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COMPARISON BETWEEN PERONEUS BREVIS FLAP AND REVERSE SURAL ARTERY FLAP FOR COVERAGE OF DEFECTS AROUND THE HEEL.

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ABSTRACT

BACK GROUND: Post traumatic soft tissue defects around the lower third of the leg, ankle and foot always have been challenging to reconstruct. Reverse sural flaps have been used for this problem with variable success. Free tissue transfer has revolutionised management of these problem wounds in selected cases.

METHODS: A nonrandomized prospective study of 12 patients admitted with soft tissue defects around the Heel hospitalized at Government Chengalpattu Medical College Hospital in the Dept. of Plastic surgery from Jan 2015 to Jan 2017 was done . Patients with posttraumatic moderate size defects around the Heel requiring flap cover for exposed bone, tendon & implant were included in the study .

RESULTS: Six patients underwent DPBF (*distal peroneal brevis flap*) and six RSAF (*reverse sural artery flap*). Mean age of patients of DPBF's was 35 years(range 16 -63).Nine were male patients ,three were female patients. Both groups had good results with varying factors influencing the outcome.

CONCLUSION: RSAF AND DPBF are reliable for moderate size defects around the heel. Both flaps gave a good functional outcome. DPBF is better for aesthetic, short duration of stay and small sized soft tissue defects compared to RSAF.

KEYWORDS : heel defect, peroneus brevis flap and reverse sural artery flap

INTRODUCTION

Posttraumatic soft tissue defects around the ankle and foot represent a difficult reconstructive problem due to exposure of the bones, joints and tendons. Several reconstructive procedures have been proposed to repair soft tissue defects in these regions, including local cutaneous flaps, pedicled fascial or fasciocutaneous flaps and pedicled muscle flaps. Local flaps in the foot have limitations of reach and reduced amount of soft tissue that can be transported at the cost of unacceptable donor site morbidity.

Donski and Fogdestam described distally based fasciocutaneous flap based on the perforators of the peroneal artery around the ankle and their communications with the superficial sural artery. This flap, with its modifications, has been used for moderate-sized defects. The skin territory supplied by these lower peroneal perforators is limited, and useful flaps therefore have to be based on its communications with another fascial, fasciocutaneous or neurofasciocutaneous plexus. This limits its dimensions, pedicle length and the distal reach.

Microvascular tissue transfers provide a large amount of soft tissue at the most desired places, and are quiet reliable in experienced hands. But, non-availability of microsurgical expertise and facility at peripheral centres, the cost and, sometimes, the patient-related factors may preclude the option of free flap. Although free-tissue transfer plays an important role in limb salvage, better understanding and applications of regional flap designs have sometimes provided easier and more cost-effective alternatives for soft tissue coverage of the injured lower extremity.

Peroneal perforators supply skin over the lateral and posterior aspects of the leg. Flaps based on these perforators of peroneal artery have been proposed for the coverage of lower third of leg and foot. These flaps include the skin supplied by the peroneal perforators either as propeller flap or as island flap with inclusion of peroneal vessels. Multiple communications exist between the peroneal artery and the tibial arteries, as demonstrated by Cormack and Lamberty. Based on these communications, the authors have described reverse peroneal artery flaps. Distally based islanded peroneal artery flap, although a versatile tool for foot reconstruction, is prone to venous congestion.

Inclusion of superficial vein for easier drainage has been tried successfully by multiple authors for similar distally based flaps. Short saphenous system in the leg has constant anatomy and drains the whole posterior leg. Unlike in the radial forearm flap where the pedicle is very close to the superficial vein, peroneal vessels are further away from the short saphenous system. To harvest these two systems together and to maintain their communication was challenging. Hence, flap designs of reverse sural and DPBF were combined to get the advantages of both the systems. It also minimises disadvantages like low perfusion pressure in the upper third and inadequate venous drainage, respectively, of both flaps.

In our study, posttraumatic wounds and soft tissue defects around the Heel remain a challenge. Defects at this site often require a Flap cover. The Reverse Sural artery Flap and Peroneus Brevis Flap are good options for coverage. We did a prospective study of 12 patients admitted in duration of 2 years with posttraumatic moderate sized defects around the Heel who underwent RSAF & PB Flaps.

ANATOMY REGARDING FLAP

DPBF :The muscle is the nethermost of the two muscles in the posterolateral compartment of the leg. It arises from the lower half of the lateral surface of the fibula and from the intermuscular septa. It lies between the extensor digitorum longus anteriorly and the flexor hallucis longus posteriorly. The muscle terminates in a short tendon that runs behind the lateral malleolus and then bends forward to end at the base of the fifth metatarsal bone. In the area behind the lateral malleolus, the muscle is still fleshy and is crossed by the tendon of the peroneus longus. A common synovial sheath envelops the two tendons, which are covered by the superior peroneal retinaculum. The blood supply is provided by small segmental branches, usually three to four in number, arising from the peroneal artery. Another set of nutrient vessels coming off the anterior tibial artery supplies the upper part of the muscle belly. The nerve supply is from the superficial peroneal nerve, the lower stem of the common peroneal nerve that winds around the neck of the fibula. The muscle's function, in common with that of the peroneus longus, is to perform eversion and plantar flexion of the foot.

RSAF :The sural artery issues from the popliteal artery. It joins the sural nerve coursing between the two heads of the gastrocnemius and follows the lateral edge of the Achilles tendon. The sural artery is intimately connected with the sural nerve and plays an important role in supplying the skin of the lower and middle posterior leg. It terminates with the lateral supramalleolar branch of the fibular artery and posterior tibial artery. A pair of comitant veins travel with the sural artery. The sural nerve descends in close association with the lesser saphenous vein, coursing posterior to the lateral malleolus, to innervate the lateral side of the foot and the fifth toe. The vascularization of the nerve is ensured by the sural artery in the proximal third of the leg and by an arterial fascial plexus issuing from the perforators of the fibular artery. Approximately four to eight perforators arise from the fibular artery, pierce the crural fascia, and give rise to several branches that join adjacent perforators, forming an interconnecting vascular suprafascial plexus that extends from the proximal part of the leg to the posterior margin of the lateral malleolus. A larger perforator is located approximately 5 cm proximal to the lateral malleolus. After giving off the anterior perforator that pierces the interosseous membrane, the distal portion of the fibular artery gives off a posterior lateral malleolar branch and more distally, the lateral calcaneal artery.

OBJECTIVE:

To observe the clinical effect of distally based PB muscle Flaps and RSA Flaps for coverage of defects around the Heel.

EXCLUSION CRITERIA:

1) Diabetic patients.
2) Patients below 12 years.
3) Patients not willing for surgery.

MATERIALS & METHODS:

A nonrandomized prospective study of 12 patients admitted with soft tissue defects around the Heel hospitalized from Jan 2015 to Jan 2017 was done. Patients with posttraumatic moderate size defects around the Heel requiring flap cover for exposed bone, tendon & implant were included in the study . Details like age, sex, etiology, dimensions of defects, reason for flap cover and complications, if any, were noted from patients' medical records

We included patients with moderate size defects in our study , where in the patients in two groups were made comparable by same site selection,matching range of area and similar age group. Flap selection was random. Data was collected on a proforma including information regarding the patients age, gender, occupation, and wound characteristics including etiology, site, size & depth.

Routine investigations included full laboratory investigations, Random Blood sugar & Plain Xrays. Pre-operatively, any history of previous injuries/surgeries to the limb, size and the site of the defect and peripheral pulses were assessed. This flap was planned when at least one of the major vessels is palpable. Arterial Doppler examination was carried out only when there was suspicion of lower limb ischaemia or history of vascular injury. Peroneal perforators were not routinely marked pre-operatively. All the procedures were performed under spinal anaesthesia. Most of the steps of surgery were carried out under the permissible time of tourniquet control. Patients were kept in lateral position Patients were operated under Regional anesthesia. Postoperatively patients received antibiotic for five days & adequate analgesia. Flap was assessed daily . Patients were discharged once flap and split skin grafting were healthy on assessment after first dressing and subsequent dressings. Patients were followed up twice weekly for the first month and then once a month for six months.

FLAP DESIGN DIMENSION AND TECHNIQUE

FLAP DESIGN AND DIMENSIONS: DPBF

The muscle flap, nearly 10 cm long by 3 cm wide, can be swung forward to cover the upper half of the lateral malleolus and the adjoining part of the fibula.[1] A split-thickness skin graft provides the epithelial cover. There will be no functional loss using this muscle flap if the peroneus longus is preserved intact.

OPERATIVE TECHNIQUE: DPBF

The distal portion of the muscle belly can be felt immediately behind the lower third of the fibula in front of the Achilles tendon. Access to the muscle is by a longitudinal incision along the posterior border of the lateral malleolus. The distal 10 to 12 cm of the muscular attachment to the fibula can be released without compromising the blood supply to the muscle flap.[2] Having cut through the superior peroneal retinaculum, the tendon is isolated. Damage to the peroneus longus tendon with its peritendineum, situated superficial to that of the brevis, must be avoided. The peroneus brevis tendon should be transected as far distally as possible.[3]

Fig. no 1 Preoperative picture

Fig. no 2 Postoperative picture DPBF

Fig. no 3 late postoperative picture with minimal graft loss

FLAP DESIGN AND DIMENSIONS: RSAF

Considering the anatomic structures involved, the flap pedicle includes superficial and deep fascia, sural nerve, lesser saphenous vein, and sural artery.[4] The lesser saphenous vein is generally used to determine the axis of the pedicle. The pivot point of the pedicle is the main perforator, located 5cm proximal to the lateral malleolus, as it is the most reliable. The two more distal perforators issuing from the posterior lateral malleolar and lateral calcaneal branches are likely to provide a pivot point for the pedicle. Nonetheless, dissection is more risky at this level, and the width of the pedicle is limited. The standardized sural flap is designed as follows. The skin island is designed on the posterior aspect of the calf at the junction of the two heads of the gastrocnemius. The pivot point of the pedicle and the source supplying the flap is the most reliable perforator. The pedicle is a strip of adipofascial tissue, including subdermal tissue, lesser saphenous vein, sural nerve, and deep fascia. The ratio of length to width of the pedicle is approximately 4:1. Some points should be reemphasized. The pivot point is approximately 5 cm proximal to the lateral malleolus and posterior to the fibula. The axis of the pedicle is oblique and can be located precisely by the course of the lesser saphenous vein.[5] The length of the pedicle is determined by the arc of rotation required. However, a reliable adipofascial pedicle should not exceed the ratio of 4:1 (i.e., if the pedicle length is 12 cm, the width is about 3 cm). The design of the skin island is in continuity with the pedicle. The dimensions of the flap can reach 15 cm in length and 12 cm in width.

OPERATIVE TECHNIQUE: RSAF

A prone position is indicated only when the defect is located at the posterior aspect of the heel or the lateral aspect of the ankle. In other cases, the patient lies in a supine position, the ipsilateral buttock slightly elevated. Flexion and adduction of the hip and flexion of the knee allow raising the flap in a rather comfortable position while the whole anterior aspect of the ankle and the medial side of the leg remain easily accessible. The flap is outlined approximately at the junction of the two heads of the gastrocnemius. The precise location of the skin paddle depends on the length of pedicle required. The pivot point of the pedicle is about three finger-breadths proximal to the tip of the lateral malleolus. The line of incision is traced over the course of the sural nerve and lesser saphenous vein, which may have been identified previously with Doppler ultrasound .[6] A distal transverse short debridement, resulting in an H shaped incision, allows the raising of two skin flaps to isolate the adipofascial pedicle. In cases of a thick subcutaneous layer, it is advisable to leave a thin layer of adipose tissue connected with the two skin flaps. The pedicle is isolated by two parallel incisions, fascia included, before raising the flap. Once the pedicle is isolated, the flap, with fascia included, is raised. Small arteries arising from the fibular artery should be ligated and divided within the adipofascial pedicle. Note that these small perforators can be used as a pivot point for a more proximal pedicled flap, with the aim of covering any part of the middle third of the leg. The arc of rotation allows easy coverage of the posterior aspect of the heel. The skin bridge is incised to bury the pedicle. The donor site and the exposed aspect of the pedicle are covered with a split thickness skin graft The postoperative course should be carefully evaluated. Excessive pressure on the pedicle or on the flap must be avoided. Slight elevation of the lower extremity is possible, avoiding any contact of the flap that could result in partial or total necrosis.

Fig. no 4 soft tissue defect heel pad with RSAF marking

Fig. no 5 postdebridement raw area

Fig. no 6 RSAF postoperative picture

RESULTS :

Six patients underwent PBF s and six RSA Flaps. Mean age of patients of DPBF's was 35 years(range 16 -63).Nine were male patients ,three were female patients. First 6 pts given below in table no. 1 under went DPBF and remaining underwent RSAF.

Table no. 1

S.l. No.	Age	Sex	Etiology	Defect location	Dimension	Complications
1	35	M	Trauma	Rt. Heel	5cm x 2 cm	Venous congestion with flap tip necrosis with graft loss
2	49	M	Trauma	Rt. Heel	4.5cm x 4 cm	Venous congestion
3	33	F	Trauma	Lt. Heel	3cm x 4 cm	Nil
4	16	M	Trauma	Rt. Heel	4.5cm x 3.5 cm	Nil
5	25	M	Trauma	Lt. Heel	2cm x 5 cm	Flap tip necrosis with graft loss
6	31	F	Trauma	Rt. Heel	3cm x 3 cm	Nil
7	38	M	Trauma	Rt. Heel	7.5cm x 6.5 cm	Venous congestion
8	40	M	Trauma	Lt. Heel	15cm x 8.6 cm	Nil
9	29	M	Trauma	Rt. Heel	10cm x 9 cm	Venous congestion with partial flap loss
10	38	F	Trauma	Rt. Heel	7cm x 10 cm	Venous congestion
11	50	M	Trauma	Lt. Heel	5cm x 6 cm	Nil
12	37	M	Trauma	Rt. Heel	11cm x 6 cm	Venous congestion

Venous congestion was more common with RSAF's (four of six) as compared to DPBF's(two of six)

One out of four RSAF's with venous congestion had partial flap loss.

Out of the six patients who underwent DPBF's, two patients had flap tip necrosis. None of them had bone or tendon exposure. One patient was managed with regular dressing while the other patient regrafting was done.

No patient in RSAF's or DPBFs suffered from total flap loss.

DISCUSSION

Soft tissue defects of the lower third of the leg are difficult to reconstruct. Free flap is currently the treatment of choice for large soft tissue defects of the lower extremity and it solves the problem of donor site morbidity in the immediate vicinity of the flap. It is however a technically demanding procedure for surgeons with less microsurgical experience

Successful soft tissue reconstruction of large defects over the lower leg, ankle and foot is often a limb-saving procedure Fasciocutaneous or neurofasciocutaneous flaps from the leg are useful and versatile reconstructive options for patients with moderate-sized soft tissue defects of the leg, ankle and foot. Inability to reach distal defects with limited arc of rotation of wide and short adipofascial pedicles and the precarious venous drainage has been their problems. Although a free flap can provide sufficient tissue for reconstruction, not all patients are suitable candidates for free tissue transfer because of the existing comorbidities and economic constraints.

The presented flap design has included reverse flow peroneal artery along with the reverse sural design to achieve reliable cover. A sural flap has limited dimensions. This neurofasciocutaneous flap is perfused by lower peroneal perforators and has an axial pattern of circulation in the lower 2/3rd of the leg. Flap harvested from the upper leg behaves as a random pattern extension of this flap and is unreliable. Inability to harvest reliable tissue from the upper third of the leg limits flap dimensions, the pedicle length and, ultimately, the distal reach of this flap.Multiple modifications like delaying, wider than usual pedicle,supercharging and taking part of gastrocnemius muscle with the flap have been attempted to extend the flap to proximal the leg, with doubtful benefit. Ayyapan and Chaddha tried to secure the skin from the proximal third by adding all the connective tissue between the heads of the gastrocnemius.

Lateral and posterior leg is normally supplied by perforators of peroneal artery reaching the skin via the posterior intermuscular septum. There are constant perforators 7–21 cm from the fibular head.Although they were not marked pre-operatively in this study, it may be safer for beginners . In our experience, these perforators were mostly direct septocutaneous perforators. Intramuscular course if present is through the flexor hallucis longus, and is very short. Thus, dissection of the perforator to the source vessel is quick. Once the perforator has been dissected to the peroneal vessels, the periosteum over the fibula is reflected just proximal to the selected perforator. This helps in complete visualization of the main pedicle and further dissection. The peroneal vessels are ligated proximally and are reflected distally as necessary for comfortable reach.

The presented technique of including the peroneal artery along with its perforator in the pedicle acts as arterial supercharging of the flap based on the supramalleolar perforators . This significantly increases the perfusion pressure in the flap taken from the upper third of the leg. When these advantages are combined, flap from the upper leg achieves all the advantages of an axial pattern flow. Harvesting the flap from the

upper leg improved the effective pedicle length and helped reaching distal defects up to the bases of the toes. Inclusion of both sural and peroneal systems improves venous drainage and makes the pedicle more substantial to avoid any kink while taking the flap to foot. Additionally, peroneal vessels get covered with well-vascularised tissue. We did not encounter any venous or arterial insufficiency in any of the flaps. The maximum flap dimension was 26 cm × 13 cm. Irrespective of the dimensions of the flap, no augmentation procedure like extra anastomosis was necessary.None of the cases in this study required any delay procedure.

The main disadvantage of this flap is sacrifice of the peroneal artery. As long as either the posterior or the anterior tibial artery is patent, this was inconsequential in our patient population. On the contrary, we propose DPBF for reconstruction of injuries to the ankle and foot, preferably where the leg is uninjured. Peroneal artery is the least important source of blood supply to the ankle and foot, where the main supply comes from the anterior tibial and posterior tibial arteries. With two major supply vessels intact, the risk to the foot is minimal while successful cover achieved is a major reconstructive achievement in an otherwise difficult area. . We did not observe any ischaemia-related complications anywhere in the leg attributable to harvest of the DPBF.

Peroneal artery is least likely to have atherosclerosis. In the presented series, six patients had successful flap cover.

This flap offers the following multiple advantages over other distally based fasciocutaneous flaps: (1) reliable flap dimensions can be extended up to the knee joint line, (2) pedicle length can be planned liberally to avoid acute kinking and (3) with longer pedicle, the flap can reach more distal areas over the sole and dorsum of the foot.

CONCLUSIONS:

To conclude, RSAF AND DPBF are reliable for moderate size defects around the heel. Both flaps gave a good functional outcome.

DPBF s had better aesthetic appearance at donor site and recipient site.

DPBF 's have the advantage of ease of surgery, speedy recovery, less hospital stay and no donor site morbidity.

DPBFs appear to be preferred choice for defects around the heel.

RSAFs should be chosen over DPBFs for larger size defects.

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