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Preoperative color Doppler ultrasonographic examination in the planning of thoracodorsal artery perforator flap with capillary perforators

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Summary *Introduction:* The thoracodorsal artery perforator flap with capillary perforators (TAPcp) is based on capillary perforators arising from the descending branch of the thoracodorsal artery and can overcome the drawbacks of the conventional TAP flap, which results in anatomical variations due to the presence of a dominant muscle or septocutaneous perforators. We applied color Doppler ultrasonography (US) to preoperatively visualize capillary perforators of the descending branch of thoracodorsal artery to facilitate successful flap elevation.

Patients and methods: Using preoperative color Doppler US, we examined seven flaps in seven patients who had undergone reconstruction with TAPcp flaps between January 2014 and April 2015. Capillary perforators with diameters <0.5 mm were identified in the anterior border of the latissimus dorsi (LD) muscle. Perforator courses and their penetration points were marked to guide dissection.

Results: All seven TAPcp flaps were successfully harvested without pedicle damage or perfusion disorders. No serious postoperative complications occurred such as total necrosis or absorption of the transferred adipose flap. In all seven cases, capillary perforators and the descending branch of the thoracodorsal artery were found almost exactly where the preoperative color Doppler US was targeted.

Conclusion: Using the technique described herein, capillary perforators of the descending branch of the thoracodorsal artery are easily visualized, and TAPcp flaps can be easily used for various kinds of reconstruction. Moreover, this technique is quick and safe to administer.

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Introduction

The thoracodorsal artery perforator (TAP) flap was first reported in 1994 by Angrigiani et al.¹ Since then, it has been used as a reconstructive workhorse and it has revolutionized the field of reconstructive surgery. The advantages of this flap include longer flap pedicle, shorter operation time, less donor-site morbidity, and primary thinness.² This flap is suitable for both large and small defects, and the relatively longer and larger diameter of its pedicle vessels enable its use in various surgical reconstructions. However, the main disadvantage of this flap is that the dominant large muscle perforators are often absent.

Some reports described variations of the TAP flap. Kim et al. classified TAP flaps into three types: transmuscular, septocutaneous, and direct cutaneous perforator flaps.³ This classification is useful for further understanding of this flap. Schwabegger et al.⁴ reported muscle-sparing latissimus dorsi (LD) musculocutaneous flaps with dominant muscle perforators. Saint-Cyr et al.⁵ reported pedicled or free descending branch muscle-sparing LD flaps. Koshima et al.⁶ reported a TAP flap with capillary perforators (TAPcp) to overcome the drawbacks of the conventional TAP flap, which requires the dominant muscle or septocutaneous perforators. The concept of TAPcp is based on the fact that small capillary perforators arising from the lateral descending branch of the thoracodorsal artery can nourish a large skin territory.

The TAPcp and the muscle-sparing LD flap are based on similar concepts but from different viewpoints. The muscle-sparing LD flap is based on the volume of spared LD muscle. Meanwhile, the TAPcp flap is based on the capillary perforators arising from the descending branch of the thoracodorsal artery (Figure 1). The diameters of these capillary perforators are approximately 0.3–0.5 mm, and these capillary perforators pass through the anterior border of the LD muscle. Dissection of these clusters of capillary perforators in muscle layers can damage them. Hence, according to a previous report, inclusion of capillary perforators with small and thin portions of the anterior border of the LD muscle is necessary.⁶

In order to achieve less inclusion of muscle to preserve donor-site functions as much as possible, preoperative image examination to locate capillary perforators arising from the descending branch of the thoracodorsal artery is important. Many reports have preoperatively examined the outcomes of perforator flap surgery by using a handheld Doppler system, color Doppler ultrasonography (US), or

multi-detector row computed tomography (MDCT).^{7–13} They were mainly used to find dominant large perforators, whose diameters are usually >0.5 mm. However, only few reports described findings from preoperative image examinations of capillary perforators with diameters of approximately 0.3 mm.¹⁴

In this report, we performed a preoperative color Doppler US assessment to identify capillary perforators before harvesting TAPcp flaps. The handheld Doppler system and MDCT are not suitable to detect capillary perforators because of the limitation of these modalities to catch and distinguish each capillary perforator. Meanwhile, color Doppler US can reliably detect the pulsation of capillary perforators.^{14–16} To the best of our knowledge, this is first study to use color Doppler US for preoperative examination in order to identify capillary perforators from the descending branch of the thoracodorsal artery.

Patients and Methods

We examined seven flaps of seven patients who had undergone reconstruction with TAPcp flaps between January 2014 and April 2015 at the Department of Plastic and Reconstructive Surgery, University of Tokyo Hospital, by following the protocol approved by the Institutional Review Board of the University of Tokyo Hospital.

The patients' characteristics are listed in Table 1. The study cohort comprised three men and four women, with a mean age of 51.2 years (range: 12–80 years). All of the patients underwent color Doppler US prior to TAPcp flap surgery. All flaps were free flaps. The flap dimensions ranged from 17×4 cm to 36×12 cm, with a mean size of 27.9×8.6 cm.

Color Doppler US examinations were performed the day before surgery by using a Noblus US diagnostic scanner (Hitachi Aloka Medical, Ltd., Tokyo, Japan) with a 12- or 15-MHz transducer. The examination was completed within 10 min and did not require specialist skills.

In the preoperative examination, patients were placed in the supine position, with the arm abducted at 90° , because the TAPcp flap can be harvested in the supine position.⁶ The descending branch of the thoracodorsal artery was subsequently identified on color Doppler US. Capillary perforators with diameters <0.5 mm were identified in the anterior border of the LD muscle (Figure 2). The anterior border of the LD muscle and the course of the capillary perforators were marked to facilitate dissection.

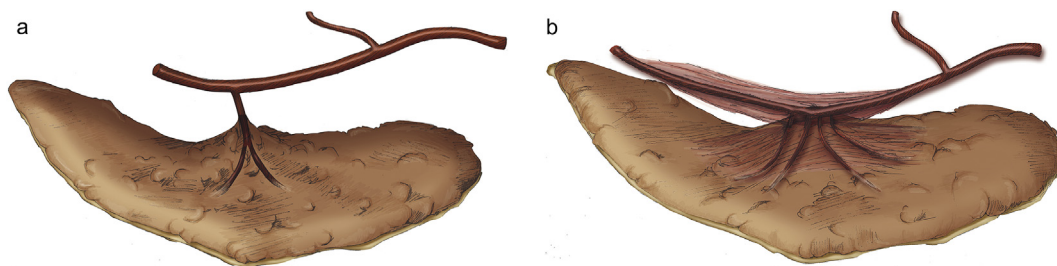


Figure 1 a. The conventional TAP flap is based on a strong, dominant perforator, which is usually >0.5 mm in diameter. b. The TAPcp flap is based on clusters of capillary perforators, which are usually <0.5 mm in diameter.

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