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Great Saphenous Fasciocutaneous Flap, A Versatile Option for Coverage of Complex Lower Limb Defects

KEYWORDS

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ABSTRACT *INTRODUCTION : Reconstruction of the defects of leg and foot has always challenged the plastic surgeons and has encouraged them to look for more options. Before 1981 the only available option was that of random pattern flap with limited range of motion and limited length to width ratio. It was Ponten who revolutionized the concept of defect coverage by suggesting the inclusion of the fascia in the flaps. After this, the concept of perforator flaps, muscle flaps, neuro-fasciocutaneous flaps were introduced. Masquelet et al introduced the concept that there is a rich plexus of vessels around the superficial nerves on which we can raise neuro-fasciocutaneous flap, thereby increasing the options of lower limb defect coverage. This study aims at describing the versatility of saphenous flap in reconstructing defects of leg and foot and to develop a classification scheme for the same.*

MATERIAL AND METHOD : This study is a retrospective analysis of charts of patients with defects of leg and foot who underwent various saphenous flap cover at the Department of Plastic and Reconstructive surgery between January 2014 to February 2016. A total of 31 patients with soft tissue defect of leg an foot were included in the study. There were 28 males and 3 females with average age of 40years(19-60 years). Most common cause of injury was road traffic accidents followed by post-burn defects. The defects were present on the anterior and lateral aspect of the knee, dorsum of the foot, sole and the opposite leg. Hand held Doppler was used to mark the perforators preoperatively. Saphenous flaps were classified as proximally, distally based flaps, propeller flap, cross leg flap and saphenous free flap.

RESULTS : All flaps were planned preoperatively and perforators were marked. The size of the flaps ranged between 24-216 sq. cm. Of 31 patients, 13 patients underwent coverage with proximally based saphenous flap, 9 patients had distal saphenous flap coverage, 3 had propeller flap and 5 defects were covered with cross leg saphenous flap. One patient with defect over the dorsum of foot underwent saphenous free flap cover. All flaps were uneventful with full recovery except in 4 patients, 3 patients had partial necrosis of the flap (2 patients with distal saphenous flap, 1 with propeller flap cover). These changes were attributed to venous congestion and the flap was later debrided and left to granulate and then split skin grafting was done. Fourth patient had cross leg saphenous flap cover and had complete necrosis of the flap due to generalized atherosclerotic disease. There was no donor site morbidity in any case.

CONCLUSION : The saphenous fasciocutaneous flap is reliable and versatile in both flap design and elevation. Different types of this flap can meet the demands of different defect sizes and locations. Furthermore, a satisfactory functional and aesthetic result can be achieved with minimal donor site morbidity.

INTRODUCTION

Reconstruction of the defect of leg in foot has always remained a challenge. There were only limited options before Ponten suggested the use of local fasciocutaneous flap in 1981 (1). It was after this that the use of local fasciocutaneous flap gained popularity. Distally based fasciocutaneous flaps, sural artery flap and muscle flaps with skin graft were proposed in succession. These local fasciocutaneous flaps fell short in terms of donor site morbidity, limited length-width ratio and poor flap mobilization. It was after this that Koshima and Soeda introduced the concept of perforator pedicle flap and Masquelet et al introduced the reverse sural neuro-fasciocutaneous flap. He proposed that a rich network of vessels is present around the sural nerve and saphenous nerve and vein and that these plexus have numerous anastomoses with the perforators of peroneal and posterior tibial artery. A greater saphenous neurofasciocutaneous perforator flap exceeding the length-width ratio can be harvested by including both saphenous nerve and vein. The saphenous flap was first described by Acland et al (2) as a free neurovascular flap based on saphenous artery in 1981. After this pedicled, reverse pedicled and perforator flaps have been described (3,4,5,6). In this article, we have described the versatility of saphenous flap in reconstruction of defect of lower leg and foot and tried to develop a classification scheme for the same.

ANATOMY OF THE SAPHENOUS ARTERY

The descending genicular artery arises from the superficial femoral artery and gives rise to two branches named as musculoarticular and saphenous artery, within 3 cm distance of its origin. Saphenous artery arises approximately 12 cm from the inter epicondylar line (7). Here the diameter of the artery is between 1-2.5mm. Two vena comitantes and saphenous nerve accompany the saphenous artery. The saphenous artery is initially located deep in the roof of the adductor canal then it runs distally and superficially within a loose fascial space bounded superiorly by Sartorius muscle, posteriorly by tendons of adductor magnus muscle and anterolaterally by vastus medialis muscle.

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The artery runs distally in this plane for 12-15cm until it passes medially into the leg beneath the tendinous portion of distal part of Sartorius and gives it's distal perforators. The terminal portion of the saphenous artery distal to the Sartorius muscle runs adjacent to the deep fascia and sends branches into the subcutaneous tissue below the medial condyle of tibia and forms a plexus. The distal end of saphenous artery reaches approximately 12 cm below the knee joint (7). This forms the basis of proximally based pedicled saphenous flap and the free flap.

The saphenous nerve and saphenous vein which runs along with the artery has a rich plexus around them and also these plexus have anastomotic connections with the perforators of the posterior tibial artery, thereby, making it the basis of distally based saphenous flap, cross leg flap and propeller flap with increased length to width ratio. The saphenous nerve and vein runs medial to the shin of tibia and if included in the flap helps in extending the length to width ratio of the flap raised on the distal posterior tibial artery perforators (8).

METHOD

A retrospective analysis was conducted between January 2014 and February 2016 at the Department of Plastic and Reconstructive Surgery, SMS Hospital, and the charts of patients with leg and foot defects who underwent various saphenous flaps were reviewed. A total of 31 patients with soft tissue defects of the leg and foot were included in the study. There were 28 males and 3 female patients in the study. The average age of the patients was 40 years (19 years to 60 years). Most of the defects were caused due to Road traffic accidents (RTA) and the others were post-burn defects. The defect sizes ranged between 20-148 sq. cm. and were located over the anterior, medial aspect of the leg, anterior and lateral aspect of the knee, dorsum of the foot and opposite leg. Hand held Doppler was used to mark the perforator of the posterior tibial artery preoperatively.

We classified the saphenous flap into 5 types. 1. Proximally based saphenous flap 2. Distally based saphenous flap 3. Propeller flap 4.Neurosensory fasciocutaneous free flap 5. Cross leg flap.

Flaps were planned preoperatively and perforators were marked. The axial line of the flap lay between anterior medial malleolus and medial epicondyle of femur and each of the flaps was designed along the course of great saphenous vein with specific pedicle to address the clinical situation.

USES OF SAPHENOUS FLAPS

The choice of the saphenous flap depends upon the defect location. The actual flap design must satisfy the particular requirement of the specific recipient site. The proximal saphenous flap is based on the saphenous artery and the plexus around the saphenous nerve and vein. Total flap dimension is 8 cm in width and 24 cm in length and therefore the flap is available in the upper two-thirds of the leg to cover defects of the medial, supero-lateral and posterior parts of the leg. The distal flap can be used to cover the defects in the middle and lower third of the leg, foot and the heel. The flap can be islanded on its pedicle to increase its reach. It can be harvested for sole reconstruction when appropriate perforators are available. The above two flaps can be used as cross leg flaps for defects over the other leg when there is no local tissue available. The advantage of this is that this cross leg flap can be used for covering defects which might be inaccessible for classic cross leg flaps. Another option is to use the posterior tibial artery perforator and its anastomosis with the plexus around the saphenous nerve and vein as propeller flap with increased length to width ratio for covering the defects over the lower two-thirds of the leg, ankle and the dorsum of the foot. The propeller flap possesses the advantage of greater freedom of movement. Finally, the saphenous fasciocutaneous flap can be used as free flap for defects as big as 20x 8 cm. these flaps are based on the saphenous artery that gives a long pedicle and has a relatively good diameter at its origin. The saphenous nerve included in this flap can be used for providing sensation for sole reconstruction.

RESULTS

This study comprised of 31 patients with 28 males and 3 females having an average age of 40 years (19 years to 60 years). The size of the flap ranged between 24 to 216 sq. cm. (mean 56.2 sq.cm.). Road traffic accidents comprised the majority of the etiology (26 patients) and the rest were burn patients. Of the 31 patients, 13 underwent proximally based saphenous flap, 9 patients had coverage with distally based saphenous flap, 3 patients had propeller flaps and 5 had cross leg flap for coverage of knee and lower leg defects. One patient with defect over the dorsum of foot underwent saphenous free flap cover from the opposite leg. All flaps were uneventful except in 4 cases, in 3 patients there was partial necrosis of the flap (2 patients with distally based flap and 1 with propeller flap). This was attributed to venous congestion and the distal portions of the flaps were debrided and wounds were left to granulate which was later covered by split skin thickness graft. Fourth patient had cross leg saphenous flap cover and had complete necrosis of the flap due to generalized atherosclerotic disease. The mean duration of the surgery was 45-60 minutes for proximal and distal flaps, 90-120 minutes for propeller and cross leg flap and 3- 4 hours for free flap. There was no donor site morbidity noted in any patient and all the patients had good graft take. One patient who underwent coverage of the defect over the lower leg with saphenous free flap had an uneventful course with good contouring.

DISCUSSION

Coverage of the defects of the leg has always remained a challenge and there has been a constant effort made to find new methods. Initially the flaps used for coverage of the leg defects were random pattern flaps that had the constraints of length to width ratio. In 1981, Ponten demonstrated that the length to width ratio can be increased by including the deep fascia in the cutaneous flap (1). This was followed by the era of perforator flaps in late eighties, when Koshima et al and Kroll and Rosenfield (9) attempted to design their flaps based on the perforators of the source arteries. These flap were used as free flaps and required higher technical skill and surgical time and also not all patients were suitable for free flaps because of existing morbidities and the inability to endure lengthy procedures. In 1992, Masquelet et al reported the use of flaps on nutrient vessels of the cutaneous nerves and the veins of the lower limbs, since then neuro-fasciocutaneous flaps have been widely applied. The sural fasciocutaneous perforator flap has achieved great popularity since then (10,11,12,13). Lu et al summarized and classified the different types of suralneuro-fasciocutaneous perforator flaps (14). These flaps were very helpful in coverage of the leg defects but these had various limitations like coverage of leg defects when there is lateral tissue involvement, massive scars and the defects over the upper third of the leg etc. Therefore,

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alternatives were sought to overcome these challenges.

Masquelet et al described the anatomy of the posterior tibial artery and its perforator (10) and Zhang et al described the nutrient vessels of the saphenous nerve and vein and found 11 main sources of vascular support that send out deep fascial branches, periosteal branches and cutaneous branches to these structures (15). It was the effort of Saint Cyr et al (16) who described the vascular territories of the perforators as perforasomes and helped in better understanding of the dynamic characteristics of the perforasomes and applying them in harvesting pedicled perforator flaps. Finally, Dai et al published their work comparing the perforator pedicle and fascial pedicle of sural neurocutaneous flap and found that the former is associated with lower rate of flap necrosis (17). Acland et al (2) described the saphenous flap and declared that these flaps were preferable for lower leg reconstruction as these are thin and have a long vascular pedicle and a dependable nerve supply. Mathes and Nahai classified the saphenous flap as type II fascio-cutaneous flap. According to the classical textbooks and the study conducted by Gocmen-Mas et al (7) the diameter of the artery at its origin ranged between 1.8-2.5mm.

It was on these studies that we classified the saphenous flaps as saphenous artery based proximal flap, distally based perforator flaps, propeller flap, proximal or distally based cross leg flap and the free flap. The indications of these flaps were based on the location of the defect, size and the soft tissue condition etc.

In our study the most commonly used flaps were proximally and distally based flaps. These flaps can be harvested as a much larger than conventional random flap without considering the length to width ratio by including the nutrient vessels of the saphenous nerve and vein. These flaps are much easier to harvest and take lesser time then propeller and free flap. The proximal flap was found to be the most reliable flap as it also includes the saphenous vein which helped in good venous drainage from the flap hence lesser chances of venous congestions. The largest defect size for which the proximal flap was used was 14x 14cm. and while harvesting this flap care must be taken to detach the Sartorius muscle from its insertion at the medial epicondyle as the artery id deep above the intercondylar line. The distally based flaps must include the saphenous nerve and vein and must be based on a reliable perforator of posterior tibial artery. There were 3 propeller flaps included in the study and the defect size covered by these flap ranged between 15-60 sq. cm. According to Schaverien and Saint Cyr (18), three clusters were described in the lower leg (4-9,13-18, and 21-26cm from the intermalleolar line), each cluster having 23% of the total number of perforators and the presence of at least one perforator in each cluster in 80% of cases(16).A septocutaneous perforator was consistently found approximately 5 cm above the medial malleolus.(18,19).Moreover, Rubino et al found that the harvesting of a flap based on a single perforator produces hyperperfusion of this perforator, contributing to the recruitment of nearby perforasome territories.(20)These studies made possible a reliable bloodsupply to a mid-sized propeller pedicled on the perforator of the posterior tibial artery. Only one out of the three propeller flap had distal necrosis but later it was debrided and covered with split thickness graft.

conclusion

The greater saphenousfasciocutaneous perforator flap is reliable and versatile in both flap design and elevation. Different types of this flap can meet the demands of different defect sizes and locations. Furthermore, a satisfactory functional and aesthetic result can be achieved with minimal donor site morbidity.

FIGURE 1: PROPELLER FLAP

FIGURE 2: PROXIMALLY BASED SAPHENOUS FLA

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FIGURE 3 CROSS LEG SAPHENOUS FLAP

FIGURE 4 SAPHENOUS FREE FLAP.

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