INTRODUCTION

In 1984, Song et al. introduced the anterolateral thigh (ALT) flap based on the septocutaneous branches of the descending branch of the lateral circumflex femoral artery (LCFA). Currently, the ALT flap has gained popularity for use as a soft-tissue flap for reconstruction of regional and distal defects. Early anatomic dissections on cadavers revealed that the vascular anatomy was variable and that the majority of skin vessels were septocutaneous as opposed to musculocutaneous in nature. More recent studies and series indicate predominance for skin vessels to be musculocutaneous perforators and not septocutaneous vessels. This flap has been extensively reported in the literature and has become a workhorse flap for reconstruction of small or large defects, both simple and complex, with excellent results and minimal morbidity at the donor site.

The ALT flap is supplied by either septocutaneous vessels or musculocutaneous perforators that usually arise from the descending branch of the LCFA. Earlier anatomic studies suggested that the location for flap harvest was based predominantly on areas with direct septocutaneous vessels, but more recent large series indicate that it is primarily based on musculocutaneous perforators instead (87% musculocutaneous versus 13% septocutaneous perforators). Less commonly, the perforators may originate from other sources such as the transverse branch of the LCFA.

The purpose of this study was to demonstrate anatomic variation of bilateral anterolateral thigh flap vasculature in the same individual.

MATERIALS AND METHODS

We performed an observational retrospective case series study in 11 patients who needed bilateral ALT flaps for reconstruction.
flaps for the treatment of severe burn sequelae and for reconstruction of head and neck severe defects following cancer ablation, and we found bilateral anatomic variation in the main cutaneous branch of the descending branch of the LCFA between both thighs in the same individual. After that, we decided to perform an observational prospective study in 7 cadavers to confirm our findings.

The research was performed in Buenos Aires, Argentina, in the Division of Plastic Surgery and Pathologic Department of Santojanni Hospital, and in the CT Section Radiology Department of Italian Hospital, between June 2014 and January 2016.

This study was approved by the institutional review committee of Francisco Santojanni. The principles outlined in the Declaration of Helsinki have been followed. Informed consent was not required.

Cadavers and patients were placed in the supine position. A line was drawn from the anterior superior iliac spine to the lateral superior aspect of the patella. A circle with a radius of 3 cm was drawn at the midpoint of this line, delineating the predominant location of the skin vessels.

The medial margin of the flap incision was first made through the skin and subcutaneous tissue, reaching the level of the fascia of the thigh. The dissection proceeded above the fascia in a lateral direction, using a scalpel, until the skin vessels were encountered. Cutaneous nerves overlying the fascia were preserved at the donor site whenever possible. After identifying a suitable skin vessel and confirming that its course pierced through the fascia and entered the subcutaneous tissue, the lateral skin flap incision was made down to the same suprafascial plane followed by an incision in a medial direction until the same skin vessel was visualized. A fascial incision was made in the direction of the skin vessel, exposing the rectus femoris muscle. An incision was then made in a lateral direction until the septum separating the rectus femoris from the vastus lateralis was visualized. The entire septum was exposed by retracting the rectus femoris medially. At the medial aspect, the descending branch of the LCFA could be seen coursing over the vastus lateralis muscle. Branches of the descending branch were observed either perforating the vastus lateralis muscle or traveling within the septum to reach the skin of the anterolateral aspect of the thigh. For septocutaneous vessels, the dissection was performed in a retrograde fashion, and the vessel was dissected away from the surrounding tissues. In cases of a musculocutaneous perforator vessel, intramuscular dissection was performed in the following manner: the point of exit of the perforator was exposed and the muscle fibers anterior to the vessel are separated using teeth forceps; tenotomy scissors were first used to spread the fibers out in a transverse plane over the perforator and then cut those fibers. This same series of steps was performed throughout the vessels with an intramuscular course in a retrograde fashion. Small intramuscular branches, which generally arise from the lateral and posterior sides of the perforator and less commonly from the anterior side, were ligated. Perforator dissection proceeded until the vessel diverged from the descending branch of the LCFA or further until adequate pedicle length was achieved. The main nerve and nerve branches supplying the vastus lateralis and the rectus femoris were carefully dissected away from the vessels and preserved (Figs. 1–4).

The patients underwent multiple detector computed tomography angiography (MDCTA) on a 320-MDCT scanner (Aquilion ONE Dynamic volume CT, Toshiba). The gantry rotation time was 350 milliseconds with modulated tube current and a tube voltage of 100 kVp. MDCT angiography was performed using automatic bolus detection software to identify peak contrast enhancement and launch the acquisition. The entire abdomino-iliac-lower extremity system from above the suprarenal aorta to the popliteal artery was covered in 1 imaging procedure (Fig. 5).

![Fig. 1. Septal course (right thigh) and intramuscular course (left thigh).](image-url)
Fig. 2. Septal course (A, C, E, right thigh) and intramuscular course (B, D, F, left thigh).
Ethical Approval

This study was approved by the institutional review committee of Francisco Santojanni. The principles outlined in the Declaration of Helsinki have been followed. Informed consent was not required.

RESULTS

We found bilateral anatomic variation in the main cutaneous branch of the descendental branch of the LCFA between both thighs in the same individual.

In 72.2% of cases, we observed that the main cutaneous branch was septocutaneous in 1 thigh and musculocutaneous in the contralateral thigh, in 16.7% the main cutaneous branches were musculocutaneous in both thighs, and in 11.1%, the main cutaneous branches were septocutaneous in both thighs (Table 1 and Fig. 6).

DISCUSSION

The LCFA arises from the profunda femoris artery and travels laterally, deep to the rectus femoris and sartorius muscles. At this point, the vessel gives rise to 3 branches: the ascending, transverse, and descending branches. After arising from the LCFA, the descending branch travels in a caudal direction on the medial aspect of the vastus lateralis muscle.7 In approximately 30% of patients, the branch divides into a medial and a lateral branch at the midpoint of a line joining the anterior superior iliac spine and the lateral aspect of the superior border of the patella. The medial branch courses medially under the rectus femoris muscle and has branches that supply this muscle and the skin overlying the anteromedial aspect of the thigh. The lateral branch courses inferiorly in the septum between the vastus lateralis and the rectus femoris muscles. This branch is a source of either musculocutaneous perforators that traverse the vastus lateralis muscle or septocutaneous vessels, both ultimately supplying the overlying skin.

The LCFA-vl perforator flap has been classified into 8 variants by Kimata et al.,4 and into 4 subtypes by Shieh et al.10

In addition, Wong et al.11 prospectively analyzed 89 consecutive flaps and found that a previously unnamed vascular branch in the lateral thigh was present in 34% of patients. In a study of 1,043 LCFA-vl flaps from 2004 to 2007, Chen et al.12 found 6 anatomic variants, which may have contributed to total or partial flap loss.

Bilateral ALT flaps are used for different reasons.13–15 The most common reason in our series was the need for good quality tissue in the treatment of severe burn sequelae and for reconstruction of head and neck severe defects following cancer ablation. It was also indicated in cases when a flap failed previous flap or for coverage of another area.

In cases where the contralateral side is used in a second surgical procedure, there might be a tendency to preoperatively expect the vascular anatomy to be similar to that of the operated side. This study demonstrates that this is not always the case. The differences between each side in the same individual are statistically significant. Therefore, previous contralateral surgery should be utilized as preoperative guide for surgical planning. Preoperative angiographic studies are of great assistance for surgical planning.

CONCLUSIONS

Significant anatomic variation exists between the right and the left perforating branches of deep circumflex femoral arteries. Hence, preoperative imaging by

Fig. 3. Intramuscular course (right thigh) and septal course (left thigh).
Fig. 4. Intramuscular course (right thigh) and septal course (left thigh).
CTA aids in determination of the vascular anatomy of the descending branch of the LCFA and in selection of septocutaneous branches, thereby reducing operative time.

**Fig. 5.** Intramuscular course (right thigh) and septal course (left thigh) on CTA.

**Table 1. Variation of ALT in the Same Individual**

| Case | Sex | Age | Right | Left |
|------|-----|-----|-------|------|
| 1    | M   | 33  | IM    | IM   |
| 2    | F   | 28  | IM    | S    |
| 3    | F   | 73  | S     | IM   |
| 4    | M   | 35  | IM    | S    |
| 5    | M   | 72  | IM    | S    |
| 6    | M   | 44  | S     | M    |
| 7    | M   | 45  | IM    | IM   |
| 8    | M   | 63  | IM    | IM   |
| 9    | M   | 62  | S     | IM   |
| 10   | F   | 70  | S     | IM   |
| 11   | M   | 69  | S     | IM   |
| 12   | M   | 72  | S     | IM   |
| 13   | M   | 66  | S     | IM   |
| 14   | F   | 56  | S     | S    |
| 15   | F   | 86  | S     | IM   |
| 16   | M   | 73  | S     | S    |
| 17   | M   | 76  | S     | IM   |
| 18   | F   | 68  | IM    | S    |

F, female; IM, intramuscular extrategumentary course; M, male; S, septal extrategumentary course.

**Fig. 6.** Variation of ALT in the same individual. S, septal extrategumentary course; IM, intramuscular extrategumentary course.

CTA aids in determination of the vascular anatomy of the descending branch of the LCFA and in selection of septocutaneous branches, thereby reducing operative time.

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