Acute vascular complications (flap necrosis and congestion) with one stage and two stage distally based sural flap for wound coverage around the ankle

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ABSTRACT

Introduction: The understanding of the skin's vascular anatomy has improved in the last decade. It has lead to technique modification such as the staged procedure in performing sural flaps and improvement in the flap survival rate. The aim of this study was to evaluate the acute vascular complications (flap necrosis or congestion) of 29 patients who underwent distal base sural flap for coverage of wound around the ankle.

Methods: Twenty-four males and five females with a mean age of 37.1 years old underwent sural flap surgery to cover wounds at around the ankle. There were 12 cases of open fracture, five infected fractures, four spoke injuries, four degloving injuries and four diabetic foot ulcers. Twenty-three cases were done as a single stage procedure while six as a two-stage procedure. The flaps were tunnelled under the skin in three cases.

Results: Twenty one flaps healed uneventfully, seven acute vascular complications occur in a single stage group: five developed partial necrosis, one had congestion with epidermolysis, and one had complete flap necrosis. Complications were treated by dressing or skin grafting and only one required a repeat flap surgery.

Conclusions: Acute vascular complications may be minimised when sural flap is done in stages for elderly, diabetic, smokers and/or patients with large wound around the ankle. Even if the flap appears necrotic, the underlying structure may still be covered as the fasciosubcutaneous layer of the flap may still survive.

KEY WORDS:
Wounds, pedicled flap, postoperative complications

INTRODUCTION

Soft tissue coverage in the distal tibia, heel and the ankle remain a challenging problem in orthopaedic surgery. Some surgeons consider free flap as the best option for this region because of high failure rate of local flap.[1] However, many reconstructive surgeons also have reported successful result using a distally base reverse sural flap especially in a wound that is relatively too small or in patients who are not fit for free flap surgery.[2]

The ischaemic complications for sural flap have been reported to be as high as 36%. As a result, a two stage procedure was introduced to improve the outcome especially in patients with significant co-morbidities.[3] The improvement was due to the opening up of the choke vessels which are the communicating vessels between the adjacent perforators and the angiosome territory.[4] After reviewing our initial five years experience performing sural flap, we began performing a delayed (two stages) procedure for patients with co-morbidities or large wound distal to the ankle with no ischaemic complication. To the best of our knowledge, no study has assessed the short-term outcome between the single stage and two stage sural flaps in the English literature.[5]

The aim of this paper is to review the acute vascular complications (flap necrosis and congestion) between the one and two stage sural flap in covering soft tissue defects around the ankle.

MATERIALS AND METHODS

Included in this study were all the sural flaps that were performed by the first author in Department of Orthophaedic, Hospital Tengku Ampuan Afzan (HTAA) from September 2004 till June 2015. There were 24 males and five females whose age ranged from seven to 70 years old (mean 37.1 years old). Nine wounds were at the distal tibia, eight at the ankle, nine at the heel, two at the dorsum of foot and one at the distal fibula.

Twelve cases were due to open fracture, five infected fracture, four spoke injury, four degloving and four diabetic foot ulcer. Seven patients had diabetes with two of them being hypertensive, one is obese and two were smokers. Two patients were more than 70 years old.

Excluded from this series were patients whose wounds could not be covered by the sural flap because of very large wound or damage at the donor site, and/or have associated vascular injuries or peripheral vascular disease (Ankle Brachial index less than 0.8).

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Twenty-three cases were done as a single stage procedure while six were done as a two stage procedure. In three cases, the flap was tunnelled under the skin.

Vascular anatomy
The sural angiosome receives two main blood supply which are the anterograde and retrograde arterial systems. The anterograde systems are mainly from the superficial sural artery, which accompanies the sural nerve and the myocutaneous perforators coming from the medial and the lateral belly of gastrocnemius. The retrograde arterial systems are provided by the septocutaneous perforators from the peroneal artery and the posterior tibial artery. There are also the neurocutaneous and venocutaneous perforators arising from small arteries that accompany the sural nerve and the lesser saphenous vein respectively. [3,4]

Surgical technique
The positioning of the patient depends on the location of the wound. The operation is done in prone position when the wound is located at the heel or hind foot. The patient is put on supine position when the wound at the distal tibia or the medial malleolus, while lateral position is for wound located at the anterior ankle or lateral malleolus. Firstly, skin perforators along the posterolateral border of the lower leg are mapped with an ultrasonic doppler. The most distal perforator is located about 5 to 8cm from the lateral malleolus. The pivot point is marked just proximal to the identified perforators (Figure 1A).

A higher-most pivot point is usually taken to preserve all the potential perforating vessels without compromising the flap reach. The size of the flap is measured to be 1cm bigger than the size of defect. Once the preparatory steps have been done, the skin is incised to the level of the fascia under tourniquet control.

The dissection starts proximally where the sural nerve with its artery and the lesser saphenous vein are located and excised between the two head of the gastrocnemius muscle. If the flap is wide, the lateral sural nerve and its accompanying artery is included with the flap. The proximal half of the flap consists of island of skin while the distal half only includes the fascia and the subcutaneous tissue with the lesser saphenous vein. The fasciosubcutaneous part of the flap is kept wide to ensure vascularisation from both tibialis posterior and the peroneal perforators are included. In the majority of the flap we incised the skin and repaired it near the pivot point keeping in mind not to compress the pedicle[3] (Figure 1B). Tunnelling is only done for wound at the distal tibia. The donor site is covered with split thickness skin graft (SSG).

In a two stage procedure (delay technique), the superior and lateral flap is incised through the fascia and elevated until just distal to the gastrosoleus musculotendinous junction. The anterograde arterial system (lesser saphenous vein, the sural nerve and the myocutaneous perforators from the gastrocnemius muscle) are divided and ligated. The skin edge is sutured back into its donor site (Figure 1C). The flap is then transferred into its recipient site as a second procedure a week later.

The surgical wound is then covered with loose dressings with the skin paddle expose for monitoring of the flap. Wound inspection is done three days after the surgery and the skin graft donor site is inspected 10 days after the surgery.

Partial necrosis is defined as any marginal necrosis or de-epithelialization; complete necrosis is defined as total loss of skin and dermis. Epidermolysis occur following venous congestion and will recover without additional surgery.[6]

RESULTS

Twenty one flaps healed uneventfully, five had partial flap necrosis (three de-epitheliasation and two marginal necrosis) which were managed by skin grafting or healed by dressing, one had flap congestion with epidermolysis which was treated by tunnel release, one had donor skin necrosis which was treated with debridement and skin grafting, and one had complete flap necrosis. Complete flap necrosis occurred in a 35-year-old man who had an open fracture of the tarsal bone. The patient with open fracture of the tarsal bone was treated with debridement and rotational flap (Table I).

DISCUSSION

Complete and partial flap necrosis rate in HTAA is 3.4% and 24.1% respectively and is higher compared to other studies. Excellent success rate for sural flap was reported from 80% to 100% and complications were few.[3] In a meta-analysis of 50 articles, the rate of complete flap necrosis was 3.3%, partial necrosis 11% and other complication such as venous congestion, oedema, infection and recurrent of osteomyelitis were 4.6%.[3] The failure rate was higher amongst our earlier patients however was reduced following some modifications introduced in the procedure that were preoperative perforator identification and introduction of the two stage procedure in high risk patients.

According to Follmar *et al.,* the two stage procedure was proposed by Angelats and Albert in 1984.[3] There exists a few techniques that has been described in the literature. Kneser completely elevates the flap until he reaches the pivot point and leaves the turning and transposition of the flap to the defect for the second surgery. [6] Erdman did a similar technique but he keeps approximately 50% of the superior part of the flap intact to allow some perfusion from the proximal leg.[7] Perret incised the superior and lateral portion of the flap through the fascia and ligated the lesser saphenous vein and sural vessels without undermining it.[8] We modified his technique by undermining the flap and ligated the lesser saphenous vein and sural nerve with its vessels and the perforators from the gastrocnemius muscle. Basically we cut the anterograde arterial system of the sural angiosome and allow one week for the choke vessels that communicate with the retrograde arterial system to open up. Underlying osteomyelitis was reported as risk factors for persistence infection and amputation. [8,9] Muscles flap with good blood supply is preferred than fasciocutaneous flap for coverage of infected wound. Another method to improve the flap survival is to include a cuff of gastrocnemius muscle. Anatomical studies have shown that there are constant anastomoses between the gastrocnemius muscle and the

Table I: List of patients treated with sural flap

Case	Age	Gender	Location of defect	Diagnosis	Co-morbidities	Procedure	Flap dimension (cm)	Complication and treatment
1	42	M	Anterior ankle	Open fracture dislocation right ankle	None	1 stage	11X6	None
2	35	M	Dorsum foot	Open fracture tarsal bones	None	1 stage	13X5	Complete necrosis, rotational flap
3	20	M	Anterior ankle	Open fracture dislocation right ankle	None	1 stage	10X10	None
4	67	M	Distal tibia	Open fracture grade IIIB	None	1 stage	9X8	None
5	42	F	Distal tibia	Open fracture grade IIIB	None	1 stage with tunneling	7X6	None
6	50	F	Heel	Diabetic ulcer	Diabetes mellitus	1 stage	6X5	None
7	47	M	Distal tibia	Infected open fracture	None	1 stage	8X6	None
8	51	F	Distal tibia	Open fracture grade IIIB	Diabetes mellitus, hypertension	1 stage	10X8	De-epithelisation, SSG
9	29	M	Distal tibia	Infected non union	None	1 stage with tunneling	6X7	None
10	24	M	Distal fibula	Infected open fracture	None	1 stage	6X5	None
11	51	M	Medial ankle	Open fracture dislocation ankle	None	1 stage	6X5	None
12	18	M	Anterior ankle	Open fracture dislocation ankle	None	1 stage	10X7	None
13	70	M	Medial ankle	Infected medial maleolus fracture	Diabetes mellitus, hypertension	1 stage	6X5	marginal necrosis, SSG
14	41	M	Distal tibia	Open fracture grade IIIB	None	1 stage	6X6	None
15	24	M	Anterior ankle	Degloving injury	None	1 stage	10X7 dressing	De-epithelisation,
16	7	M	Heel	Motorcycle spoke injury	None	1 stage	4X3	None
17	10	M	Heel	Motorcycle spoke injury	None	1 stage	6X5	None
18	27	M	Dorsum foot	Open Lis Franc fracture	None	2 stage	14X5	None
19	70	M	Distal tibia	Degloving injury	Diabetis mellitus	1 stage	6X5	Donor site necrosis, SSG
20	50	M	Heel	Diabetic ulcer	Diabetes mellitus	2 stage	11X6	None
21	8	F	Heel	Motorcycle spoke injury	Obesity	1 stage	10X7	Marginal necrosis, dressing
22	65	M	Heel	Motorcycle spoke injury	None	2 stage	10X7	None
23	57	M	Distal tibia	Infected open fracture	Smoker	1 stage with tunneling	10X5	Flap congestion, epidermolysis, tunnel release
24	38	F	Heel	Diabetic ulcer	Diabetes mellitus	2 stage	8X8	None
25	22	M	Heel	Degloving injury	Smoker	2 stage	8X7	None
26	42	M	Distal tibia	Open fracture grade IIIB	None	1 stage	7X6	None
27	19	M	Medial ankle	Open fracture dislocation ankle	None	1 stage	10X6	None
28	19	M	Anterior ankle	Degloving injury	none	1 stage	10X8	De-epithelisation, SSG
29	33	M	Heel	Diabetic Ulcer	Diabetes mellitus	2 stage	10X8	None

SSG : split thickness skin graft

Fig. 1a: Planning of the flap where the proximal part include island of skin. The perforators were identify and mark near the ankle joint.

Fig. 1b: The flap is rotated to cover wound at the heel. The skin at the leg were incised and sutured back near the pivot point.

Fig. 1c: In a stage sural flap, the supero-lateral part of the flap is incised till the fascia. The sural nerve with its artery, the lesser saphenous vein and the myocutaneous perforators from the gastrocnemius muscles are ligated.

vascular axis of the sural nerve.[10] This method has been successfully performed in patients with osteomyelitis, diabetes and open fracture.[10-13] In order to improve the survival of the musculoneurocutaneous flap, Fodor *et al.* made a cutaneous extension over the neurovascular axis (axial flap) for patients with comorbidities or previous lateral malleolar operation. [10] Two out of five of our patient with underlying infection had minor complications that resolved with minor surgery and antibiotics.

Tunnelling of the flap was also reported as risk factors for complications.[8] We noted that tunnelling caused venous congestion in two of our patients. One resolved after surgical decompression of the tunnel and in another patient where decompression was not done, the swelling persisted for many years. Flap congestion may be avoided by doing a stage procedure. [5] Tunnelling should be avoided in the high-risk groups. Maffi introduced the interpolation of the sural flap, which is exteriorising the flap and thus avoiding a

Fig. 2a: Patients with degloving injury anterior to the ankle with expose extensor tendon.

Fig. 2b: The flap appearance at 2 weeks after surgery showing evidence of distal necrosis.

Fig. 2c: The flap appearance at 8 weeks after surgery showing the extend of necrosis had been well demarcated.

Fig. 2d: During debridement, the extensor tendons were still covered by a fasciosubcutaneous layer of the flap.

subcutaneous tunnel in order to avoid flap compression and venous congestion. This procedure is also done in a stage fashion where the flap is divided eight months after the initial operation. [14]

Patients who are elderly, smokes, obese or suffering from diabetes and peripheral vascular disease have been identified as having risk factors for flap failure.[8] We also consider large wounds distal to the ankle as a risk factor because of the distance between the tips of the flap to the perforators. In these cases, the two-stage procedure should be done to minimise complications.

We observed that elderly patients have very thin skin. The difficulty is to preserve the lesser sephanous vein and sural neurovascular bundle while at the same time trying to maintain the vascularity of the dermis. One of our patients developed necrosis of the donor skin which required surgical debridement and split thickness skin graft. Few authors have also reported that age is a significant risk for flap necrosis.[9]

In obese patients, the thickness of the flap tends to be too thick compared to the skin of the sole. This leads to problems in anchoring the flap to the recipient site that then leads to edge necrosis. Such an event happened to one of our patient. Interestingly, we observed that the fasciosubcutaneous layer of the flap usually survives even though the dermocutaneous part of the flap appeared necrotic. (Figure 2) Three of the partial necrotic flaps need only to undergo a split skin graft procedure since the bone and tendon were still covered. Gumener R *et al.* observed that the fasciosubcutaneous network is the richest arterial network in the skin and is able to survive without the overlying skin.[15] However Bocchi *et al.* observed that there is no different in the survival rate of reverse fasciosubcutaneous and the reversed islanded sural flap.[16]

This paper is our experience performing single and two stage sural flaps over the last 10 years. We believe our protocol for selection of patients for the two-stage technique may minimise the acute vascular complications. A prospective study with bigger number of patients is needed to confirm our finding.

CONCLUSION

Acute vascular complications (partial necrosis and flap congestion) may be minimised when sural flap is done in stages for elderly, diabetic, smokers and patient with large wound around the ankle. Even if the flap appears necrotic, the underlying structure may still be covered as the fasciosubcutaneous layer of the flap may still survive.

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