Imaging Studies for Preoperative Planning of Perforator Flaps: An Overview

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KEYWORDS

• MDCT • Perforator flap • Propeller flap • CT angiography • Suprafascial perforator directionality

KEY POINTS

- For safely planning perforator flaps, accurate preoperative assessment of perforators is recommended because their vascular anatomy varies between individuals.
- To assist in preoperative perforator assessment, perforator computed tomographic angiography (P-CTA) with multidetector-row computed tomography is currently one of the best available methods.
- The location of reliable perforators and their subcutaneous course between the deep fascia and skin, known as suprafascial perforator directionality, can be accurately determined preoperatively using P-CTA.
- Using P-CTA, surgeons can share 3-dimensional information of the perforator's location, diameter, and course, in relation to other anatomic structures preoperatively in a short time, which can shorten operative time and improve operative outcomes.

INTRODUCTION

Perforator flaps have been gaining popularity over the last decade in the reconstructive surgery field. Advances in perforator-flaps transfer techniques allow harvesting of thin, pliable, and well-vascularized cutaneous flaps with minimal donor site morbidity as a consequence of the preservation of innervation, vascularization, and functionality of the underlying donor muscle. Perforator flaps are usually harvested as island flaps separated from all the surrounding skin and nourished by only one or 2 perforators arising from the deep major artery (**Fig. 1**). Vascular anatomy of perforators varies between individuals; therefore, accurate preoperative determination of the location of reliable perforators and their subcutaneous course between the deep fascia and skin is important for safely planning perforator flaps.

To assist in preoperative perforator assessment, perforator computed tomographic angiography (P-CTA) with multidetector-row computed tomography (MDCT) has been developed to reveal the anatomic details of individual flap perforators.[1] MDCT differs from traditional computed tomography (CT) in that the scanner array has multiple detector rows in the scanning direction as opposed to just one detector row in traditional CT, allowing for acquisition of more than one image per

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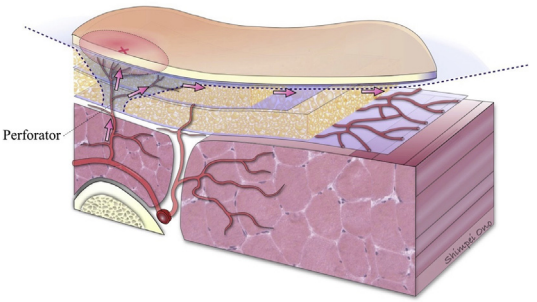

Fig. 1. The course of perforators. Red cross: the point where the perforator penetrates the deep fascia. Pink arrows: vascular flow from the perforator to the subdermal vascular network.

revolution of the x-ray detector tube around the patients. Thus, MDCT provides several thin-sliced CT images obtained in a short time. Compared with the product image provided by traditional single-detector-row CT, the higher number of thin-sliced CT images from MDCT provides increased spatial resolution in the resulting product image allowing for a multiplanar evaluation of perforators and 3-dimensional images of the perforating vessels.

The aim of this report is to describe the authors' experience using P-CTA with MDCT in detecting the perforators preoperatively and a step-by-step approach to harvest perforator flaps based on this technique.

STEP-BY-STEP APPROACH TO HARVEST OF PERFORATOR FLAPS

Case Presentation

A 37-year-old male truck driver presented with a pilonidal sinus in the sacrococcygeal region (**Fig. 2**). The patient had symptoms of the disease with multiple recurrent abscesses and spontaneous drainage for more than 5 years. A perforator-based propeller flap vascularized by the superior gluteal artery perforator (SGAP) was planned to cover the defect after the pilonidal sinus resection. Perforator-based propeller flap, a type of pedicled perforator flaps, is an island flap in which flap movement is achieved by rotation around its vascular (perforator) axis (**Fig. 3**).[2,3] The perforator axis itself is stationary, and flap movement is achieved by rotation around this perforator. It has been so called because it is like a propeller in which the blades rotate around a fixed axis.[2]

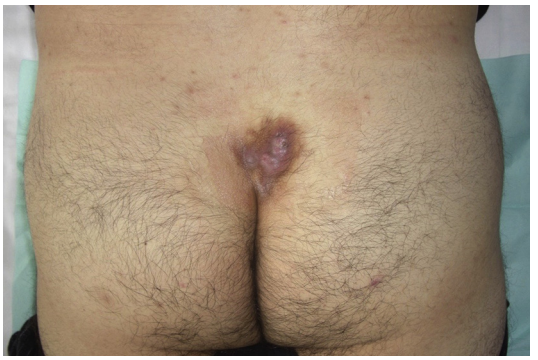

Fig. 2. A pilonidal sinus in the sacrococcygeal region.

Perforator computed tomographic angiography

Because a perforator-based propeller flap is usually nourished by one or 2 perforators, preoperative assessment of candidate perforators is an important step in designing the flap. In this case, the SGAP was selected as the flap's pedicle. P-CTA analyses used 64-row MDCT (Light Speed VCT; GE Healthcare, Waukesha, WI) and were performed by a team including plastic surgeons, radiologists, and radiology technicians (**Fig. 4**). Scan parameters are summarized in **Table 1**.[4] The patient was scanned in a prone position similar to the operative positioning in which the normal contours of the buttock fat are not distorted by the pressure of lying against a flat surface. The scan range was limited by the superior border of the iliac bone to the gluteal fold to include tissues that will be used intraoperatively. The scan was performed with a rotation speed of 0.4 seconds per rotation, detectors coverage of 40 mm, and a detector configuration of 0.625 mm and 64 rows. This acquisition protocol allowed for a table speed of 137.5 mm/s and a scan time of less than 10 seconds for CTA.

For CTA, axial images of 0.625-mm thickness were reconstructed with an interval of 0.3 mm overlapping technique (eg, a 50% overlap means that half of the current image slab is covered by the preceding image and the other half by trailing image. Each point in the scanned volume is contained in exactly two reconstructed images. This would improve quality of MPR and volume images) and transferred to a workstation (Advantage Workstation; GE Healthcare, Chicago, IL) in the department of radiology or to a personal computer (Macintosh OSX; Apple Inc, Cupertino, CA) having an open-source digital imaging and communications in medicine (DICOM) image viewer software (OsiriX software; Pixmeo, Geneva, Switzerland) installed on it. The CTA images were reconstructed using maximum-intensity projection and volume-rendering techniques (**Fig. 5**).

Selection of perforator

A couple of candidate perforators suitable to act as the pedicle of a flap were easily identified around the defects in the reconstructed images.