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FLOW THROUGH FLAPS: A FIVE YEAR EXPERIENCE IN A LIMITED RESOURCE CENTER
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ABSTRACT

Background: **Preservation of well vascularized extremity is one of the ultimate goals in limb reconstructions. With a paradigm shift towards limb salvage there is need to revisit flaps that could be used to ensure adequate blood flow as well reconstruction of the defects. In this series we share our experiences and outcomes of flow through flaps done in the background of limited resources.**

Objective: **To audit patients managed by flow through flaps between January 2019 and December 2024 in Nairobi, Kenya.**

Design: **A prospective study**

Study Setting: **Kenyatta N Hospital and other private institutions in Nairobi**

Study Subjects/Participants: Sixteen patients with both upper and lower limb requiring reconstruction.

Results: **A total of 16 patients with both upper and lower limb conditions were reconstructed with flow through flaps. The mean age for the patients was 38.5 years with an age range of 24 to 64 years. Twelve patients had post traumatic defects while two patients had defects secondary to skin malignancy extirpation and the rest lymph-edema. Most commonly used flap was anterior lateral thigh flap (10 patients). All defects were successfully reconstructed with flow through flaps and no case of flap or extremity loss was encountered.**

Conclusion: **Flow through flaps are reliable flaps in the reconstruction of extremities ensuring adequate blood flow as well as soft tissue coverage. The choice of the flap should be influenced by the extent of the defect as well as the anticipated length of the vascular defect.**

INTRODUCTION

Limb salvage procedures have in the recent past become the corner stone in the management of extremities allowing for good functional outcome and eventual return of patients to a productive lifestyle. Most of these procedures require reconstruction of the vasculature with the gold standard being use of vein grafts to establish vascular flow (1). Vein grafts could however, lead to more anastomosis and an increased incidence of thrombus formation (1). They could also require alternative procedures for soft tissue or bony reconstructive leading to overall increase in the operating time that could be counterproductive. Flow through flaps on the other hand could allow for one stage reconstruction with the flap being used for soft tissue or bony reconstruction as well as ensuring continuity of the blood vessels (2-4). Though these flaps have been described over the last 20 years there use has been limited to well establish microsurgical centers (3,4). We audit patients managed with flow through flaps in our unit for the last five years and share our experiences, outcomes and lessons learned in a resource constrained setting.

MATERIALS AND METHODS

Study Design: This was a prospective audit of patients treated with flow through flaps between January 2019 and December 2024. For all patients the primary etiology was noted. A thorough history and physical examination were taken to determine the vascular status of the extremity. CT angiography was done in cases where the vascularity was not clear. An appropriate flap was then chosen based on the extent and tissue deficiency to be reconstructed. During surgery both proximal and distal anastomosis of the arteries were done by end to end anastomosis while for the veins the anastomosis was only done proximally (Figure 1A-C).

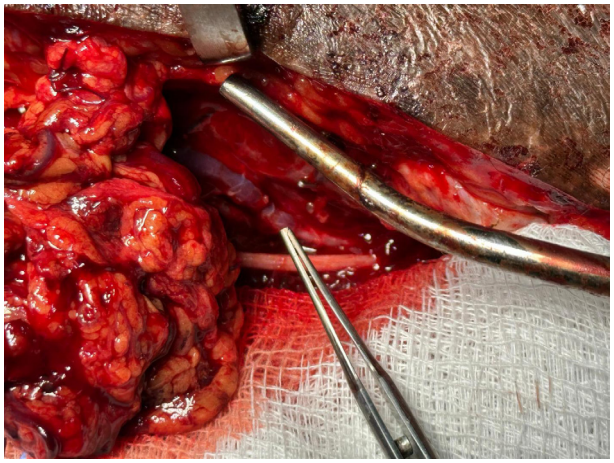

Figure 1A: Flow through omental flap with forceps showing the proximal anastomosis

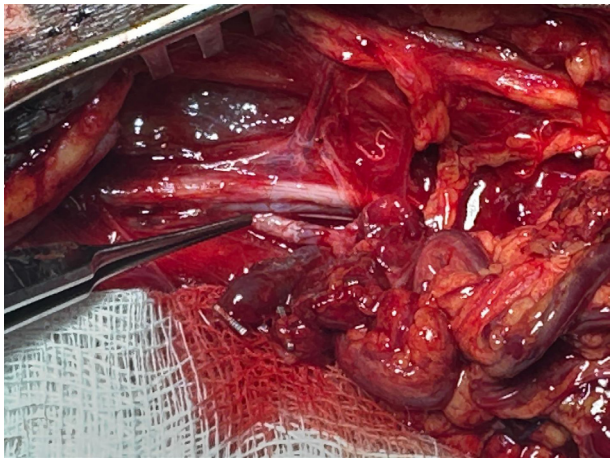

Figure 1 B: Flow through omental flap in1A above with forceps showing the distal anastomosis

Peri-operatively patients were monitored closely with four hourly monitoring of the flap for the first two days followed by once daily for the next five days. Patency of the flow through was determined by clinical examination and Doppler after the first week of surgery. Further clinical evaluations were done at 3, 6 months and at one year. Complications that arose during the surgery were noted.

RESULTS

A total of sixteen patients were followed up during the study period. The age ranges for the patients was 24 to 63 years with a mean age of 38.5 years. The male to female ratio was 3:1. Etiological causes of the defects were Motor vehicle accident (11), tumor extirpation (2), lymph edema (2) and gunshot injury (1). Fourteen patients had defects on the lower limbs with two on the upper limbs. Vessels reconstructed were anterior tibial (8), posterior tibial (4), dorsalis pedis (2) and radial arteries (2). Vascular defects varied between 5cm to 7.7 cm with a mean of 6 .3 cm. The surface area covered by the flap was between 76 to 192 cm2 with a mean of 142.3cm2. Anterior lateral thigh flap was utilized in 11 patients with radial forearm and omental flap in two patients each and free fibula flap in one patient.

Table 1: Summarizes the findings during the study.

laps used	Frequency	Percentage
Anterior lateral thigh flap	11	68
Omental flap	2	13
Radial forearm flap	2	13
Free fibula flap	1	6
Total	16	100

Table 2: Summarizes clinical diagnosis, length of vessel defect and the average size of the flap

Diagnosis	Frequency	Length of arterial defect(cm)	Flap (cm2)
Scc distal leg	1	6cm	120
Post traumatic	8	7cm	142
Wound distal leg			
Posttraumatic wound	2	7cm	145
Forearm			
Lymphedema	2	8cm	12 cm
Distal foot gunshot injury	1	5cm	50
Rt hand injury	1	8cm	192
Total	16		

Complications encountered were post-surgical wound sepsis in two patients whom were treated conservatively.

DISCUSSION

Emphasis in managing lower limb trauma and malignancy has shifted towards limb salvage, with formation of Ortho-plastic units in many centers to spearhead such efforts. However, defects with both tissue loss and vascular insufficiency pose extra challenges. Reconstruction of such conditions in majority of cases require free flaps. Ironically, free flaps could technically lead to further deprivation of

blood flow to the limb since one of the vessels has to be sacrificed as a recipient vessel. Alternatives to this could be concurrent reconstruction of the blood vessels with either venous grafts, end to side anastomosis or employing flow through flaps.

Vein grafts have remained the gold standard in reconstructing vascular defects. It however has inherent weaknesses of extra donor site morbidity, increased operating time and high incidence of thrombus formation due to high arterial pressures causing tortuosity of the veins leading to kinking and thrombus formation (5,6). End to site anastomosis on the other hand has a theoretical risk of clot formation at the anastomosis site rendering the whole limb avascular. With flow through flaps the vascular status of the extremity is however improved or preserved.

Flow through flaps has been documented in literature for the last three decades or more (2,4). There use has mainly been in the head /neck and lower extremity reconstruction (2,4, 7-9). With these flaps, complex defects that would require multiple reconstructive procedures have successfully been done in a single stage, obviating the need of prolonged surgeries or multiple procedures (7-9). In the head and neck region they have been used for covering defects as well as act as conduit that allows for a second flap after tumor extirpation surgery (2,8). Their use in the lower limbs on the other hand has primarily been in lower limb trauma ensuring soft tissue coverage of extremities while allowing for blood flow to the extremity (2,10).

Most commonly used flap in our series was anterior lateral thigh flap, followed by radial forearm flap, free fibula flap and omental flap. Anterior lateral thigh flap has been reported in many series as a workhorse flow through flap for both the head / neck and lower limb regions. (2,4,7). The flap could cover extensive defects of up to 300cm^2 making it an ideal flaps for large defects. It could also be raised as a composite flap with rectus femoris muscle allowing both functional muscle reconstruction and soft tissue coverage (Figure2A, -2C).

Figure 2A: Right arm defect with only patent radial artery, loss of nerves and flexor muscles

Figure 2B: Reconstruction of the defect in figure 2A with a composite ALT FLap and rectus femoris Muscle

Figure 2C: Successful reconstruction of the defect in 2A above at 3 months of follow up.

The long pedicle allows it to bridge long vascular defect making it ideal for such wounds. Radial forearm flap considered the gold standard flap for tongue reconstruction can also be good flow through flap as demonstrated in our series. The flap also has a long pedicle of up to 25 cm making it an ideal flap for bridging large defects and allowing for a secondary flap to be used. The disadvantage of this flap however, is the donor site that is conspicuously exposed on the forearm. Omental flaps has been reported as a flow through flap in a number of studies (11,12). The flap like a radial forearm flap has a large and long pedicle that could extent up to 30cm in length. It is an easy flap to raise with an excellent donor site. Its biggest disadvantage is the limited tissue accompanying it making it less ideal in covering extensive or complex defects. In our series, we used it extensively for patients with lymph edema.

In conclusion, flow through flaps have a wide range of application both in reconstructive and aesthetic surgery. While this flaps have been practiced in many well established centers there is need to reinvent them in upcoming centers of reconstruction especially in mid and low income countries. With these flaps there is increased possibilities to salvage more extremities as well reconstruct difficult defects especially in the head and neck region.

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