitis and nonunion. The subjective and objective criteria used for establishing union were absence of pain on full weight bearing, lack of swelling, tenderness, or abnormal mobility at the fracture site with radiographic evidence of bridging callus in various phases of consolidation. The injured limb was labeled free of infection in the absence of pain, swelling, or discharge from the fracture site or any of the clamp sites along with the absence of any radiological evidence of osteomyelitis, like sclerosis, osteolysis, and implant loosening.

RESULTS:

The mean age of the patients was 30.4 years (ranged 18 to 55 years). 8 fractures were AO type 42B, 4 fractures were simple AO type 42A fractures, and 10 had complex AO type 42C fracture pattern. On debridement, 8 patients had Gustilo type II injury, 6 patients had Gustilo type I, and 8 patients had Gustilo type III injury and complex fracture anatomy. Average delay in debridement and application of external fixator was 19.2 h (range, 3-36 h) from the time of injury. The delay was due to late presentation, as many cases had to be moved from remote locations. Average delay in plating was 16 days. Most of the type 1 and type 2 injuries were taken up within 30 days for plating, and type 3 injuries were taken up 21-56 days after injury. In 6 patients (27.3%), there was infection from the one or two pins sites, which was cured by dressing, changing pins and oral antibiotics.

4 patients in which one (12.5%) from Gustilo type II and three (37.5%) from Gustilo IIIB injuries were developed deep infection, and two patients with superficial infections were cured by debridement and implant retention. Two patients (9.1%) again treated with implant removal and Ilizarov external ring fixator. Two patients with Gustilo IIIB injury developed deep infection around the plate. The fracture developed into an infected nonunion, requiring removal of the implant and Ilizarov external ring fixator and multiple surgeries.

Thus overall, 4 patients (18.2%) cases were developed deep infection, most of which patients were either from Gustilo type III i.e three patients (37.5%) or one (12.5%) from Gustilo type II injuries. Most of the patients who developed intramedullary infections were also had pin tracts infection previously. None of the patient with Gustilo Type I injury developed infection.

In Gustilo type I fractures, the average time to union was 21 weeks, whereas for Gustilo types II and III, it was 30 and 52 weeks, respectively. There were two cases of frank nonunion (9.1%), both followed by infection of the fracture site and loosening of the implant. There were two cases of malunion.

DISCUSSION:

Primary internal fixation may not be feasible in cases of delayed presentation and polytrauma. These cases require staged reconstructive protocol using external fixation as the primary method of bony stabilization.

External fixator followed by delayed Internal fixation minimizes the disadvantages of external fixator alone (bad cosmesis, frequent pin trouble, risk of fracture through the pin tract, risks of malunion, delayed union, and nonunion, and non-compliance of patients in pin tract care affecting fixator durability. This type of fixation is often used for severe open tibial fractures, especially for patients with polytrauma, as a 'damage control' method. It is a useful and safe solution for open or closed fractures in severely damaged multi-trauma patients. However, it risks having deep infection as a result of pin-site infection, prolonged external fixation, the short safety interval between removal of the external fixator and plating, non-curettage of pin sites at the removal of the external fixator, and poorly vascularised soft tissue coverage or delayed skin coverage.^{[1],[24],[26]}

Review of the available literature shows that use of conventional pin fixators is associated with a high risk of pin tract infection. Hence, definite fixation within 14 days is recommended. If definite fixation either by nail or plate is delayed (more than 3 weeks), the rate of infection rises remarkably to about 20-45%. If there is established pin tract infection, it may even be as high as 71%. (Table 1)^[20]

There are few limitations of the study. First, there were no blind observers. Second, although AO classification of fracture pattern is quite accurate with negligible intraobserver variation, the same cannot be said for Gustilo classification of open injury. Finally, being a retrospective study, proper randomization and comparison with a control cohort who underwent primary stabilization with pin fixator was not possible; hence, the available literature was used to compare the results of this study.

There was only a high rate of Gustilo type III open fracture (37.5%, 3/8), compared to the reports by Matsoukis et al.[21] (25% type III, and 5% deep infection), McGraw et al. [22] (80% type III, and 44% deep infection) and Gustilo et al. [23] (42% type III, and 32% deep infection).

37.5% (3/8) patients were developed infection in whom the pin tract had infection during external fixator period.

Chirag M Shah studied infection rate in tibial plateau associated with overlapping of pin tract sites and concluded that in the "overlapping" group, 24% developed a deep infection compared with 10% of the 132 patients in the "nonoverlapping" group (P=0.033).

Thus, we concluded that this is a contraindication of the plating in the patients with pin site infection and we should think an alternative treatment in Gustilo Type III injuries.

Surgeons should make a conscious effort to place external fixator pins outside of future definitive fixation sites to reduce the overall incidence of deep wound infections, particularly in patients with risk factors for infection, such as smoking and severe soft tissue injuries.

However, Laible C et al demonstrated no increase in infection rate of definitive fracture fixation site contamination from external fixator pins.

CONCLUSION:

On the basis of the high incidence of complications in both the present series and the few reports in the literature, we concluded that alternative treatment options should be carefully considered before electing this sequential method of fixation.

Fig 1.

Fig 2

Fig 3

Table 1- Details of the different series in the literature.

	Gustilo II, IIIa,b fractures (number)	Duration of external fixation (days)	Safe interval (days)	Pin-track infection (%)	Deep infection (%)	Healing time (wk)	Nonunion (%)
McGraw et al ¹	7/16	59.5	16	42.8	28.5	13.6	57.1
Maurer et al ²	20/24	52.1	73	25.0	20.0	-	-
Johnson et al ³	7/13	84.0	14	28.5	0.0	11.6	0.0
Blachut et al ⁴	34/41	17.0	9	5.0	5.0	-	5.0
Wheelwright and Court-Brown ⁵	10/21	57.4	12	33.3	4.8	27.5	0.0
Siebert et al ⁶	24/135	44.8	6	8.3	0.0	21.5	4.1
Bernati et al ⁷	10/21	185.0	0 [†]	9.5	0.0	19.5	-
Antich et al (present series)	17/17	27.0	10	20.5	5.8	26.0	5.8

[†] not as an established protocol
[‡] at the same surgery stage

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