A CLINICAL STUDY OF VARIOUS METHODS OF FOOT DEFECT RECONSTRUCTION WITH RESPECT TO DORSUM OF FOOT ANKLE AND ITS OUTCOME

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M.Ch. PLASTIC SURGERY

BRANCH III

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CERTIFICATE

This is to certify that the dissertation entitled, "**A CLINICAL STUDY OF VARIOUS METHODS OF FOOT DEFECT RECONSTRUCTION WITH RESPECT TO DORSUM OF FOOT ANKLE AND ITS OUTCOME"** Submitted by **DR. V.S.VALARMATHY** in partial fulfilment of the requirements for the award of the degree of M.Ch in Plastic Surgery by The Tamilnadu Dr.M.G.R. Medical University Chennai is a bonafide record of the work done by him in the Department of Plastic Reconstructive & Facio-Maxillary Surgery, Madras Medical College, Chennai, during the academic year 2010 to 2013.

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This is submitted to the Tamil Nadu Dr.M.G.R.Medical University Chennai, in partial fulfillment of the requirements for the examinations to be held in AUGUST-2013 for the award of M.Ch.degree (branch III) in plastic surgery

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INTRODUCTION

Foot re-construction poses a particular challenge to the plastic surgeon. The aim of foot reconstruction to give us adequate soft tissue cover and maintaining functional recovery Defects of Foot & Ankle with exposed tendon & bone require either local & free flap coverage.

With a good understanding of anatomy regarding Dorsum of foot and ankle the availability of pedicled and free flaps provides a durable coverage for the foot defects. Surgical techniques to reconstruct the foot can be differentiated by five main criteria

1. Local Fasio Cutaneous Flaps

2. Distally based superficial sural artery flaps

3. Distally based lateral Supramalleolar artery based flaps

4. Perforator based Propellar flaps

5. Microvascular free flaps

a) Anterolateral Thigh Flap

b) Lattisimus Dorsi Muscle Flap.

To select the suitable method of reconstruction factors like defect size involvement of surrounding structures, and morbidity of the surgical procedures should be considered for all the cases and functional and aesthetic aspects.

The reconstructive problems due to exposed bone, tendon, vessels which needs coverage with local tissue flaps, loco regional or distant flap and limitation imposed by donor site morbidity. Also there are many wound where closure are not possible even for small defects which requires soft tissue cover.

Several types of Flaps are designed for reconstruction dorsum of foot. The reversed flow island flaps have been developed in the form of Fasiocutaneous flap require sacrifice of leg artery and has contour deformities of the donor site.

[12]**Distally based superficial sural artery flap** has reliable blood supply was described by Masquellet 1992. It is a Flap easy to elevate and major arteries are not sacrificed. This Flap is useful for medium sized defects of Dorsum of the foot and ankle. Except for donor site morbidity and loss of sensation over the lateral aspect of the foot due to sacrifice of sural nerve, the flap doesn't affect the function of the limb.

[8]**Distally based lateral Supramalleolar artery based flaps** which is based on the perforator of peroneal artery is useful for reconstruction of moderate size defects on the Dorsum and medial and lateral malleolar ankle defects.

[18]**Perforator based Propellar flaps** was done by Koshima from Japan in 1989, provides a like tissue reconstruction with autogenous tissue and reduced donor site morbidity. These Flap involves dissection of the perforator, Hyper perfusion and increased blood flow exists in the perforator flaps as whole pressure head of source vessel is directed in to single best perforator. Reduction of steal phenomena by other tissues like muscle and fascia. Flap combines the benefit of increased blood flow of musculocutaneous system MINUS THE MUSCLE. The SBP is chosen by size, visible and palpable pulsatile nature and this also contributes to increased flow and larger flap harvest .98% success rate by ready recruitment of more perforosomes opening the linking vesssels.

[18]**Microvascular free flaps** demonstrates versatility of all soft tissue procedures and provides a best choice for treating the whole Dorsum of the foot. The main advantage is that they are raised from a distant donor site has its own blood supply and actively improves the venous and lymphatic drainage of the traumatized area. Free flaps are

thin and gives a durable coverage of the foot. Although they are inferior to local flaps in texture and color match this is considered less imported in the crush injuries of foot. Free flaps should have adequate dimensions which make complete reconstructive procedure possible.

The optimal outcome demands the surgeon to pay attention to the preoperative and post operative phase at the donor and the recipient sites.

SYSTEMATIC APPROACH

Patient Factor

- Age
- General Health
- Comorbidity
- Profession and
- Socioeconomic status

Defect Etiology

- Crush
- Degloving
- Amputation

Size and Depth of the Wound

Exposed Structure on the Dorsum of the Foot.

Contamination and Edema of the Surrounding Tissue

AIMS & OBJECTIVE

Primary Objective

To analyze the foot defects and discuss the various established reconstructive options available and their application

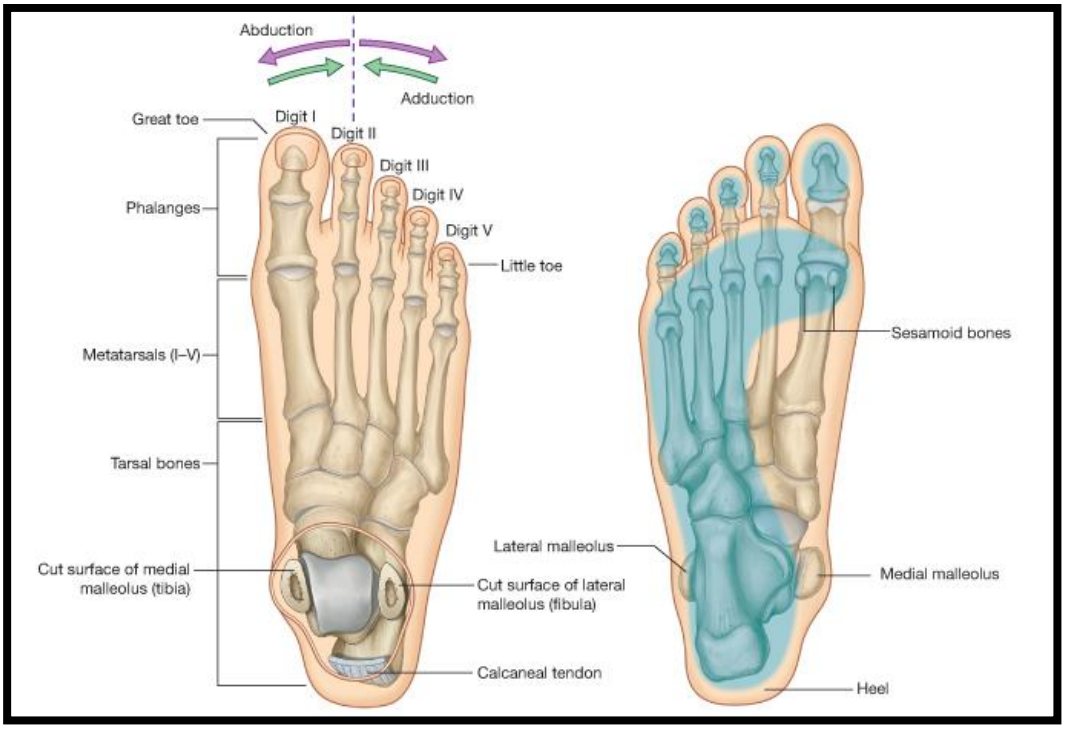
Secondary Objective(s)

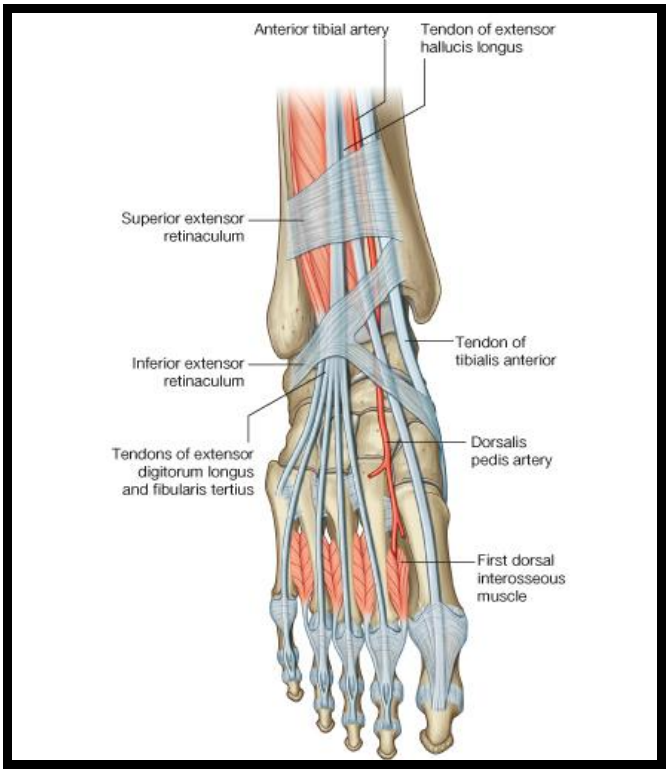
To evaluate the functional outcomes of various surgical procedures following dorsum of foot and ankle defects.

SURGICAL ANATOMY OF DORSUM OF FOOT AND ANKLE

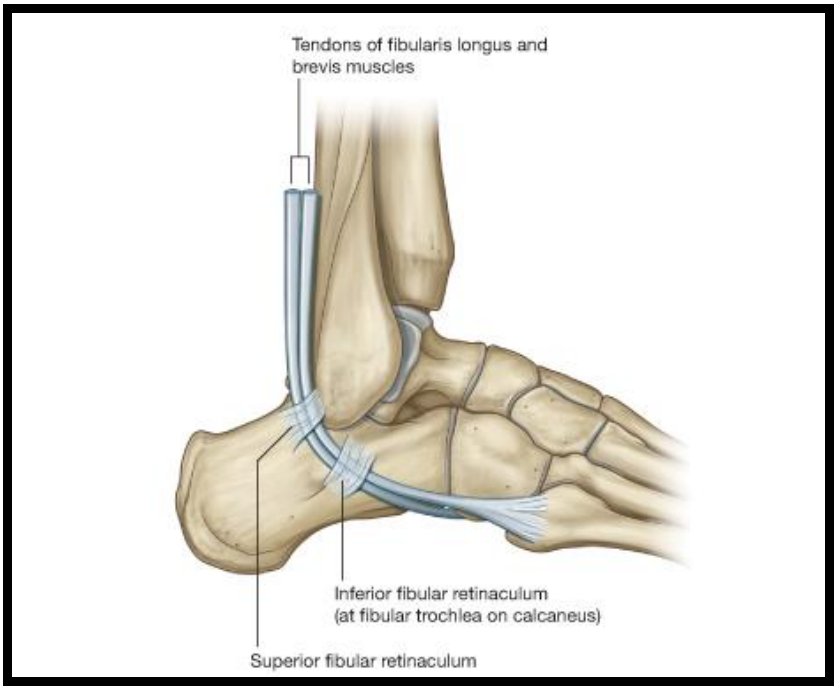
Dorsum of foot is divided into four regions namely medial border, lateral border, dorsum of the foot, dorsum of the ankle. Aanterior aspect of the foot contains loose and mobile skin when compared to weight bearing plantar skin. From the reconstructive aspect there are several anatomical constraints exists. Foot is a peninsula with no distal tissue available for proximal reconstruction.

Normally also reduced blood flow along the antero lateral aspect of the leg and foot. There is always paucity of tissues for the reconstruction of the dorsum of the foot. Dorsum of the foot contains plenty of lymphatic's and superficial veins in the subcutaneous tissue, skin ligaments which attach periosteum to the dermis exists only at the medial and lateral border of dorsum of the foot.

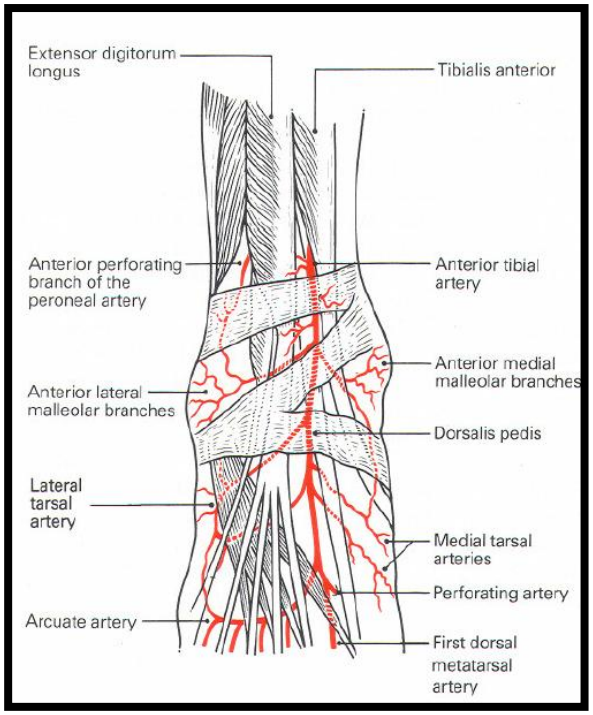

Abduction
Adduction
Great toe
Digit I
Digit II
Digit III
Digit IV
Digit V
Little toe
Phalanges
Metatarsals (I–V)
Tarsal bones
Cut surface of medial malleolus (tibia)
Cut surface of lateral malleolus (fibula)
Calcaneal tendon
Sesamoid bones
Lateral malleolus
Medial malleolus
Heel



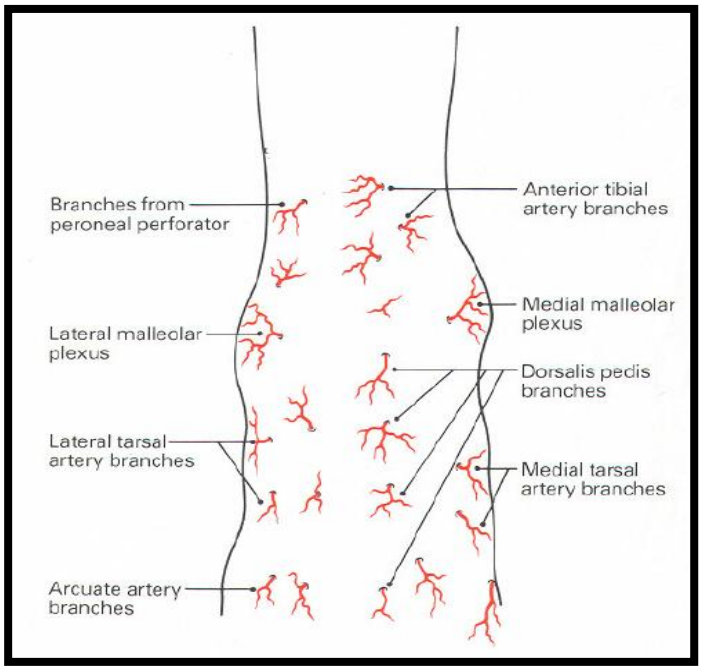
Extensor retinacula.



Fibular retinacula. Lateral view, right foot.



Anterior aspect of the right ankle and tarsus showing the main vessels from which the principal cutaneous vessels arise.



Anterior aspect of the right ankle and tarsus showing the cutaneous branches which one might expect, in principle, to find supplying the skin. In practice multiple very small vessels tend to exist rather than the discrete vessels shown here.

The dorsum of the foot is sub served by four cutaneous nerves namely medial and lateral border by saphenous and sural nerves respectively whereas whole of the dorsum of the foot is supplied by superficial peroneal nerve except at the first web space supplied by deep part of peroneal nerve. The perforator which supply anterior aspect of the foot arise along the dorsalis pedis and continuation as first dorsal metatarsal artery.

There are very few perforators which arise from arcuate artery and dorsal metatarsal arteries. The fascia of dorsum of the foot is condensed to form superior and inferior extensor retinacula.

Inferior extensor retinaculum is a Y shaped structure is stem extending from non articular superior surface of the calcaneum to medial malleolus and plantar fascia. The dorsal venous arch receives tributaries from dorsum of toes and forms great saphenous vein on the medial aspect along

with medial marginal vein. Laterally it forms small saphenous vein with lateral marginal veins. Dorsum of the foot extends beyond the line joining the malleolar region to the dorsum of the toes.

The skeleton of the foot covered by dorsal capsular ligament and introsseous ligaments form the deep boundary for the soft tissue on the dorsum of the foot.

The tibialis anterior tendon receives separate synovial sheath extending from inferior retinacula to tuberosity of navicular bone. Just in front of the ankle joint, the extensor hallusis longus tendon is medial to the neuro vascular bundle with which contains deep peroneal nerve and anterior tibial artery which continues as dorsalis pedis artery.

Lateral to neuro vascular bundle the extensor digitorum longus and peroneous tertieus tendons. On the enroute to phalanges and the base of the fifth metatarsal

bone respectively. Extensor digitorum brevis and extensor hallusis brevis is situated beneath the long extensor tendons.

Extensor digitorum brevis arise from the introsseus tunnel between the talus and calcaneum and there exists a separate slip of Extensor hallusis brevis which cross over neuro vascular bundle on enroute to hallucial phalanx. The neuro vascular hilum on anterior aspect of the foot exists close to the skeleton beneath the Extensor hallusis brevis muscle.

BLOOD SUPPLY OF ANKLE AND FOOT

The region around the ankle joint is supplied by branches of the anterior tibial, posterior tibial arteries and peroneal vessels.

The anterior tibial artery

This gives off anterior medial and lateral malleolar arteries about two fingers' breadths above the ankle as it passes beneath the tendon of extensor hallucis longus. In

addition it gives off one or two small cutaneous twigs directly above the extensor retinaculum .Each of the malleolar arteries may be double. The anterior lateral malleolar artery crosses the tibia deep to the extensor tendons.

The deep branches join the plexus on the periosteum and capsule of the ankle joint where they anastomose with branches from the lateral tarsal artery and the perforating branch of the peroneal. (The latter occasionally supplies skin.) The superficial branches pass above, below and sometimes through, the extensor retinaculum to reach the skin. They are very small and fine. The anterior medial malleolar branch runs over the medial malleolus and has deep and superficial branches.

The posterior tibial artery

This contributes to the skin on the posterior and medial aspects of the ankle. The posterior medial malleolar

artery sends branches to the malleolar network. Other branches run posteriorly to the skin over the tendo calcaneus and calcaneal branches run postero-inferiorly over the medial surface of the calcaneus. In the midline posteriorly these cutaneous vessels anastomose poorly with branches of the peroneal artery. There is, however, a large anastomosis between posterior tibial and peroneal arteries immediately anterior to the Achilles tendon.

The peroneal artery

This continues dorsally on the posterior surface of the lateral malleolus beneath the peroneal tendons. It sends branches forwards and ends as calcaneal branches directed postero-inferiorly to the skin over the lateral surface of the calcaneus. These are about 5 cm long and about four or five in number. The small saphenous vein overlies the lower part of this artery.

REVIEW OF LITERATURE

[1][,2]Katoh H. Hasegava M. at all studied distally based superficial sural artery flap 50 cases in which 36% complications like partial or complete necrosis of the flap, infection, and hematoma. Venous congestion, arterial insufficiency may be obvious explanation for complications.

[3]Almeida MF, Dacosta RV Okawa described reverse flow islanded sural flap in which technical errors are often the main cause especially among inexperienced surgeons can be easily avoided by following possible causes like lesser saphenous vein and sural nerve to be included in the flap.

[4],[5]Launso, chouCk studied adipofascial turnover flap of leg and ankle. The twisting of the base of the pedicle at the pivot point must not be too tight, the

adipofascial pedicle should not exceed the ratio 4:1.Age alone is not the risk factor by itself. The risk factor includes DM, venous insufficiency and peripheral arterial disease. If all these factors are present the risk of necrotic flap is very high. With respect to technical guidelines and limitation implied by the risk factor co morbidity sural artery flap is a valuable tool for reconstruction of dorsum of foot and ankle. Voche p, Merle M. Stussi Jd. The lateral supra malleolar flap: experience with 4 I flaps.

[6][7] Masquelet Ac, Romana C, Beveridge J etal studied later Supramalleolar flap in 60 cases used for coverage of dorsum of foot and ankle defects. The best indication for use of this flap involves dorsum of the foot and posterior aspect of the heel which requires supple skin. [8]The post operative course should be managed very cautiously. Foot should be elevated for 5 days post operatively and walking is allowed only progressively to avoid Flap congestion. [9]Touam C, Rostoucher P, Bhatia A studied distally based fascio cutaneous flap for the

coverage of lower one third of leg in which he describes The immediate venous congestion of the flap will result from any operative errors. Compression garments can be used after complete healing.

[10] Chai Zeng B, Zang F studied about the neuro fasciacutaneous perforator flap for ankle and foot reconstruction in which the sensibility of the Sural flap can be restored by suturing the peroneal nerve to the nerve at the recipient site. This procedure is valuable if the flap is designed to the lower part of the leg which is supplied by the superficial peroneal nerve.

[11][12] Stevenson TR , Mathes SJ describe the foot injuries with free muscle flap Studies of intramuscular LD muscle anatomy demonstrated the branching of artery and vein into transverse and longitudinal segments allowing the part of muscle for smaller defects. The LD muscle has been transferred as a motor unit to restore the function of the leg.

[13][14] Engel H,Cheng MH describes free ALT flap in which the perforator is marked preoperatively and the flap is elevated between the intermuscular septum of rectus femoris and vastuslateralis

[15][16] Reconstruction of foot defects with free lateral arm fascio cutaneous flap by ULUSAL DG, UNTYT used for reconstruction of the foot and ankle defects. the free flap should have less donor-site morbidity and a adequate pedicle for microsurgical anastomosis.

[17]Heler L and Levin LS studied lower extremity microsurgical reconstruction in which a fasciocutaneous free flap represents a good substitute to other flaps. Among the fasciocutaneous free flap alternatives, are the lateral arm flap, the radial flap, the anterolateral thigh flap,[17] superficial circumflex inferior artery flap, superficial inferior epigastric artery flap can be utilised, these flaps have someproblem, such as severe donor-site morbidity; a

tiny pedicle;; requirement for a change of position during surgery, hindering a two-team approach. the free TDAP flap is a reliable alternative for the reconstruction of soft-tissuedefects in the foot and ankle region.

[18]Perforator flaps were described Koshima and his colleagues in 1984 which provides autogenous tissue for reconstruction with reduced donor site morbidity. The advantage of perforator flap include preservation of muscles and nerves reduced bleeding and colour and texture match. Hence versatility of flap gives good match and better mobility of the map.

[19]The propeller flap concept was described by Hiyakusoku et al in 1981 who describes adipo cutaneous flap with a random blood supply.

[20][21] In 2003 WEI and Mardine coined and described free style free flaps raised on peroforators flaps. The flaps with more than one perforator allowed rotational or advancemental maneuvers depending on the vessel preserved

[23][24] Hallock defined a perforator of any vessel that enter superficial plane through a defined septum in deep fascia. The perforator flap have been shown to be well vascularised due to structural haemodynamic enhancements described by Rubino etal [25] used as free or pedicle flap. They can provide adequate cover for the defects.

[26] In 1981 Ponten described inclusion of deep fascia in extremities used to reconstruct more reliable flaps.

[27] Rubino and Coscia have shown that there is inversion of blood velocity between pedicle artery and perforator artery compare to normal circulation and proportion of the flow entering the perforator artery.

[28]The problem of anatomic variations can be overcome by using Doppler to identify the perforators which are then included in the flap.

[29] In contrast to free perforator flap local perforator flaps offer a limited range of flap movement depending on the tissue elasticity and the perforator vessel length which was described by Francisco G Bravo, Hardy P Schwarzt University hospital Spain. He described type 1 Flap with a single perforator with any type of movement and islanded design which has maximum range of movement. Type 2 flaps with a single perforator with limited arc of rotation. Type 3 peninsular flap which is a fascio cutaneous are random flaps in which skin bridge is maintained with single perforator included in the flap.

[30] Recent establishment of perforator flaps has revived the quest of cutaneous perforator as the “god rush” in the plastic surgery in 1970 to 1980 for the evaluation of free flaps.

SURGICAL TECHNIQUE

Lateral Supramalleolar Flap, raised on the lateral aspect on the lower leg very useful for covering defects involving ankle and foots it is a distally based pedicle flap the patient in supine position with tourniquet design of the flap done a line of incision is drawn anterior to lateral malleolar and reaches the depression of sinus tarsi on the lateral aspect of the hind foot (case 11).

The skin including the fascia incised continuity along the anterior margin of the flap and anterior to lateral malleolus .posterior skin hinge is maintained. the pedicle is first exposed lying deep to the extensor retinaculum, which is incised and the muscles of the extensor compartment exposing the lower compartment of the tibiofibular space in order to identify the vascular structures chiefly the cutaneous branch of the flap the perforating branch is ligated just proximal to the cutaneous branch. posterior margin of the flap is incised superficial peronial nerve is

severed proximally and proximal end is buried in the muscle pedicle is isolated with its loose areolar tissue untill it reach sinus tarsi. Closure of donor site is performed by suturing the peroneal and extensor muscle together, SSG is applied over it.

The medial sural artery originates from the popliteal artery, or less often from a common sural trunk at approximately the level of the knee joint. Potparic et al found a double medial sural artery in 15% of cadavers, and occasionally even more were present. The external diameter of the artery at its origin is approximately 3 mm. There are usually two venae cornmitantis and their diameter is approximately 3.5mm (case 6).

The medial sural artery enters the deep surface of the muscle along an elongated interfascicular hilum, with many longitudinally oriented branches extending as far as the point of insertion into the Achilles tendon. Vascular communications also exist between the lateral and medial

heads of the muscle that can allow total muscle survival even with loss of integrity of the dominant medial sural pedicle.

The flap boundaries should be centered around the most distal reasonable perforator, or they can be placed slightly eccentrically to ensure adequate pedicle length. The approximate eccentric location is the distance from the knee joint to the most proximal border of the flap. Although the maximum dimensions of the flap have not yet been determined, they should approach the dimensions of conventional calf fasciocutaneous flaps because both rely on the same fascial plexus.

Walton and Bunkis stated that this boundary extends from the superior flexion crease of the popliteal fossa to the junction of the middle and lower third of the calf (at approximately the level of the triceps surae), and transversely from the medial to lateral mid axiallines. The

donor site can be closed directly without a skin flap if the flap is less than 7 cm in width.

Dissection Use of a tourniquet without limb exsanguinations enhances the identification of all vascular structures. The lateral and/or distal border of the flap should first be incised through the deep fascia and raised to confirm the adequacy of the proposed perforators to the flap. If the perforators are inadequate, the boundaries of the flap must be repositioned.

If perforators are adequate, all borders of the flap may be incised through the deep fascia, with care taken to preserve any proximal superficial veins as a reserve conduit for venous outflow. If a sensate flap is desired, the posterior femoral cutaneous nerve can be found near the midline and preserved with the flap. The usual, tedious intramuscular dissection of the desired perforator (or perforators, if they seem to line up in a longitudinal array from the same or adjacent superficial branch) is carried

through the medial gastrocnemius muscle until the requisite pedicle length and/or vessel caliber is obtained.

Muscular branches must be cauterized or clipped as encountered. If used as a local pedicled flap, this dissection would end when the flap is long enough to reach the defect without tension .In all cases the tourniquet is first deflated to evaluate the adequacy of flap perfusion. A local flap can be directly inset or used as a free flap and transferred following the customary microsurgical approach.

The dual venous system of the anterior tibial artery perforator flap is comprised of the deep concomitant veins of the anterior tibial system or the superficial veins of the lesser saphenous system. The deep peroneal nerve accompanies the anterior tibial vessels. This is the source of motor branches to the tibialis anterior muscle, which branch off from the main trunk within the proximal third of the lower leg (case 9).

The Doppler is very useful for locating perforators preoperatively. The flap is outlined on the anteromedial aspect of the distal third of the lower leg, incorporating at least one such perforator.

The use of a tourniquet simplifies visualization, and, after it is inflated, Dissection begins at the dorsum of the foot and proceeds to the proximal third of the lower leg through a curvilinear skin incision. The lateral border of the flap is raised first until the anterior tibial perforators are exposed.

The perforators are dissected back to the more proximal anterior tibial vessels. Several perforators are typically found in the distal third of the lower leg.

The medial incision can then be completed, and the whole flap elevated suprafascially. An island ATAP flap with a single perforator allows unimpeded transfer as a

local flap to an adjacent defect. If a dominant perforator over 0.5 mm in diameter can be found, an entire ATAP flap up to 10 cm in length usually survives.

If a larger flap is required, a combined ATAP flap that includes a posterior tibial artery perforator flap can be used as a free flap. The posterior tibial perforator flap is vascularized by posterior tibial system perforators, located along the posterior border of the distal third of the tibia. Through an incision medial to the combined flap, perforators of the posterior tibial artery and the greater saphenous vein are dissected as far as possible, then transected; the main posterior tibial system is preserved, The proximal and distal ends of the anterior tibial vessels must be transected to be included with the combined free flap.

After revascularization, the distal portion of the flap is sometimes ischemic. Anastomosing a retained posterior tibial perforator to small muscular branches of the anterior

tibial system then is mandatory. Venous anastomoses can use either concomitant veins of the anterior tibial artery or the greater and/or lesser saphenous vein.

Distally, the retinaculum on the anterior aspect of the ankle joint is retained to avoid postoperative bowstringing. This may require a longitudinal stair-step incision through the retinaculum with subsequent reapproximation to allow the nerve to be transected even further distally within the foot. As the pedicle vessel to this vascularized nerve graft, only a short length (5cm) of the anterior tibial vessel is required to nourish a long length of the nerve graft.

A cutaneous perforator of the anterior tibial vessels can also be dissected with a small skin flap to obtain simultaneous skin coverage or to create a monitoring ATAP flap.

Local Adipofascial Flap. Island anterior tibial artery perforator flaps can be useful for adjacent lower leg

defects. The adipofascial flap is less invasive, as direct donor site repair is possible.

Lateral Calcaneal Artery Perforator Flap

The lateral calcaneal artery flap is a proven and for providing sensate coverage of the posterior ankle in a single stage. The flap supplies well-vascularized, thick epithelialized skin with a thin yet sturdy subcutaneous layer that has normal sensitivity. An extended form of the flap with the same characteristics can reach the plantar portion of the heel. In addition to this now classic proximal pedicled form of this flap, variations include a distally based version, or transfer as an island flap, adipofascial flap. Each variation has its own set of advantages that will be discussed (case 3).

The lateral calcaneal artery perforator flap can be considered a direct perforator flap. Traditionally, the flap contains the lateral calcaneal artery. The lateral calcaneal artery is usually the terminal branch of the peroneal artery.

With the patient in a supine position, the location and course of the lateral calcaneal artery is marked on the patient's skin. With the leg dependent, the course of the lesser saphenous vein is also marked. The pedicle of the flap lies immediately above and posterior to the level of the lateral malleolus. The base of the flap is usually left intact and optimally should be at least 4 cm in width. If necessary, the distal portion of the flap may be wider than the proximal end.

The short version of the flap encompasses the vertical distance between the lateral malleolus and the plantar heel. The length and width of the desired flap is then planned in reverse, using a cloth pattern over the defect and transposing it to lie over the previously demarcated artery. If there is an excessive amount of callous or slightly greater length is required, the flap can be gently curved distally, maintaining the previously marked artery as close to the center of the flap as possible. After the requisite debridement of the defect, the dissection of the planned flap is most easily begun just anterior to the Achilles tendon.

The incision here in the posterior margin of the flap must be made down to the periosteum of the oscalcis.

A plane is developed distally, leaving the periosteum intact. The anterior incision is made immediately behind the convexity of the lateral malleolus and carried down to the subcutaneous tissues. At the distal end of the flap, the neurovascular structures are ligated as these incisions are joined. The flap is mobilized in a retrograde fashion in the natural cleavage plane beneath the deep fascia. Great care must be taken to avoid injury to the arterial pedicle, which extends deep to the fascia proximally. Optimally, the vessels are never completely exposed to minimize the risk of traumatizing them. The retrograde dissection continues to the level of the lateral malleolus.

If a tourniquet is not employed, an audible Doppler probe can be used intraoperatively to ensure that the artery has been properly included within the flap. Immediately above the lateral malleolus, the lateral calcaneal artery

begins to disappear behind the fibula, making further dissection difficult. The flap should then be rotated and inset. Graft must be used to close the donor defect.

If a cutaneous flap is an appropriate option for lower limb reconstruction, muscle perforator flaps are an excellent choice as these can be extremely large with great reliability. The donor site can often be from the same limb, to limit the extent of the inevitable surgical morbidity. Each muscle perforator flap donor site has unique qualities that must be carefully scrutinized before its use in the lower extremity as a free flap, or local flap if that is an option. More often than not for large defects, a free flap will be necessary in this region. Whatever the choice, the final transfer must be thin enough to be unobtrusive so as to minimize any aesthetic deformity, allow use of normal clothing and shoe wear, and allow unencumbered ambulation.

ANTEROLATERAL THIGH FLAP

Anterolateral thigh flap is reliable septocutaneous flap for free tissue transfer usually done for larger defects of the lower limb especially involving the anterior aspect of the foot and ankle is based on the lateral circumflex artery. Used as a Free tissue transfer the length and width of the flap is tailored according to the defect (case 1).

The Flap is elevated on the anterolateral aspect of the thigh with the axis joining the ASIS to superolateral border of petella.Perforator is marked in the center of the axis and the flap is elevated. Maximum length of the flap elevated is 30cms and width is around 15cms. Direct donor site closure after subcutaneous release are 8 cm length and 4 cm width. Incision is made and inter muscular septa identified between rectus femoris (medially) and vastus lateralis laterally. Vascular pedicle is identified and dissected and the flap is transferred to the recipient site.

FREE TISSUE TRANSFER OF LD MUSCLE

The microvascular transfer of LD muscle is most reliable of all free tissue transfers for lower extremities particularly distal part of the leg and foot. When taken along with a skin paddle donor defect can be closed primarily. LD muscle can be reliably transferred using entire bulk.

When skin island is included, should be placed over the perforators which is determined by Doppler. The extended LD flap includes thorocolumbar fascia and overlying skin.

The zone of injury in the leg is so extensive that vein grafts are used for micro surgical anasthomoses outside the zone of injury. When transferring the muscle as motor unit, helpful to take incision that will permit easier coaptation with a distal tendon in the leg.

It is better to place temporary suture at regular interval before removing it from donor site, as a guide to restore resting length when transferred to the leg.

End to side anasthomoses have been shown to be reliable as end-to-end repairs and are absolutely necessary for patients with one vessel legs or blood to the distal extremity is tenuous. The technique has been described in which the thoracodorsal artery is harvested with a short segment of subscapular artery.

CASE - 1

A case of soft tissue sarcoma of the Dorsum and the ankle

Wide local excision and reconstruction with free Anterolateral Thigh Flap

CASE - 2

Post Traumatic soft tissue defect Dorsum of the Foot

Split Skin Graft

CASE - 3

Soft Tissue Defect lateral Malleolus

Lateral Calcaneal Artery Flap

CASE - 4

Post Traumatic soft Tissue Defect Dorsum of the Foot

Perforator from arcuate artery

CASE - 5

Post traumatic soft tissue defect left dorsum of foot

Split Skin Grafts

CASE - 6

Post Traumatic/Post Infective Raw area

Reverse Superficial Sural artery Flap

CASE - 7

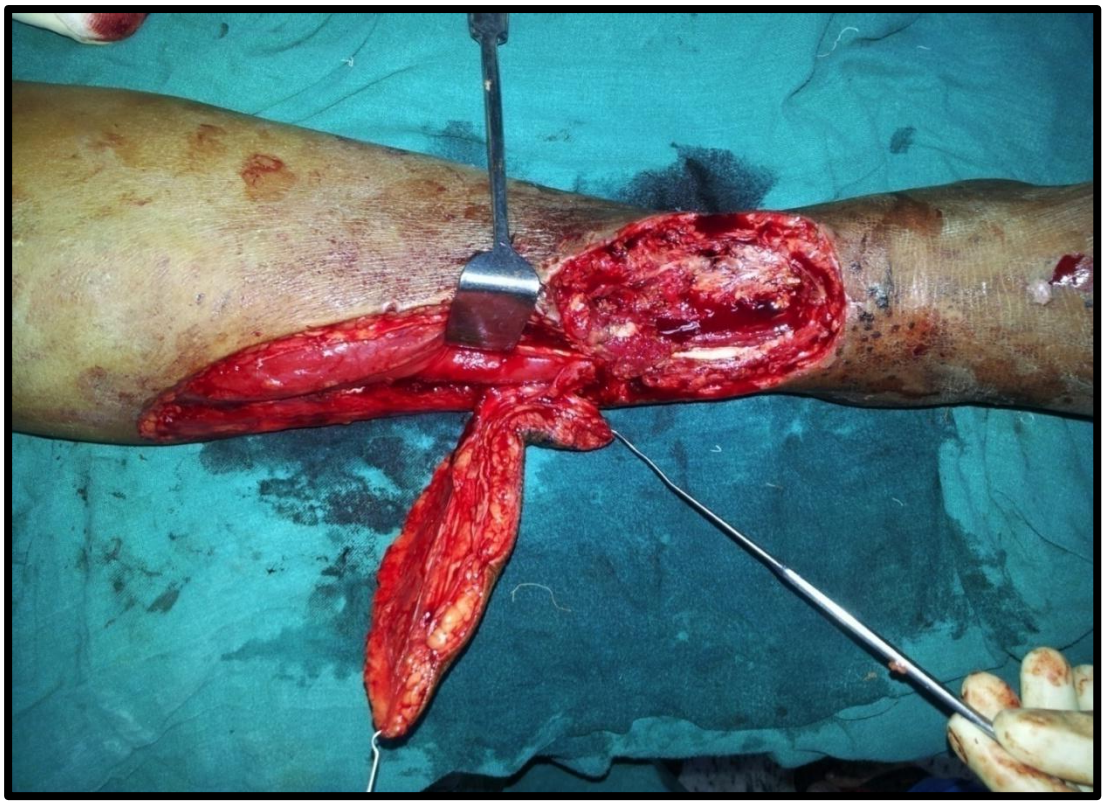
Post Infective Amputation Right Great Toe

Perforator of FDMA

First Dorsal MetaTarsal Artery Flap inset

CASE - 8

Post Infective Soft Tissue Defect Right Ankle



Superficial Peroneal Artery perforator shown.

Superficial Peroneal Nerve Artery Perforator Flap INSET.

CASE - 9

Post Traumatic Soft Tissue Defect Medial Malleolus

Anterior Tibial Artery Perforator

Anterior Tibial artery Perforator Flap inset

CASE - 10

Post Traumatic Soft Tissue Defect Ankle

Marking of the perforator Flap

Descending Branch of Ramus perforans Perforator

Final Flap Inset

CASE - 11

Post Traumatic Soft Tissue Defect Dorsum of the Foot

Lateral Supra malleolar Flap Markings.

Final Flap Inset

MATERIALS AND METHODS

The study was conducted in department of plastic reconstructive, Maxillofacial Surgery, Madras Medical College and Rajiv Gandhi Govt. General Hospital, Chennai during the period of August 2010 to February 2013.

Thirty patients were examined and analysed based on the established reconstructive options and operated in emergency or elective settings.

PREOPERATIVE ASSESSMENT

Pre-operatively assessment included a thorough history and physical examination. Time and mechanism of injury, age, occupational status and general health of the patients are the factors considered before surgery. The foot and the Ankle were assessed with regard to vascular status with degree of contamination and severity of soft tissue loss. Skeletal assessments were done with x-ray of the foot

and ankle. The degree of communition,bone loss and intra articular damage were studied. Basic blood investigations were done. Informed written concerns were obtained from all patients. Prophylatic antibiotics were given to all patients.

INTRAOPERATIVE MANAGEMENT

The main priority in the acute management of foot injuries were given to restore the vascularity, skeletal stabilization. Soft tissue coverage was done to restore the function of the foot.

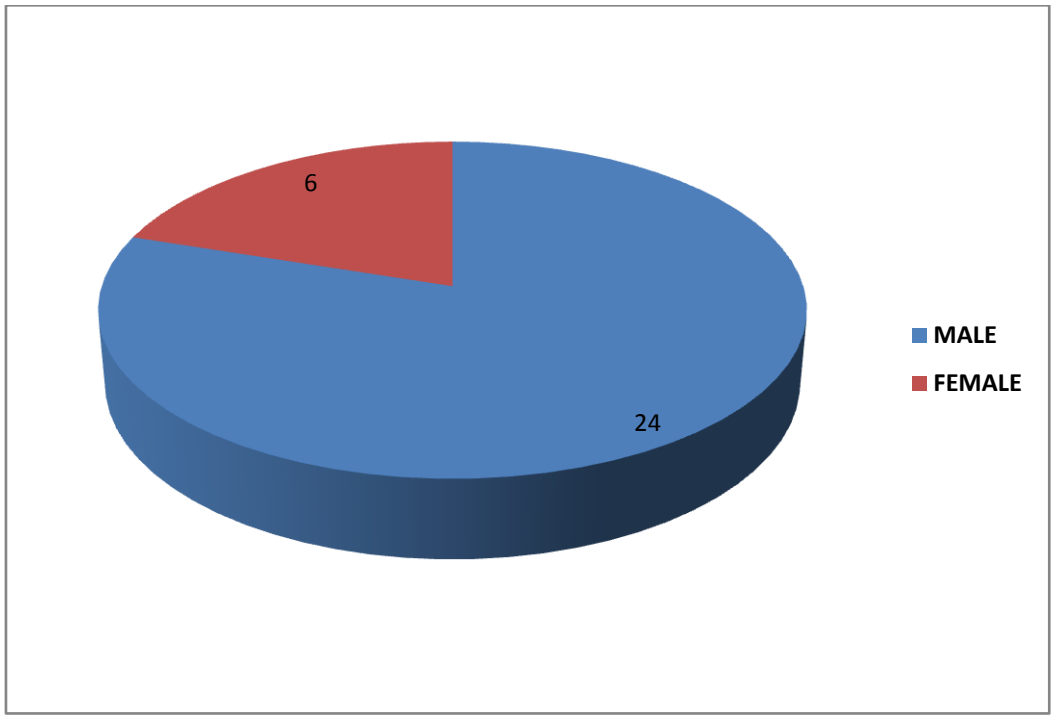
Thorough wound irrigation was done and debridement done under tourniquet control. Metatarsal and tarsal bones were fixed. Tourniquet was deflated after complete excision of devitalised skin, fascia and muscle.

FACTORS CONSIDERED IN CHOOSING FLAPS

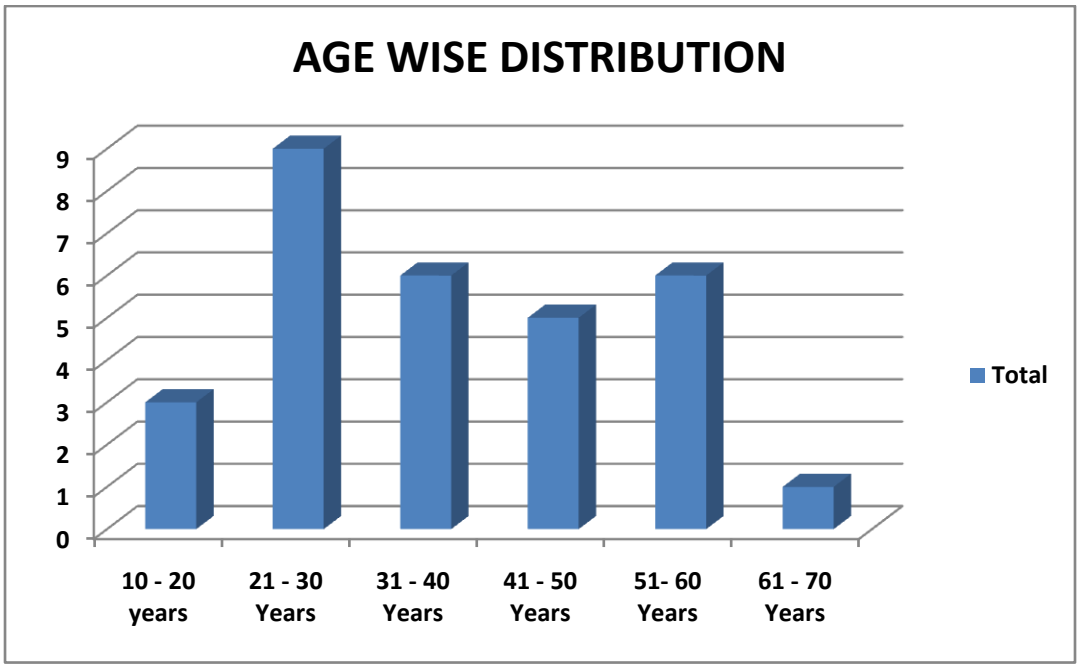
- Defect will be analysed on the structures lost like bone, tendon and the remaining structure to be reconstructed.
- Reconstructive selection of Flaps looks for color match, texture match and pliability.
- Also the method which consumes least time and less number of stages but providing maximal function is selected.
- Post operatively patient after discharge from the ward was followed up every week for first two months, then every two weeks for next 3 months. Physiotherapy was started as soon as the flap settled to prevent stiffness and early rehabilitation.

OBSERVATION

Six were female patients and twenty four were male patients.

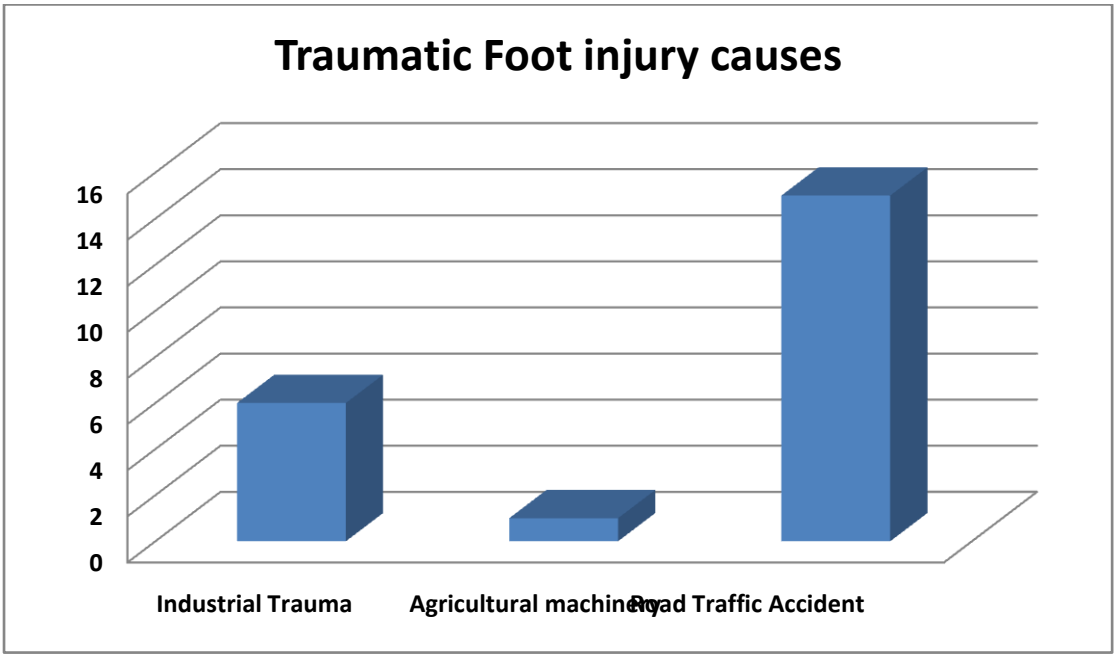


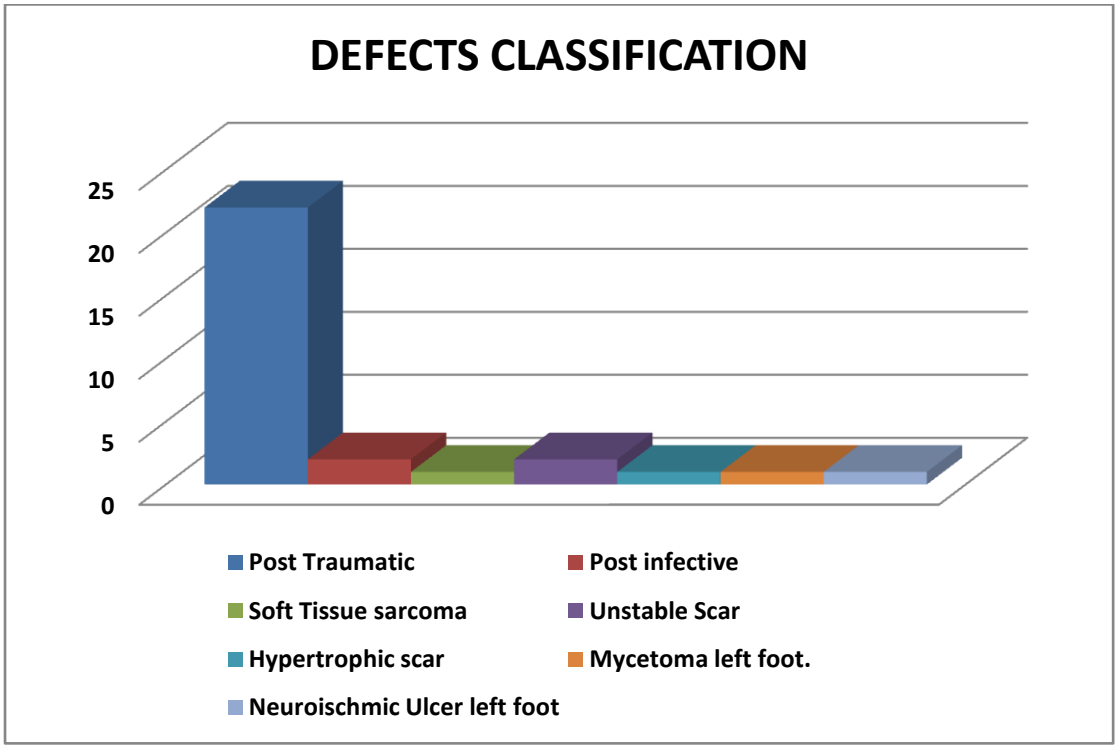
Age of the patients ranged from 10 to 70 years.

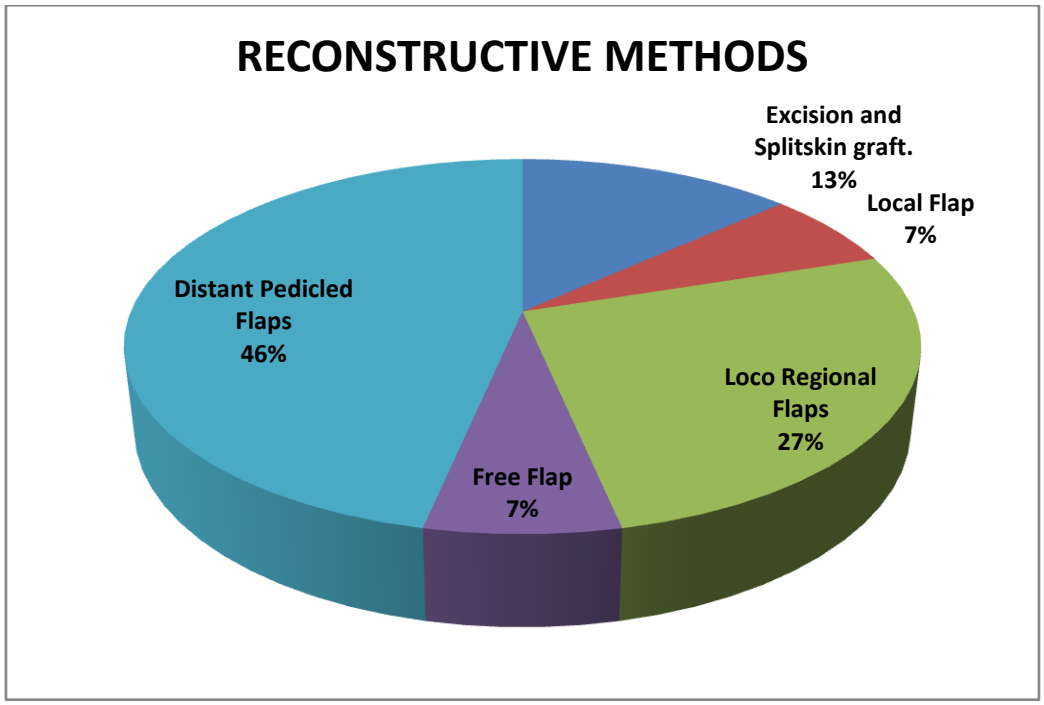


DISTRIBUTION ETIOLOGY

Post Traumatic Defect	22
Industrial Trauma	6
Agricultural machinery	1
Road Traffic Accident	15




DEFECTS CLASSIFICATION
25
20
15
10
5
0
Post Traumatic
Post infective
Soft Tissue sarcoma
Unstable Scar
Hypertrophic scar
Mycetoma left foot.
Neuroischmic Ulcer left foot



RECONSTRUCTIVE METHODS	TOTAL NUMBER
Excision and Split Skin graft.	4
Local Flap	2
Loco Regional Flaps	8
Free Flap	2
Distant Pedicled Flaps	14

ANALYSIS OF RESULTS

Of the 30 cases operated, trauma was the major cause of injury followed by infection. In traumatic, RTA was the major cause followed by work spot injuries. Most of the injuries in the Dorsum of the foot were associated with exposure of tendons and bones which required flap cover.

Due to the severity of the injuries local flaps were unavailable for reconstruction and distant flaps were utilized for the same. Loco Regional Flaps were used in 9 cases in which peroneal artery perforator flap in 3 cases, anteriortibial artery perforator flap in 4 cases and arcuate artery perforator flap in 1 case.

2 Cases were operated with micro vascular free flap since the defects were large in which loco regional flap were not adequate.

Distant pedicle flaps in which 4 cases showed distal tip necrosis, 3 cases of reverse sural flap and one case of lateral supramalleolar flap, the raw area healed with secondary intention.

2 Cases of perforator flaps showed congestion but the flap survived. Skin graft loss was found in 4% of cases grafted, post-operatively physiotherapy was started once the graft and flap settled well.

Follow up of the patients was done for 3 to 6 months and functional assessment of the foot was done with ankle and toe movements.

Aesthetic results were analysed by texture and color match. Correction of contour deformities and donor site morbidity. Color and texture match was better with loco regional flap than distant flaps

DISCUSSION

Providing a stable cover is needed not only for barefoot population and also for shoe wearing population. Providing a stable flap cover paves a way for subsequent bony and tendon cover. Split skin graft placed on dorsum of the foot apart from loss of colour match texture match and thickness match produces secondary lymphedema of the toes.

Stable flap cover on the dorsum of the foot especially if it is a loco regional flap provides good colour match texture match and thickness match with intact sensation and freedom from lymphedema this can be achieved by loco regional flaps like propeller flaps based on perforators on dorsalis pedis artery, first dorsal metatarsal artery, arcuate artery and without sensation achieved by regional flaps like reverse superficial sural artery flap, lateral supramalleolar flap and medial supramalleolar flap.

When defect is large, stable cover can be obtained by single stage distant free flaps which also provides good colour match, texture match ,and thickness match (with upon thinning) without sensation. The free flaps also promotes realignment and regeneration of lymphatics. Thereby they are free of secondary lymphedema.

The simple split skin graft is a poor choice for the dorsum of the foot cover because in our population which involves walking on uneven surface with soft and supple cover. From the departmental statistics between Aug 2010 to Feb 2013 we found out split skin graft on the dorsum of the foot resulted in 35% of cases with unstable scar, recurrence of ulcer and in one case with marjolins ulcer. Whereas the flap cover cases there is no recurrence or unstable scar, contractures with a flap cover in order to reduce a morbidity associated with split skin graft.

When defect size is small, propellar flaps based on the perforator which is rendered direct cutaneous by

periperforator dissection provides stable flap cover. From the study we found out venous congestion in propellar flap is grossly reduced by complete periperforator dissection by releasing all fascial attachment. Our incidence rate of partial necrosis is 1%. This is about 5% in the reverse flow flap like reverse superficial sural artery flap, lateral supramalleolar flap and medial supramalleolar flap. Reduced incidence of necrosis in propeller flaps is related to hyper perfusion.

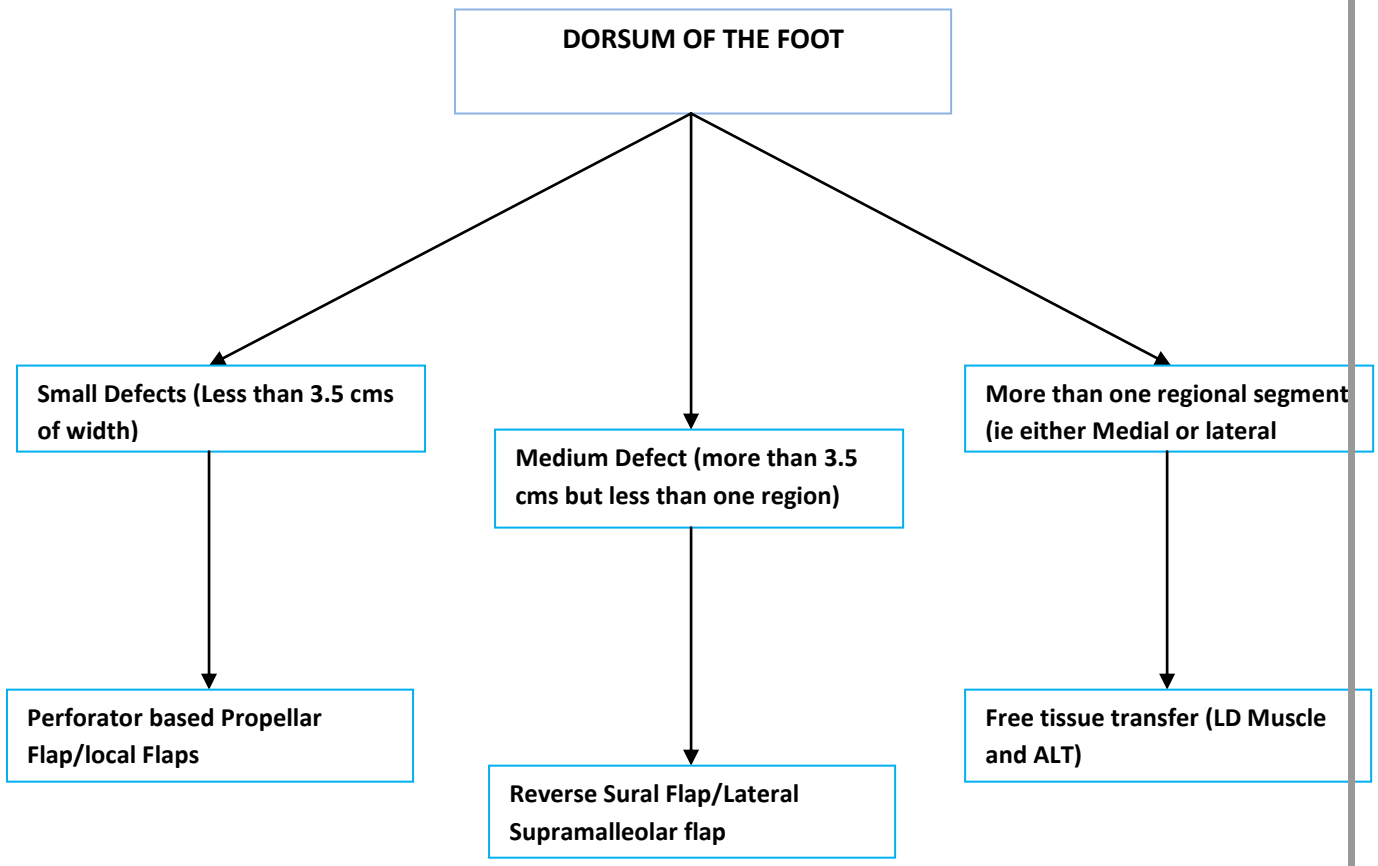
In the reverse flow flaps using Y-V baudet principle, we were able to cover the defect extending to the dorsum of the toes by releasing the tethering effect of proximal most perforator (in lateral supramalleolar flap ramus perforns release). In reverse superficial sural artery flap, Peroneal artery perforator release and maintaining distal most perforator.

Even in these reverse flow flaps skeletonising on the bridging perforator increase in the arc of rotation without

any kinking and hypoperfution. In large defect distant flaps are choice because there is no aesthetic deformity of the leg segment as it occurs in reverse flow regional flaps. The distant flaps in single stage provides stable reconstruction for dorsum defects.

Donor site of antero lateral thigh flaps which was only used in1 case was primarily closed. In one case lattismus dorsi free flaps were used. It is harvested as muscle flap with small cutaneous paddle. With nil morbidity at the donor site as these all are function preserving partial LD flap harvested with intra neural fascicular dissection. So our extensile approach is protocol.

ALGORITHM


DORSUM OF THE FOOT
Small Defects (Less than 3.5 cms of width)
Medium Defect (more than 3.5 cms but less than one region)
More than one regional segment (ie either Medial or lateral
Perforator based Propellar Flap/local Flaps
Reverse Sural Flap/Lateral Supramalleolar flap
Free tissue transfer (LD Muscle and ALT)

CONCLUSION

The tissue on the dorsum of foot is thin, mobile and nonglabrous to allow movements of the joints of the foot. The thin layer of areolar tissue covering the tendons permits smooth tendon gliding. Reconstruction should aim at all the structural component of foot. The surgeon should analyze the efficiency and outline correct reconstructive plan. Local skin flaps has color match, texture match and thickness match, should be considered if the defect is relatively small.

Perforator flap should be considered as second option for smaller defects of the dorsum and ankle since these perforator flaps have 98 % success rate is related to hyperperfusion of this flaps. Hyper perfusion and increased blood flow exists in the perforator flaps as whole pressure head of source vessel is directed in to single best perforator. Reduction of steal phenomena by other tissues like muscle and fascia and the flap combines the benefit of

increased blood flow of musculocutaneous system minus the muscle.

The SBP is chosen by size, visible and palpable pulsatile nature and this also contributes to increased flow and larger flap harvest .98% success rate by ready recruitment of more perforosomes opening the linking vessels

Morbidity of donor site is almost nil.Source vessel with prominent cutaneous nerve, muscle and fascia are maintained at donor site. Most of the donor areas are closed primarily. Aesthetic reconstruction- no dog ears, contour deformities Systemic morbidity also minimal

Because it is microsurgical technique minus the microsuturing, blood loss is minimal. Our average operating time is 1 1/2 hours. Loupe magnification is used in all cases.

Distant pedicle flaps like reverse superficial sural artery flap and lateral supra malleolar flap are useful in covering small to medium sized defect of the foot and forms an excellent alternative to other forms of reconstruction.

The Free tissue transfer should be reserved for those cases where there is no local options available. Forms an excellent choice for the reconstruction of large defects of the foot for the benefit of well vascularized supple skin. Reconstruction should aim to replace functional and structural component of the foot in which free flaps are excellent options.

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PROFORMA FOR CLINICAL CASE STUDIES

NAME: PS No:

AGE: I.P No:

SEX: D.O.A:

ADDRESS: D.O.S:

D.O.D:

PH NO:

CLINICAL DETAILS:

CO-MORBIDITIES:

PROCEDURE DONE: (with photos)

POSTOPERATIVE FOLLOW-UP:

DOCUMENTATION

Serial No.

Aetiology

Comorbidity

Risk Factors

Defect size

Site

Flap type

Flap dimension

Flap Outcome

Donor Site Morbidity

Followup

Recurrence

MASTER CHART

S.No	NAME	Age	Sex	Mode of defect	Option used
1	Manivannan	33	M	Hypertrophic scar.	Excision and Splitskin graft.
2	Vijayakumar	21	M	Post-Traumatic .	Reverse superficial sural artery flap.
3	Subramani	46	M	Post-Traumatic .	Splitskin graft.
4	Pandian	12	M	Post-Traumatic soft tissue defect- dorsum of the ankle.	Lateral Supramalleolar Flap.
5	Kasi	58	M	Neuroischmic Ulcer left foot	V-Y advancement Flap.
6	Arumugam	45	M	Post-Traumatic raw area left foot.	Reverse superficial sural artery flap.
7	Brindha	21	F	Post-Traumatic raw area right foot.	Reverse superficial sural artery flap.
8	Jayaraman	55	M	Mycetoma left foot.	Excision and Splitskin graft.
9	Sabapathy	55	M	Post-Traumatic raw area left ankle.	Perforator based propellar Flap.
10	Vasudevan	31	M	Post-Traumatic raw area right foot.	Lateral Supramalleolar Flap.
11	Kannaiyan	70	M	Post-infective raw area left foot.	Splitskin graft.
12	Vinoth	25	M	Post-Traumatic raw area left foot and ankle.	Reverse superficial sural artery flap.
13	Thulasiraman	20	M	Post-Traumatic raw area right foot.	Lateral Supramalleolar Flap.
14	Ganesan	60	M	Post-Traumatic raw area right foot.	Splitskin graft.
15	Rathnakumar	24	M	Unstable scar right ankle.	Excision and Splitskin graft.
16	Mahendran	22	M	Post-Traumatic raw area left foot.	Reverse superficial sural artery flap.
17	John	24	M	Post-Traumatic raw area right foot.	Perforator based propellar Flap.

18	Ramaiah	11	M	Post-Traumatic raw area right foot.	Perforator based propellar Flap.
19	Palani	50	M	Post-infective raw area left lateral malleolus.	Lateral calcaneal artery flap.
20	Sumathy	40	F	Soft Tissue sarcoma.	Free Anterolateral Thigh Flap.
21	Bharathy	55	F	Post-Traumatic raw area left foot.	Splitskin graft.
22	Deepak	22	M	Post-Traumatic raw area medialmalleolus.	Free Lattisimas dorsi muscle Flap with SSG.
23	Raja	30	M	Post-Traumatic raw area left foot	Perforator based propellar Flap.
24	Ranganathan	41	M	Post-Traumatic amputation of great toe.	First dorsal metatarsal artery perforator Flap.
25	Bhaskar	40	M	Post-Traumatic raw area left foot.	Perforator based propellar Flap.
26	Ramachandaran	54	M	Unstable scar right foot.	Excision and Splitskin graft.
27	Ramya	30	F	Post-Traumatic raw area left foot.	Perforator based propellar Flap.
28	Ravi	40	M	Post-Traumatic raw area right foot.	Perforator based propellar Flap.
29	Leela	40	F	Post-Traumatic raw area right foot.	Splitskin graft.
30	Gowri	45	F	Post-Traumatic raw area right foot.	Splitskin graft.

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI -3

Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To

Dr.V.S.Valarmathy,
II Year P.G. in M.Ch Plastic Surgery,
Madras Medical College, Chennai -3

Dear Dr.V.S.Valarmathy,

The Institutional Ethics committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled "A Clinical study of various methods of foot defect reconstruction with respect to dorsum of foot & Ankle defects and outcome" No.05122012.

The following members of Ethics Committee were present in the meeting held on 11.12.2012 conducted at Madras Medical College, Chennai -3.

1. Dr.S.K.Rajan, M.D.FRCP, DSc --- Chairperson
2. Prof. R. Nandhini MD -- Member Secretary
   Director, Instt. of Pharmacology ,MMC, Ch-3
3. Prof. Dr.A.Radhakrishnan MD -- Member
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7. Prof. S.Devivanayagam MS -- Member
   Prof of Surgery, MMC, Ch-3
8. Thiru. S. Govindsamy. BA, BL -- Lawyer
9. Tmt.Arnold Saulina MA MSW --- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/ Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

R Nandini 21/12/12
Member Secretary, Ethics Committee

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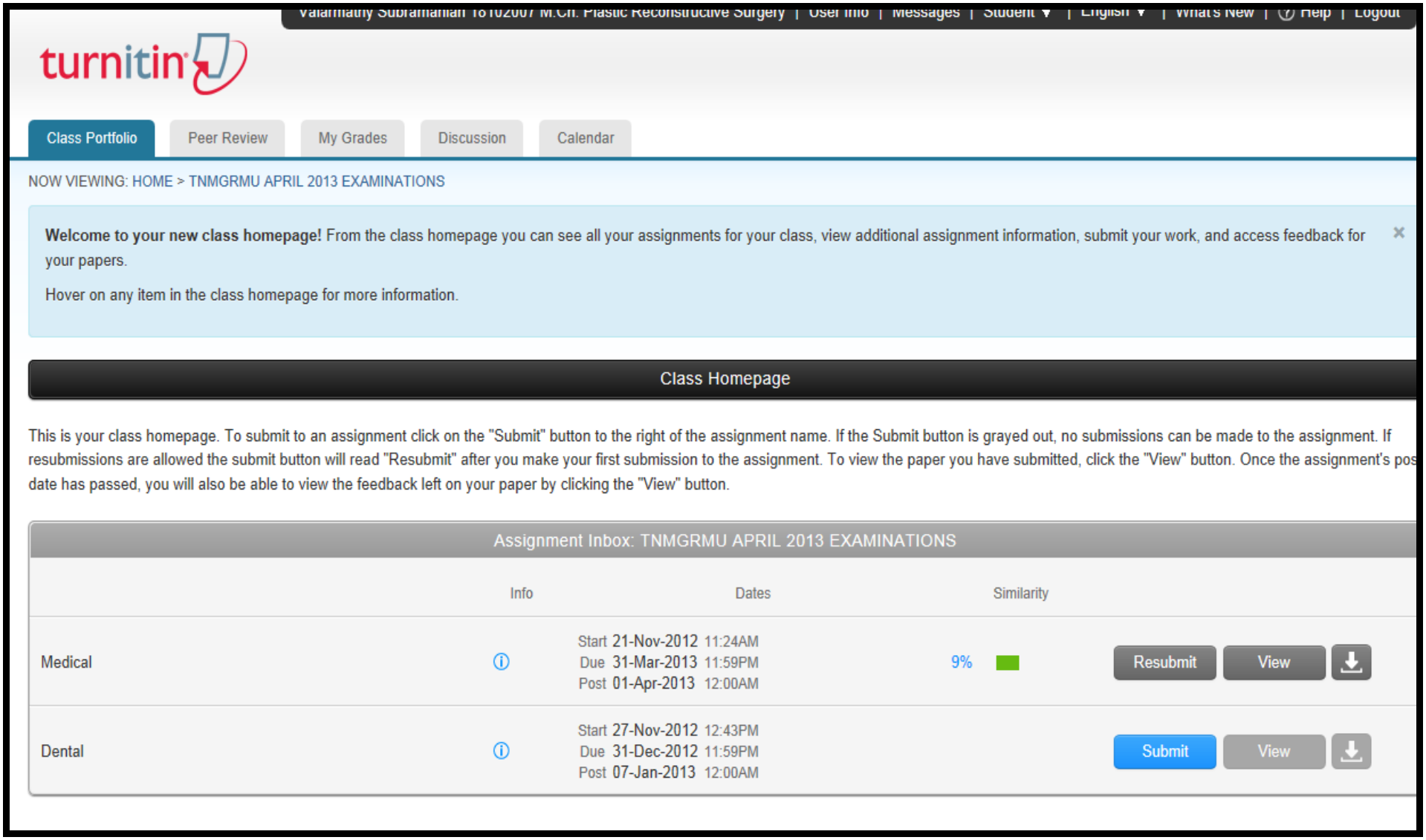
Assignment title	**Medical**
Author	**Valarmathy Subramanian 18102007 M.Ch. Plastic Reconstructive Surgery**
E-mail	**vsvalar@gmail.com**
Submission time	**23-Mar-2013 05:09AM**
Total words	**6159**

First 100 words of your submission

AIM OF THE STUDY Primary Objective To analyze the foot defects and discuss the various established reconstructive options available and their application Secondary Objective(s) To evaluate the functional outcomes of various surgical procedures following dorsum of foot and ankle defects. Introduction Foot re-construction poses a particular challenge to the plastic surgeon. The aim of foot reconstruction to give us adequate soft tissue cover and maintaining functional recovery Defects of Foot & Ankle with exposed tendon & bone require either local & free flap coverage . With a good understanding of anatomy regarding Dorsum of foot and ankle the availability of pedicled and free flaps provides...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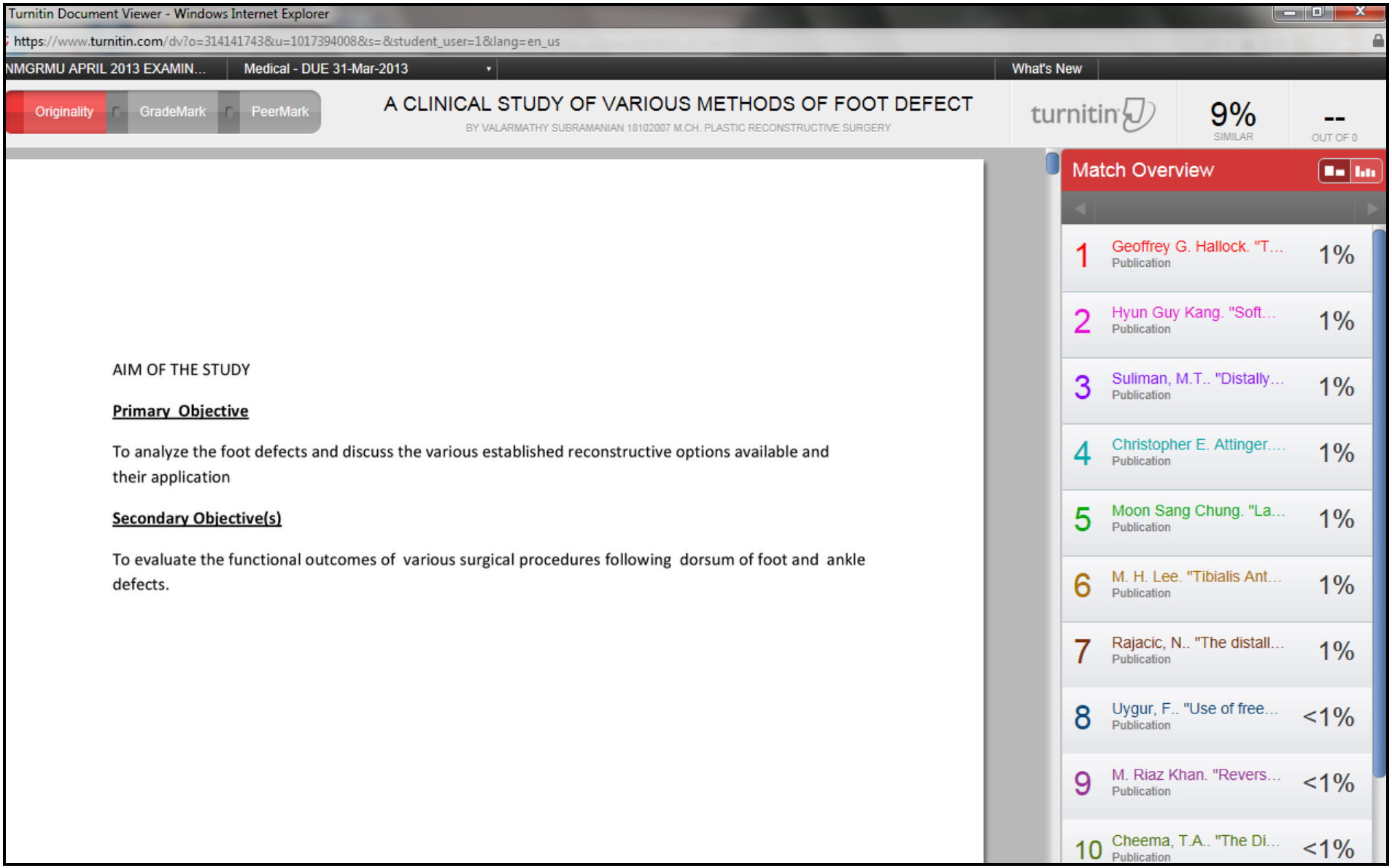
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What's New
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A CLINICAL STUDY OF VARIOUS METHODS OF FOOT DEFECT
BY VALARMATHY SUBRAMANIAN 18102007 M.CH. PLASTIC RECONSTRUCTIVE SURGERY
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AIM OF THE STUDY
Primary Objective
To analyze the foot defects and discuss the various established reconstructive options available and their application
Secondary Objective(s)
To evaluate the functional outcomes of various surgical procedures following dorsum of foot and ankle defects.
Match Overview
1 Geoffrey G. Hallock. "T... Publication 1%
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3 Suliman, M.T.. "Distally... Publication 1%
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