Research Article

Treatment of grade 3a and 3b compound tibial fractures with external fixation and primary immediate bone grafting

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Abstract

Introduction- The present study report results of a series of type 3A and 3B open fractures treated with debridement and fracture fixation and immediate bone grafting. **Methods-** Twenty one patients were treated from January 2017 to January 2018. All fractures were treated with a modular external fixator. Nine fractures were type 3A and 12 were type 3B. All fractures received debridement, external fixation, bone grafting and flap or skin graft coverage. All fractures were analyzed for time to fracture union, incidence of pin tract infection, incidence of wound infection, flap complications, and delayed or non union. **Results-** After a mean follow up period of 14 months (range 12 to 16 months), it was concluded that the time to fracture union was 22 weeks, and all fixators were removed only after radiological evidence of fracture union. 1 (5%) patients developed deep wound infection, one experienced delayed union. **Conclusion-** Along with early wound coverage and external fixation, primary bone grafting can be employed in grade 3 open fractures of tibia with good results and without any increased risk of wound complications

Keywords: Compound fracture tibia, Flap Converge, External fixation, Bone Grafting

Introduction

Compound fractures of tibia are very common, and in some series constitute nearly 60% of all tibial fractures [1]. The optimum treatment of open tibial fractures remains controversial. Since a long time, it has been recognized that fractures managed with open wound technique have a much higher rate of complication as compared to those closed with flaps [2]. Early skeletal stabilization by external fixation reduces further soft tissue trauma, restores anatomy and reduces dead spaces [3]. Unilateral external can be used as a definitive treatment for complicate shaft tibia fractures, provided that good anatomical reduction be achieved, irrespective of the type of external fixator used [4]. Several authors have evaluated the efficacy of early bone grafting [2,5,6] in open tibia fracture, but only few have previously evaluated its use along with flap coverage and external fixation in primary setting [7]. The present study have sought to evaluate safety and effectiveness of addition of bone grafting the "fix and flap" strategy for open tibial fractures.

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Materials and Methods

Study setting- This study was performed in Chirayu Medical College and hospital, a tertiary level facility, under department of orthopaedics.

Duration of study-This study was conducted from January 2018 to January 2019.

Sampling methods- All consecutive patients being admitted with compound tibial fractures were considered for this study and thereafter subjected to inclusion and exclusion criteria.

Sample size- Twenty one patients fulfilled the inclusion criteria and were included in this study.

Inclusion criteria- Severity of soft tissue injury was classified according to Gustilo and Anderson grade, into type 3A (n=9) or 3B (n=12) fractures.

AO classification was used to classify the fracture pattern.

Exclusion criteria- Fractures with vascular injury (Gustilo and Anderson type 3 C), limbs not amenable to limb salvage surgery with Ganga hospital score of more than 14, and fractures with segmental defects were excluded from this study.

Details of surgical procedure- All injuries were debrided only at the time of surgery, and wound was lavaged with 9 litres on normal saline with pulse lavage. In the present study only unilateral fixator was used. The source of bone graft was proximal tibia in all cases. This cancellous graft was placed over posterior aspect and the lateral aspect of tibia Choice of flap coverage was peninsular transposition flap or Gastrocnemius muscular flap in proximal third, bipedicle or peninsular transposition flap in middle third, and transposition or reverse sural flap in distal third. All flaps which needed skin grafting received it at the time of index surgery all flap surgeries were performed by senior author, an orthopaedic surgeon. Splints were used in all patients.

Patients were discharged after suture removal and wound healing, and were reviewed clinically and radiologically every 20 days. Weight bearing was commenced only on fracture healing.

Pin tract infection was considered to have taken place if there was erythema plus discharge, positive microbiology, or loosening severe enough to warrant pin removal.

Data collection and analysis- Data collection and analysis were done in WPS office suite.

Ethical consideration and permission- Due approval from Institutional Ethical committee was taken.

Results

Over a mean follow up 14 months (range 12 to 16 months) current results for time to fracture union were analyzed, incidence of pin tract infection, incidence of wound infection, flap complications, and delayed or non union. Mean time for fracture union was 22 weeks. All external fixators were removed only after sufficient fracture union. Walking cast was not applied in any case, but weight bearing was started as tolerated with a functional brace. A total of 109 schanz pins were used in external fixation among all 21 patients. Out of them pin tract infection occurred in 23 pins in 9 patients. All were treated by pin cleansing and oral antibiotics. However nine pins in nine patients had to be changed, when they did not respond to above treatment.

Figure-1: A case of open type 3B fracture of tibia. External fixator is in place. Primary bone grafting has been done. Faciocutaneous transposition flap is being raised.

Figure-2a and b: Clinical photograph showing external fixation with flap coverage of proximal tibia. Split thickness skin graft has been applied over flap harvest area

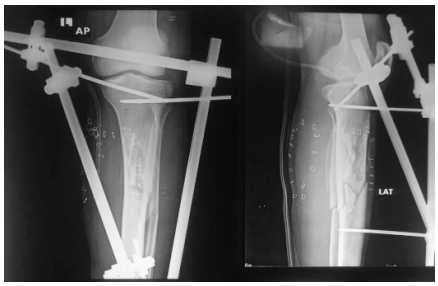

Figure-3: Radiograph showing fracture fixation with external fixator in place. Arrow pints to location of bone graft

Figure-4: Radiograph Showing fracture union

Figure-5: Clinical Photograph showing status of flap 4 months after surgery

Deep infection occurred in one patient. This patient developed osteomyelitis, and discharge culture revealed a growth of *pseudomonas* species. This was treated by flap elevation; sequestrectomy, debridement, and two negative pressure wound dressing application, prior to repeat bone grafting and flap closure, when wound demonstrated negative culture. This same patient went into delayed union requiring external fixation for 37 weeks. Pin breakage (at thread runout) occurred in one patient. This was managed by broken fragment removal under anaethesia. All patients had reduction in ranges of motion at knee and ankle joint, which tended to persist even after rehabilitative physiotherapy.

Table 1: Method of coverage along with grade of open fracture.

Serial number	Grade of open fracture	Method of coverage
1	3B	Gastrocnemius Medial head + SSG
2	3A	Primary Closure
3	3B	Bipedicle flap + SSG
4	3B	Fasciocutanous flap+SSG
5	3A	Delayed primary closure
6	3A	Delayed primary closure
7	3B	Hemisoleus Flap + SSG
8	3A	Primary closure
9	3B	Gastrocnemius medial and lateral heads + SSG
10	3A	Primary Closure
11	3B	SSG
12	3B	SSG
14	3A	Delayed primary closure
15	3B	Bipedicle flap + SSG
16	3A	Primary closure
17	3B	Reverse sural flap + SSG
18	3B	SSG after Negative pressure wound dressing
19	3A	Primary closure
20	3B	Transposition flap
21	3B	Free radial forearm fasciocutaneous flap

Discussion

There has been significant controversy regarding timing of bone grafting for open tibial fractures, with a study exhibiting increased infection rate when bone grafting was performed at the same time of soft tissue reconstruction [9]. However other studies have shown that early bone grafting produces good results [6, 7, 10] without additional risk of an increased rate of infection. Fischer et al used intrameduallary nailing in their series for skeletal reconstruction [9], and internal fixation may have increased the infection rate. Authors think that it is not wise to ascribe the increased infection rate to bone graft alone, as is evident from the infection rate in the present study. Out 5 percent infection rate is comparable to those of other authors [6, 7] who have advocated primary bone grafting

Some authors have performed bone grafting in compound tibia fractures after a variable time from the primary procedure. Fakoor et al [4] compared bone grafting in 3rd week versus 6th week and concluded that early bone grafting results in earlier union without added increase in infection rates. In an interesting study by Zheng et al [11], open bone grafting with Negative pressure wound dressing (NPWD) was used to treat open tibial fractures in patients who were not candidates for microsurgical coverage and observed high rates of fracture healing. In the present study one patient has also been treated in a similar manner, having declined a flap procedure.

Papaionnou et al [12] reported a large series of patients treated with definitive external fixation without bone grafting for fractures of tibial diaphysis and concluded that open type 2 and 3 fractures have a greater tendency to progress to non union. In our series which considered only type 3 fractures, only a 5 percent non union rate was observed, and this can be attributed to primary bone grafting.

In a number of previously done studies which treated open fractures of tibia with definitive external fixation, bone grafting had to be done as a secondary procedure. Authors aimed to perform primary bone grafting in order to reduce the incidence of reoperations and achieve a high union rate. External fixation for definitive or initial management of tibial fractures has a long history, with pin-to-bar external fixation being the standard of care for definitive management. Its popularity may have declined with the advent of intramedullay nailing [13], but it still has advantages of safety in tibial fractures. Intramedullary nailing is clearly the method of choice only when it comes to closed tibial fractures [4]. Beltsios et al in a large study with 223 observed union rates as 87 percent in cases of tibial fractures being treated with external fixation, and in all these cases external fixator could be used as the definitive treatment modality.

The authors concluded that good initial reduction was important no matter what type of fixator had been applied, as it was often surprisingly difficult to achieve a secondary reduction if the primary reduction was unsuccessful. Helland et al. [14] noted a significantly faster healing time in patients with exact reductions compared with fractures with greater than 2 mm translational displacement.

External fixators can be applied quickly; they provide fracture stability and alignment with minimal physiologic insult, there is no metal implant across the fracture site, and there is less vascular damage in a tibia that may already be compromised, particularly with some types of tibial shaft fractures. Another advantage of external fixators is that a second operation for removal of the device is not needed, with implications for cost effectiveness and patients' morbidity [4].

Bhandari et al. carried out an indirect comparison between reamed intramedullary nails and external fixators from several prospective randomized studies that compared external fixation with reamed and unreamed IM nails. They concluded that use of reamed nails significantly reduced the risk of re-operation when compared with external fixators but not that of deep infection or nonunion [15].

Recently there have been many improvements in external fixator designs. Traditionally, external fixator half-pins are of stainless steel which is substantially stiff. Among the many different techniques to enhance fixation at the pin–bone interface, hydroxyapatite (HA) coating of the pins has been shown to be one of the most effective.

The HA coating provides a significant increase in direct bone apposition with a decrease in the fibrous tissue interposition at the pin–bone interface. Moroni et al. [16] showed that HA-coated tapered pins improved the strength of fixation at the pin–bone interface, which corresponded to a lower rate of pin tract infection. HA coating, owing to the increase in purchase at the pin-bone interface, may make extracting these pins more

difficult or painful if without anesthesia. Although the present study is limited by a relatively small number of patients, authors rest assured about the safety of primary bone grafting for tibia fractures when used in conjuction with external fixation and when adequate soft tissue management has been undertaen in the primary setting. A larger study is required to further validate these findings.

Conclusions

From the present study, following conclusions were drawn:

1. When taken in combination with adequate soft tissue management, primary bone grafting is a safe and effective technique in treatment of open Tibial fractures
2. Primary Bone grafting can reduce the need for secondary surgical procedures and enhance the indications of external fixation
3. External fixation along with bone grafting and soft tissue coverage can be used as a definative procedure for treatment of grade 3A and #B open fractures.
4. Early soft tissue reconstruction with flap converge leads to a low infection rate.

What this study adds to existing knowledge?

Many surgeons today lack awareness about optimal management of open fractures and the appropriate modality of soft tissue and bony reconstruction. Primary bone grafting is not routinely performed due to fear and apprehension of infection.

External fixator is regarded by many as only temporizing procedure, and many feel that a secondary procedure is almost always needed.

This study demonstrates that external fixator can be used as a definitive procedure for tibial fractures, when appropriate debridement and soft tissue coverage can be used. Primary bone grafting is a safe and reliable procedure and does not add to the complication rates.

Contributions by individual authors

- **Dr. Rajul Gupta** was planned and performed all the surgeries, planned the external fixator design and the flap coverage.
- **Dr. Vaibhav Maheshwari** assisted in all the procedures and prepared the manuscript. He was also involved with follow up care.
- **Dr. Sandeep Gour** assisted in all the procedures and was involved in follow up of the patients. He also did the post operative wound care and was involved in the review of literature.
- **Dr. Deepak Nadkarni** approved all the external fixator designs and the soft tissue coverage procedure choice.
- **Dr. K. K. Verma** performed the VAC dressings and the Free Radial forearm flap

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