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Planning digital artery perforators using color Doppler ultrasonography: A preliminary report

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KEYWORDS

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Summary Digital artery perforator (DAP) flaps have been applied for the coverage of finger soft tissue defects. Although an advantage of this method is that there is no scarification of the digital arteries, it is difficult to identify the location of the perforators during intraoperative elevation of the DAP flap. In this study, anatomically reliable locations of DAPs were confirmed using color Doppler ultrasonography (US) in healthy volunteers. A successful case using an adiposal-only DAP flap for the coverage of a released digital nerve using preoperative DAP mapping with color Doppler US is also described. A total of 40 digital arteries in 20 fingers of the right hands of five healthy volunteers (mean age: 32.2 years old) were evaluated. The DAPs were identified using color flow imaging based on the beat of the digital artery in the short axial view. In total, 133 perforators were detected, 76 (an average of 3.8 per finger) arising from the radial digital artery and 57 (an average of 2.9 per finger) arising from ulnar digital artery. Sixty-three perforators (an average of 3.2 per finger) in the middle phalanges and 70 (an average of 3.5 per finger) in the proximal phalanges were found. Overall, an average of 1.7 perforators from each digital artery was detected in the proximal or middle phalanges. Moreover, at least one DAP per phalanx was reliably confirmed using color Doppler US. Preoperative knowledge of DAP mapping could make elevating the DAP flap easier and safer.

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Introduction

Various flaps for fingertip reconstruction have been reported including the thenar flap, VY advancement flap, reversed digital artery flap, cross-finger subcutaneous flap, and reversed dorsal metacarpal flap^{1–6}; however, the coverage areas are very limited and major arteries, such as the digital and dorsal metacarpal arteries, must be sacrificed to elevate these flaps. In order to overcome these disadvantages, the use of a digital artery perforator (DAP) flap for fingertip reconstructions without sacrificing the main digital arteries was reported by Koshima et al., in 2006.⁷ In addition, the adiposal-only DAP flap with a skin graft can be applied in finger reconstruction.⁸ The main advantage of these perforator flaps is that they do not require division of the main underlying vessel.⁹ However, it is difficult to identify the depth, path, and branches of perforators while harvesting the perforator flap. A preoperative knowledge of perforator mapping is critical for the selection of perforators and flap design and can help avoid time-consuming dissections.

Recently, color Doppler US has been shown to provide an easy preoperative identification of perforators as an alternative to angiography, computed tomography angiography (CTA), or magnetic resonance angiography (MRA).^{10–16} However, to date, there have been no reports of identifying DAPs using color Doppler US. The purpose of this study was to evaluate the anatomically reliable locations of DAPs in healthy volunteers using color Doppler US and to report a successful case where a DAP flap was planned preoperatively using color Doppler US.

Materials and methods

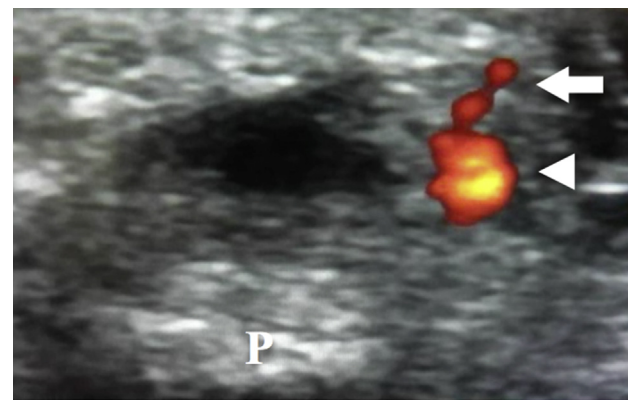
We applied color Doppler US imaging to the right hands of five healthy volunteers (mean age: 32.2 years old, range 25–49 years, two women and three men). A total of 40 digital arteries in 20 fingers were evaluated (five index, five middle, five ring, and five little fingers). Exclusion criteria were a history of hand injury and neurovascular disease. The digital arteries of the radial and ulnar sides and the perforators arising from them were identified using a Doppler US (Venue40; GE Healthcare Japan Corporation, Tokyo, Japan) with a high-frequency probe (L8-18i-SC, B-mode, 8–18 MHz), and the pulse repetition frequency was adjusted for a velocity of 15 cm/s. All color Doppler US examinations were performed by the first [K.S.] or second author [K.T.].

During the examinations, volunteers were seated with their hands completely supinated on the injection stand. Marks were placed on each phalangeal crease. The probe was placed on the volar side of the fingers axially (short axial view). The ulnar digital artery was detected first, and then the probe was slowly moved from the proximal to the distal side (gently pushing it to avoid collapsing the perforator vessels).

Perforators were identified by color flow imaging based on the beat of the digital artery in the short axial view (Figure 1A) and were recorded in the middle or proximal phalanges (Figure 1B). The perforators from the radial digital artery were also detected using the same method. The total number of digital artery perforators in each finger was recorded. The origins of the perforators arising from the digital artery were also identified in short axial views and divided into four areas: the volar, dorsal, medial, and lateral areas of the digital artery. The Mann–Whitney U test was employed to assess statistically significant differences, and a *P*-value of <0.05 was considered to indicate a significant difference.

Results

In total, 133 perforators were detected arising from the digital artery (76 perforators from the digital artery of the



A



B

Figure 1 Image obtained with color Doppler ultrasonography. A: Perforators identified using color flow imaging in the short axial view. The arrow indicates the digital artery perforator, the arrowhead indicates the digital artery, and P indicates the phalangeal bone. B: The location of the perforator is marked on the finger.

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