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Thoracodorsal artery perforator flap and Latissimus dorsi myocutaneous flap — anatomical study of the constant skin paddle perforator locations

Mark Schaverien, Corrine Wong, Steven Bailey, Michel Saint-Cyr*

Department of Plastic Surgery, University of Texas Southwestern Medical Center, 1801 Inwood Road, Dallas, TX 75390-9132, USA

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Summary *Background:* Ischaemic flap complications can be a problem following harvest of the latissimus dorsi (LD) musculocutaneous flap or thoracodorsal artery perforator (TAP) flap. We investigate the reliable locations of the perforators of the thoracodorsal artery.
Methods: Twenty latissimus dorsi flaps harvested from cadavers were used in the study. In fifteen flaps the thoracodorsal artery was injected with coloured latex, and the locations of perforators were recorded. In five flaps perfusion of the skin paddle was evaluated using 3D CT angiography following injection of the thoracodorsal artery with a barium sulphate/gelatin mixture.
Results: At least one perforator originating from the descending branch of the thoracodorsal artery was found in all specimens, whereas no perforators from the transverse branch were found in 33% of flaps. At least one perforator originating from the descending branch in all flaps was found between 9.5 and 15.4 cm from the posterior axillary fold, within 4.3 cm of the lateral border of the latissimus muscle. 58% of all perforators from the descending branch, and 39% of all perforators from the thoracodorsal artery were found in this region. CT scanning of the hemiback flaps demonstrated contrast in the superior two-thirds. Perfusion of the skin paddles in three locations was demonstrated- superior transverse (bra strap), vertical and lower transverse.
Conclusions: Thoracodorsal artery perforators could be found within a reliable region. Positioning of the TAP flap skin paddle over this region will maximise the chances of including a perforator and may reduce the risk of ischaemia. For a musculocutaneous LD flap, the skin paddle can be in any of the 3 popular locations, i.e. upper transverse, vertical and lower transverse, as they were shown to be well vascularised.
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* Corresponding author. Tel.: +1 214 645 3115; fax: +1 214 645 3105.
E-mail address: michel.saint-cyr@utsouthwestern.edu (M. Saint-Cyr).

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Background

The latissimus dorsi (LD) musculocutaneous flap remains a workhorse for local and distant reconstruction of the chest wall, breast, head and neck, and limbs.[1–10] The flap was first described by Tansini in 1896 as a skin rotation flap pedicled in the axilla for reconstruction of mastectomy defects, where high rates of distal flap necrosis prompted cadaveric appraisal of the vascular anatomy of the region.[11,12] In 1906 the latissimus dorsi musculocutaneous flap was described, demonstrating increased reliability of the skin paddle, and in 1912 D'Este described a superiorly based latissimus dorsi skin flap for reconstruction of the mastectomy defect.[13] Adoption of Halstedian doctrines prevented the reintroduction of the latissimus dorsi musculocutaneous flap for breast reconstruction until the description in 1976 by Olivari,[14] followed by descriptions by Schneider, Hill, and Brown, Muhlbauer and Olbrisch, McCraw, Dibbell, and Carraway, and Bostwick, Vasconez, and Jurkiewicz.[1–4]

The skin paddle is generally designed based on aesthetic considerations of the donor and recipient site.[15,16] The rate of ischaemic complications of this flap is up to 10%[5–10,17–19] (In one of the larger series with 201 LD flaps, Pinsole et al. recorded a flap necrosis rate of 4%[10]). This study presents an anatomical appraisal of the constant locations of the perforators from the thoracodorsal artery, knowledge of which may reduce the risk of ischaemic skin paddle complications.[5]

Methods

Twenty latissimus dorsi musculocutaneous flaps harvested from ten fresh cadavers acquired through the Willed Body Programme at UT Southwestern Medical Center were used in the study. The ipsilateral arm was placed in 90 degrees of abduction, with the elbow in 90 degrees of flexion, and the posterior axillary fold, inferior angle of the scapula, and the lateral border of the latissimus muscle were clearly marked. Dissection was performed with identification and preservation of the neurovascular pedicle. The distances between the landmarks marked on the flap were measured before and after flap harvest to confirm that changes in dimension had not occurred during flap harvest due to elastic recoil of the integument. The thoracodorsal artery was cannulated and irrigated with warmed (37 °C) normal saline until the effluent was clear, and any leaks were sealed using bipolar cautery.

In fifteen flaps this was followed by manual injection of 10 ml of coloured latex (Ward's; Rochester; NY). The specimens were then left at room temperature for 24 h to allow the latex to cure. All musculocutaneous perforators of diameter $\geq$0.5 mm encountered were identified and their location measured from the landmarks. The perforators were then followed down to their origin.

In five flaps the thoracodorsal artery was injected with barium sulphate/gelatin mixture (barium sulphate 40 g; normal saline 100 ml; powdered gelatin 4 g). Two of the specimens were entire hemiback adipo-cutaneous flaps, where the margins were the midline, mid-axillary line, C7 level superiorly and level of the iliac crest inferiorly. The adipocutaneous flap was harvested from cepahalad to caudal in a subfascial plane. Three other specimens were musculocutaneous flaps, each with three skin paddles, attached to the underlying latissimus dorsi muscle. The locations of the skin paddles were the 1) traditional transverse skin paddle whereby the scar is hidden under the bra strap, 2) vertical skin paddle and 3) lower transverse skin paddle, which corresponded to one of the lower adipocutaneous rolls (accentuated when the patient flexes laterally). A helical CT scan was then acquired using a GE Lightspeed 16-slice scanner (General Electric, Milwaukee, WI) set to perform a slow helical scan protocol. All images were viewed on the CT workstation utilising TeraRecon software (TeraRecon, Inc., version 3.2.2.21).

Results

Anatomical dissection

The thoracodorsal artery bifurcated into transverse and descending branches at the neurovascular hilus in all specimens, which occurred at mean of 5.1 cm (range 2.1–7.5 cm) from the posterior axillary fold, and at a mean of 2.2 cm (range 1.3–3.1 cm) from the lateral edge of the latissimus dorsi muscle. The mean length of the descending branch was 15.2 cm (range 13.2–19.0 cm).

There were a mean of 3.6 musculocutaneous perforators $>$0.5 mm in diameter (range 1–8) per flap. At least one perforator was found originating from the descending branch in all specimens and 70% of all perforators originated from the descending branch, and 30% from the transverse branch. No perforators from the transverse branch were found in 33% of flaps. The descending branch yielded a mean of 2.5 perforators per flap (range 0–7), and the transverse branch 1.1 perforators per flap (range 0–3). The most proximal perforator from the descending branch was found to have the largest diameter of the perforators from the descending branch of the thoracodorsal artery in al specimens.

At least one perforator in each flap $>$0.5 mm was found between 9.5 and 15.4 cm from the posterior axillary fold within 4.3 cm of the lateral border of the latissimus muscle (Figure 1). 58% of all perforators from the descending branch, and 39% of all perforators from the thoracodorsal artery were found in this region. In 53% of flaps the most proximal perforator from the descending branch was found in this region, and in the remainder it was the second. From the bifurcation of thoracodorsal artery at least one perforator was found from 5 to 10 cm, within 4.3 cm of the lateral border of the latissimus muscle. 61% of all perforators from the descending branch were found in this region, and 41% of perforators from the thoracodorsal artery.

CT scanning

The whole hemiback adipocutaneous flaps demonstrated contrast in the superior two-thirds, and almost reaching the midline in the midback region (Figure 2). The musculocutaneous flaps showed perfusion of the skin paddles in all three locations. The upper transverse (bra strap) skin paddle was perfused mostly by the transverse branch of the