

# **AN ANALYSIS IN RECONSTRUCTION OF TRAUMATIC DEFECTS OF LEG AND FOOT**

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PLASTIC SURGERY**



**GOVT. KILPAUK MEDICAL COLLEGE & HOSPITAL  
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## **CERTIFICATE**

This is to certify that the dissertation titled “AN ANALYSIS IN RECONSTRUCTION OF TRAUMATIC DEFECTS OF LEG AND FOOT” of Dr. S. SURESH KUMAR in partial fulfillment of the requirements for M.Ch. Branch – III (Plastic Surgery) Examination of the Tamilnadu Dr. M.G.R. Medical University to be held in August 2006. The period of study was from July 2003 to June 2005.

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## **DECLARATION**

I, **Dr. S. SURESH KUMAR** solemnly declare that dissertation titled, ““AN ANALYSIS IN RECONSTRUCTION OF TRAUMATIC DEFECTS OF LEG AND FOOT ” is a bonafide work done by me at Govt. Kilpauk Medical College & Hospital during 2003-2005 under the guidance and supervision of my Unit Chief **Prof. A. DHANIKACHALAM, M.S., M.Ch., (Plastic Surgery), CTBS (USA)**.

The dissertation is submitted to Tamilnadu, Dr. M.G.R. Medical University, towards partial fulfillment of requirement for the award of **M.Ch. Degree (Branch – III) in Plastic Surgery**.

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## INTRODUCTION

Management of lower extremity trauma with bone and soft tissue injury remains a formidable problem.

Road traffic accidents, fall from height, sporting injuries and Gun shot injuries are the common causes for traumatic defects of leg and foot.

Treatment of lower extremity has evolved over the last two decades to the point that many extremities that would have required amputation are now routinely salvaged.

Treatment requires a team approach with the orthopedic, vascular and plastic surgeon.

Classification of the severity of wounds given by Gustilo have allowed us to make an appropriate plan for reconstruction and also to be aware of the eventual prognosis.

Fracture management has improved over the recent years by external fixation, intra medullary rodding and Internal plating, bone lengthening, artificial bone matrix and bone growth factors.

Soft tissue management has improved over the recent years with a better understanding of local fasciocutaneous flaps, local muscle flaps and micro vascular free tissue transfers and also, the technique of vascular and nerve repair has been further refined.

Extremity salvage is a long complicated process. so patients must be made aware of the expected course and the anticipated functional outcome.

The goal of the reconstructive surgeon must be to salvage an extremity that is more functional than an amputated leg with prosthesis.

We plastic surgeons have helped to bring about a fundamental change in the management of severe lower extremity injuries through new advances in soft tissue reconstruction, micro vascular replantations, nerve repairs and comprehensive planning of reconstructive problems.

We must periodically reassess our own work, chart our future developments, and summarize them for the benefit of all involved in patient care. It was with these concepts in mind that this study was conceived and planned.

## **AIM OF STUDY**

- ❖ To analyze various reconstructive options for traumatic defects of leg and foot.
- ❖ To analyze the incidence, age, sex and etiology of the traumatic defects of leg and foot.
- ❖ To study the versatility of various flaps used in the reconstruction of traumatic defects of leg and foot.

## **MATERIALS AND METHODS**

This study was conducted in the Department of Plastic Surgery, Govt. Kilpauk Medical College hospital and Govt. Royapettah hospital over a period of 24 months. (July 2003-June 2005)

All the cases with traumatic defects of leg and foot were included in this study. No specific selection criterion was used.

A total no of 294 patients were included in this study.

A careful history was taken looking in to the etiological factor, type of treatment at the time of injury-by a general surgeon or an orthopaedician.

Each patient was subjected to thorough clinical examination to asses the present status of the wound

All patients underwent baseline investigations like Blood Hb, urine albumin, sugar and deposits, Blood urea and sugar, X-ray chest and ECG. X-ray of local part was taken as and when necessary.

Pus for culture and sensitivity was sent only for cases with signs of infection.

An orthopedic consultation was taken for cases, which needed orthopedic intervention at the time of surgery.

Vacuum assisted closure system was used in a few cases with gross infection and a non-healing tendency.

Defects of leg and foot were classified into knee defects, upper third leg defects, middle third leg defects, lower third leg defects, ankle defects and foot defects for ease of discussion and arriving at conclusions

All the patients were kept under continuous follow up till the wound heals completely.

Then follow up was done according to the needs of the individual patient.

## HISTORICAL REVIEW

Ambrose pare (1509-1590) -First surgeon to perform amputation, to describe phantom pain, modern concept of choosing an amputation site according to the plan for a prosthesis.

Pierre-Joseph Desault (1744-1795) -Coined the term “Debridement”

Ollier (1825-1900) - introduced the concept of immobilization with plaster cast.

Trueta -introduced true surgical debridement and observed that infection could be avoided, if all the devitalized tissue is excised.

Ponten-1981 - introduced the concept of fasciocutaneous flaps.

Barclay et al - confirmed ponten’s experience by doing anatomic dissections.

1906 - The first report of a musculocutaneous flap.

Mathes and nahai - 1978, 1982 - classification of vascular anatomy of muscles and their standard reference textbooks. Large and associates -1985; Alden and shan -1986 - Improved transportation, introduction of antibiotics, resuscitative measures, blood banking and aseptic techniques – decrease in mortality from 8% in world war I to 4.5% in world war II.

George C. Cormack and Lamberty - 1986 - Detailed description of arterial anatomy of skin flaps.

Joseph Lister - 1867 - described in the Lancet, a series of 11 patients with compound fractures treated successfully with occlusive dressings soaked in carbolic acid. Cannon and constable - 1977 - Restoration of an intact cutaneous covering is the primary surgical requisite following trauma of lower extremity, because deep healing can be no better than the surface covering.

## **MICROSURGERY**

J.B. Morphy - 1986 - First to restore arterial circulation in humans after resection of femoral traumatic aneurysm.

Alexis Carrel - 1902 - Introduced a precursor for the modern method of vascular anastomosis by development of triangulation technique and the inclusion of the intima in vascular anastomosis.

Nylen - 1920 - An otolaryngologist pioneered the clinical practice of microsurgery.

Jacobson and Suarez - Fathers of modern micro vascular surgery.

## UNIQUENESS OF LEG AND FOOT ANATOMY

Humans', being a bipedal animal, full weight bearing in the erect posture is on the two lower extremities.

Muscles of the leg predominantly provide ankle function like dorsiflexion, plantar flexion, inversion and eversion. So a significant functional muscle loss of the leg can be tolerated and bipedal ambulation will be still maintained. Therefore loss of leg muscles is not a contraindication for reconstruction and salvage of lower extremity.

The hydrostatic pressure imposed on the leg, increases the incidence of edema, deep vein thrombosis and venous stasis problems.

The relatively unprotected anteromedial portion of tibia leads to many instances of bone exposure, which require specialized soft tissue coverage in the event of injury.

The bones of leg are tibia and fibula. Tibia provides 85% of the weight bearing of leg whereas fibula serves only as a structure for muscle and fascial attachments.

Fibula is an excellent source of vascularized bone graft because only proximal and distal portions of fibula are important and it has an independent blood supply from the peroneal artery.

Since the full force of the body is transposed to the foot, normal sensation of the plantar aspect of foot is necessary for normal ambulation.

Normal sensation of foot is required for tactile sense, position sense and protection of vulnerable pressure bearing regions. So loss of the posterior tibial nerve with loss of sensation of the plantar aspect of the foot is a relative contraindication for lower extremity salvage.

## DESCRIPTIVE ANATOMY OF LEG AND FOOT

Sl . No	Compartment	Muscle	Nerve	Artery
1.	Leg – Anterior	Tibialis anterior. Extensor hallucis longus. Extensor digitorum longus. Peroneus tertius.	Deep Peroneal Nerve.	Anterior tibial artery.
2.	Leg – Lateral.	Peroneus longus and Brevis.	Superficial peroneal nerve.	Peroneal and anterior tibial artery.
3.	Leg – Superficial posterior	Gastronemius, soleus, Plantaris and Popliteus.	Tibial nerve	Popliteal – Sural branches. Peroneal artery Posterior tibial artery.
4.	Leg – Deep Posterior	Flexor Hallucis Longus. (FHL). Flexor Digitorum Longus (FDL) Tibialis Posterior (TP)	Tibial Nerve	FHL – Peroneal FDL – Posterior Tibial TP - Peroneal
5.	Foot – Dorsum	Extensor digitorum brevis. Extensor hallucis brevis.	Deep peroneal nerve.	Dorsalis pedis artery.
6.	Foot – Plantar aspect	Four layers of muscles	Medial plantar and lateral plantar nerve.	Medial plantar and lateral plantar artery.

## SOFT TISSUE RECONSTRUCTION OF LEG AND FOOT

➤ **Split Skin Grafts.**

➤ **Local Flaps**

### *Fascio Cutaneous*

❖ Based Proximally

❖ Based Distally.

➤ *Random Pattern*

➤ *Axial Pattern*

### *Muscle Flaps*

i. Based Proximally

ii. Based Distally.

➤ **Myocutaneous flaps**

➤ **Cross leg flaps**

➤ **Free flaps**

## SPLIT SKIN GRAFT

Split skin grafts are best used to cover exposed muscle or soft tissue, but occasionally to cover bone with healthy periosteum or tendon with healthy paratenon.

## LOCAL FLAPS

Local fasciocutaneous or muscle flaps are useful to cover small to moderate size defects of bone or exposed vessels or tendons.

## **FASCIOCUTANEOUS FLAPS**

Ponten in 1981 reported the use of fasciocutaneous flaps in the lower leg. His experience was all with proximally based flaps without a prior delay to include skin, subcutaneous fat and deep fascia.

The leg is supplied by fascial plexus fed by perforators from the anterior tibial, posterior tibial and peroneal arteries. This basic pattern of cutaneous supply is augmented superomedially by the saphenous artery and posteriorly by the superficial sural arteries and musculocutaneous perforators from Gastrocnemius muscle.

### **CLASSIFICATION**

**Type A:** Flap dependent on multiple fascio cutaneous vessels entering its base and oriented along the long axis of the flap.

**Type B:** Flap dependent on a single fasciocutaneous perforator which is consistent in its position and presence.

**Type C:** Flap dependent on multiple perforators passing along a fascial septum. (Septo cutaneous perforators)

**Type D:** An osteo - myo - fasciocutaneous free tissue transfer.

### **MUSCLE FLAPS:**

Local Muscle flaps are used to cover defects of exposed bone, tendon, implant or a fracture site.

Medial or lateral Gastrocnemius muscle is useful for defects of knee or proximal third of leg.

Gastrocnemius Myocutaneous flap can be used to cover large defects, but donor deformity is more.

Soleus muscle flap is used to cover middle third and lower third leg defects.

Smaller defects can be covered by other muscles from anterior and lateral compartment, but they have less reliable blood supply and are not readily expendable.

Draw back in using local muscle flaps is that, they are usually in the zone of injury and their viability is sometimes doubtful.

## **CROSS LEG FLAPS**

Before the advent of free flaps and perforator flaps, cross leg flaps were routinely used in the reconstruction of leg and foot defects.

Cross leg flaps require a long period of immobilization. So the chances of contracture formation and deep vein thrombosis are very high.

As of today, cross leg flaps are used in special salvage situations like, when a recipient artery is not available for free tissue transfer or microsurgical facilities are not available.

## **FREE TISSUE TRANSFER**

Free flaps have revolutionized the treatment of lower extremity injuries with major bone and soft tissue loss.

Any defect in leg and foot can be covered with a free flap, provided a recipient artery is available.

Most of the lower one third leg defects require a free flap.

# **CLASSIFICATION AND RECONSTRUCTION OF LEG AND FOOT DEFECTS.**

## **CLASSIFICATION:**

- **Knee Defects**
  
- **Upper third leg defects**
  
- **Middle third leg defects**
  
- **Lower third leg defects**
  
- **Ankle defects**
  
- **Foot defects**

## **KNEE DEFECTS –RECONSTRUCTION**

### **Skin Grafts**

#### **1. Local Flaps**

- Fascio cutaneous flaps – Perforator flap.
- Gastronemius muscle and musculocutaneous flaps.

#### **2. Distant Flaps**

- Cross leg Flap
- Free Flap

## **UPPER THIRD LEG DEFECTS – RECONSTRUCTION**

#### **1. Skin Grafts**

#### **2. Local Flaps**

- Fasciocutaneous Flaps.
- Gastronemius muscle flap with split skin graft.
- Gastronemius Myocutaneous flap for large defects.
- Soleus muscle flap.

#### **3. Distant Flaps**

##### **a. Cross leg flap**

- i. Random
- ii. Musculocutaneous – very rarely used.

##### **b. Free Flap.**

## **MIDDLE THIRD LEG DEFECTS – RECONSTRUCTION**

#### **1. Skin Grafts.**

#### **2. Local Flaps.**

- a. Fasciocutaneous flaps.
- b. Soleus muscle flap with split skin graft.
- c. Gastronemius Myocutaneous flap.
- d. Tibialis anterior muscle with split skin graft for small lateral defects – rarely used.

**3. Distant Flaps.**

- a. Cross leg flap.
- b. Free Flap.

**LOWER THIRD LEG DEFECTS – RECONSTRUCTION**

**1. Skin Grafts.**

**2. Local Flaps.**

*Fasciocutaneous flaps.*

- i. Based Proximally
- ii. Based distally (Reverse Sural)

*Soleus muscle flap*

- i. Based superiorly.
- ii. Based inferiorly.

**3. Distant Flaps.**

- i. Cross Leg Flap
- ii. Free Flap.

**ANKLE DEFECTS – RECONSTRUCTION**

**1. Skin Grafts**

**2. Local Flaps**

## Fascio cutaneous flap

### **3. Axial Skin Flap**

- i. Lateral calcaneal artery flap
- ii. Reverse sural fasciocutaneous flap
- iii. Dorsalis pedis fasciocutaneous flap

### **4. Muscle flaps**

- i. Reverse soleus muscle flap.
- ii. Extensor digitorum brevis muscle flap.

### **5. Distant flap**

- i. Cross leg flap.
- ii. Free flap.

## FOOT DEFECTS – RECONSTRUCTION

### 1. Skin Grafts

### 2. Local Flaps

i. *Fasciocutaneous flap*

ii. *Axial skin flap*

- Lateral calcaneal artery flap
- Dorsalis pedis fasciocutaneous flap
- Reverse sural Fasciocutaneous flap
- Medial plantar artery flap
- Toe fillet flap

### 3. Muscle Flaps

- i. Flexor digitorum brevis
- ii. Abductor hallucis
- iii. Abductor digiti minimi

### 4. Distant flaps

- i. Cross leg flap
- ii. Free flap

## REVIEW OF LITERATURE

- Fabio and Santanelli has shown in their study that the most frequent cause of lower extremity trauma are
  - Motor cycle accident – 28 %
  - Vehicle accident – 24%
  - Pedestrian accident – 12%
  - Domestic accident – 13%
  - Fire arm accident – 2%
  - Work and sport related – 13%
  - Crushing lesion – 8%
  
- In the past, the main emphasis in the treatment of complex limb injuries was placed upon the reconstruction of bony defects. Recently, however, reconstructive soft-tissue procedures have gained the attention they deserve. The salvage of a severely injured extremity depends rather on the feasibility of reconstructive surgical tissue procedures than on restoration of the bony defect. If primary closure of a soft-tissue defect is not possible, preliminary covering has to be obtained with artificial skin replacement (vacuum sealing) until definitive covering with muscle or musculocutaneous flaps can be achieved. With the microvascular restorative techniques available today even complex soft-tissue problems can

be solved. Nevertheless, an appropriate infrastructure and a trained and skilled surgeon are essential (Kinzl L. et al)

- Trentz O et al has described that severe crush injuries of lower limbs with loss of bone and soft-tissue need a clear concept of treatment. After resuscitation the examination and restitution of the injured limbs blood supply has absolute priority. Long term healing is strongly influenced by the correct debridement. After stabilisation crushed soft-tissue and disintegrated bone fragments are removed. Second look operations are performed every 24-48 hours until a clean and good vascularized wound can be guaranteed. The coverage with a local or free muscle flap should be performed within 96 hours. Immediately after coverage of the soft-tissue defects the reconstruction of the bone defect is started. The method depends on the degree of bone loss and includes bone grafting, callus distraction or bone segment transports with unilateral fixators.
- From May 1997 until May 2003 36 patients were treated using neurovascular flaps. Above the sural or the saphenous nerve an adipo-facial flap is dissected, rotated into the defect and fixed without tension. Wound closure of the donor-site defect is done primarily or by mesh-graft. In 35 cases the flap healed without functional impairment. Primary healing was achieved in 30 patients. In 5 cases partial loss of the skin island was registered, whereby subcutaneous tissue remained vital. Revision by mesh-graft transplantation led to successful healing in these patients. In only one patient necrosis of the flap was seen. Neurovascular

flaps usually result in reliable and complete healing of soft tissue defects of the lower extremity(Meyer C.et al).

- Kozarski et al has described that the specificity of the lower leg is in sparse collateral blood flow of the skin cover in the middle and distal part, reduced subcutaneous tissue and the prominence of the front side of tibia immediately under the skin. These characteristics of the lower leg make the application of the standard plastic reconstructive principles, which have been applied in the other regions of the body to a certain degree impossible. The author has told that the aim of this study was to show the available reconstructive methods in the treatment of the lower leg soft tissue and to analyze its application in the management of war wounds in the injured from the civil war in the former Yugoslavia.
  
- Berger A et al has presented a treatment concept based on their personal experience between 1981 and 1995 after more than 5000 skin transplantations, some 3000 local tissue transfer, over 200 distant flap transfers and more than 1200 free microvascular tissue transfer to all regions of the body. New therapy concepts do not entirely replace the elder ones, but are integrated into the treatment schedule.
  
- Clinical consideration of anatomy of skin vascularity led to the establishment of distally pedicled flaps in the extremities. In certain situations, distally pedicled flaps are a quick and safe alternative to free microvascular tissue transplantation or distant pedicled flaps.

However, an exact indication for this method as well as exact planning and performance of the operation is necessary for success.(Graf P.et al).

- Trenkic S et al has described that reconstruction of soft tissue defects of the lower leg from 1966-2003, using fasciocutaneous flaps. Their experience with soft tissues defects in 69 patients is shown in the study. Different types of fasciocutaneous flaps were used (proximally and distally based fasciocutaneous flap island, fasciosubcutaneous) based on septocutaneous perforators of all 3 main arterial trunks of the lower leg. The author had complete or almost complete necrosis in only 4 patients, whereas in other patients flaps survived. Results obtained using fasciocutaneous flaps, even in reconstruction of war wounds convinced them that fasciocutaneous flaps are reliable method of reconstruction of the soft tissue defects of the lower leg, especially its distal third and regions of malleoli.
- Sharma GN, Nepram SS have used a fasciocutaneous flap based on sural artery accompanying the sural nerve to cover moderate-sized defects of lower leg and foot in 12 cases. This eliminates the sacrifice of major vessels, and the procedure is easy, quick, and dependable.

The recent rediscovery of inclusion of the deep fascia during elevation of random skin flaps has enhanced the viability of large local flaps as a reconstructive option in the lower leg. In selected cases of relatively uncontaminated, moderate-sized defects, the choice of this

maneuver has permitted closure of many defects which previously might have required a complex microsurgical tissue transfer. This series of 41 random-based local fasciocutaneous flaps in the lower leg in 38 patients has in all cases except two been successful in achieving preferred wound healing.

- In another study from U.S.A. Hershck et al has treated ten patients with medial gastrocnemius muscle flaps during a 24-month period. Four of the 10 patients underwent primary muscle rotation-plasty for reconstruction following tumor resection; 3 patients had soft-tissue defects following trauma; 2 patients had skin ischemia following total knee arthroplasty; and 1 patient had a soft-tissue defect from scar formation. At follow-up of 6 to 24 months, the soft-tissue coverage was maintained in all patients. All of the muscle rotation flaps survived. The gastrocnemius rotation flap provides reliable anterior knee soft-tissue coverage.
- In a short review by Salimbeni – Ughi G et al various methods of closing skin defects associated with severe injuries of the leg raised the question for using a myocutaneous flaps and particularly a gastrocnemius flaps. The surgical technique is described and the versatility of the flap is demonstrated with several examples and discussed showing how both the medial and the lateral gastrocnemius flap, can be used as a pedicle as well as a free flap, ipsi- and contralaterally.

- The distally based superficial sural artery flap is an important skin flap that can be used for soft tissue defects of the distal lower limb and proximal foot. It is a versatile flap, has a wide arc of rotation and requires minimal expertise.

Forty patients with soft tissue defects of the lower leg due to various causes were treated with sural flaps and the results are discussed. The flap was either used as a long pedicled flap or islanded to treat patients with ages ranging from 4 to 75 years. The arc of rotation of the flap was 90-180 degrees with minimal flap loss in most of the cases. On this basis they would like to reintroduce the safe and reliable use of the sural flap to treat large soft tissue defects of the distal lower limb and the proximal foot (Raveendran SS et al).

- The reverse sural artery flap is a fasciocutaneous flap based on the median superficial sural artery and its communication with the perforating branch of the peroneal artery situated in the region of the lateral malleolar gutter. Reverse flow is established after elevation of the flap and with division of the sural artery and the nerve proximally.

In a study from Scotland the authors present resurfacing of acute open fractures of the lower third of the leg in 7 patients immediately after the acute phase of injury. Reconstruction was carried out within an average of 3 days after injury. All 7 patients sustained low-velocity injuries. Although 2 patients had partial necrosis of the distal tip of the flap, all patients had excellent recovery with minimal donor site morbidity.

- In a study from Central Hospital, China twenty-three patients with exposure wounds on the leg were selected for the treatment by using different kinds of the cross-leg flaps, including 5 in medial knee skin flap, 12 in gastrocnemius myo-cutaneous flap and 6 in posterior calf fascial skin flap. The patients were successfully treated with the complete survival of the flaps. No infection occurred. The results were good with the long-term follow-ups. The method of the cross-leg flap is a safe and good way for repairing the soft tissue defects of the leg with the advantages such as color and texture of the transplanted tissue to be matched the recipient well.
- Perforator flaps are defined as skin flap without fascia or muscle and they are nourished by one or more perforating vessels perforating the fascia, muscle, or intermuscular septum. As early as 1985 in Japan, Koshima et al proposed this concept over that of the fasciocutaneous flap, which was believed to be nourished by fascial plexus. The pedicle perforators are classified as septocutaneous, muscular (intermuscular), periosteal, and intertendinous perforators. As useful perforator flaps in the lower extremity, posterior tibial perforator island flaps, saphenous island flaps, peroneal island flaps, malleolar island perforator flaps, deep inferior epigastric perforator free flap (DIEP flap), anterolateral thigh free flap (ALT flap), and latissimus dorsi muscle free perforator flap (thoracodorsal artery perforator flap, T-DAP or TAP flap) were described. These flaps have the advantage of minimal donor-site morbidity, relatively rapid dissection and flap elevation, and reliable skin territory.

- Yazar S et al has described that the management of bone loss that occurs after severe trauma of open lower extremity fractures continues to challenge reconstructive surgeons. Sixty-one patients who had 62 traumatic open lower extremity fractures and combined bone and composite soft-tissue defects were treated with the following protocol: extensive debridement of necrotic tissues, eradication of infection, and vascularization of osteocutaneous tissue for one-stage bone and soft-tissue coverage reconstruction. Fifty patients had vascularized fibula osteoseptocutaneous flaps, six had vascularized iliac osteocutaneous flaps, and five patients had seven combined vascularized rib transfers with serratus anterior muscle and/or latissimus dorsi muscle transfers. One patient received a second combined rib flap because the first combined rib flap failed. Transfer of the appropriate combination of vascularized bone and soft-tissue flap with a one-stage procedure provides complex lower extremity defects with successful functional results that are almost equal to the previously reported microsurgical staged procedures and conventional techniques.
- Tissue of amputated or nonsalvageable limbs may be used for reconstruction of complex defects resulting from tumor and trauma. This is the "spare parts" concept. By definition, fillet flaps are axial-pattern flaps that can function as composite-tissue transfers. They can be used as pedicled or free flaps and are a beneficial reconstruction strategy for major defects, provided there is tissue available adjacent to these defects.

In a German Study between 1988 and 1999, 104 fillet flap procedures were performed on 94 patients (50 pedicled finger and toe fillets, 36 pedicled limb fillets, and 18 free microsurgical fillet flaps) The majority of our cases resulted from severe trauma with infected and necrotic soft tissues, disseminated tumor disease, or ulcers in elderly, multimorbid patients. On the basis of these data, a classification was developed that facilitates multicenter comparison of procedures and their clinical success. Fillet flaps facilitate reconstruction in difficult and complex cases. The spare part concept should be integrated into each trauma algorithm to avoid additional donor-site morbidity and facilitate stump-length preservation or limb salvage.

- Local muscle flaps, pioneered by Ger in the late 1960s, were extensively used for foot and ankle reconstruction until the late 1970s when, with the evolution of microsurgery, microsurgical free flaps became the reconstructive method of choice. To assess whether the current under use of local muscle flaps in foot and ankle surgery is justified, the authors identified from the Georgetown Limb Salvage Registry all patients who underwent foot and ankle reconstruction with local muscle flaps and microsurgical free flaps from 1990 through 1998. Thirty-four pedicled muscle flaps were used: 19 abductor digiti minimi (56 percent), nine abductor hallucis (26 percent), three extensor digitorum brevis (9 percent), two flexor digitorum brevis (6 percent), and one flexor digiti minimi (3 percent). An additional skin graft for complete coverage was required in 18 patients (53 percent). Diabetes did not significantly affect healing and limb salvage rates. Local muscle flaps provide a simpler, less expensive, and successful alternative to microsurgical free flaps for

foot and ankle defects that have exposed bone (with or without osteomyelitis), tendon, or joint at their base. Local muscle flaps should remain on the forefront of possible reconstructive options when treating small foot and ankle wounds that have exposed bone, tendon, or joint. (Study from a Limb centre, Washington by Attinger CE et al).

- "Vacuum Assisted Closure" (VAC) is a noninvasive negative pressure healing process indicated in the treatment of chronic wounds associated with unfavourable local or systemic factors. It is indicated for the treatment of traumatic and/or surgical skin defects in order to accelerate the healing process. VAC is based on a simple technology of controlled depression of the lesion which healing process. It exerts a mechanical force on the tissues and attracts the wound edges centripetally. It induces an increased peripheral blood flow, improved local oxygenation and promotes angiogenesis and proliferation of good quality granulation tissue. Wound healing in a humid medium is complete or may require secondary surgical management (skin graft, flaps). The preferential indications for Vacuum Assisted Closure include pressure sores, leg ulcer, wounds with skin defects, burns, complications of surgical wounds and delayed healing (Voinchet V et al).
- In a study from U.S.A. Venturi ML et al has shown the use of sub-atmospheric pressure dressings, available commercially as the vacuum-assisted closure (VAC) device, has been shown to be an effective way to accelerate healing of various wounds. The optimal sub-atmospheric pressure for wound healing appears to be approximately 125 mm Hg utilizing

an alternating pressure cycle of 5 minutes of suction followed by 2 minutes off suction. Animal studies have demonstrated that this technique optimizes blood flow, decreases local tissue edema, and removes excessive fluid from the wound bed. These physiologic changes facilitate the removal of bacteria from the wound. Additionally, the cyclical application of sub-atmospheric pressure alters the cytoskeleton of the cells in the wound bed, triggering a cascade of intracellular signals that increases the rate of cell division and subsequent formation of granulation tissue. The combination of these mechanisms makes the VAC device an extremely versatile tool in the armamentarium of wound healing.

- Seventy-five patients with lower-extremity wounds with exposed tendon, bone or hardware, most of which were the result of trauma, were selected for this study. Dressings made of sterile open-cell foam with embedded fenestrated tubing were contoured to the wound size and placed into the wound. The site was covered with an adhesive plastic sheet. The sheet was placed beneath any external fixation devices, or the fixation device was enclosed within the sheet. The tubing was connected to the vacuum-assisted closure pump. Continuous subatmospheric suction pressure (125 mmHg) was applied to the wound site. The wounds were inspected and the dressings were changed every 48 hours. Vacuum-assisted closure therapy greatly reduced the amount of tissue edema, diminishing the circumference of the extremity and thus decreasing the surface area of the wound. Profuse granulation tissue formed rapidly, covering bone and hardware. The wounds were closed primarily and covered with split-thickness skin grafts, or a regional flap was rotated into the granulating bed to fill the defect. Successful coverage was obtained without complication in 71 of 75

patients. Wounds have been stable from 6 months up to 6 years (Defranzo AJ et al).

- Between 1988 and 1996, they applied 33 flaps to 28 patients. The numbers and kinds of the free flaps are as follows: 12 latissimus dorsi, nine radial forearm, seven lateral arm, three vascularised fibula grafts with skin, one gracilis, and one medial plantar flap. Three free flaps were lost (12%). The success rate is 88%. The advantage of free flaps is that they allow the reconstruction of the large defects in one-session operations. Thus, they decrease the rate of infection and increase that of non-union. The patient returns to his active life at an earlier stage (Kaplan I et al).

## OBSERVATION AND RESULTS

A total number of 294 patients were included in this study and treated.

### INCIDENCE – YEAR WISE

<b>Year</b>	<b>No. of. Cases</b>
July 2003 – December 2003	71
January 2004 – December 2004	153
January 2005 – June 2005	70
Total	294

As shown in the table, there is uniformity in the number of cases coming to the department with these defects every year.

### AGE AND SEX INCIDENCE

The table shows age wise and sex wise distribution of traumatic defects of leg and foot.

<b>Age Group</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
< 12 Years	19	10	29
>12 Years	216	49	265
		Total	294

Above table shows:

- Children account for only 10% of cases.
- Most of the cases with traumatic defects of leg and foot are seen in males who account for 73% of cases.
- Females present less frequently and account for only 17% of cases.

#### **ETIOLOGICAL INCIDENCE**

<b>S. No.</b>	<b>Etiology</b>	<b>No. of Cases</b>
1.	RTA	244
2.	Fall from Height	30
3.	Sport Injuries	10
4.	Gun Shot Injuries	Nil
5.	Others	10
	Total	294

Above table shows : Road traffic accidents are the commonest cause for traumatic defects of leg and foot followed by fall from height and others.

## SITewise INCIDENCE

S.No	Site	No. of Cases
1.	Knee	29
2.	Upper 1/3 leg	74
3.	Middle 1/3 leg	30
4.	Lower 1/3 leg	68
5.	Ankle	64
6.	Foot	29
	Total	294

Above Table Shows:

- Middle third defects are less common when compared to upper third and lower third leg defects.
- Lower third defects and ankle defects are almost equal in occurrence.
- Foot defects are half that of lower third leg and ankle defects.
- Ankle defects have presented in variety of ways: Anterior, Posterior, Medial and Lateral defects.
- Toilet injuries are almost equal in occurrence to traumatic defects in ankle. Foot defects have presented as dorsal defect, plantar defect or heel pad avulsions.

## TYPE OF SURGERY

S.No	Procedure	No. of Cases
1.	SSG	176
2.	Flap	88
3.	Others	30
	Total	294.

Above Table Shows:

- SSG was done for 60% of the cases.
- 30% of the cases were treated with various flaps.
- Among flaps, local cutaneous and fascio cutaneous flaps were done in 70% of cases.  
Local muscle and musculocutaneous flap was done in 30% of cases.
- Gastronemius muscle flap was used in 8 patients.
- Soleus muscle flap was used in 12 patients.
- Gastronemius myocutaneous flap was used in 1 patient
- Reverse sural artery flap was used in 9 patients.
- Cross leg flap was used in 2 cases.
- Toe fillet flap was used in 2 cases with plantar defects.
- Vacuum assisted closure system was used in 2 cases and ultimately treated with a skin graft in one patient, and a local fascio cutaneous flap in the other.
- No free flap was done in our hospital.
- A few cases of soft tissue avulsion injuries were treated. Radical debridement and skin

graft was done for almost all cases.

- There were only a few dropouts from the study.
- Few skin grafts done in general surgery department and orthopedic department were not included in the study.

# COMPLICATIONS

## COMPLICATIONS IN SPLIT SKIN GRAFT

Graft Loss	No. of Cases
Partial	30
Total	10
Total	40

Above Table Shows:

- Total grafts loss was seen in 6% of cases.
- Partial graft loss was seen in 17% of cases.

Most of the graft loss was salvaged by a regraft. Remaining cases healed by secondary intention.

## COMPLICATION IN FLAPS

<b>Flap Loss</b>	<b>Fascio cutaneous</b>	<b>Muscle and Musculocutaneous</b>
Partial	7	1
Total	3	1

- Flap loss in fasciocutaneous flaps was circumvented by split skin graft.
- Total flap loss in a soleus muscle flap was salvaged by a fasciocutaneous flap.
- Partial flap loss in another soleus muscle flap was managed by advancing the remaining muscle.

## DISCUSSION

This study reveals certain facts about traumatic defects of leg and foot.

### **Incidence:**

147 patients are admitted with traumatic defects of leg and foot every year in this study. This incidence is high when compared to studies in literature (*Meyer C et al* and *Trenkic S et al*).

Reasons may be:

- 1) Most of the studies in literature concentrate in one particular area (eg-lower third leg or ankle) or one particular flap (eg-Gastrocnemius muscle flap or reverse sural artery flap). But this study includes all cases with traumatic defects of leg and foot and all the available treatment options.
- 2) Being a major trauma centre, most of the RTA cases are referred to our hospital which may account for a high incidence.

**Age:**

In this study the age of patients range from 3½ to 92 years. The mean age is between 25 and 35 years in most of the literature studies (*Suri MP et al*). The mean age in this study group is 34 years.

**Sex:**

Traumatic defects of leg and foot are common in male patients. Studies have quoted figures of 66% (*Suri MP et al*) and 64% (*Akhtar S et al*) of patients being male.

In this study also males account for 73% of cases. This high incidence in male is because they are commonly involved in Road Traffic Accident (RTA).

**Etiology:**

RTA's are the commonest cause for traumatic defects of leg and foot in this study.

*Fabio* and *Santanelli* have quoted similar figures in their studies.

**Site:**

In this study, upper third leg defects, lower third leg defects and ankle defects account for majority of cases. But in literature reviews (*Yilmaz M et al* and *Raveendran SS et al*) lower third leg defects and ankle defects are predominant.

**Type of Reconstruction:**

The commonest surgical procedure done in this study is SSG – 60%. Flaps are done in 30% of cases.

Studies had quoted figures of SSG – 54% and Flaps – 32% (*Berger A et al*).

So, most of the cases with traumatic defects of leg and foot can be managed by SSG. Appropriate cases with exposed tendon, bone and hardware need flaps.

- Among flaps about 70% (61 patients) are treated with local cutaneous and fasciocutaneous flaps in this study. Most of the literature reviews quote similar figures (*Trenkic S et al*).

Inclusion of deep fascia during elevation of random skin flap has enhanced the viability of large random flaps (*Hallock GG*).

Partial or total flap loss occurred in 16% (10 cases) of fasciocutaneous flaps in this study.

This flap loss is slightly higher than the literature reviews (*Trenkic S et al* – 6 to 8%, *Chittoria R et al* – 10%).

Reason may be – Most of the fasciocutaneous flaps done in this study are inferiorly based flaps. A randomized study comparing the complications of superiorly based and inferiorly based fasciocutaneous flaps in the future may substantiate the above reason.

### **Muscle Flap :**

In this study gastronemius muscle flap was used in 8 patients.

**Hersh CK et al** has quoted similar figures in their study. But only three of their cases were due to trauma. Gastronemius muscle provides a reliable soft tissue coverage for knee and upper third leg defects with exposed bone or hardware.

- In this study Soleus muscle flap was used in 12 patients.

Total flap loss occurred in one patient and partial flap loss occurred in another patient.

Similar figures are quoted in literature (**Kauffman CA et al**).

- Gastronemius myocutaneous flap was used in one patient in this study.

Gastronemius myocutaneous flaps are used in select situations where the reach of muscle alone is difficult (**Salimbeni-Ughi G et al**).

- In this study reverse sural artery flap was used in 12 patients. Studies have quoted similar figures (**Sharma GN et al**).

Venous stasis is the commonest problem encountered in this flap (**Yilmaz M et al**) which is circumvented by

Leg elevation and vasodilators.

Ligation of short saphenous vein

Connecting short saphenous vein to a vein in the recipient site.

Superficial skin necrosis or necrosis of the distal end of the flap can be easily managed by debridement and grafting (*Singh S et al*).

- In this study cross leg flap was used in 2 patients and it has given a durable coverage.

With the advent of microsurgical techniques the need for cross leg flap is reduced. But in centres where free flaps are not done, there is still a place for cross leg flap.

- Fillet flap was used in 2 patients in this study. Fillet flap as a spare part concept should be used wherever possible to avoid additional donor site morbidity (*Kuntscher MV et al*).
- In this study Vacuum assisted closure was used in 2 cases. VAC can be used in selected cases of traumatic defects to accelerate wound healing. (*Voinchet V et al, Venturi ML et al and Defranzo AJ et al*)
- In this study degloving injuries are treated with radical debridement and skin grafting. Similar treatment protocol is quoted in literature studies (*Mandel MA*).

## SUMMARY AND CONCLUSION

- 294 patients with traumatic defects of leg and foot were treated during the period of July 2003 – June 2005.
- Males account for majority of the patients and RTA was the commonest cause.
- The number of cases are almost the same ever year. So awareness should be created among the general public to reduce the incidence of RTA.
- Upper third and lower third defects of the leg and ankle defects account for most of the cases.
- Problems in reconstruction are mainly encountered in the ankle and lower third leg defects because, local tissue availability is very minimal in these areas.
- Vacuum assisted closure (VAC) system was used in 2 cases and good results were achieved. So in future, VAC can be used for more no of cases.
- Perforator flaps (i.e.) Island fascio cutaneous flaps have negated the need for cross leg and free flaps. Of course there is a necessity for cross leg flap in some extreme situations, but their numbers have been drastically reduced.
- The referral for reconstruction is not done early enough sometimes, and so the residual morbidity of the skeleton makes the reconstruction redundant.
- Antibiotic coverage and anti microbial needs are not standardized yet.

- Ilizarov fixation is still a bugbear for reconstruction. Restricted operative field makes the surgery difficult and sometimes it becomes necessary to redo the whole reconstruction.
- Free flaps have not been taken up in the right earnest, probably due to logistics, but in future we are trying to do free flaps, which will ultimately improve our armamentarium.

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