

ARTICLE

## The inverted love-heart flap: a new island flap design

Sadhishaan Sreedharan<sup>a,b,c</sup>, Jieyun Zhou<sup>a,b,c</sup> and Adel Morsi<sup>a,b,c</sup>

<sup>a</sup>Plastic and Reconstructive Surgery Unit, Western Health, Footscray, Australia; <sup>b</sup>Plastic, Hand and Faciomaxillary Surgery Unit, the Alfred, Melbourne, Australia; <sup>c</sup>Plastic and Reconstructive Surgery Unit, Monash Health, Dandenong Hospital, Dandenong, Australia

### ABSTRACT

**Background:** Island flaps are more mobile than local flaps in-continuity and rely on the laxity of the adjacent tissues. We present a new island flap design, called the inverted love-heart flap, used to reconstruct cutaneous defects of the limbs.

**Methods:** A retrospective chart review of patients who underwent inverted love-heart flap reconstruction post excision of a cutaneous malignancy during July 2017 to July 2019 was performed.

**Results:** Seventeen patients underwent 18 inverted love-heart flap reconstructions postexcision of a cutaneous malignancies during the study period. There were no reported cases of partial or total flap necrosis.

**Conclusion:** The inverted love-heart flap offers a reliable reconstruction for cutaneous defects. It has the advantage of a primary donor site closure, minimal patient morbidity and avoids the need for skin grafting and postoperative immobilization.

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### KEYWORDS

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### Introduction

Cutaneous malignancies are the most common cancers worldwide and surgical excision is the primary treatment for solitary skin lesions. Where primary closure is not possible, the main objective is to replace as closely as possible the absent tissue with minimal donor site morbidity [1–3]. Local flaps, when compared to skin grafts, have the advantage of better color and contour match, while having donor-sites that usually can be closed primarily [2,4–6]. Among these, island flaps whose vascularity is achieved from the underlying perforators, tend to be more mobile than local flaps in-continuity but rely on the laxity of the adjacent tissues [1,2,5].

In this article, we present a new island flap design called the ‘Inverted Love-Heart Flap’ for the reconstruction of soft tissue defects postexcision of cutaneous malignancies. The design of the flap resembles a love-heart symbol, giving rise to its name. It relies on a V-Y advancement principle and can be considered a modification of this flap. Following inset, the flap likens a teardrop.

### Methods

A retrospective chart review of all patients who underwent an inverted love-heart flap reconstruction following excision of a cutaneous malignancy from July 2017 to July 2019 was performed. Postoperatively, all patients had a bulky dressing applied and were advised to keep this dry and intact for seven days. The patients were discharged home on the day of surgery on prophylactic oral antibiotics and with no weight-bearing restrictions. Patients were questioned during the postoperative consultation on their pain levels and on their satisfaction with the flap. However, a standardized patient reported outcome measure was

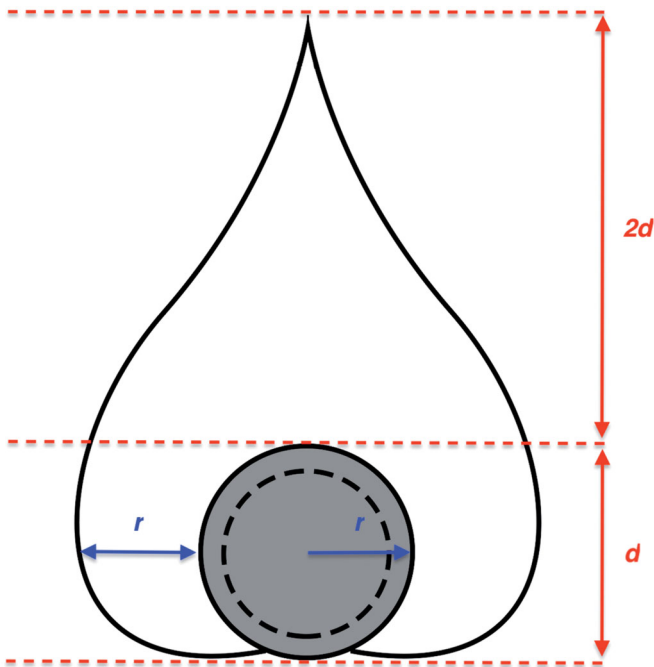
not utilized. Patients were followed up, as a minimum, until the flap was healed.

### Flap design

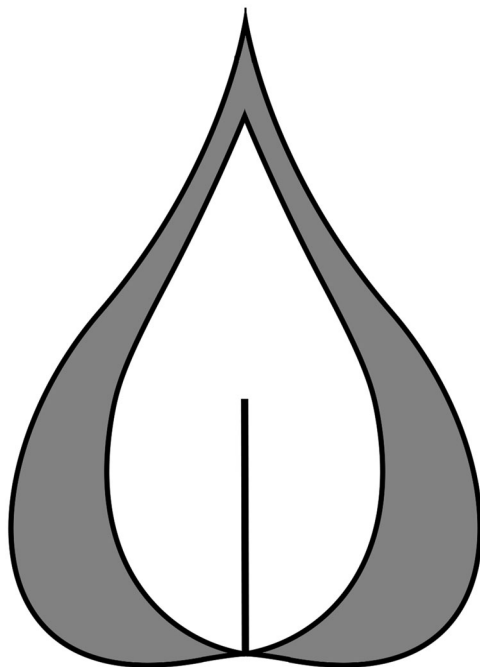
The inverted love-heart flap is a random pattern flap, designed around a circular cutaneous defect. Pre-operative Doppler ultrasound is not required as no specific perforator is used. The ideal axis of the flap is in line with cutaneous veins and perforators. The vertical axis of the flap should be orientated perpendicular to the line of greatest skin laxity. In the lower limb, this was generally longitudinal. The height of the flap has a 3:1 ratio to the diameter of the circular defect. Each lateral arm of the flap has a width that is equal to the radius of the circular defect. An inverted heart shape is traced from the superior pole to the widest axis then to the inferior portion of the defect (Figure 1).

### Flap elevation and inset

Once the lesion has been excised, the outer margins of the flap are dissected to allow its mobilization into the defect. Careful dissection is performed to prevent any undermining of the flap, preserving the integrity of any perforators and cutaneous veins. The deep fascia is not routinely divided in this dissection. The original cutaneous defect is closed firstly by direct apposition of the lateral arms of the flap, using interrupted deep dermal sutures. This creates an inverted T-junction at the distal pole of the flap. There is now a resultant teardrop-shaped island within the secondary inverted heart-shaped defect (Figure 2). The secondary defect is closed from superior to inferior by completing a V-Y advancement of the superior pole. This recruits the perpendicular laxity of the surrounding tissues (Figure 3). The skin can then be closed to complete the inset, leaving a teardrop-shaped scar (Figure 4). Figure 5 depicts intra-operative flap raise and inset.



**Figure 1.** The height of the flap and the diameter of the circular defect ( $d$ ) has a 3:1 ratio. Each lateral arm of the flap has a width that is equal to the radius ( $r$ ) of the circular defect.

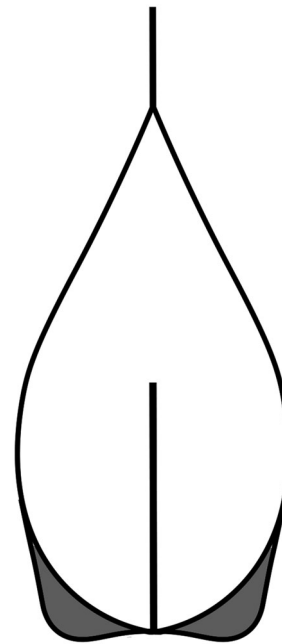


**Figure 2.** The circular defect is closed by direct apposition of the lateral arms of the flap creating an inverted T-junction at the distal pole of the flap.

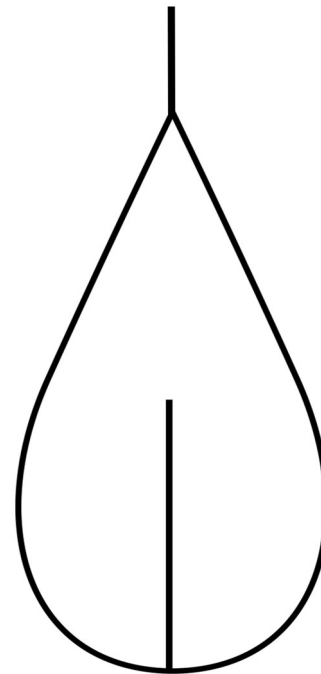
### Results

During the study period, 17 patients underwent 18 inverted love-heart flap reconstructions following excision of a cutaneous malignancies (Table 1). The flap was used to reconstruct 16 cutaneous defects of the leg, one thigh defect and one dorsal hand defect. One patient underwent an inverted love-heart flap adjacent to a previous keystone flap (Figure 6). One patient had two inverted love-heart flaps on the same leg.

The average age of patients in the study was 72 years old. The average cutaneous defect size to be reconstructed was



**Figure 3.** The secondary defect is closed from superior to inferior and a V-Y advancement of the superior pole is completed.

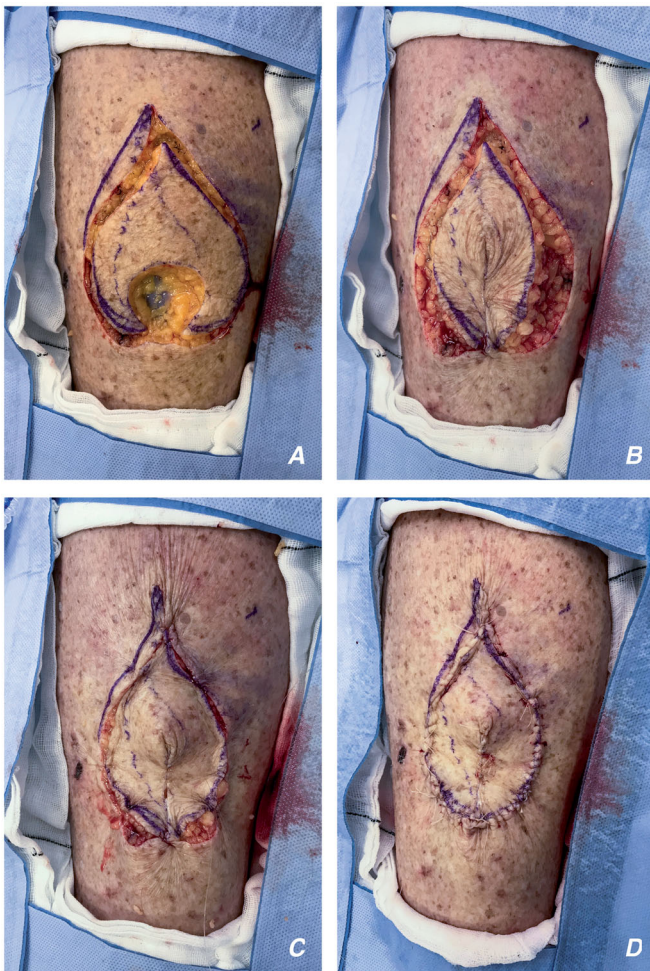


**Figure 4.** The completed inset of the inverted love-heart flap leaving a resultant teardrop-shaped scar.

$19 \times 22$  mm with an average surface area of  $340 \text{ mm}^2$ . The mean follow-up time was 4.5 months (range 1–19 months). There were no reported cases of partial or total flap necrosis, wound infection or bleeding. There was one reported case of minor wound dehiscence at the distal T-junction of the two lateral arms of the flap. This healed uneventfully with dressings. Postoperatively, patients reported minimal pain and satisfaction with the flap appearance.

### Discussion

Local flap reconstruction of cutaneous defects offers several distinct advantages over skin grafts [1–3]. Firstly, local flaps provide



**Figure 5.** Intraoperative photography of the inverted love-heart flap being elevated and inset on a lower limb postexcision of a cutaneous malignancy.

a superior aesthetic reconstruction as it replaces like-with-like, offering similar color and contour match without secondary contracture. Secondly, local flaps do not require a period of relative immobilization that is often practised with skin grafting limbs, reducing risk of postoperative deconditioning [2,3,6]. This was our experience with the inverted love-heart flap; the surgery was performed as a day procedure and patients could ambulate immediately without any negative consequences on flap survival.

A well-designed local flap utilizes the surrounding tissues' laxity and redistributes the tension from the primary cutaneous defect [2–6]. With the inverted love-heart flap, islanding the flap and blunt dissection at the periphery facilitates both centripetal movement and preservation of neurovascular perforators to the flap. If required, the deep fascia can be divided to increase the centripetal movement of the flap. Closure of the primary defect is achieved by advancement of the two lateral arms of the flap. Next, the V-Y advancement of the superior pole allows distribution of the original defect circumferentially around the flap. The remaining secondary defect can then be primarily closed by utilizing the recruited laxity and redundancy of the surrounding tissues.

The main limitation of this study is that the inverted love-heart flap has only been used to reconstruct defects of the upper and lower limb. As the flap relies on the relative laxity of the surrounding tissue for primary closure of the secondary defect, its suitability for reconstruction must be assessed on a case-by-case basis. Furthermore, while patients reported satisfaction with the

**Table 1.** Summary of the inverted love-heart flap cases.

Patient	Gender	Age (years)	Pathology	Location	Cutaneous defect			Flap dimensions			Complications
					Width (mm)	Length (mm)	Area (mm <sup>2</sup> )	Maximal Width (mm)	Maximal length (mm)	Follow-up Time (months)	
1	F	75	Melanoma	Left calf	30	35	825	60	105	5	Nil
2	F	80	BCC	Left pretibial	20	25	393	40	75	2	Nil
3	F	55	SCC	Left lateral leg	17	22	294	35	65	1	Nil
4	F	79	Lentigo Maligna	Left lateral leg	14	24	264	30	75	1	Nil
5	F	80	SCC	Right pretibial	16	18	226	35	55	7	Nil
6	M	76	SCC In situ	Right lateral leg	17	26	347	35	80	2	Nil
7	M	51	SCC	Right medial leg	21	20	330	40	60	1	Nil
8	F	80	BCC	Left medial leg	20	22	346	40	65	1	Nil
9	F	86	SCC	Left pretibial	16	21	264	30	65	3	Nil
10	F	67	SCC	Right lateral leg	25	25	491	50	75	19	Nil
11	M	76	SCC	Right pretibial	18	16	226	35	50	1	Nil
12	M	59	SCC	Right pretibial	26	26	531	50	80	2	Nil
13	M	79	SCC	Left pretibial	19	15	224	40	45	4	Dehiscence
14	F	76	SCC	Right lateral leg	16	18	226	30	55	14	Nil
15	F	71	SCC	Left medial leg	19	26	388	40	80	10	Nil
16	M	64	SCC	Right medial leg	16	21	264	30	65	4	Nil
17	F	74	SCC	Right anterolateral thigh	10	21	165	20	65	1	Nil
	F		SCC	Left dorsal hand	18	22	311	35	65	3	Nil

SCC: Squamous cell carcinoma; BCC: basal cell carcinoma.



**Figure 6.** An inverted love-heart flap used to reconstruct a soft tissue defect adjacent to a previous keystone flap reconstruction. Note the island flap can be designed off the vertical axis to facilitate closure of the primary defect.

postoperative result and minimal pain, a standardized patient-reported outcome measure was not utilized as the study was a retrospective chart review.

The V-Y principle has been extensively described in the literature. Since its original description, many modifications have been presented in the literature [7–9]. Two modifications that bears resemblance to the inverted love-heart flap are the ‘Fish mouth’ V-Y advancement flap described by Niranjana et al. in 2000 [8] and the ‘Pacman’ flap described by Aoki and Hyakusoku in 2007 [9]. The principle that these two flaps share with the inverted love-heart flap is that the concave advancing lateral arms of the flap are approximated together to close the primary defect thus extending the reach of a traditional V-Y advancement flap [7]. However, we believe that the unique geometry of the inverted love-heart flap allows a more robust and reliable reconstruction. Both the Fish Mouth and Pacman flaps have very narrow lateral arms that only extend halfway along the diameter of the defect to be reconstructed. This creates larger tension across the primary defect. In contrast, the inverted love-heart flap is designed with lateral arms that extend beyond the entire length of the defect, with a width at least equal to the radius of the primary defect. We believe that these differences in the flap’s design minimizes tension and reduces the risk of dehiscence or partial flap necrosis.

## Conclusion

The inverted love-heart flap is both a simple and reliable reconstruction method for cutaneous defects on the distal limbs. It provides a robust alternative to skin grafting, with the advantages of immediate postoperative mobilization, minimal patient morbidity as well as satisfactory esthetic outcomes.

## Disclosure statement

The authors have no financial interests to disclose.

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