

Venous Flap Reconstruction following Wide Local Excision for Primary Cutaneous Malignancies in Extremities

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Background: Cutaneous malignancies in the extremities are relatively common, and radical treatment such as ray amputation was performed for certain advanced skin cancer cases in the past. The concept of surgical treatment of primary cutaneous malignant tumor has gradually changed, and preservation of the extremity by performing the appropriate excision and reconstruction became possible. Various reconstructive methods after the resection of malignant tumors such as skin grafts, local flaps, and free flaps, including perforator flaps have been noted. Due to limitations and some disadvantages of these reconstructive materials for extremities, the arterialized venous flap arose as an alternative method. The arterialized venous flap, which has arterial inflow through an afferent vein perfusing the flap and venous outflow through the efferent veins, is considered to function as a great reconstructive material for distal extremities. Although efficacy of this flap has been noted in the past, usage of the flap considering the oncological aspects and application of the flap to the toes and feet have never been reported.

Methods: Thirteen reconstructive cases from October 2005 to October 2016 using venous flaps after excision of primary cutaneous malignancy in the distal extremities were performed in our institution.

Results: For all cases, satisfactory functional and cosmetic outcomes were observed.

Conclusions: Reconstruction using the arterialized venous flap is considered a reliable and versatile method. Careful application of this flap satisfies functional, cosmetic, and oncological aspects of all distal extremities with cutaneous malignancy. (*Plast Reconstr Surg Glob Open* 2022;10:e4220; doi: [10.1097/GOX.0000000000004220](https://doi.org/10.1097/GOX.0000000000004220); Published online 22 March 2022.)

INTRODUCTION

Cutaneous malignant tumors, often seen in the extremities, and advanced skin cancers, in selected cases, required ray amputation in the past. However, the treatment principles have gradually evolved with the emphasis on importance of conservative treatment for cutaneous malignant tumors. With the emergence of new techniques and concepts for appropriate excisions and following reconstructions, suitable operative treatments that preserve functional and aesthetic aspects became possible.

Soft tissue reconstructions of the extremities have generally been accomplished by various operative methods such as skin graft, local flaps, and free flaps. However, due to limitations and disadvantages of skin grafts and flaps, application of venous flaps for the reconstruction of distal extremities emerged.

The venous flap was first introduced by Nakayama et al in 1981 in a rat model.¹ The advantages of this flap are its thinness, pliability, no need to sacrifice major arteries, and its ease in flap harvest. When this arterialized venous flap first appeared, it was mostly used for reconstruction of fingers and hands in trauma cases,²⁻⁶ but recently the application of this flap after the resection of skin cancers of the digits was reported.⁷ Although Park et al⁷ have exhibited the efficacy of this flap for cutaneous malignancy of fingers, oncological aspects of possible risk of lymphatic and hematogenous metastasis and use of venous flap for other areas of extremities such as feet and toes were not mentioned. We want to emphasize the relevance of oncological concepts when performing reconstruction after the resection of cutaneous malignant tumors by

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selecting an appropriate donor site that is not related to the metastatic pathway of the tumor. Through our clinical cases, we report effectiveness and versatility of venous flap reconstruction for all distal extremities with cutaneous malignancy.

MATERIALS AND METHODS

Subjects

Thirteen cases of reconstruction using the venous flap after excision for primary cutaneous malignancy in the distal extremities from October 2005 to October 2016 were performed (Table 1). Patients included nine men and four women (median age: 68 years; range: 35–81 years). Localization of the malignancy was the thumb (nail bed) in two cases, ring finger (nail bed) in one case, middle finger in two case, cubital fossa in one case, dorsum of the hand in two cases, big toe (nail bed) in two cases, Achilles' tendon in one case, medial malleolus in one case, and anterolateral part of the foot in one case. Types of malignant tumor were malignant melanomas [tumor thickness: 0 mm (in situ) to 5.2 mm, mean 2.5 mm] in six cases, squamous cell carcinoma in four cases, dermatofibrosarcoma protuberans in one case, and Bowen's disease in two cases. Sentinel node biopsy was carried out in four cases, and groin nodes dissection was carried out in two cases. The harvest site of the venous flap was from the opposite side of the affected/resected area for all cases; three cases were harvested from the dorsum of the feet, seven cases from the forearms, and three cases from the lower thighs. We categorized the flap sizes into three types from the report by Woo et al, in which flaps smaller than 10 cm² were classified as small, those larger than 25 cm² were classified as large, and the rest were classified as medium.⁸ In our cases, four cases were classified as small, five cases were medium, and four cases were large.

Surgical Technique

Appropriate excision of the cutaneous malignant tumor was performed by the same plastic surgeons who performed the reconstruction following the resection under general anesthesia. Appropriate resection margins were followed by National Comprehensive Cancer Network guidelines and the most recent edition of

Takeaways

Question: How to reconstruct the defects after the wide local resection of cutaneous malignant tumors in extremities while preserving good aesthetical and oncological aspects.

Findings: Reconstruction using venous flaps led to successful postoperative courses with aesthetically satisfying results in all cases with malignant tumors in extremities.

Meaning: Arterialized venous flap reconstruction after excision of primary cutaneous malignancy in the extremities is considered as a reliable and versatile method satisfying all functional, cosmetic, and oncological aspects.

guidelines for skin cancer published from the Japanese Skin Cancer Society. Recipient artery and veins were preoperatively checked using Doppler and ultrasound, and they were carefully prepared before the harvest of the flap. The site of venous flap was selected from the opposite side of the affected area. A tourniquet was used to compress the proximal area of the donor site to reveal the distribution of the subcutaneous venous system. The flap including these veins was designed slightly larger than the size of the defect to fully cover the area, and it was elevated at the supra-fascial layer. At least two veins were included as efferent veins, if possible. Primary closure or skin grafting was performed at the donor site.

RESULTS

Postoperative MRSA infection was observed in one case, but all flaps exhibited complete survival. The average diameter of the anastomosed vessel was 1.2 mm (range 1.1–1.6 mm). Skin grafting was used for closure of the donor site in four cases, and primary closure was possible in nine cases. For the cases of lymphadenectomy, one case underwent preventive dissection, and another case resulted in lymphatic metastasis in three places. The postoperative follow-up period ranged from 12 to 156 months, with the median of 68 months. Local recurrence was not observed in any case, but one patient with lung metastasis died during the follow-up period. Aesthetic and functional postoperative outcomes were acquired in all cases.

Table 1. Demographic Data of Patients, Tumor Types/Locations, Donor Site, Anastomosis Type

Case	Age	Gender	Tumor	Location	Size (Length (cm) × Width (cm))	Donor Site	Type	Duration
1	62	Female	MM	Middle finger	Medium (4×3)	Forearm	A:1 V:1	13 y
2	41	Male	DFSP	Cubital fossa	Large (7×9)	Dorsum of foot	A:1 V:2	12 y 6 mo
3	75	Male	SCC	Thumb	Small (3×3)	Forearm	A:1 V:1	12 y 1 mo
4	76	Male	SCC	Dorsum of the hand	Large (7×5)	Lower extremity	A:1 V:2	12 y
5	76	Male	MM	Foot	Large (11×6)	Dorsum of foot	A:1 V:1	11 y 4 mo
6	51	Female	MM	Big toe	Medium (4.5×3)	Lower extremity	A:1 V:1	10 y 11 mo
7	35	Female	MM	Achilles' tendon	Medium (5×4)	Dorsum of foot	A:1 V:1	10 y 8 mo
8	70	Male	Bowen	Thumb	Medium (3×4)	Forearm	A:1 V:1	7 y 2 mo
9	81	Male	MM	Big toe	Medium (4×3.5)	Lower extremity	A:1 V:1	12 mo
10	50	Male	SCC	Dorsum of the hand	Small (3.5×2)	Forearm	A:1 V:1	6 y
11	57	Female	MM	Ring finger	Small (4×2.5)	Forearm	A:1 V:1	5 y 5 mo
12	68	Male	Bowen	Medial malleolus	Large (6.5×4)	Forearm	A:1 V:1	3 y 7 mo
13	81	Male	SCC	Middle finger	Small (3.5×2)	Forearm	A:1 V:1	2 y 2 mo

DFSP, dermatofibrosarcoma protuberans; MM, malignant melanoma; SCC, squamous cell carcinoma.

Case Reports

Case 5

A 76-year-old man was diagnosed with malignant melanoma on the outer edge of the right foot with tumor thickness 1.13mm T4N0M0.

Sentinel node biopsy was performed during resection, and metastasis of the sentinel lymph node was not observed in the groin. Resection was performed 2cm away from the tumor, including the periosteum. After pathologically confirming no malignant tissue remained in the margin of frozen tissue sections, a venous flap was harvested from the dorsum of the foot. The recipient artery was anastomosed to the distal vein of the flap, and the recipient veins were anastomosed to two proximal veins of the flap. Because the size of the defect was moderately large, split-thickness skin grafting to the donor site was performed. Postoperative flap condition was well with no complications, including the formation of callositas (Fig. 1).

Case 6

A 51-year-old woman was diagnosed with malignant melanoma on the right big toe with tumor thickness 4mm T4N0M0. She was recommended amputation of her affected big toe in another hospital and came to our institution for a second opinion. Sentinel node biopsy was performed during resection, and metastasis of the sentinel lymph node was not observed in the groin. The tumor was completely resected at the level below periosteum with 1-cm horizontal margin. After pathologically confirming that no malignant tissue was present in the margin of the frozen specimen, a venous flap was harvested from the opposite leg. An afferent vessel and an efferent vessel were anastomosed.

Recurrence and metastasis were not observed over 10 years after the operation, and the shape of the reconstructed toe was maintained aesthetically well (Fig. 2).

Case 13

A 81-year-old man was diagnosed with squamous cell carcinoma on the left middle finger. The tumor was completely resected with 5-mm horizontal margin. The frozen section on the margin confirmed that no malignant tissue was present. A venous flap was taken from the opposite forearm, and the arterial blood was supplied from an afferent vein and drained to the efferent vein. Primary closure was performed.

No recurrence or metastasis was observed over 2 years after operation, and the shape of the reconstructed finger was satisfactory (Fig. 3).

DISCUSSION

For cutaneous malignancies in the distal extremities, amputation was conventionally considered in selected progressive cases. However, conservative treatment with appropriate excision and reconstruction has gradually emerged, and it has been said that the treatment does not negatively affect prognosis and cause recurrence in most cases when resection is properly performed.⁹ Hence, our policy on resection of a cutaneous malignant tumor is to perform an extended resection after confirming the diagnosis by excisional biopsy. This extended resection must be carried out carefully by excising the tumor at the sufficient deep resection margin. Frozen section examination is performed to pathologically confirm that the tissue in the margin does not include malignancy.

Reconstructions of the extremities following the resection of the tumor have generally been accomplished by



Fig. 1. Case 5. A, A 76-year-old man with malignant melanoma on the outer edge of the right foot. B, After tumor resection, reconstruction using venous flap harvested from the opposite foot was performed. C, Venous flap from the plantar side. D, Closure of the donor site. E, Postoperative appearance of the reconstructed foot. F, Postoperative appearance of the donor site.

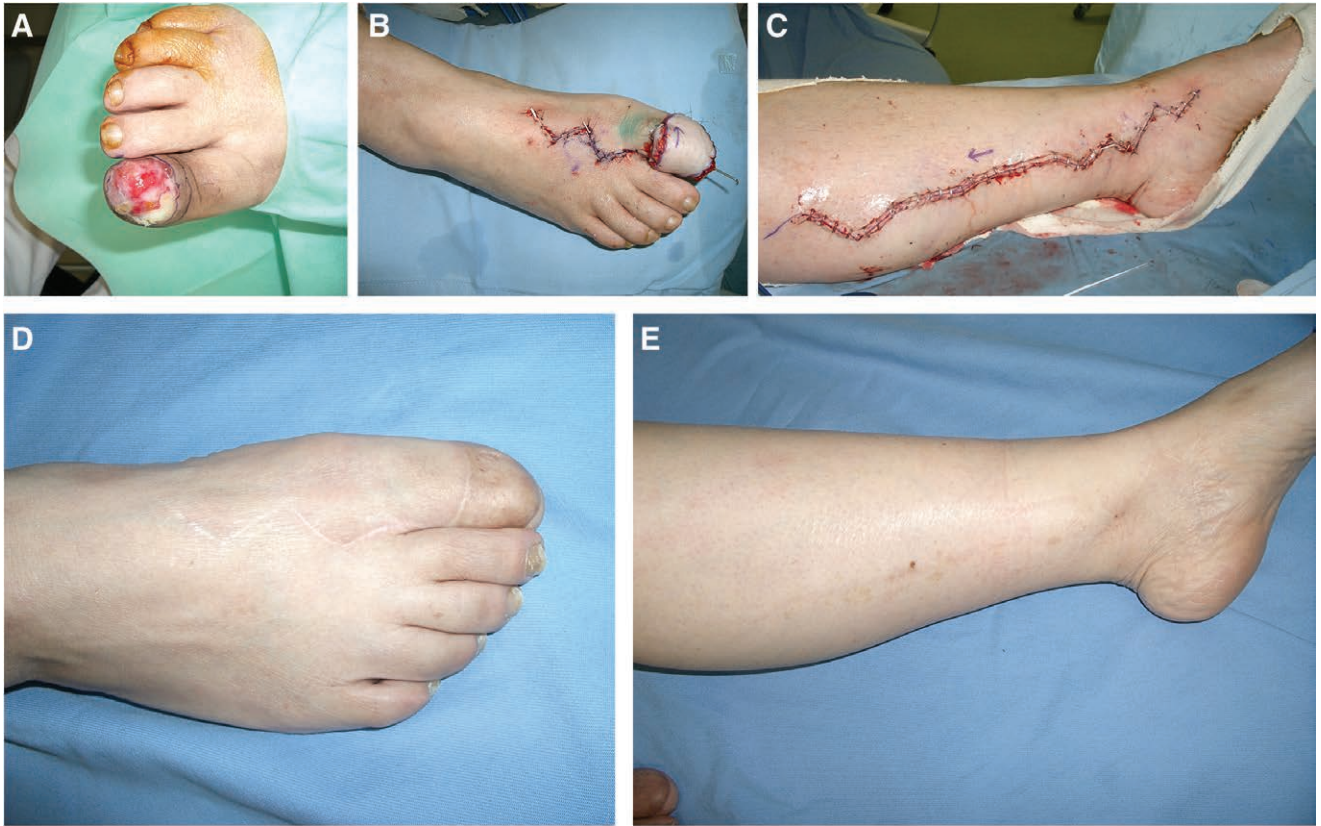


Fig. 2. Case 6. A, A 51-year-old woman with malignant melanoma on the right big toe. B, Tumor resection and reconstruction using venous flap harvested from the opposite leg were performed. C, Closure of the donor site. D, Postoperative appearance of the reconstructed toe. E, Postoperative appearance of the donor site.

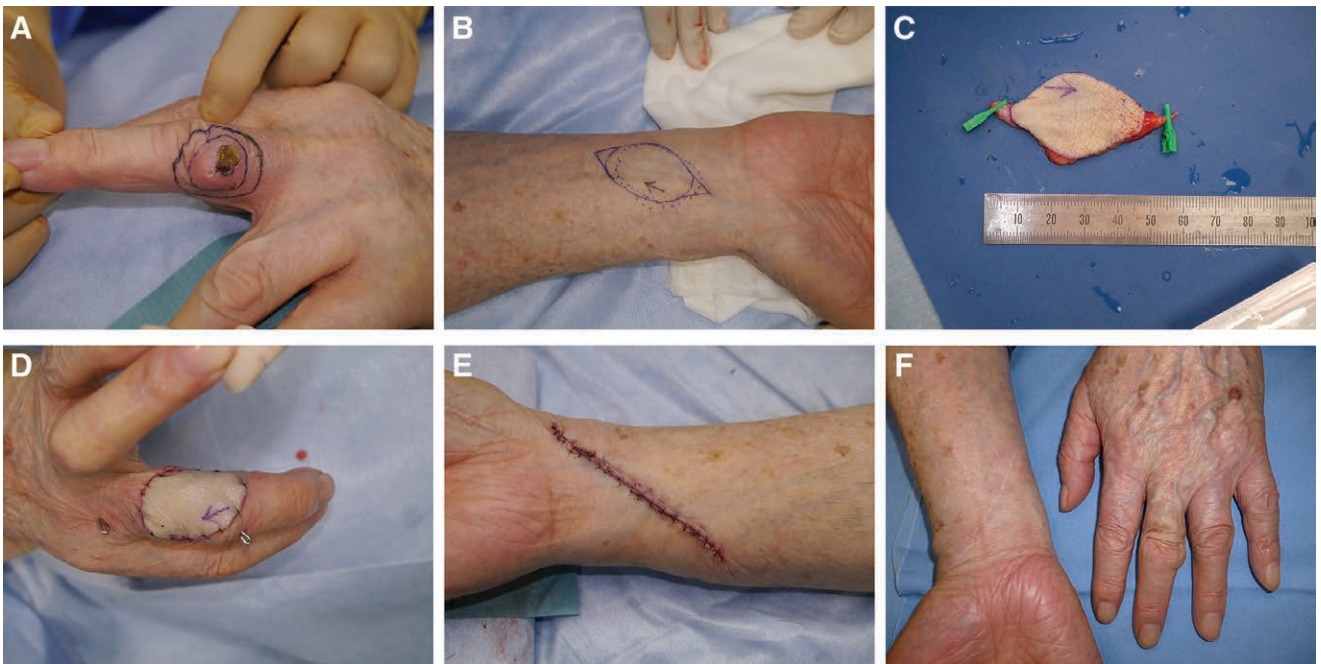


Fig. 3. Case 13. A, An 81-year-old man with squamous cell carcinoma on the left middle finger. B, Design of venous flap on the right forearm. C, Harvested venous flap. D, Venous flap was fixed to the defect after tumor resection. E, Closure of the donor site. F, Postoperative appearance of the reconstructed finger and donor site.

various operative methods such as skin grafts, local flaps, and free flaps. However, there are limitations and disadvantages for skin grafts and flaps. The main disadvantages of skin grafts in distal extremities are the retraction, which can lead to motion impairment, and the need for a well-vascularized bed, which cannot be always available. Local flaps and free flaps are sometimes too bulky for use with the loss of main arterial pedicles.

The arterialized venous flap, which has arterial inflow through an afferent vein perfusing the flap and venous outflow through the efferent veins, was first introduced by Nakayama et al.¹ Ever since the emergence of this flap, several studies and clinical trials have been reported.¹⁰⁻¹⁵ Advantages of the venous flap are (1) the main artery can be preserved, (2) it is thin and pliable, (3) harvest of the flap is relatively easy, (4) sensory perception can be preserved, and (5) it can be used as a sensory flap. Additionally, this flap solely relies on the venous system for flap perfusion; thus, the selection of donor site is flexible.

However, because cutaneous malignancy often carries the risk of lymphatic and hematogenous metastasis, surgeons need to take into consideration that careless surgical manipulation on the proximal side of the resected area may disseminate malignant cells. Thus, when selecting the donor site for reconstruction, we believe that the area of flap harvest should be unrelated to possible metastatic pathways of the tumor.¹⁶ The arterialized venous flap harvested from the nonaffected side satisfies this oncological concept and can function as a great reconstructive material.

There are some disadvantages of venous flaps. Because some areas of its hemodynamics are still unknown, uncertainty in engraftment is mentioned in various reports.^{7,17,18} Congestion and partial necrosis along with difficulty in postoperative monitoring of the flap are some challenging troubles that plastic surgeons often face when they use this venous flap for reconstruction. To minimize these postoperative vascular complications, modifications in anastomosis patterns such as arterialized venous flap with retrograde perfusion have been reported.⁷ In our cases, we endeavored to anastomose at least two efferent veins to recipient veins for better drainage in large flaps. Also, because diameter of the vessels may be responsible for flap perfusion, we attempted to select recipient arteries with smaller diameters to prevent over perfusion.¹⁸ Postoperative congestion of flaps was not exhibited, and complete flap survival was evident in all cases.

Finally, usage of venous flaps for hand and finger reconstructions after trauma and resection of malignant tumors have been exhibited in previous studies.^{2,7} However, venous flap reconstruction performed upon cutaneous malignancies on feet and toes have not been reported. Reconstruction of the foot, especially areas close to the sole of the foot, often requires sufficient soft tissue padding. A conventional free flap often carries thick subcutaneous tissues, which can possibly cause friction between the flap and the bone, and this might result in postoperative gait problems. Thin flaps such as the superficial circumflex iliac artery flap and antero-lateral thigh flap may be great options for reconstructive

materials for medium and large defects. However, these flaps can even be too bulky, and they require thinning to apply for reconstruction of feet and toes. Venous flaps provide sufficient coverage with thin padding and pliability, and they are applicable for reconstruction of toes and feet. In our cases, venous flaps transferred to defects of the feet and toes exhibited satisfactory functional and cosmetic results, indicating the effective and versatile use of this flap in all extremities.

CONCLUSIONS

Reconstruction using the venous flap was performed after excision of primary cutaneous malignancy in the distal extremities in 13 cases. Through our clinical cases, we have indicated the efficacy of using arterialized venous flaps for the reconstruction of all distal extremities while preserving important oncological aspects. Reconstructions performed by microsurgeons with thorough knowledge of oncology possibly lead to satisfying postoperative results functionally and aesthetically. Further study and accumulation of cases are necessary to refine surgical techniques and to unveil unknown aspects of arterialized venous flaps.

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