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Original Article

Outcome of Soft Tissue Coverage in Open Tibia Fractures with Non-Microvascular Flap at a Tertiary Care Hospital

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Abstract

Background

Open tibia fractures are high energy injuries often associated with large soft defects, extensive soft tissue stripping and contamination requiring multiple debridement procedures. Collective ortho-plastic approach helps us achieve proper debridement, adequate fixation and early soft tissue coverage. Due to fairly high incidence of failure, steep learning curve, time consuming procedure and the cost of treatment for those tedious free flaps, non-microvascular flaps are being preferred to cover the soft tissue defects or exposed hardware in open tibia fractures.

Materials and Methods

A prospective study was carried out in 19 patients to assess the outcome of soft tissue coverage in open tibia fractures with non-microvascular flap. Out of these patients, 6 patients were treated with medial gastrocnemius flap, 5 patients with medial hemi-soleus, 5 patients with reverse sural fasciocutaneous flap, and 3 patients with local rotational random flaps. Outcome measures included bony union, deep surgical infection and flap failure.

Results

84% patients were male whereas 16% patients were female. Road traffic accident was the major cause of the defect among the patients (74%). Complications in the form of deep infection (10%), non-union (21%), delayed union (10%) and marginal flap necrosis (21%) were observed.

Conclusion

In our study, early soft tissue coverage with appropriate non-microvascular flaps in management of severe open fractures of tibia was associated with more favourable outcomes.

Keywords: *Open fracture, Debridement, Soft tissue injuries*

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Introduction

Open tibia fractures are usually severe injuries that occur in the setting of high-energy trauma, predominantly due to road traffic accident [1]. These injuries are isolated injury or part of polytrauma and often associated with large soft tissue defects, extensive periosteal stripping and contamination requiring multiple wound debridement procedures [2, 3]. These fractures have been a major challenge even for experienced orthopaedic surgeons, as they need aggressive debridement, adequate fracture fixation, and early flap coverage [4]. It is only possible when there is a collective ortho-plastic approach rather than the conventional orthopaedic approach where fixation of fracture gets the paramount importance [5]. Timely soft tissue coverage prevents bone desiccation, promotes healing, clears bacteria, and minimizes risk of infection [6, 7].

Soft tissue defect in open tibia fracture may require non-microvascular or microvascular flap. Non microvascular flaps are technically less demanding whereas microvascular flaps involves steep learning curve, time consuming procedure and available only in few centres in our part of the world [8]. Due to fairly high incidence of failure and the cost of the treatment for those time consuming and tedious free flaps, non-microvascular flaps are being preferred to cover the soft tissue defects or exposed hardware in open fractures [9, 10]. Practical knowledge of the local vascular anatomy to harvest appropriate local and regional flaps to cover the exposed fracture or hardware will help to manage a vast majority of such cases thereby reducing case burden in higher tertiary centre.

The aim of the study of open fracture of tibia treated by non-microvascular flaps was to analyse the final outcome in terms of time taken for union and complications.

Materials and Methods

This is a prospective study that was carried out in the department of Orthopaedics of Nobel Medical College Teaching Hospital, Biratnagar between periods of August 2019 to July 2021. This study was approved by the Institutional Review Committee of Nobel Medical College. The written and informed consent was taken from the entire patient participating in the study. The inclusion criteria were Gustilo III open fracture of the tibia with soft tissue defect that could be managed by non-microvascular flap. Open tibia fracture treated by split skin graft, requiring vascular reconstruction, bone loss, free flap or amputated before any reconstructive procedure were excluded from the study. All the patients fulfilling the inclusion and exclusion criteria over the period of two years were included for study by consecutive sampling technique.

The method of fracture treatment was determined mainly on the basis of fracture personality, their time of presentation, farm yard or gutter contamination, and adequate debridement [11]. All open fractures presenting in acute period were treated with adequate debridement and definitive fixation, whereas those with delayed presentation were initially managed with debridement and external fixation followed by secondary definitive fixation after wound coverage and control of infection. A total of 212 tibia fractures, including polytrauma, came to emergency department of Nobel medical college, Biratnagar, out of which 23 patients had Gustilo grade III open fractures during our study period. Out of 23 patients, 3 patients required free flap and vascular reconstruction, whereas 1 patient was lost to follow up. Hence, 19 patients were included in our study. Initially 15 patients were classified as Gustilo IIIA fractures after first debridement but later on full thickness skin necrosis were seen and reclassified as Gustilo IIIB after repetitive debridement. Staged treatment with external fixator followed by definitive internal fixation was done on 12 patients, rest of the patients were treated with early definitive fixation. The commonly followed protocol to cover the soft tissue defect was to use gastrocnemius muscle flap for upper third leg, hemi-soleus muscle flap for middle third leg and reverse sural fasciocutaneous flap for lower third leg but whenever possible, local rotational flap was done. In our study, out of 19 patients, 6 patients were treated medial gastrocnemius flap, 5 patients with medial hemisoleus, 5 patients with reverse sural fasciocutaneous flap, and 3 patients with local rotational random flap (Fig 1).

After adequate debridement and stabilisation of fracture, flap was planned according to the location, size and soft tissue status of the leg. For medial gastrocnemius or medial hemisoleus flap, incision was designed in such a way that incorporated the wound. Medial gastrocnemius muscle was separated bluntly from underlying soleus, sharply divided from aponeurosis distally with 1cm cuff of tendoachillis attached to the flap and detached from midline raphe (fig 2)[12]. Medial hemisoleus muscle was separated from overlying gastrocnemius, underlying deep posterior compartment, from tendoachillis distally leaving the tendinous portion and from lateral hemisoleus in midline(fig 3). Major pedicles located at 12cm and 14 cm from knee joint were protected

which act as pivot while rotating the flap for insetting [13]. All the raw areas were covered with split skin graft after adequate hemostasis and application of drain. The reverse sural artery pedicle flap is based upon consistent perforating artery from the peroneal vessels which is located 5cm proximal to the tip of the distal fibula posteriorly which acts as pivot point. Surgery was done on prone position with appropriate elliptical fasciocutaneous flap having adequate pedicle width (4cm) and length raised from proximal to distal direction (Fig 4) [14, 15].

Post-operative protocol was non weight bearing mobilisation and foot elevation with adequate padding till the flap settled. Patient was discharged within 7 days once skin graft suture was removed. Toe-touch to partial weight bearing from 1 month and full weight bearing as tolerated after 2-3 months based upon healing seen on x-ray on subsequent follow up. All the data were collected, compiled and entered in MS EXCEL and analyzed by using SPSS version 23.

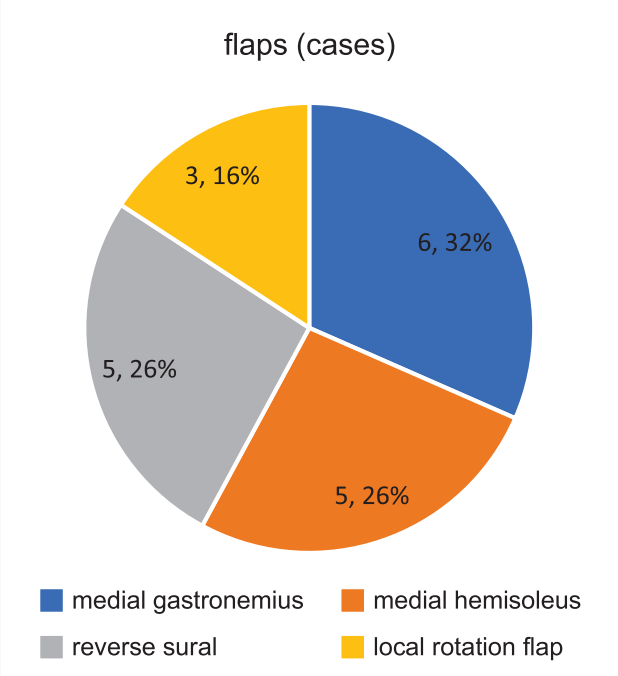

Figure 1: Pie-chart showing different flaps operated

Results

Over the study period, a total of 20 flaps were performed out of which 1 patient was lost to follow-up. Their age ranged from 18 to 60 years with mean age of 31 years. 84% patients were male whereas 16% patients were female. Road traffic accident was the major cause of the defect among the patients (74%). The proximal leg defects (42%) were managed with medial gastrocnemius flap in 6 patients and proximally based fasciocutaneuos rotation flap in 2 patients, the middle leg defects (26%) were managed with medial hemisoleus flap, and the distal leg defects (32%) were managed with reverse sural flap in 5 patients and local rotation flap in 1 patient. Staged treatment with external fixation followed by definitive fixation was done in 12 patients (63%). The earliest flap was done on 7th day with range from 7th to 15th day. Average numbers of debridement before flap was 3. The fracture union time was 12 to 20 weeks with mean of 16 weeks. Complications in the form of deep infection (10%) , non union(21%) , delayed union (10%) and marginal flap necrosis (21%) were observed (Table 1)

Table 1: Post-operative Complications

S.N.	complications		Numbers of patients(%)
1.	Infection	superficial	3(15)
		deep	2(10)
2.	Non union		4(21)
3.	Delayed union		2(10)
4.	Marginal flap necrosis		4(21)

Superficial infection was managed conservatively with dressing. Two patients had infected non-union which were treated with wound debridement and external fixation followed by nailing. Two patients with aseptic non-union were managed with exchange nailing. Delayed union was managed with dynamization. Marginal flap necrosis was observed in reverse sural flaps which required debridement and closure.

Figure 2 : Medial gastrocnemius muscle flap. a)open tibia fractures with skin flap necrosis with external fixator in situ. b) medial gastrocnemius flap raised. c) internal fixation and flap covering the soft tissue defect. d) healed flap.

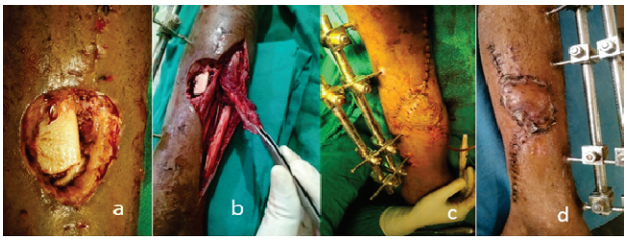

Figure 3: Medial hemi soleus flap. a) exposed fractured tibia after debridement. b) medial hemi soleus flap raised. c) soft tissue defect covered with medial hemi soleus flap with external fixator in situ. d) well settled medial hemi soleus flap

Figure 4: Reverse sural fasciocutaneous flap. a) full thickness skin necrosis over distal leg. b)after debridement of same wound. c) soft tissue defect covered with reverse sural fasciocutaneous flap. d) Well settled reverse sural fasciocutaneous flap.

Discussion

Management of open tibia fractures with skin loss requires holistic approach involving thorough debridement, early bone fixation and wound coverage for fast bone union, early mobilisation, lower infection rate and hospitalisation costs. Open tibia fractures with less severe soft tissue injuries (Gustilo grade I to grade IIIA) have relatively favourable outcome because of simpler soft tissue components which could be managed either by primary closure, delayed primary closure, or with split thickness skin grafts [8]. Severe open fractures (Gustilo grade IIIB and IIIC) require complex soft tissue coverage which can be managed using viable tissue available locally, regionally or from a distant location. Free flaps are often associated with high infection rates, non-union, flap failures, prolonged hospital stay and financial burden [16]. Majority of the wounds associated with open tibia fractures can be covered by orthopaedic surgeon using local regional flaps in the form of proximally or distally based perforator fasciocutaneous flaps, muscle or myocutaneous flaps and cross leg flaps. Soft tissue defect in distal part of tibia is real challenge for reconstructive surgeon because of limited availability of local flap. The need for free flap or microvascular flap in the management of these open fractures can be restricted to few large wounds where local regional flaps are not possible. Timing of soft tissue coverage is still a subject of controversy but acts as a critical determinant for better outcome [17, 18]. Early soft tissue coverage minimizes the risk of osteomyelitis and fracture non-union. Benefits of early management of open fractures with fix and flap concept is quick healing, early mobilisation and significant reduction of infection and can avoid complication associated with open wound therapy. Early soft tissue coverage can be opted safely if criteria led by Rajasekaran et al are followed [11, 19].

In the past, the reconstructive approach to soft tissue defects used to be step-wise process stating with simple, local measures or skin grafting prior to progressing to more complex procedure such as free flap."Reconstructive ladder approach" has been replaced by the so-called "reconstructive elevator" bypassing less effective local procedures and proceeding directly to local or free flap coverage of soft tissue defects [20]. Definitive fracture fixation versus staged treatment is considered after accounting different variables including fracture personality, contamination level, vascular insult, wound size and character, and the overall physiological status of the patient. Non-microvascular soft tissue coverage options include fasciocutaneous or muscle flaps. Fasciocutaneous flaps offer excellent soft tissue coverage in non-degloving injuries and their advantages are close to the soft tissue defect, reliable, easy to harvest, good contouring of the defect and one time definitive soft tissue cover without sacrificing healthy and functioning muscle. In contrary, muscle flap may be necessary for larger and more complex soft tissue defects because they are able to obliterate dead space. Large studies with long term follow up showed no difference in bone healing or infection rates with the use of either fasciocutaneous or muscle flap [21, 22].

The rate of complications was lower in patients who had soft tissue reconstruction as early as possible [19, 23]. Incidence of deep infection was 10% whereas primary union rate was 79% in our study which is comparable to previously reported series [8, 24]. The results of this study suggests that good bone healing, minimal soft tissue complications and early functional recovery can be achieved by early debridement, stable fixation and immediate soft tissue coverage with ipsilateral muscle or fasciocutaneous flap whichever is feasible. Hence, basic knowledge of local vascular anatomy and non-microvascular flaps help orthopaedic surgeons manage the severe open tibia fractures with ortho-plastic approach and only few cases require plastic surgeon to cover the soft tissue defect with free flap.

The limitations of our study are limited study population, no control group, only non-micro vascular flaps included and no negative wound pressure therapy was used.

Conclusion

In our study, early soft tissue coverage with appropriate non-microvascular flaps in severe open fractures of tibia was associated with more favourable outcomes. Optimal management of open tibia fractures require timely administration of systemic antibiotics, radical debridement,

stabilisation, and early soft tissue coverage for better functional outcome.

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Conflict of interest: None

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