



## The medial arm pedicled perforator flap: Application of phenomenon of one perforator perfusing multiple perforator angiosomes



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### ABSTRACT

*Background:* The medial arm is an optimal potential donor site for treating skin defects around the elbow. However, whether a reliable pedicled perforator flap could be harvested from the medial arm remains unanswered. The purpose of this study was to report the technique and our results using the medial arm pedicled perforator flaps.

*Methods:* A total of eight flaps in seven patients underwent the medial arm pedicled perforator flaps to treat skin defects around the elbow. The flap was pedicled on one perforator  $1.3 \pm 0.3$  mm in diameter within 3 cm above the medial epicondyle. The flap size varied between 10 and 20 cm in length and between 6 and 10 cm in width.

*Results:* Of the eight flaps in seven patients, seven flaps survived uneventfully except that one suffered venous insufficiency. Six patients were followed up for 1 month to 2 years. One patient was lost to follow-up after 7 days. The wounds in all patients healed satisfactorily. No deep wound infection and wound dehiscence developed. No revision surgery was performed in the survived flaps.

*Conclusions:* The survival of the medial arm pedicled perforator flap confirms the phenomenon of one perforator perfusing multiple perforator angiosomes in the medial arm, although this study has the retrospective clinical nature and limited number of the patients. The medial arm pedicled perforator flap is a useful tool to treat skin defects around the elbow.

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### Introduction

Skin defects around the elbow pose a unique challenge for the reconstructive surgeon [1,2]. With regard to the skin texture, colour, and thickness, the medial arm is an optimal potential donor site for treating skin defects around the elbow. However, whether a reliable pedicled perforator flap could be harvested from the medial arm remains unanswered.

Maruyama et al. [3] first utilized the medial arm as a reverse flap to cover skin defects around the elbow based on the posterior ulnar recurrent artery (PURA). Through the anastomotic connection between the PURA and superior ulnar collateral artery (SUCA), the PURA can reliably perfuse the medial arm skin via one or two cutaneous perforators arising from the SUCA [3]. Anatomic studies have demonstrated that there exists a row of five or six cutaneous perforator arteries along the medial intermuscular septum in the

medial arm [4–7]. Based on the work of Maruyama et al., we postulate that there exists the phenomenon of one perforator artery perfusing multiple perforator angiosomes in the medial arm.

The concept of a perforator angiosome is defined as the anatomic skin territory of each cutaneous perforator artery [8,9]. Each perforator angiosome connects with neighbours via either reduced calibre choke arteries or true anastomoses without a change in calibre [9]. According to the reports of Taylor et al. [10], if the anastomotic connections between the perforator angiosomes are by the choke anastomoses, one cutaneous perforator can safely perfuse one adjacent perforator angiosome in any direction when a flap is raised on one perforator and necrosis occurs at the next choke zone in sequence. However, if the anastomotic connections are by true anastomoses, then one perforator could perfuse multiple perforator angiosomes, such as in the distally based sural flap in the leg [10].

Based on the aforementioned evidences, we hypothesize that the anastomotic connections between the perforator angiosomes in the medial arm are by true anastomoses, and one perforator artery can perfuse multiple perforator angiosomes. If there exists a constant perforator  $>1$  mm in diameter around the medial

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epicondyle, a pedicled perforator flap can be harvested from the medial arm. In our previous anatomic study in 22 specimens, we already noticed a constant perforator >1 mm in diameter existing behind the medial intermuscular septum [11]. Based on this perforator artery, we designed a medial arm pedicled perforator flap and performed eight flaps in seven patients with skin defects around the elbow. The purpose of this study was to report the technique and our results using the medial arm pedicled perforator flaps in the treatment of skin defects around the elbow.

## Patients and methods

This was a retrospective consecutive case series study. We included all patients who had undergone the medial arm pedicled perforator flaps for the coverage of skin defects around the elbow from 2005 to 2013. A total of seven patients were included in our study. The patient age ranged from 22 to 82 years. Of the seven patients, six were men and one was a woman. In addition, eight flaps in seven patients were performed to cover skin defects around the elbows (Table 1). The flap size varied between 10 and 20 cm in length and between 6 and 10 cm in width.

### Surgical procedure

The patient was positioned supine with the affected extremity disinfected from the shoulder to the hand. The upper extremity was brought into a supinated and abducted position. The skin paddle, usually <10 cm in width, was outlined over the medial arm from the medial epicondyle along the medial intermuscular septum, that is, a line drawn from the medial epicondyle to the axilla (Fig. 1A). The point of pivot was marked at 3 cm above the medial epicondyle. The length of the flap was determined by the distance from the pivot point to the distal margin of the recipient.

The flap elevation started from the posterior margin of the skin paddle, which was incised up the fascia. Then a blunt dissection was carried out under the fascia towards the medial intermuscular septum. Along its posterior aspect, a perforator with its vena comitantes was identified within 3 cm above the medial epicondyle (Fig. 1B). The basilic vein was divided and ligated at the distal margin of the skin paddle. The medial antebrachial cutaneous nerve should be meticulously dissected and protected to avoid painful neuroma. Then, the anterior margin was incised and undermined subfascially towards the medial intermuscular septum. The flap was raised by incising the medial intermuscular septum from the humerus in a retrograde fashion until the origin of the perforator was reached (Fig. 1C). During the elevation of the flap, the course of the ulnar nerve should be noticed to avoid

inadvertent injury. The flap elevation was completed and transposed to the recipient (Fig. 1D). The donor site was closed primarily.

## Results

Of the eight flaps in seven patients, seven flaps in six patients survived completely. One flap suffered venous insufficiency leading to partial necrosis (Fig. 2). Six patients were followed up for 1 month to 2 years. One patient was lost to follow-up after 7 days. The wounds in all patients healed satisfactory. No deep wound infection and wound dehiscence developed. The sutures were removed after 2 weeks. No revision surgery was performed in the surviving flaps.

## Discussion

Since the monumental report of the perforator angiosomes by Taylor and Palmer, the survival and necrosis of a flap should be reappraised by the pattern of the anastomotic connections between the perforator angiosomes in series [8,9]. In 80% of cases, one perforator artery as the pedicle of a flap can safely perfuse one and a half perforator angiosomes because of the frequently existing choke anastomoses between the perforator angiosomes [10]. However, if the anastomotic connections are by true anastomoses, the resistance of blood flow between perforator angiosomes is low compared to those connections by choke anastomoses, which will produce the phenomenon of one perforator perfusing multiple (more than two) perforator angiosomes [10].

In the series, based on one perforator artery nearby the medial epicondyle, seven flaps completely survived in eight medial arm pedicled perforator flaps, indicating the phenomenon of one perforator perfusing multiple perforator angiosomes. Many studies have demonstrated that there are at least five to six septocutaneous and/or myocutaneous perforators in the medial arm. The perforators arise from different sources, including the brachial artery and SUCA [3–7]. After penetrating the fascia, these perforators further give off branches, forming a longitudinal-oriented vascular network along the medial intermuscular septum. In other words, there exist at least five to six longitudinal-oriented perforator angiosomes in the medial arm. In 22 cadaver arm dissections, we noticed that one perforator artery  $1.3 \pm 0.3$  mm in diameter constantly existed within 3 cm above the medial epicondyle. [11] It arose from the medial vascular arcade of the elbow, which was composed of the SUCA, inferior ulnar collateral artery (IUCA), and PURA. After arising from the medial vascular arcade of the elbow, it ascended along the posterior aspect of the medial intermuscular

**Table 1**  
Patient characteristics.

Patient	Gender	Site	Cause	Flap size	Result
1	M	Left Anteromedial aspect of proximal forearm	Post-release of ischaemic contracture of forearm due to crush injury	10 cm × 6 cm	CS
2	M	Right Medial aspect of the proximal forearm	Malignant tumour excision	10 cm × 7 cm	CS
3	M	Right Anterior aspect of the elbow	Frostbite	10 cm × 5 cm	CS
4	M	Left Posterior aspect of elbow	Exposure of plate fixing the olecranon	14 cm × 9 cm	CS
5	F	Bilateral Posterior aspect of left elbow Anterior aspect of right elbow	Animal bites	L: 15 cm × 6 cm R: 8 cm × 6 cm	CS
6	M	Left Anteromedial aspect of forearm	Skin necrosis due to crush injury	12 cm × 7 cm	CS
7	M	Left Anteromedial aspect of forearm	Traumatic skin defect	20 cm × 10 cm	1/4PN

M, male; F, female; CS, complete survival; PN, partial necrosis.

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