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Case Series

Immediate versus early soft tissue coverage for severe open grade III B tibia fractures: a comparative clinical study

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ABSTRACT

Controversy remains regarding timing in the management of grade III-B open tibia fractures. Many authors recommend an immediate definitive soft tissue coverage within a critical period of 12 hours, yet in many patients, this may be impossible due to concomitant injuries or delayed referral. The present case series aims to compare the role of immediate versus early soft tissue coverage for severe open grade III-B tibial fractures. 20 cases of tibial fractures of were divided into two groups; 10 cases each. Immediate group (within 12 hours) and early group (3-7 days), according to the soft tissue coverage time. Strict criteria for inclusion in the first group included debridement within 12 hours of injury, no sewage or organic contamination, the presence of bleeding skin margins, and the absence of systemic illness. All 20 cases had been treated by a debridement and soft-tissue cover with a muscle pedicle or fasio-cutanous flap. Functional outcome measures included deep infection rate, stable soft tissue coverage, number of inpatient's stays, number of surgical procedures, and union time. The mean follow-up period was 24 months. Mean inpatient time was 30 and 41 days respectively. Mean surgical procedures were 2.2 and 3.4 respectively and union time was 26 versus 34 weeks. Mean inpatient time, mean surgical procedures per time and union time were pointedly less in the immediate flap coverage group which significantly improves results concerning early union, healing time, and cost of hospitalization and rehabilitation.

Keywords: Grade III-B tibia fracture, Soft tissue coverage, Muscle pedicle flap, Fasciocutaneous flap

INTRODUCTION

Fractures of tibia and fibula are the most common long bone fractures. They are also the most common open fractures owing to the location of the tibia, which is subcutaneous and devoid of muscular envelope through its length. The decision tree for treatment is complex because, fractures of the tibia can range from completely un-displaced fractures with minimal soft-tissue damage, to traumatic amputations.

Fractures of the tibia that are open and high-energy are often accompanied by tissue loss, wound contamination, and compromised vascularity. These conditions often lead to amputation. The management of these severe injuries remains a challenge for orthopedic reconstructive surgeons. Studies have compared the timing of soft tissue coverage of Gustilo type III B open tibia fractures with associated outcomes such as rate of deep infection, primary union, length of hospitalization, flap failure, and eventual secondary amputation, but, controversy remains regarding timing in the management of grade III-B open tibia fractures.[1,2] Many authors recommend an immediate definitive soft tissue coverage within a critical period of 12 hours, yet in many patients, this may be impossible due to concomitant injuries or delayed referral.[1,3]

Gustilo type III open fractures are both a complex therapeutic problem and an economic burden because of the multiple operations needed and long recovery.[1,3]

General indications for flap reconstruction of the wound are exposed bone, blood vessels, nerves, tendons, and open joint cavity. Timing of the wound closure is an intriguing question for both reconstructive and fracture surgeons.[4] Publications on this topic are few, and randomized studies are difficult to perform. Primary wound closure in the Gustilo type III open tibial fractures should be done immediately after radical debridement. According to Godina et al, primary closure provides fewer complications, better postoperative results, shorter recovery time, and lesser economic burden than secondary soft tissue defect reconstructions, which are performed after 5 or more days based on second-look debridement.[5] Secondary reconstructions are related to the higher incidence of flap complications, osteomyelitis, number of surgeries, and longer time to recovery.[5]

DeLong et al have recently reported that there was no statistically significant difference in the incidence of osteomyelitis and delayed union/nonunion rates with respect to the timing of wound reconstruction.[6] Besides medical indications, the factor influencing the timing of wound reconstruction is the organization of trauma service, i.e., availability of prolonged use of operation room at any time.[3]

The present study aims to compare the role of Immediate versus early soft tissue coverage for severe open grade III-B tibial fractures.

CASE SERIES

20 cases of type III B tibial fractures were divided into two groups; 10 cases each. Immediate group (within 12 hours) and early group (3-7 days), according to the soft tissue coverage time. Strict criteria for inclusion in the first group included debridement within 12 hours of injury, no sewage or organic contamination, the presence of bleeding skin margins, and the absence of systemic illness. All 20 cases had been treated by a radical debridement and soft-tissue cover with a muscle pedicle or fascio-cutaneous flap. Functional outcome measures included deep infection rate, stable soft tissue coverage, number of days of hospital stay, number of surgical procedures, and union time. The mean follow-up period was 24 months.

In all 10 cases of the immediate group, flap coverage was done at the time of debridement and skeletal stabilization, within 12 hours of injury. 3 fascio-cutaneous flaps, 3 transposition flaps, 2 gastrocnemius flaps, one reverse sural flap and one soleus flap were used along with orthopedic procedures which included intra-medullary nailing in 4 cases and external fixator in 6 cases.

In the early flap group (10 cases), flap coverage was done in 3 to 7 days. 3 fascio-cutaneous flaps, 2 transposition flaps, 3 gastrocnemius flaps and 2 soleus flap were used along with orthopedic procedures which included intra-medullary nailing in 3 cases and external fixator in 7 cases.

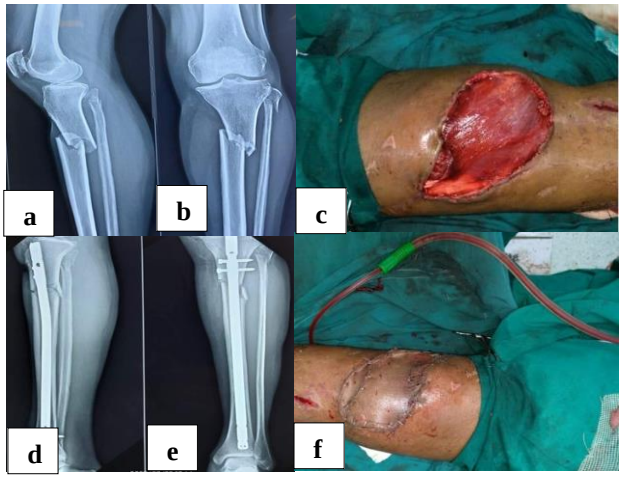

Figure 1: A case of type III proximal third tibia with fibula fracture treated by gastrocnemius flap and tibia nailing (a, b) pre-operative X-rays, (c) intra-operative image, (d, e) post-operative x-rays, and (f) post-operative image.

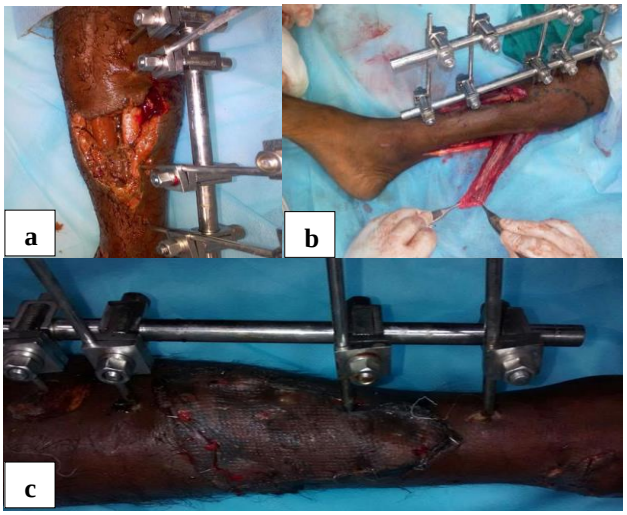

Figure 2: Case of type III tibia fracture with external fixator with soleus flap procedure (a) pre-operative image showing open wound and external fixator, (b) intra-operative image procuring soleus flap, and (c) post-operative image.

Statistical methods

Statistical testing was conducted with the statistical package for the social science system version (SPSS) 28.0. Continuous variables are presented as mean±SD, and categorical variables are presented as absolute numbers and percentage. The comparison of normally distributed continuous variables between the groups was performed using student's t test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher's exact test as appropriate. $P<0.05$ was considered statistically significant.

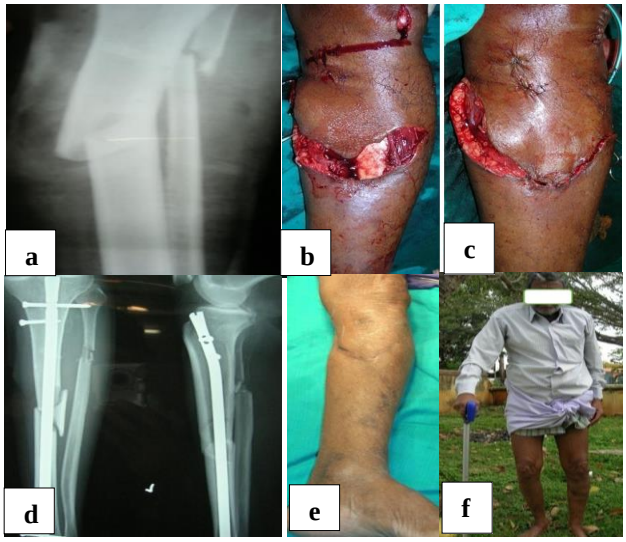

Figure 3: A case of type III tibia with fibula fracture treated with transposition flap and tibia nailing (a) pre-operative X-rays, (b, c) intra-operative image, (d) post-operative x-rays, and (e & f) after recovery images.

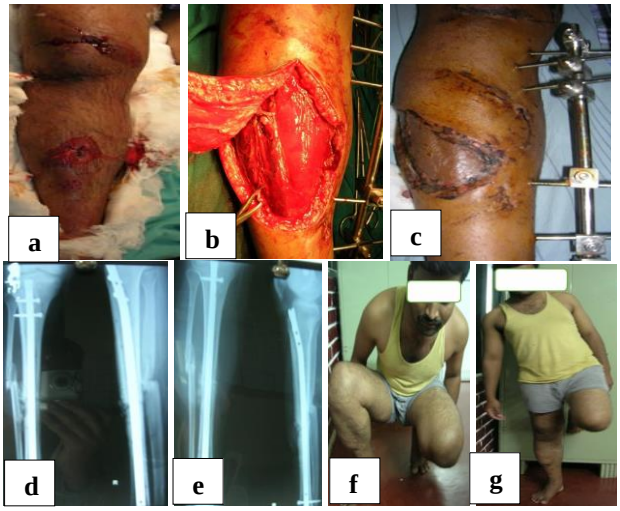

Figure 4: A case of type III tibia and fibula fracture treated with fasciocutaneous flap and external fixator followed by implant conversion to tibia nailing (a) pre-operative image, (b) intra-operative picture flap and external fixator, (c) healed soft tissue injury, (d) external fixator converted to tibia nailing, (e) X-rays showing bony union, and (f, g) clinical picture of patient after recovery showing good range of motion.

Results

It was observed that under group 1, mean age was 33.30±8.53 years while under group 2, mean age was 34.80±10.79 years. Further it was observed that there was no significant difference in mean age when group 1 was compared with group 2 (p value 0.734) (Figure 7). It was observed that under group 1, 50% of the patients were in age of 21-30 years while 30% of the patients were in age group of 31-40 years and 20% of the patients were in age group of >40 years. Similarly, it was observed that under group 2, 50% of the patients were in age of 21-30 years while 20% of the patients were in age group of 31-40 years and 30% of the patients were in age group of >40 years. Further it was observed that there was no significant difference in age group distribution when group 1 was compared with group 2 (p value 0.819) (Figure 8). It was observed that under group 1, 10% of the patients were Females while 90% of the patients were males. Similarly, it was observed that under group 2, 20% of the patients were females while 80% of the patients were males. Further it was observed that there was no significant difference in gender distribution when group 1 was compared with group 2 (p value 1.000) (Figure 9).

Figure 5: A case of type III lower third tibia fracture treated by reverse sural flap and tibia nailing (a) and (b) intra-operative images showing reverse sural flap, (c, d) pre-operative x-rays, (e) and (f) post-operative x-rays of tibia nailing, (g and h) post recovery clinical images.

It was observed that under group 1, mean in-patients time was 30.00±3.68 days while under group 2, mean in patient's time was 41.00±5.12 days. Further it was observed that there was a significant difference in mean in patient's time when group 1 was compared with group 2 (p value <0.001) (Table 1).

Table 1: Comparison of in patients time between two groups.

Variable	Group 1	Group 2	P value
	Mean±SD	Mean±SD	
In patients time (days)	30.00±3.68	41.00±5.12	<0.001**

**Signifies highly significant p value<0.001

In group 1 and 2, infection rate was one patient in each group but the second group had seven deep infections leading to delayed union. No cases of chronic osteomyelitis in the series. Soft tissue coverage was

achieved in both. It was witnessed that under group 1, mean number of surgical procedures was 2.20±0.79 while under group 2, mean was 3.40±0.97. Further it was observed that there was a significant difference in mean number of surgical procedures when group 1 was compared with group 2 (p value 0.007).

It was witnessed that under group 1, mean union time was 26.00±3.62 weeks while under group 2, mean union time was 41.00±5.42 weeks. Further it was observed that there was a significant difference in mean fracture union time when group 1 was compared with group 2 (p value <0.001) (Table 2). It was observed that under group 1, 90% of the patients were in 21-30 weeks while 10% of the patients were in 31-40 weeks. Similarly, it was observed that under group 2, 60% of the patients were in 31-40 weeks while 40% of the patients were in >40 years. Further it was observed that there was a significant difference in fracture union time distribution (weeks) when group 1 was compared with group 2 (p value <0.001) (Table 2 and Figure 10).

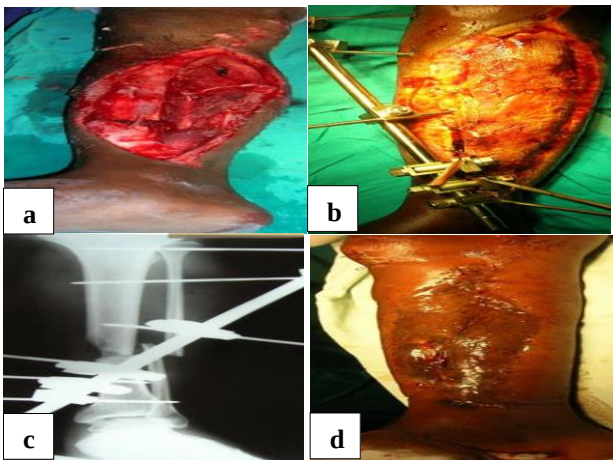

Figure 6: Case of type III tibia with fibula fracture treated with soleus muscle flap and external fixator (a) pre-operative clinical image, (b) post-operative image with flap and external fixator, (c) post-operative X-ray image, and (d) post recovery image.

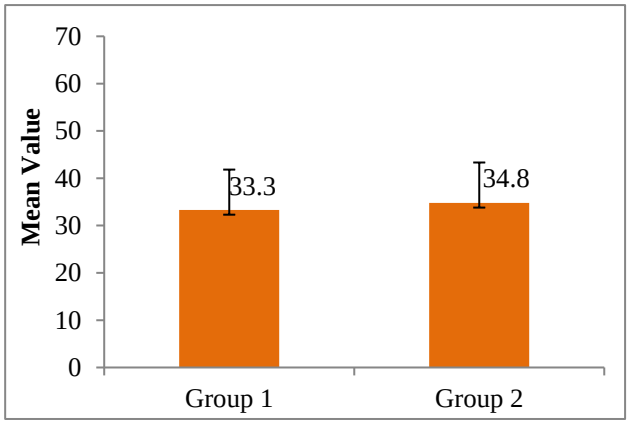

Figure 7: Comparison of mean age between two groups.

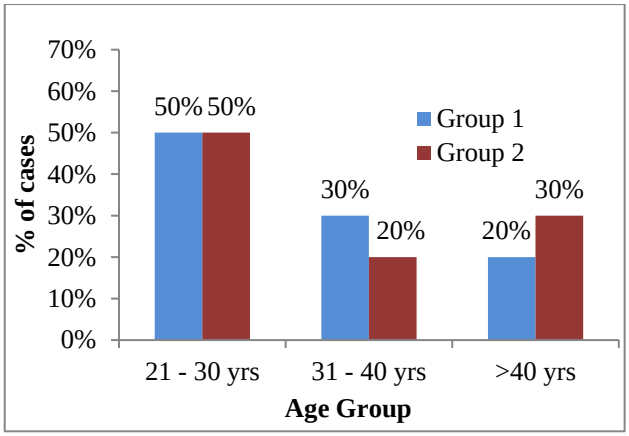

Figure 8: Comparison of age group distribution between two group.

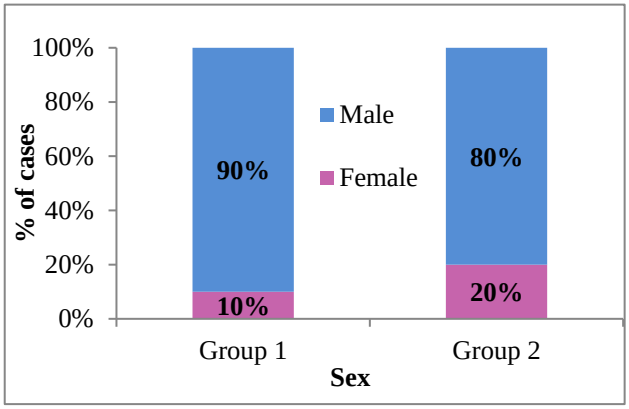

Figure 9: Comparison of gender distribution between two group.

Table 2: Comparison of fracture union time distribution between two groups.

Variable	Group 1	Group 2	P value
	Mean±SD	Mean±SD	
Union time (weeks)	26.00±3.62	41.00±5.42	<0.001**

**Signifies highly significant p value<0.001

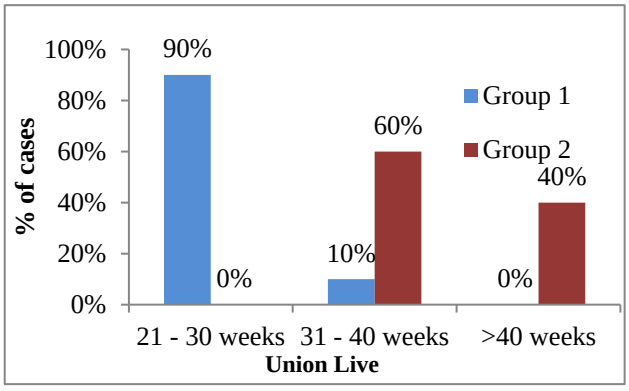

Figure 10: Comparison of union time distribution between two group.

**signifies highly significant p value<0.001

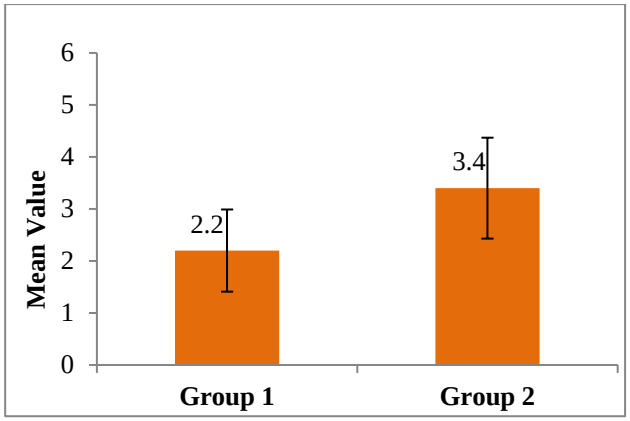

Figure 11: Comparison of mean number of surgical procedures between two groups.

**signifies significant p value <0.05

DISCUSSION

The management of the Gustilo type III B open fractures starts with assessment mode of injury, clinical assessment, radiological examination, and fracture classification.[1,7] The classification of fracture impacts the surgical management strategy as well.[8] There are numerous treatment guidelines advocated for Gustilo type III B open tibial fractures in the literature. They vary in the type of osteosynthesis, timing of soft tissue coverage, type of flap used, and method of treatment for bone defect. Indication for immediate or early soft tissue coverage was significantly more often influenced by the availability of the plastic surgery team. Delayed wound reconstruction was opted more often in cases where the treatment was started by a general surgeon or orthopedician without any microsurgical team support.[7] Our study included 20 cases of soft tissue coverage (10 immediate and 10 early) with the help of our operation theater unit which comprised of anesthetist, intensivist, orthopedic surgeon and a plastic surgeon. Management of all severe trauma cases required multi-disciplinary team approach.

The primary aim of management in all 20 cases was to cover the exposed bone with soft tissue, either by primary closure or by using flap. Surgical debridement (one radical debridement as a first procedure in all 20 cases and serial follow up debridement, as additional procedure to remove necrotic tissue, slough and infected zone) was done in all cases. After debridement, the presence of bleeding skin/tissue margins (zone of tissue viability and hyperemia) was considered, to decide upon the soft-tissue cover either with a muscle pedicle flap or fascio-cutaneous flap or by primary closure. Strict guidelines were followed for wound cleanliness including no sewage or organic contamination. Stalekar et al also stated that wound cleanliness is required for any type of wound closure or reconstruction.[7]

The need for wound and exposed bone coverage is the top demand of any surgical team as soft tissue coverage provides the paramount conditions for the healing of fracture and soft tissue gaps. In our study, dimensions of the soft tissue defect determined the selection of the flap type, as local flaps were used for minor defects and free flaps for larger ones. Similar protocols were used by Stalekar et al as well.[7] Also there was no statistically significant difference in the number of flaps and the flap types between the groups. Soft tissue coverage using flaps are usually the treatment of choice in type III tibal fractures and their usage ranged from 65% to 100% in different studies.[7,9-12] Our results support similar approach. We performed 3 fascio-cutaneous flaps, 3 transposition flap, 2 gastrocnemius flaps, one reverse sural flap and one soleus flap in immediate soft tissue defect group and 3 fascio-cutaneous flaps, 2 transposition flaps, 3 gastrocnemius flaps and 2 soleus flap in early soft tissue defect group. After a single radical debridement (immediate group cases) or repeated debridements (early group cases), when the wound margins and bone were feasible, it was necessary to cover the soft tissue defect with a definitive flap as it transformed the open fracture in to the closed one, thus providing the conditions necessary for fracture and soft tissue healing.[7,11]

We found no case of osteomyelitis in both of our study groups and no major complications, expect one case in group 2 study group, in which there was deep infections, leading to 5 debridement procedures and delayed union. No significant difference in the incidence of any major bone complications between the groups with immediate and early soft tissue coverage. In our opinion, long term and successfully complete removal of contaminated, devitalized or inflammatory changed soft tissue could be achieved by a single aggressive debridement in all patients. In a few cases we required serial thorough debridements to achieved the same goal. This is the main factor that contributed to no prevalence of osteomyelitis in both of our study groups.

DeLong et al treated 12 cases of grade III B open fractures by thorough debridement, stabilization and primary closure within 24 hours.[13] They found no significant increase in infection or non-union rate similar finding were observed in our study as well.

The total number of Gustilo type III open tibial shaft fractures with bone defect and type of residual bone defect depended on the method of debridement and timing of soft tissue coverage.[7] Aggressive radical debridement and immediate soft tissue coverage defined the number of cases with a bone defect and type of bone defect, which rarely changed during the successive treatment. Immediate soft tissue coverage prevented additional bone loss. Time to recovery was significantly shorter in patients with immediate soft tissue coverage. Repeated debridement contributed to the increased number of procedures, hospital stay and longer duration of soft tissue healing and bone union. In the early soft tissue coverage group of the lower leg, higher number of debridements were required. Every repeated debridement was carried to remove the superficial infection and necrotic tissue. Also second group of early soft tissue coverage as compared with

immediate soft tissue coverage group, the wound took more time for recovery and hence influenced the final result of injury healing time (p value <0.001) and hospital stay duration (p value <0.001). It in-turn affected the financial burden to the patient's families.

In the fix and flap technique by Godina et al, 532 complex open tibia fractures were treated and found that the incidence of flap failure and deep infection rate when treated within 72 hours (group 1) was 1% and 1.5% respectively as compared with surgical intervention after 72 hours (group 2, incidences were as high as 12% and 17.5% respectively).[14] Bone-healing time was 6.8 months in group 1 as compared to 12.3 months in group 2. The average length of total hospital stay was 27 days for group 1 and 130 days for group 2. The number of surgeries averaged 1.3 for group 1 and 4.1 for group 2. Similarly, in another study of fix and flap technique by Gopal et al, 84 grade III B open tibia fractures were treated and found that the incidence of deep infection rate when treated within 72 hours was 6% as compared to 30% with surgical intervention after 72 hours.[15] Both of these studies, support our findings that immediate soft tissue coverage along with fracture management can help us achieving early union, reduces number of hospital stay days and in turn reduces the financial burden in patients with type III B tibia fractures.

Hupel et al concluded in their study that limited reaming and insertion of loose fitting Interlocking intramedullary nail spares cortical circulation better and a biologically sound option especially for severe trauma cases.[16] Antich-Adrover et al stated that in cases of early conversion of external fixator to intramedullary nailing; the risk of sepsis is similar to that of primary intramedullary nailing.[17] In our study, we have 7 cases where we did primary intramedullary nailing and highlight the point that intramedullary nailing is a viable option even in cases of type III B tibia fractures.

CONCLUSION

There is no major difference in terms of infection rate and stability of the flap in both study groups but mean inpatient time, number of surgical procedures and union time was statistically significant finding in immediate flap coverage group which meaningfully improves end results with respect to early union, healing time, and cost of hospitalization and rehabilitation. Immediate soft tissue coverage of the wound after radical debridement prevents additional bone loss and the main reason for smaller total number of operations and shorter time to recovery. Management of all severe trauma cases required multidisciplinary team approach and We recommend randomized, prospective study of this aggressive approach.

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