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Planning and outcome of soft tissue defects of the foot

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Abstract
Background: Covering soft tissue defect of the foot is important with respect to function and aesthetic means. It is a challenging task and requires a clear cut planning so as to use the right flap for the right size and site in the foot.
Materials & methods: A total of fifty three patients with soft tissue defects in the foot admitted between August 2014 to April 2015 under Hand & Microsurgery, Department of Orthopaedics, were included in this study. Post-operatively they were monitored for any flap related complications.
Results: The most common defects were trauma related followed by trophic ulcers and infective causes. Various coverage options which include fasciocutaneous flaps, muscle flaps, free flaps and split thickness skin grafts (STSG) were used. All the flaps were satisfactorily taken up at the end of follow-up period (three months).
Conclusion: Planning of the defect based on site and size is very important so as to obtain satisfactory result.

Keywords: Defects, flaps, function, ulcers, tissue

1. Introduction
Soft tissue defects are a very frequent presentation around the ankle and foot region as a result of road traffic trauma, chronic osteomyelitis or following implant exposure after orthopedic surgery [1]. The fractures which occur in this region are quite often open, exposing the tendons and bones making flap cover mandatory [2]. Due to limited availability of the overlying skin and relatively poor vascularity of the skin of lower leg there are various problems encountered in covering these defects. The surgeon should have a clear idea about the flaps, meticulous dissection, regional anatomy especially the muscles and perforators to the skin and be able to detect complications early. The size and site of the defect is also vital in deciding about flap coverage.
The various reconstructive options available are fasciocutaneous flaps as random or propeller flaps, muscle flaps, free flaps and split thickness skin grafts (STSG). Negative pressure wound therapy (NPWT) also plays a major role in assisting soft tissue defects management.

1.1 Aims of the study
The wound coverage considerations for soft tissue defects of the foot based on the size and site in the foot.

2. Materials and methods
A total of fifty three patients admitted from August 2014 to April 2015 under Hand & Microsurgery, Department of Orthopaedics, were included in this study.
The defects in the foot were classified based on the size according to Pinsolle *et al* [3]. and site according to Hollenbeck *et al* [4]. The foot was divided into seven distinct subunits, based on functional and aesthetic concerns, that can be addressed with a variety of options to cover the defects in the respective subunits.
Fasciocutaneous flaps were planned based on perforators from the peroneal and posterior tibial arteries. Muscle flaps taken were abductor hallucis longus, abductor digiti minimi, flexor digitorum brevis and distally based peroneus brevis flap and free flaps.

3. Results

The fifty three patients with defects of the foot were treated with various flap coverage and were evaluated. The gender distribution (Table one) in our study among the 53 patients was, forty were males (75%) and thirteen were females (24%).

In our study we encountered thirty one (58%) left sided defects, twenty one (40%) right side and one (2%) case with defects on both sides. The anatomical location of defects (Table two, Fig two) as discussed were divided based on subunits. The maximum were in subunit three (32%) and minimum in subunit one and six (2%).

The etiology of soft tissue defects (Fig one) in our study was mostly due to road traffic accidents which accounted to twenty (38%) cases, defects due to trophic ulcers were nineteen (36%) cases and infective cause were fourteen (26%) cases.

Among the various flaps done a total of twenty six muscle flaps, thirteen free flaps, fourteen fasciocutaneous flaps, twenty eight skin graft and seven cases of VAC were used as supplement to wound healing (Table three).

Frequent wound inspection and dressings were done for the flaps so as to detect any venous congestion. The patients were followed up on a weekly basis for one month and monthly for the next three months. At the end of follow-up period, all flaps were taken up and we did not encounter any complications.

4. Discussion

Soft tissue loss from the foot due to trauma or as a result of diabetic foot is a difficult problem to treat. The unique functional properties of the plantar soft tissue integrated with biomechanics of weight bearing allows them to resist external stresses and to protect the architecture of the soft tissue. The replacement of soft tissue after a full thickness loss from these areas requires tissues whose physical properties are similar to those that were lost [5].

Flap surgery particularly free flap reconstruction, requires microsurgical expertise with equipment to aid in these procedures. Post-surgery, there should be adequate facilities for the intensive care of these flaps so as to limit complications to the minimum.

Ger in the late 1960s pioneered local muscle flaps which were extensively used for foot and ankle reconstruction. In the late 1970s with the evolution of microsurgery, microsurgical free flaps became the reconstructive method of choice [6].

A meta-analysis by Follmar *et al* [7]. of fifty articles that reported 82% success rate with the use of 720 distally based sural flaps. Partial or marginal flap necrosis was reported in 11% and a complete flap necrosis in 3.3%. Akhtar *et al*, in their study of eighty four patients observed flap survival in 78.5%, partial necrosis in 16.5% and complete necrosis in 9.5% [8]. In another study done by Samira Ajmal *et al*, complete flap survival was noted in 80% of the patients, partial flap loss in 8%, marginal necrosis in 8% and complete loss in 4% [9].

Pinsolle *et al* [3],in their study on soft tissue reconstruction options of the foot, classified defects according to size and the various coverage options for these defects (Table four). They treated most of the small and medium sized defects using regional flaps and the large defects were covered using free flaps. This concluded that wider the defect more complex will be the procedure. However, free flaps always had a constant complication rate of 30% due to vascular thromboses.

Hollenbeck *et al* [4] have divided the foot into seven subunits based on functional and aesthetic demands. They have used various flap coverage for the 165 patients in their study to conclude the optimal flaps for the subunits described.

We classified defects according to size used by Pinsolle *et al* (Table four). Most of the defects were among the small group (41.5%) followed by very small group (28.3%), medium defects were six (11.3%), large were eight (15%) and very large defects were the least, two cases. The defects based on size and site was evaluated and tabulated (Table five a and b) to show the coverage considerations.

The defects in subunit one can be treated using local transposition flap, in subunit two using local muscle or plantar pedicle flap. Subunit three and four if in the plantar aspect and in small size group are best covered with local muscle flap. In case they are large in size, then free flap is the best option.

Subunit five, whatever be the size, free flap is the optimal flap. This is because it is a high functional demand area and requires a sturdy tissue cover. The flap can later be debulked if it is aesthetically not acceptable.

We encountered very few cases of defects in subunit six and seven as they come under the ankle. However, we had a few cases where the defect over these two subunits extended into the lateral and medial aspect of the foot respectively. Hence, they were covered with a fasciocutaneous flap (propeller based) no matter what the size of defect.

It should be borne in mind that defects which are superficial and upto the subcutaneous tissue can be covered with skin graft. Whereas, those defects exposing the underlying muscles, tendons and bones should be dealt with flaps.

A few defects which were very small were covered with skin grafting supplemented with a VAC dressing.

Table 1

Gender	No
Males	40
Females	13
Total	53

Table 2

Location (subunit)	Number	Percentage
1	2	4%
2	5	9%
3	17	32%
4	11	21%
5	13	24%
6	2	4%
7	3	6%

Table 3

Cases	No
Muscle flap	26
Free flap	13
Fasciocutaneous flap	14
SSG	28
VAC	7

Type of Surgery	Dorsum	Medial	Lateral	Plantar
SSG	7	2	7	12
Fasciocutaneous flap	4	3	3	14
Free flap	1	0	2	6
Muscle flap	2	1	5	8

Table 4.

Size	Cm^2 (Pinsolle *et al*)	Number of cases	Percentage (%)
Very small	</=4	15	28.3
Small	>4 and </=20	22	41.5
Medium	>20 and </=50	6	11.3
Large	>50 and </=200	8	15
Very large	>200	2	0.03
Total		**53**	

Table 5a.

Area	Very small	Small	Medium	Large	Very large
Subunit 5-Muscle flap Free flap Fasciocut Flap	4	4 1			3
Subunit 4 and 7- Muscle flap Free flap Fasciocut Flap	1	2	1	1 4	3
Subunit 3 and 6- Muscle flap Free flap Fasciocut Flap	3	3	3	2	
Subunit 3 and 4- Muscle flap Free flap Fasciocut Flap		1 2	2 2		3
Subunit 2,3 and 4- Muscle flap Free flap Fasciocut Flap	1	2 1	2	1	4

Table 5b:

	Very small*	Small*	Medium*	Large*	Very large*
Subunit 1	TF	TF	TF	FF	FF
Subunit 2	TF	TF	Local MF	Local MF	Local MF
Subunit 3	Local MF	Local MF	Local MF	FF	FF
Subunit 4	Local MF	Local MF	Local MF	FF	FF
Subunit 5	FF	FF	FF	FF	FF
Subunit 6	FcF	FcF	FcF	FcF	FcF
Subunit 7	FcF	FcF	FcF	FcF	FcF

TF- transposition flap *- according to Hollenbeck *et al*[4]
FF-free flap
MF-muscle flap
FcF- fasciocutaneous flap

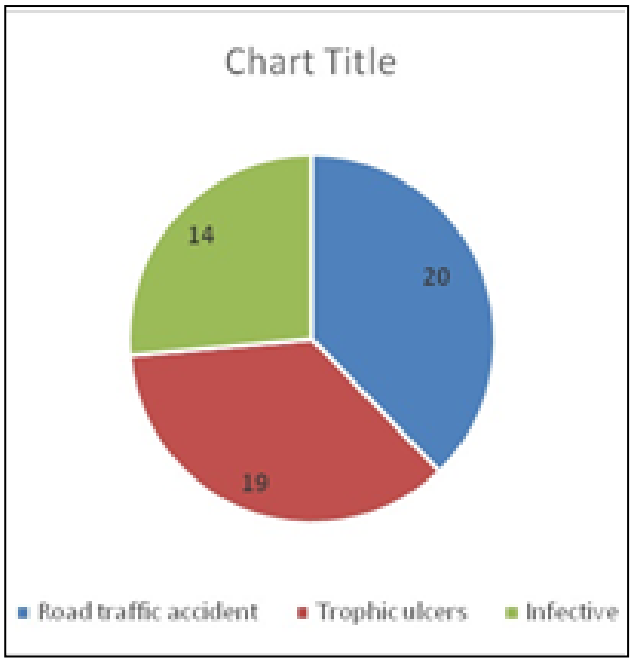

Fig 1: etiology of soft tissue defects

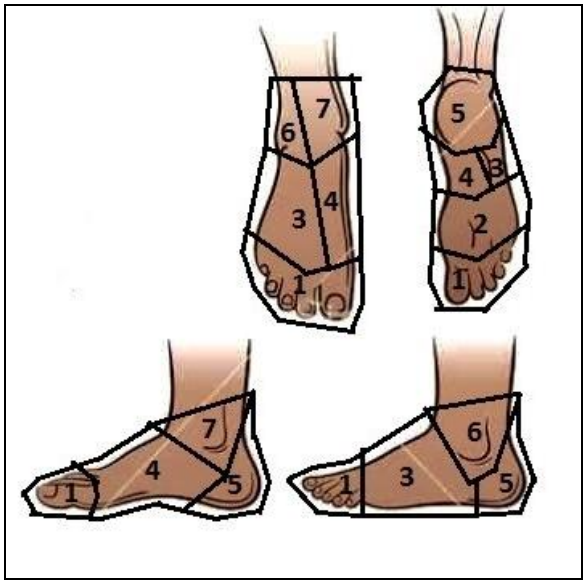

Fig 2: Divisions of the foot. Redrawn from Hollenbeck ST, Woo S, Komatsu I, Erdmann D, Zenn MR, Levin LS. Longitudinal Outcomes and Application of the Subunit Principle to 165 Foot and Ankle Free Tissue Transfers. J of Pl and Recons Surg.2010; 125:926

Fig 3a: Defect in the heel extending to lateral border of the foot. The wound was debrided

Fig 3b: Distally based peroneus brevis muscle flap used

Fig 3c: three months follow up

Fig 4a: skin defect (not exposing the tendons) on the dorsum of foot

Fig 4b: follow up after split thickness skin grafting was done

Fig 5a: Heel defect extending upto the *calcaneum*

Fig 5b: anterolateral thigh free flap was done

Fig 5c: follow up after three month

Fig 6a, b: Defect on dorsum on foot extending to medial aspect exposing the tendons, debridement was done

Fig 6c: gracilis free flap done to cover the defect

Fig 6d: split thickness skin graft

Fig 6e, f: three months follow up

Fig 7a: Plantar defect extending to subcutaneous tissue. Preoperative skin marking done

Fig 7b: debridement and mobilization of medial plantar artery based flap.

Fig 7c: post-surgery

Fig 7d: three months follow up

Fig 8a, b: pressure sore on plantar aspect of great toe. Pre-op skin marking done

Fig 8c: debridement and local transposition flap done

Fig 8d: three months follow up

5. Conclusion

Our study is unique as we have made an attempt to classify the defects of the foot based on size and site. This can help give a clear idea and decide the optimal flap for the defect before the surgeon can operate. The scope of this study can be improved by increasing the sample size.

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