COVERAGE OF THE LOWER 1/3 OF EXPOSED TIBIAL DEFECT: A PROSPECTIVE STUDYAnand Narayan Gautam¹, Vijay Y. Bhatia²**HOW TO CITE THIS ARTICLE:**

Anand Narayan Gautam, Vijay Y. Bhatia. "Coverage of the Lower 1/3 of Exposed Tibial Defect: A Prospective Study". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 07, January 22; Page: 1173-1183, DOI: 10.14260/jemds/2015/165

ABSTRACT: Reconstruction of soft tissue defects of the lower third of the leg continues to challenge the plastic surgeons seeking a safe repair with minimal morbidity. Traumatic lesions involving the lower extremity have become a common occurrence and the ever increasing vehicular accidents in our crowded cities are their main cause. The goal in treatment of open tibial fractures and lower extremity is to provision of intact, supple skin cover and preserve a limb that will be more functional than an amputation. If the extremity cannot be salvaged, the goal is to maintain the maximum functional length. **RESULT:** Perforator based fasciocutaneous flaps and sural neurocutaneous flaps are the flaps of choice for reconstruction in this region. **CONCLUSION:** Ipsilateral fasciocutaneous flaps score over other flaps in being single staged, rapid and easy and they do not compromise the vascularity of the limb.

KEYWORDS: flap, lower limb defect, tibia and soft tissue.

INTRODUCTION: Soft-tissue defects in the lower third of the leg presents a considerable problem because of inadequate and tight local tissue for reconstruction with poor circulation. Involvement of composite tissues with or without weight bearing areas often requires coverage by flaps. Various methods have been described, including primary suturing, skin grafting to local, distant, and free flaps with their indication, limitations, advantages and disadvantages. The evolving technology in trauma management today permits salvage of many severe lower extremity injuries previously even considered to be lethal.

Treatment of high energy lower extremity trauma with soft tissue and bone injury remains a formidable problem. Treatment requires a team approach with the orthopedic, vascular and plastic surgeon. The plastic surgeon has to face a variety of special problems in dealing with defects of the leg. The management becomes more difficult in more distal defects.

Certain unique features should be understood while attempting reconstructive surgery in lower extremity. The subcutaneous location of the tibia hazards of reconstruction in this region. The major problem is the poor vascularity and limited mobility of the skin. Tendon, bone and implant are frequently exposed because of the thinness of subcutaneous tissue. The subcutaneous location of the tibia poses unique problems in fracture healing because of its poorly vascularised environment. However adequate function can be restored if soft tissue cover and protective sensation is provide on a stable limb.

The classic reconstructive ladder may be a helpful guide but it should not be the sole criterion in planning. Healing by secondary intention or skin grafting will not give adequate soft tissue cover as needed in some areas of the lower limb. In other words, one need not start at the bottom of the reconstructive ladder and work through failure, and then plan a transfer that what indicated at the outset.

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The experience with the use of these reconstructive options is developing in various centers. However, still the indications, the selection of a particular technique for the different cases are not well established and are rather a matter of personal judgment. The aim of the present thesis is to study the different reconstructive options for management of exposed tibial defects.

MATERIAL AND METHODS: A total of 45 cases of defects in lower one third tibia that were treated in the department of plastic surgery over a period of 30 months from August 2010 to January 2013 constitute the material of this study. All raw areas that resulted due to acute burns were excluded from the study. The collected data was entered in Performa and then analyzed.

Patient's data including age, sex, site of injury, mode of injury, extent of injury (isolated or combined), type of wound and prior management of wound were noted. In cases with post traumatic defects with fractures, the fixation of fractures was done by orthopedic unit. Perforators were identified prior to surgery by hand held Doppler in all the cases.

PRELIMINARY MANAGEMENT: Diabetes and Hypertension, when present, were treated appropriately to control. Surgical debridement and regular dressings are the keys to successful control of infection. All foreign particles, necrotic muscle dead bone were removed during the debridement:

- Skeletal stability and restoration of the circulation of the injured limb was achieved.
- Physiotherapy was carried out while the patient was being built up for operation.
- The operative procedure was planned keeping in mind the following factors;
 1. The site of the lesion.
 2. The size of the lesion.
 3. Type and quantity of tissue loss.
 4. The age of the patient.
 5. The condition of the joints.
 6. The availability of donor sites.
 7. The nature of circulation at the donor and recipients sites.

TREATMENT BY FLAP COVER: The wounds, which were not suitable for grafting, underwent flap cover. Various types of flaps were planned keeping all criteria like site size, tissue loss etc in mind.

Flaps were chosen based on the principle of minimal morbidity and collateral damage. It was attempted to avoid functioning muscle scarifies, preserve cutaneous nerve/vessel and follow esthetic needs.

Based on the septocutaneous perforator of posterior & anterior tibial artery and peroneal artery skin with fascia as fasciocutaneous flap was raised as superiorly (proximally) based, inferiorly (Distally) based fasciocutaneous flap from the same leg (Ipsilateral) or from the opposite (Contralateral) leg (Cross leg flap). In the doubt of vascularity flap was delayed before actual raising and inseting the flap. Donor site from where the flap raised, was covered with skin graft harvested from the thigh. Graft and the limb were immobilized with plaster of paris slab. Graft dressing was done on 5th post-op day and flap sutures were removed on 14th post-op day. In case of cross leg flap, flap division and inset was done on 21st day. Patients were followed up bi-weekly and all the complications were recorded.

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SPLIT SKIN GRAFTING: Minority of the patients underwent grafting. This grafting was either a definitive treatment (Small part of bone exposed with intact periosteum with good healthy granulation tissue surrounding wound) or as a prelude to definitive treatment.

POST OPERATIVE MANAGEMENT: The essentials of postoperative management are:

- Prevention of infection.
- Alleviation of pain.
- Immobilization of certain joints and mobilization of others.
- Elevation of the limb.

DISCUSSION: The provision of skin cover for injuries in lower third of leg is a tough problem. The poor vascularity, dependent position and dearth of locally available tissues are responsible for creating difficulties in reconstruction.

The most common age group involved was the second and third decade in our study. The same was the case with study Dickson et al conducted at regional plastic surgery centres of Bradford and Leeds.¹ The male: female incidence is 8:1 in our series. There is a large variation in this. It shifts from as high as 2:1 in Hallock's evaluation of his cases² to as low as 8:1 in Padmakumar et al.

In our study of 45 patients, 16 had exposed underlying bone and 16 with exposed fracture site. All of these patients underwent flap surgery. In Rajacic et al's study³, 8 patients had underlying fracture out of a total of 21 patients (38%).

5 patients were suffering from diabetes mellitus in our study, 13 patients had a habit of smoking and 7 tobacco chewing. Smoking and tobacco chewing had a significant bearing on the survival of flap. One of the patients who had complete flap loss and four of the patients with partial flap loss were smokers and diabetic. One patient with diabetes had complete graft loss. One patient who was alcoholic and uncooperative postoperatively had partial flap and graft loss. Rajacic in his study of 21 patients had one patient of diabetes whose flap died completely. Tobacco smoke contains more than 4000 chemicals, including nicotine and carbon monoxide, both of which are deleterious to wound healing. Nicotine is vasoactive, induces endothelial injury, decreases capillary flow, and stimulates catecholamine and the release of thromboxane A₂. These effects result in thrombogenesis, decreased oxygen delivery, microvascular injury, impaired wound healing, and leukocyte, macrophage, fibroblast, and platelet dysfunction. Carbon monoxide binds to hemoglobin to form carboxyhemoglobin and leads to hypoxia.

In our study 41 patients (91%) required flap cover for their defects. Most common flap performed was inferiorly based fasciocutaneous flap 17 out of 45 (37.7%) patients. All of these flaps were inferiorly based. Only 3 flaps (17%) had necrosis. These results show that local fasciocutaneous flaps are simple to raise, sensate, replace like with like tissue, ideal for smaller defects and require no unusual surgical skills. A disadvantage of fasciocutaneous flaps is the unsightly donor site, and therefore their use should be avoided in young females. They remain one of the useful methods of skin cover for lower extremity defects. These results are in agreement with other studies Ponten B, Lamberty, Lagvankar, Hallock, Georgiadis⁵⁻⁹ who reported nearly similar complication rates, varying from 12 to 26%.

Sural flaps were the second most common flaps performed in our study. Out of 45 patients 14 (31.1%) were sural flap. The next common flap was inferiorly based sural artery incorporated

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fasciocutaneous flaps 6 out of 45 cases (13.3%). Cross leg flap performed in 3 cases majority being medially based and the survival rate was 100%. This flap was used successfully to cover large defect. These results show that cross leg flap is a very reliable flap if properly designed and transferred in selective cases where other flaps are expected to be risky or not feasible. These results are in agreement with Aydan and Bhattacharya V. and Raveendra.^{10,11} Padmakumar et. Al¹² required performing flaps in 117 patients (28%) out of their total 418 patients of leg defects. This high incidence of requirement for flaps in this region is due to high incidence of associate tibial fracture in our study.

In 1 case free LD flap done, the muscle being covered with skin graft in the second stage. Free tissue transfer has several advantages. It offers a well vascularized tissue to close cavities or defects of diminished vascularity. However, they are lengthy procedure, require the availability of well trained micro-vascular team and sophisticated equipment and high cost. A high degree of success can be achieved only by extremely careful patient selection. This is consistent with Sefarin, Sabatier and Morris, Morrison, Grabb and O'Brien Chen, Wei and Chen.¹³⁻¹⁵

The split skin graft has been performed in 4 of our patients (8%). In our study out of 4 patients who underwent grafting 1 of them underwent the same within a week (Primary and delayed primary grafting) and the rest underwent secondary grafting. We observed no cases of graft loss which required regrafting.

Nevertheless, the beneficial effects of flap cover are most evident in the fractured and exposed tibia. In these cases, when soft tissue with good vascularity is brought in, fresh nourishment that comes to the fracture site accelerates fracture healing and combats infections in addition to just giving cover.

Timing of surgery is another crucial factor to be considered. Early cover results in early healing and decreases incidence of complications. George B. Iron in his overview on indications for complex skin coverage in lower limb, states "when it is determined that the wound is ready, the patient is ready and the surgeon is ready, it is the time to operate."¹⁶

Complications can be classified as early and late or minor and major and early complication is that occurs within the first month. A major complication is defined as one in which the flap does not do the job for which it was designed or requires a second operation before it heals. Any additional procedure required to treat the donor site, despite successful recipient site wound healing was also termed a major complication. Minor complication on the other hand is defined as one in which perfect healing does not occur. This may include wound dehiscence or wound contamination with or without further surgical intervention.

In our series complication rate of fasciocutaneous flap was 17% penten in his initial landmark series on fasciocutaneous flap had Complication of 26% Padmakumar et al had a complication rate 29% in their series. Generally otherwise the rate of complications varies from 10-50% fasciocutaneous flaps (Barclay etal¹⁸ - 16% Lagvankar – 25% Wee JTK75 – 50%, Tolhurst – 10%).

After initial description of sural artery neurocutaneous flap by Masquelet et al Hasegawea 1994 and Yilmaz – 1998¹⁹ have all tried this flap with varying results. All the studies showed complication rate ranging from 9.5% (Rajacic et al to 23.5% (Yilmaz) the most common being the venous congestion of flaps. In our study of 14 patients of sural artery flap, 3 had complication. Various techniques have been used/ modifications tried to decrease or avoid this. An absolute no for tunneling, leaving skin extension over the pedicle which is used as the roof of the tunnel, are some of

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them. Also helpful is to keep the pedicle at least 2 cm wide to include nerve and accompanying superficial sural vessels and short saphenous vein.

RESULT: In the present study 45 patients with defects in the lower 1/3rd tibia that underwent various flap for coverage were included and analyzed.

Age(In years)	Male	Female	Total	Percentage
0-10	0	3	3	6.6%
11-20	2	1	3	6.6%
21-30	13	1	14	31.1%
31-40	14	0	14	31.1%
41-50	7	0	7	15.5%
51-60	3	0	3	6.6%
>61	1		1	2.2%
Total	40	5	45	100%

TABLE 1: AGE AND SEX DISTRIBUTION

Graph 1

In this study, age of the patients ranged from 6 to 62 years and was distributed in all age groups as shown in Table -1. Overall patients in second and third decade of life formed majority of the patients accounting to 62% of the total patients.

This table also shows the sex distribution. Majority of the patients in our study were male in the ratio of 8:1 which reflects the population at risk. This male preponderance is seen in all age groups except in 0-10 year age group.

Coexisting Disease/Habits	No. of patients
Smoking	13
Diabetes	5
Hypertension	2
Alcohol	2
Tobacco chewing	7

TABLE 2: COEXISTING DISEASES/HABITS

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Graph 2

The above table shows the incidence of co-existing systemic illnesses and habits of our study patients. Smoking and tobacco chewing had a significant bearing on the survival of flap. One of the patients who had complete flap loss and four of the patients with partial flap loss were smokers and diabetic. One patient with diabetes had complete graft loss. One patient who was alcoholic and uncooperative postoperatively had partial flap and graft loss.

Type of Bone Fractured	Number of patients	Percentage
Tibia alone	11	24.4%
Fibula alone	0	-
Both tibia and fibula	27	60%
No fracture (only exposed)	3	6.6%
No bone exposed	4	8.8%
Total	45	100

TABLE 3: WOUND ASSOCIATED WITH FRACTURE OF T/F

Graph 3

The above table shows the wound associated with fracture of tibia and fibula. 11 of the 45 patients had underlying tibia fracture. 27 patients had both tibia and fibula fracture (60%). There is no fibula fracture alone. All patients (41) who had either underlying fracture or bone exposed required flap coverage.

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Type of flap	Number of patients	Percentage
Fasciocutaneous flap	17	37.7%
Sural artery flap	14	31.1%
Inferiorly based sural artery incorporated fasciocutaneous flaps	6	13.3%
Cross leg flap	3	6.6%
Free flap	1	2.2%
STG	4	8.8%

TABLE 4: TYPE OF COVERAGE

Graph 4

Most common flap performed was inferiorly based fasciocutaneous flap 17 out of 45 (37.7%) patients. Sural flaps were the second most common flaps performed in our study. Out of 45 patients 14 (31.1%) were sural flap. The flap was carried to the recipient site through an external pedicle or through a subcutaneous tunnel. When a subcutaneous path is chosen, a T shaped extension of skin is taken over the pedicle close to the flap, which helps in decreasing tension at the recipient site.

The next common flap was inferiorly based sural artery incorporated fasciocutaneous flaps 6 out of 45 cases (13.3%). Cross leg flap performed in 3 cases majority being medially based. All the cross leg flap were delayed at 3 weeks before the final division and inset. In 1 case free LD flap done, the muscle being covered with skin graft in the second stage. In 4 cases split thickness grafting was done.

Immediate	Complication	Number	Percentage
	Complete flap failure	2	4.4%
	Partial flap failure	5	11.1%
	Complete graft loss	1	2.2%
	Flap retraction	6	13.3%
	Partial graft loss	9	20%
	Venous congestion	7	17.5%
	Flap edema	4	8.8%

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Late	Chronic discharge,	2	4.4%
	Infection	1	2.2%
	Ulceration	1	2.2%
	None	24	53.3%

TABLE 5: COMPLICATIONS

Graph 5

This table shows the complications that we encountered in our study. Half of the flaps (24 of 45) did not have any complication and were absolutely fine postoperatively. 4 of the flaps had flap edema and 7 venous congestion till postoperative day 5, which settled by limb elevation or loosening of tight dressing if any. 2 of these patients had complete necrosis of flap and another 5 patients had partial necrosis. One of these patients needed cross leg flap. 6 patient out of 45 had flap retraction. 2 patient require reinset of flap while rest healed by dressing. 9 patients had partial graft loss over secondary defect. One diabetic patient had gradual complete loss of graft over donor area.

2 patients had persistent discharge from the wound/flap. In all patients it was the underlying bony sequestrum that was the prime cause of the same and is treated by the referring orthopaedic surgeon for the same.

CONCLUSION:

- Distal third of leg defects form a major chunk of lower limb trauma.
- Road traffic accidents were the most common cause for defects (84%) in present study.
- Inferiorly based fasciocutaneous flap were done in majority of cases and gives good result.
- The advent of local fasciocutaneous flaps has reduced the role of distant pedicle flaps to a large extent and microvascular free flaps to some extent.
- Perforator based fasciocutaneous flaps and sural neurocutaneous flaps are the flaps of choice for reconstruction in this region.
- Free microvascular flap are gold standard for large lower tibial defects.
- Ipsilateral fasciocutaneous flaps score over other flaps in being single staged, rapid and easy and they do not compromise the vascularity of the limb.
- Cross leg and distant flap gave good result when other options are not available or exhausted.

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- Free flap is reserved for patients requiring large area to be covered tibial along with the foot or in those patients where composite tissue transfer is needed.
- The chances of flap necrosis were more in diabetic and chronic smokers (6 of 16 flaps) in present study.

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Fig. 1: Inferiorly Based Fasciocutaneous Flap With Sural Artery Incorporated.

Defect with external fixator

12th Post-operative day

Follow up after 3 month

Fig. 2: Sural Island Flap.

L/3rd leg defect

Island flap elevated

Flap in early follow

Fig. 3: Inferiorly based fasciocutaneous flap.

Defect with overlying eschar

After flap division and inset

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Date of Submission: 02/01/2015.
Date of Peer Review: 03/01/2015.
Date of Acceptance: 13/01/2015.
Date of Publishing: 21/01/2015.