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Open Tibial Fracture: The Treatment of Soft-tissue Defects of the Lower Leg after a Trauma

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Abstract

The large soft tissue defect in the lower leg and its treatment remain a challenge. The most suitably available type of tissue, the surgery timing, and the decision between free flap or local for the coverage still remain the subject of debate. One hundred and four patients were managed with a free flap or local cover for a lower leg soft-tissue defect. We compared the outcomes after treatment with free flaps versus local and musculocutaneous flaps versus fasciocutaneous flaps. In this study, we also compared the results of our patients according to the timing of the surgery: patients managed within 3 days after the trauma versus patients managed after 3 days.

Thirty-four patients (32.69%) were presented with chronic osteomyelitis and treated accordingly. Seventy patients (67.30%) with posttraumatic soft-tissue defects have been treated because of insufficient fracture coverage. The statistically significant difference in complications was not observed in free and local flaps in our study. Postoperatively. In our study group, patients managed with a musculocutaneous flap were associated with less postoperative complications than fasciocutaneous. In the number of revisions after treatment with a free flap, a significant increase could be demonstrated in the results after early or late flap coverage. There was no significant difference observed. Equal outcomes were observed in patients treated with free flaps or local flaps except local flaps, which required a lesser number of revisions postoperatively. Regarding postoperative complications, Musculocutaneous flaps are preferable over fasciocutaneous flaps. The operation timing is not to be proved a discriminating factor.

Keywords: Tibial fracture, Leg, Soft-tissue defects, Fasciocutaneous flap, musculocutaneous flap.

INTRODUCTION

Tibia bone fractures are types of fractures that commonly have an open wound with tissue necrosis or loss. Owing to its superficial position and the lack of proper soft tissue coverage, the lower leg is relatively badly supported by soft tissue. These large, soft-tissue defects remain a challenge for both the specialist reconstructive surgeons and orthopaedic surgeons. For both the damaged or loss of bone, fracture, and soft tissue

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loss, a simultaneous approach is needed. Traffic accidents (bicycle, motor, car, accidents), outdoor falls, and sports are most frequently causes of fracture.

In open fractures of the tibia, there is a high incidence of infection and malunion.[1,2] Formerly, for severe lower leg injuries, primary amputation was often used in the first-line treatment.[3] Early fracture stabilisation is essential and can be achieved by means of external fixation, plates and screws, and unreamed or reamed tibial nails. Evolution in the field of reconstructive techniques and osteosynthesis has led to recent treatment options. A thorough debridement combined with stabilisation is essential for further treatment.[4,5]

Regarding the ideal timing of the operation of soft-tissue defects and adaptability between a free or local approach for the suitable type of tissue, they still remain under discussion. Previously, studies described how they recommend different strategies and different outcomes. In this retrospective study, through an analysis of our material, we have tried to contribute to this discussion.

Patients and methods

In our study, 104 patients were treated with a local or free flap following a traumatic open fracture of the lower leg between January 2020 and March 2024. All patients were treated at a tertiary care and academic hospital. Data was gathered by reviewing patient electronic patient records, charts, and operative reports.

The patients were divided into two groups in this study. In the first patient group, patients with posttraumatic soft-tissue defects were treated with insufficient fracture coverage or primary reconstruction. Patients with chronic osteomyelitis that appear after trauma were included in the second group. In this study, we compared the outcomes after treatment with free flaps versus local and fasciocutaneous flaps versus musculocutaneous flaps. We also compared the results according to the timing of the operation. In the case of primary reconstruction, patients treated within 3 days after the trauma versus patients treated after 3 days.

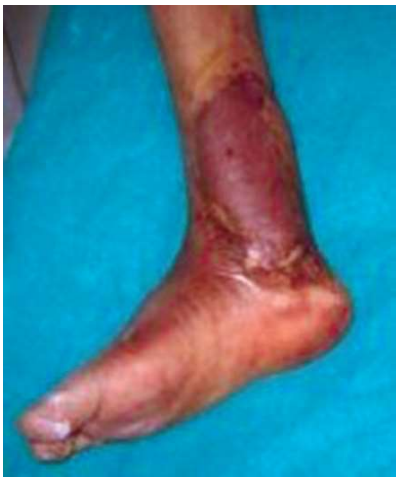
The outcome of the procedure was assessed according to the number of postoperative complications, e.g., haematoma, infections, or haemorrhage, and dehiscence; partial and complete flap revisions or failures; secondary amputations; the length of the hospital stay; and regaining preoperative mobility. In the second group, the number of relapses of osteomyelitis was also assessed as a factor for outcome. Some pictures of patients and their outcome. (*Fig. 1*)

The statistical evaluation was performed using the chi-square test. We used the Mann-Whitney test. A p value of <0.05 was considered statistically significant as far as the hospital stay is concerned.

RESULTS

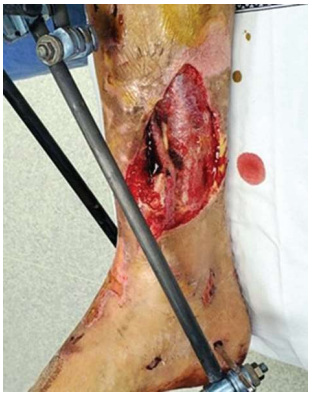
With a total of 78 men and 26 women, by far the most represented gender was male. The mean age was 44.50 years (range, 15–79 years). *Table 1*. Shows lower leg trauma causes. In the entire study group, 34 (32.69%) patients were treated because of chronic osteomyelitis that arose after the trauma, and 70 (67.30%) patients were treated because of posttraumatic soft-tissue defects and, therefore, insufficient fracture coverage or primary reconstruction.

(a)



(b)


(c)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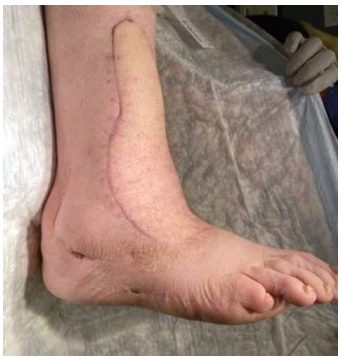
(i)

Fig. 1: (a) Pictures right lower leg trauma after a traffic accident operated on within 24 h with a free vascularised gracilis muscle flap, **(b**) Postoperative results after gracilis muscle transfer and skin grafting after 2 months of surgery, **(c)** Fractured bones right lower limb, **(d)** Debridement and external fixation of fracture, **(e)** Free vascularised fascio-cutaneous flap reconstruction, **(f)** Fracture tibia, **(g)** Local flap, **(h)** Immediate post-op local flap, **(i)** Results of local flap after 2 months

Table 1: Causes of lower leg trauma

Motorbike	30
Car	24
Bicycle	10
Pedestrian	8
Aeroplane	2
Carriage	2
Work-related accidents (17%)	
Agriculture machine	8
Forklift truck	6
Ship wharf	4
Other (10%)	
Shooting	2
Grenade	2
Sporting	2
Unknown	4

In total, 40 free flaps and 64 local flaps were used for reconstruction. Free flaps are more frequently used in the treatment of distal third fractures of the tibia because of the limited possibilities for local reconstruction. As can be expected (*Table 2*).

Table 2: Summary of transferred flaps

Location of the defect	Transferred tissue	Number
Proximal third	Local	22
	Gastrocnemius	20
	Fasciocutaneous	2
	Free	4
	Latissimus dorsi	4
Middle third	Local	16
	Soleus	12
	Sural	4
	Free	8

Location of the defect	Transferred tissue	Number
	Anterolateral thigh flap (ALT)	2
	Gracilis	2
	Rectus abdominis	2
	Latissimus dorsi	2
Distal third	Local	26
	Sural	16
	Fasciocutaneous	6
	Tibialis anterior*	2
	Flexor hallucis longus*	2
	Lateral calcaneal artery flap	2
	Free	28
	Rectus abdominis	10
	Gracilis	8
	ALT	6
	Latissimus dorsi	4

C*Both muscle transfers were used on the same patient in the same session.

In the entire study group, 32 patients (31%) developed a postoperative complication, which consisted of haematoma (10%), haemorrhage (2%), flap dehiscence (4%), or infection (23%). Partial flap discoloration occurs in twelve patients (12%), after which the necrotic skin is resected. Complete flap necrosis occurred in sixteen patients (15%). In six patients (6%) a secondary lower leg amputation had to be performed. One or more revisions were performed in thirty patients (29%). Eighty-two patients (84%) regained their preoperative mobility, and eight patients were limited to some extent after treatment. In six patients, mobility could not be assessed because they lost follow-up shortly after discharge from the hospital. The median length of hospital stay was 16 days (range, 4–128 days).

Primary reconstruction

A primary reconstruction was performed in 70 patients. Fourteen patients (20%) had a defect localised at the proximal 1/3 of the tibia, fourteen patients (20%) had at the middle third, and 42 patients at the distal third of the tibia (60%). Gustilo classification, as shown in *Table 3*, is an overview of the initial examination at the emergency room. A local flap was done in 42 patients (60%), and 28 patients (40%) were treated with a free flap. Thirty patients (43%) underwent a fascio-cutaneous flap transfer, and 40 patients (57%) a musculocutaneous flap transfer was used.

Table 3: After the initial survey at the emergency room, Gustilo classification

Grade.	Percent
I	11
II	17
III a	20
III b	43
III c	9

The duration between the trauma and the surgery was 27 days, with an average duration of 11 days (range, 0–176 days). Two patients were treated after 6 months because of the development of compartment syndrome and late muscle necrosis of the lower leg. Some patients, because of their initially critical condition, operated on after several days. Most of these patients were polytrauma patients with a long intensive care unit stay and initial treatment for other (life-threatening) injuries. Within this group, only 24 patients were diagnosed with just a lower leg injury. Other patients were diagnosed with other fractures, pneumothorax, intra-abdominal injuries, head or brain injuries, and. Fixation of the fracture was performed after the initial trauma screening either directly or at a later stage. The fracture was stabilised by means of an external fixator in 30 patients (43%), a plate and screw fixation in 22 patients (31%), and an intramedullary nail in nine patients.

A haematoma developed in ten patients (14%) as a postoperative complication. Two patients (3%) had a haemorrhage, eighteen patients (26%) developed an infection, and four patients (6%) had a dehiscence of their flaps. In eight patients (11%) debridement was done because of a partial flap failure and in twelve patients (17%) because of complete flap necrosis. Eventually, four patients (6%) underwent a secondary amputation. *Table 4* shows the outcomes of local and free flaps and fascio-cutaneous and musculocutaneous flaps in the entire study group.

Table 4: Outcomes of local and free flaps and fascio-cutaneous and myo-cutaneous flaps

	Local flaps (N = 64)	Free flaps (N = 40)	p value	Fascio-cutaneous (N = 38)	Musculo-cutaneous (N = 66)	p value
Total complications (%)	28.12	35	0.601 χ	47.42	21.20	0.0490 χ
Infection (%)	21.90	25	0.795 χ	26.32	21.20	0.680 χ
Complete flap failure (%)	9.40	25	0.129 χ	21.10	12.10	0.389 χ
Partial flap failure (%)	12.52	10	0.784 χ	15.82	9.20	0.465 χ
Secondary amputation (%)	3.12	10	0.301 χ	10.50	3.10	0.265 χ
Revisions (%)	18.80	45	0.042 χ	26.32	30.2	0.759 χ
Regaining mobility (%)	86.20	75	0.319 χ	81.33	81.9	0.963 χ
Length of hospital stay (median, days)	13.52	31.1	0.085 M	16	17	0.280 M

X chi-squire test, M Mann-Whitney test.

Osteomyelitis

Twelve patients (35%) had a defect located at the proximal third of the tibia, twelve (36%) at the distal third, and ten (29%) patients at the middle third. Chronic osteomyelitis occurred in 34 patients after the initial trauma. A free flap was used in twelve patients (35%). A local flap was applied in 22 patients (65%), and 26 patients (76%) underwent a musculocutaneous flap transfer. Eight patients (24%) underwent a fascio-cutaneous flap transfer. None of the patients developed a haemorrhage, haematoma, or dehiscence of their flap as a postoperative complication. Four patients (12%) underwent debridement because of a partial flap failure, and four patients (12%) because of complete flap failure. Six patients (18%) developed an infection. A recurrence of osteomyelitis was noted in six patients (18%). A secondary amputation was performed in two patients (6%) because of a recurrence of chronic osteomyelitis.

DISCUSSION

In recent times, a lot of advancement has occurred in the field of surgery in the treatment of soft-tissue defects after open fractures of the lower leg. The unlimited supply of tissue and introduction of free flaps provide for reconstruction. Early treatment is advocated and more widespread after the introduction of improved techniques for fracture stabilisation and antibiotic prophylaxis.

Serial debridement's is preferred before definitive treatment advocated of delayed flap coverage refers to the expansion of the zone of injury.[4, 6] Distal one-third wounds of the leg remain a challenge for the traumatologist and plastic surgeon because of the limited possibilities for local muscle availability and its transposition. Other studies recommend initial treatment with a vacuum-assisted closure system. These studies describe VAC (vacuum-assisted closure) being applied either as a bridge to surgery by reducing the wound area and inducing tissue granulation or as a definitive treatment in combination with skin grafting.[4,7,8] But as shown in *Table 2*, free flaps are commonly used for defects of the distal third and often remain the ideal option for treatment.

Statistically significant differences were not noted when comparing the results after free flap coverage and local flap coverage in our study group, except for the for the statistically lower number of revisions after treatment with a local flap. Better results were observed in patients treated with local flaps on almost every other aspect, but these differences were not significant. When comparing free flaps from a non-traumatised region of the body, they would perform better than a local flap within the damaged lower leg. On the other hand, free flaps remain the ideal option for reconstruction, practically, for large or serious defects, whereas in smaller defects or less serious defects, local flaps can be used. Because free flaps are a long and costly procedure, a specialised team of traumatologists and plastic surgeons is required, and free flaps are commonly associated with more postoperative complications, the preference for treatment with local flaps has to be considered.[10,11] In this study, patients treated with a free flap did have a higher Gustilo classification, which in turn is associated with a higher infection rate.[9] Complications in the patients treated with a musculocutaneous flap when compared with the

treatment of fasciocutaneous flaps were statistically lower amounts postoperatively (*Table 4*). Better outcomes were observed with musculocutaneous flaps in patients treated with osteomyelitis in every aspect, but these numbers were not significant because of the small number of patients.

Musculocutaneous flaps reduce the risk of infection by providing improved circulation and oxygen transport to the wound and filling up wound dead spaces. Contrary, fasciocutaneous flaps provide a better functional and cosmetic result, especially when related to defects located at the distally in one third of the lower leg.[12,13] Previous, and older, studies show an increase in infection after early primary closure of wounds and, therefore, they prefer delayed closure.[14] But in this study, we could not find a statistical difference regarding the timing of the operation. A lot of other studies show a reduced postoperative infection and other complications after early flap coverage.[15–17,18] In this study, treatment within 3 days after the trauma did not result in a significant increase in postoperative complications such as infection or flap failure. A possibility of bias in our study could be the fact that patients treated after 3 days often could not be operated on at an earlier stage because of long intensive care unit stays or other comorbidities. These patients are assumed to be at a greater risk of developing postoperative complications. In this study, the plastic surgeon was often not consulted directly after the trauma, and this policy makes it impossible to treat patients who are candidates for treatment within 3 days.

CONCLUSION

Patients with large or serious soft-tissue defects of the lower leg where local reconstruction is impossible are treated with free flaps, and it remains the only option for reconstruction. If the size and location of the defect are small after a traumatic and open tibial fracture, it should be initially managed with a local, fasciocutaneous, or musculocutaneous flap whenever necessary. For further treatment down the reconstructive ladder has to be considered by using vacuum-assisted closure to obtain a surface area suitable. To determine if patients are candidates for early flap coverage The plastic surgeon should be consulted at an early stage in the management.

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