

Versatility of External Fixator and Phemister Bone Grafting in Managing Open Tibial

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Abstract

Introduction: It is the present day trend to use external fixator as a temporary measure till soft tissue heals up and switch over to definitive mode of internal fixation. In our study we tried to continue the fixator as a definitive treatment and augment the bony healing by bone grafting by phemister technique in cases with delayed union. *Materials and Method:* 31 open tibial fractures (Gustilo type II and III) including 5 segmental fractures, presenting 24 hours after injury were treated between 2013- 2014 with unilateral uniplanar tubular external fixators and were followed up for bony union. 10 patients with delayed union (at 3 months) without pin track infection and pin loosening were operated with bone grafting by phemister technique. The graft materials harvested from autogenous Iliac crest by standard phemister technique were applied to denuded surface of the cortex across the fracture site, without disturbing the fibrous union without removing fixator. *Results:* 24 male and 7 female patients with open tibial fractures were included in this study with average age of 34.03 years. 2 patients were lost to follow up and 4 patients had implant failure during the course of the study. Bone healing time ranged from 24-28 weeks with mean of 26.67 weeks in patients with external fixator without bone grafting. Bone healing time in patients with phemister bone grafting for delayed union ranged from 30-36 weeks with mean of 32.3 weeks. *Conclusion:* The results were very encouraging in our study which can be considered particularly important in our country with economically poor patients who face considerable hardship to afford for the 1st operation with external fixator and it becomes difficult for them to undergo another major operation with instrumentation. In situations where external fixators serve its purpose of stability without loosening and pin track infection and where patient compliance is good, these can be continued till there is bony union. If there is evidence of delayed union at 3 months, bone grafting by phemister technique is the gold standard procedure giving satisfactory outcome which helps in conversion of fibrous union to osseous union.

Keywords: Phemister; Delayed union; External Fixation; Bone Grafting; Open Fractures.

Introduction

The tibia is one of the bones that most commonly suffer an open fracture [1]. Open tibial fractures are vulnerable to nonunion and infection as a result of the precarious blood supply and lack of soft-tissue cover over the shaft of the tibia [2]. The specific method

of treatment of these fractures is controversial. There are varying treatment options for treating these fractures ranging from external fixators, ring fixators, nailing, plating, all having their own set of complications [3-6]. External fixator has gained acceptance as the preferred mode of early stabilization in open tibial fractures. The popularity of external fixation is because of the relative ease of

application and the limited effect on the blood supply of the tibia. These advantages of external fixation have been outweighed by the high incidence of pin-track infection, difficulties relating to soft-tissue management and the potential for malunion [7]. Amongst the available configurations, the unilateral uniplanar frame is being used more frequently. In fractures resulting from high-energy trauma delayed union is likely. Phemister recommended the use of bone grafting for augmenting bony union without disturbing the pre-existing callus.

The Phemister-Charnley bone grafting technique has been used with good clinical results in the treatment of delayed union of tibial shaft fractures. It is the present day trend to use external fixator as a temporary measure till soft tissue heals up and switch over to definitive mode of internal fixation. In our study we tried to continue the external fixator as a definitive treatment and augment the bony healing by bone grafting by phemister technique in cases where there was evidence of delayed union.

Materials and Methods

In a prospective study undertaken between 2013 and 2014, 31 patients with Gustilo type II and III open tibial fractures including 5 segmental fracture presenting after 24 hours of the injury were treated with debridement and external fixator as a primary and definitive mode of treatment. The patients were followed up for fracture union and if there was evidence of delayed union at 3 months, bone grafting was done by phemister technique to augment bony union. There was no pin tract infection or loosening of the schanz pins at the time of bone grafting. The graft materials harvested from autogenous iliac crest by standard phemister technique were applied across the fracture site after raising an osteoperiosteal flap, without disturbing the fibrous union and without removing the fixator. Their mean age was 34.03 years (range, 20-52 years); 24 (77.42%) were male and 7 (22.58%) were female. The cause of fracture was a road traffic accident in 19 cases (61.29%), fall from height in 7 cases (22.58%) and work-related accident in 5 cases (16.13%). Average time of presentation to our hospital was 31.48 hours after the injury.

All open tibial fractures classified as Gustilo type II, and III presenting 24 hours after the injury were included in the study. Patients non-compliant with the external fixator and Gustilo type I were excluded from the study. All the patients belonged to lower socio-economic group and were unable to afford the implants needed for subsequent internal fixation.

Operative Procedure and Follow Up

All patients with open fractures (type II and III) attending our institute are operated as an emergency in the orthopaedics OT. Thorough debridement of the wound was done. The fractures were reduced and stabilised with external fixation using AO/ASIF tubular external fixators. 12 patients had undergone plastic surgery procedures like skin flaps and grafts to cover the raw area at a later time. The patients were followed up at 4 weekly intervals to look for radiological bony consolidation or any complication like pin tract infection or loosening of the fixator till bony union and then reviewed periodically for at least one year. 10 patients with external fixator with delayed union at 3 months were planned for phemister bone grafting to augment bony union.

For phemister bone grafting, the limb with the fixator in situ was cleaned thoroughly. Fresh autogenous bone graft 2 cm long and 2-3 mm thick adhering to the principles of phemister, was harvested from the ipsilateral iliac crest. Anterior bony deep incision was made on the shin of tibia across the fracture site. Incision was modified in two patients who had a flap cover. The affected bone is exposed. Osteoperiosteal flaps were raised across the fracture site from both anteromedial and anterolateral surface. Cancellous strips taken from the iliac crest were placed beneath the subperiosteal flaps across the fracture line on two opposing sides of the bone. After proper placement of the graft, wound was closed in a single layer. Stitch removal was done after 2 weeks.

Results

31 patients of Gustilo open type II and III open tibial fractures were included in this study. The time of bony healing was defined as when on clinical and radiological examination, the limb could be allowed out of the supporting external fixator and mobilization of the limb started without subsequent deterioration. Mean follow-up time was 12 months. However, we lost 2 patients during follow-up who could not be traced. 4 cases had loosening of the schanz pins for which the fixators had to be removed. These cases had to be resorted to nailing/plating after 3 weeks of removal of the external fixators. The patients were kept in POP slab for 3 weeks to allow the pin tracts to heal. So the total number of patients for final follow up and evaluation were 25. Fractures united in 15 patients at an average time of 26.67 weeks (24 -28 weeks) following which external fixators were removed. There was no need for bone grafting as these fractures showed radiological signs

of callus formation at 2nd follow up i.e at 8 weeks. 10 cases who had signs of delayed union were planned for bone grafting using the phemister technique. There was no pin tract infection or loosening of the schanz pins at the time of bone grafting. At 10-12 weeks after bone grafting, radiologically a strong bridge formation of callus was seen. The grafts were not distinguishable. The fractures united after an average time of 20 weeks (range 18-24 weeks) of the grafting procedure in these 10 patients i.e after an average total duration of 32.3 weeks from the initial presentation which was statistically significant ($p < 0.0001$). The external fixators were removed after confirmation of bony union. The patients were evaluated radiologically and clinically (after loosening the external fixator) just before removal of external fixator. After external fixator removal, patients were evaluated clinically for fracture union. There was no

significant varus/valgus angulation at the fracture site in majority of the patients at the time of union. 3 patients had varus angulation of more than 10 degrees in which external fixator was continued without bone grafting while 1 patient with phemister bone grafting had varus angulation of more than 10 degrees. There was no significant anteroposterior angulation except in two cases who had angulation of more than 10°. There was no significant limb length discrepancy except in three patients who had limb shortening of 1.5 cm due to bone loss. Significant ankle stiffness occurred in one case which improved with physiotherapy. Superficial wound infection was seen in two cases post operatively but was easily controlled with standard antibiotics and regular dressing.



Fig. 1: A: Open type IIIB segmental fracture tibia; B: Emergency debridement and external fixator application; C: Bone grafting done after 3 months; D: Radiologic union with significant callus formation at 4 months after bone grafting; E: Patient walking on external fixator just before removal; F: Patient walking after removal of external fixator



Fig. 2: Patient at 1 year follow up with normal range of motion at both knee and ankle joint

Table 1: Case Records

Serial no	Age (yr)	Sex	Mode of injury	Fracture type	Time of presentation (hrs)	Without bone grafting	Union time With phemister bone grafting	shortenin g>1.5 cm	Varus/AP angulatio n>10°	Lost to follow up/ Implant failure
1	28	M	RTA	3A	30	28		+		
2	32	M	FFH	3A	32		30			
3	52	M	RTA	3B	36	27			+	
4	24	M	RTA	2	28		36			
5	39	M	RTA	3A	28	29				
6	44	M	FFH	3B	30					+
7	21	M	RTA	3A	30		34			
8	36	F	WRA	2	32	25				
9	38	M	WRA	3A	48	28				
10	28	F	RTA	3B	38		32	+		
11	22	M	RTA	3A	36		31		+	
12	29	F	WRA	2	28	26				
13	49	F	RTA	3B	27		32			
14	51	M	RTA	3A	32					+
15	43	M	FFH	3A	42	27			+	
16	25	M	RTA	3B	30	28				
17	27	F	RTA	3A	32		31		+	
18	20	M	FFH	3B	28					+
19	47	M	FFH	3A	27	24				
20	41	M	RTA	3B	28		32			
21	30	M	WRA	3A	26	27			+	
22	35	M	RTA	3A	28	26		+		
23	31	F	FFH	3B	30					+
24	37	M	RTA	2	32		33			
25	39	F	WRA	3A	34					+
26	24	M	RTA	3B	28		32			
27	33	M	RTA	3A	36	24				
28	35	M	RTA	2	30	28				
29	38	M	FFH	3A	28	26			+	
30	29	M	RTA	3B	28					+
31	28	M	RTA	3A	32	27				

RTA-Road Traffic Accident
WRA-Work Related Accident
FFH-Fall From Height

Discussion

Open tibial fractures is difficult to treat.¹⁶ The

duration of treatment is long and frequently necessitates repeat surgery. The healing of tibial fractures is influenced by various factors which includes soft tissue injury, comminution, infection, initial fracture displacement, concomitant injuries, patient age, and treatment modality [17]. The healing time for open tibial fractures accompanied by severe

soft tissue injury, significant displacement, or comminution is longer than more simple tibial fractures [17-22]. These fractures are reported to have an infection rate of 3-40%, and a nonunion and delayed union rate of 40-60% [1,17,20,23-26].

Currently open tibial fractures are managed by two major surgical therapies. Intramedullary nailing can result in better fracture union owing to earlier extremity weight loading and less stress shielding [27]. External fixation because of its easy application and economy is equally popular but certain complications like pin site infection may be major hazards for its use [28]. External fixation is usually recommended more for severe open fractures to allow the soft tissues to heal [29]. In our series, external fixator was applied in all the patients of Gustilo type II and III open tibial fractures presenting after 24 hours of injury and it was continued till there was evidence of bony union.

Delayed union is more likely to occur in fractures resulting from high-energy trauma, hence early prophylactic bone grafting is recommended [16,20]. Charnley recommended prophylactic bone grafting, defined as grafting performed within the first 12 weeks, in order to reduce the time to union in tibial fractures [17]. Phemister bone grafting is a time and tested procedure with excellent results and outcome. One of the most significant factors affecting the success of bone grafting is infection. The advantage of phemister bone grafting is that it can be done in low grade infection.

Souter (1969) suggested that autogenous cancellous bone-grafting as the standard treatment for delayed union of fractures. According to Souter, definite mobility of the fracture site at 12 weeks denotes potential delayed union, and cancellous bone grafting should then be performed without delay [30]. Holden in his series of sliding bone grafts in the treatment of delayed union of tibial fractures emphasized cancellous bone grafting if the fracture was still mobile at 12 weeks. He summarized that sliding bone-grafts take longer to unite, with more complications than cancellous bone-grafting. In our series, we continued the external fixator applied at the time of initial stabilisation anticipating bony union and if there was signs of delayed union at 12 weeks, bone grafting was done by phemister technique to augment bony union.

A number of randomised trials have compared the results of open tibial fractures treated either by external fixators, plates and IM nails. One quasi-randomised trial by Bach and Hansen [8] compared plate fixation with external fixation for the treatment of open tibial fractures and concluded that 50% of

patients managed with plates needed reoperation while only 6.7% of patients in the external fixator group needed a further procedure. External fixation was favoured with regard to nonunion, deep infection and failures of fixation, and plates with regard to malunion. While comparing unreamed nails and external fixators, in a prospective randomised study on 174 patients with Grade II, III A and B fractures Henley et al [11] reported no difference in the infection rate or time to union. Intramedullary nailing was considered more efficacious because fewer additional procedures were required. Similar results were reported on twenty-nine patients with grade III B fractures in a prospective randomised study by Tornetta et al [12]. In prospective randomised series on thirty-six patients with Grade IIIA and B fractures Tu et al [13] reported a higher infection rate in nailed III B fractures, but higher non-union and malunion rates in externally fixed III B fractures. All the studies had as part of their treatment protocol, a bone-grafting procedure six to eight weeks after the initial surgery.

Conclusion

In conclusion our study suggests external fixator as a versatile implant in managing open tibial fractures. In situations where external fixators serve its purpose of stability without loosening and pin track infection and where patient compliance is good, these can be continued till there is bony union. In third world countries like India, Nepal, Sri Lanka, majority of the patients belong to lower socio economic class who cannot afford the necessary implants required for second surgery (internal fixation) after initial stabilisation with external fixators. Instead of switching over to internal fixation after primary stabilisation with external fixator, the fixator can be retained till there is bony union. If there is any sign of delayed union with the external fixator in situ, phemister bone grafting which is the gold standard procedure for delayed union is effective in augmenting bony union.

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