

# Anatomical Variations of Anterolateral Thigh Flap: A Fresh Cadaver Dissection Study

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## ABSTRACT

### BACKGROUND

The anterolateral thigh (ALT) flap is one of the fasciocutaneous flaps in the thigh region based on the septocutaneous or musculocutaneous perforators derived from the lateral circumflex femoral artery (LCFA). This cadaveric study aimed to explore the variability of ALT flap anatomy.

### METHODS

Ten ALT flaps were dissected (2016-2017, Mashhad Legal Medicine Organization) in 10 fresh cadavers (7 males and 3 females). Flaps were marked in a 15 cm area centered on the middle point of a line drawn from anterior superior iliac spine to the lateral surface of the patella. Dissection began by searching the skin perforators and then continued along the pathway of the vascular pedicle.

### RESULTS

The average distance of ASIS-Patella was 44.6 cm. The mean number of skin perforators was 2.4 (ranged from 0 to 4). In one case, we did not find any skin perforator. The majority of skin perforators were musculocutaneous from descending branch of LCFA (66.7%) and the remaining were septocutaneous (33.3%). The mean length of vascular pedicle was 10.17 cm. The average diameter of vascular pedicle was 2.78 mm for the artery and 3.79 mm for the vein. The average time of flap harvesting was 85.3 min (ranged from 50 to 125 min).

### CONCLUSION

The skin perforators supplying the ALT flap showed significant variability in number, location and course. The cadaveric study could enhance the anatomic knowledge and operative skills of ALT flap harvesting.

### KEYWORDS

Anterolateral thigh flap; Cadaveric study; Skin perforator

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## INTRODUCTION

The anterolateral thigh (ALT) flap is one of the fasciocutaneous flaps in the thigh based on the septocutaneous or musculocutaneous perforators derived from the lateral circumflex femoral artery (LCFA). The LCFA has 3 main branches names ascending, transverse and descending and in some cases a fourth branch named innominate. The main branch of LCFA that gives perforators to ALT flap is descending branch<sup>1-4</sup>. The

ALT flap was first described by Song et al in 1984 as a flap based on septocutaneous vessels running in between the rectus femoris and vastus lateralis muscles<sup>5-7</sup>. However, in the majority of cases there were only musculocutaneous perforators and both septocutaneous and musculocutaneous perforators could originate from vessels other than the descending branch of the lateral femoral circumflex artery<sup>6-8</sup>.

This flap has a vascular pedicle with good length and diameter and the donor site can easily be primary closed, but the main disadvantage of this flap is variety of its vascular supply that make it more technique sensitive and difficult to perform<sup>9</sup>.

In this study, we describe the anatomic variations of ALT flap and its vascular supply characteristics based on dissection of flap on fresh cadavers.

## METHODS AND MATERIALS

This study approved by Ethics Committee of Mashhad University of medical Science by referral code IR.mums.sd.REC.1394.323.

We did 10 ALT flaps on fresh cadavers and evaluated some features of it. The parameters we assessed were:

1. ASIS – Patella distance (in centimeter)
2. Origin of perforators
3. number and type of perforators in flap (cm)
4. distance of perforators from ASIS (cm)

5. length of vascular pedicle from cut point to the first perforator (cm)

6. diameter of artery and vein in origin of vascular pedicle (cm)

7. harvesting time duration (in min)

The type of perforators classified as musculocutaneous or septocutaneous perforators.

Branches of LCFA for defining origin of perforators divided in; ascending, transverse, descending and innominate.

The flap harvesting technique that we used was the sub-fascial technique and the operation steps were: With the patient in the supine position, a line is drawn from the anterior superior iliac spine (ASIS) to the super lateral border of the patella. This line represents the intermuscular septum between the rectus femoris and

Vastus lateralis (VL) muscles. Next, a circle with a 5 cm radius is marked at the midpoint of this line. The required size of the skin flap is then marked incorporating this circle in a fusiform (Figure 1).

We started dissection from medial border of designed flap in subfascial plane. The incision made through the deep fascia, the flap raised laterally for a short distance until the intermuscular septum between the rectus femoris, and vastus lateralis is reached. Then dissection of lateral border of flap started until we got to the septum (Figure 2).

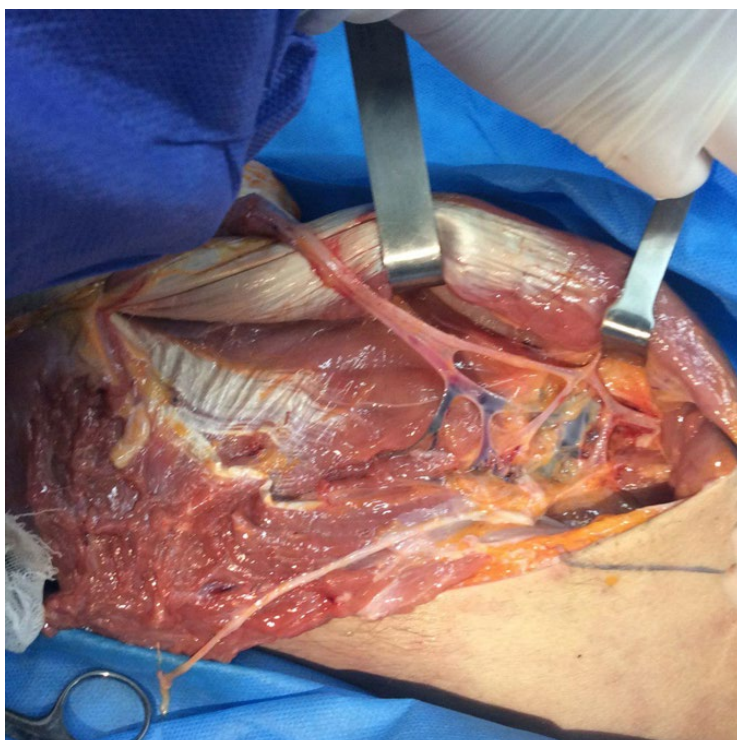
The vessels supplying the skin are either



Fig. 1: Design of fusiform flap around a middle circle



**Fig. 2:** Completion medial and lateral border of flap and perforators seen in flap



**Fig. 3:** LCFA and its branches as vascular pedicle of flap

septocutaneous or musculocutaneous perforators and commonly lie within this septum. If the vessel supplying the flap is a septocutaneous vessel,

this is simply mobilized and flap harvest can be expediently completed. For musculocutaneous perforators, intramuscular dissection is needed for

Table 1: Demographic data

| Case | Gender     | Age (yr) |
|------|------------|----------|
| 1    | M          | 50       |
| 2    | M          | 60       |
| 3    | M          | 45       |
| 4    | M          | 55       |
| 5    | M          | 35       |
| 6    | M          | 60       |
| 7    | M          | 45       |
| 8    | F          | 40       |
| 9    | F          | 60       |
| 10   | F          | 35       |
| Mean | F= 3 , M=7 | 48.5     |

Table 2: Perforator's information

| Case | Number of perforators | MC-D | MC-T | SC-D | SC_T |
|------|-----------------------|------|------|------|------|
| 1    | 3                     | 1    | 0    | 2    | 0    |
| 2    | 3                     | 2    | 0    | 1    | 0    |
| 3    | 4                     | 2    | 0    | 2    | 0    |
| 4    | 2                     | 1    | 0    | 1    | 0    |
| 5    | 2                     | 1    | 0    | 1    | 0    |
| 6    | 3                     | 3    | 0    | 0    | 0    |
| 7    | 1                     | 0    | 1    | 0    | 0    |
| 8    | 3                     | 2    | 0    | 0    | 1    |
| 9    | 3                     | 3    | 0    | 0    | 0    |
| 10   | 0                     | 0    | 0    | 0    | 0    |
| Sum  | 24                    | 15   | 1    | 7    | 1    |
| Mean | 2.4                   | 1.5  | 0.1  | 0.7  | 0.1  |

MC-D: Musculocutaneous from Descending  
SC-D: Subcutaneous from Descending

MC-T: Musculocutaneous from Transverse  
SC-T: Subcutaneous from Transverse

mobilization. Dissection starts with the unroofing of the muscle covering the perforator. The septum is then explored by using a Metzenbaum scissor until we find the vascular branch that perforators come from. Dissecting scissors are inserted into this plane and the muscle above it gently tented up. The perforator can thus be traced from the point it pierces the deep fascia to the point it joins the main pedicle. Once traced to the main branch, the fascia layer covering the pedicle is cut. The main branch distal to the point at which the perforator joins the pedicle can be ligated and divided.

The flap can then be completely islanded. The flap is lifted gently off its bed, presenting the inferior surface of the perforator to the surgeon. The surgeon

lifts the flap gently off its bed with his nondominant hand while the assistant retracts the muscle laterally and inferiorly with retractors. This clearly presents the posterior aspect of the perforators. The pedicle is mobilized proximally and harvested at a point just proximal to descending branch's beginning point, which is the main vessel supplying the flap (Figure 3). To measuring the diameter of artery and vein in origin of vascular pedicle, we used a rhinoplasty caliper and a digital caliper with accuracy of 0.01 mm.

The flap was restored to its place after completion of measurements.

The collected data were analyzed using Microsoft excel 2010 and reported as mean (averages) values.



**Table 3:** Characteristics of vascular pedicle

| Case        | Length of pedicle(cm) | Diameter of Artery(mm) | Diameter of Vein(mm) |
|-------------|-----------------------|------------------------|----------------------|
| 1           | 10                    | 3.1                    | 5                    |
| 2           | 11.5                  | 1.7                    | 2.5                  |
| 3           | 11                    | 3                      | 5                    |
| 4           | 11                    | 3.8                    | 3.1                  |
| 5           | 9                     | 2.3                    | 4.5                  |
| 6           | 10                    | 3.2                    | 3.8                  |
| 7           | 10                    | 2.1                    | 4.1                  |
| 8           | 9                     | 2.8                    | 4.2                  |
| 9           | 10                    | 3                      | 1.9                  |
| <b>Mean</b> | 10.17                 | 2.78                   | 3.79                 |

**Table 4:** Information about distances to ASIS

| Case        | ASIS-Patella<br>(cm) | ASIS-Perforator1<br>(mm) | ASIS-Perforator<br>(mm) | ASIS-Perforator3<br>(mm) | ASIS-Perforator4<br>(mm) |
|-------------|----------------------|--------------------------|-------------------------|--------------------------|--------------------------|
| 1           | 40                   | 16                       | 20                      | 24                       | -                        |
| 2           | 42                   | 18                       | 20                      | 22                       | -                        |
| 3           | 46                   | 21                       | 23                      | 29                       | 31                       |
| 4           | 46                   | 19                       | 27                      | -                        | -                        |
| 5           | 46                   | 20                       | 23                      | -                        | -                        |
| 6           | 47                   | 18                       | 22                      | 27                       | -                        |
| 7           | 43                   | 16.5                     |                         |                          | -                        |
| 8           | 48                   | 18                       | 22                      | 25                       | -                        |
| 9           | 46                   | 16                       | 25                      | 32                       | -                        |
| 10          | 42                   | -                        | -                       | -                        | -                        |
| <b>Mean</b> | 44.6                 | 18.05                    | 22.75                   | 26.5                     | 31                       |
| <b>Mean</b> |                      |                          | 24.57                   |                          |                          |

**Table 5:** Harvesting time

| Case | 1   | 2   | 3  | 4   | 5  | 6  | 7  | 8  | 9  | 10 | Mean |
|------|-----|-----|----|-----|----|----|----|----|----|----|------|
| Time | 105 | 125 | 95 | 115 | 75 | 95 | 60 | 75 | 50 | 58 | 85.3 |

## RESULTS

We had 3 female and 7 male cadavers and worked on 4 Right and 6 Left legs (Table 1).

We found 24 perforators from 10 ALT flaps. The mean of perforator's number was 2.4. In 1 case we did not any perforator and maximum of perforators that we found was 4 perforators in 1 case. Sixteen (66.7%) perforators were musculocutaneous and 8 (33.3%) of them were septocutaneous. Moreover, 22 (91.7%) perforators were from descending branch of LCFA and 2 (8.3%) of them were from transverse branch of LCFA (Table 2).

The mean length of vascular pedicle of flap was 10.17cm. The average diameter of pedicle's artery

and vein were 2.78mm and 3.79mm (Table 3).

The mean distance of ASIS-Patella was 44.6 (40-48cm). The mean distance between the ASIS and perforators was 24.57 cm (Table 4).

The average time for harvesting of flap was 85.3 min and the range of harvesting time was between 50 to 125 min (Table 5).

## DISCUSSION

Reconstruction of head and neck defects is always a challenge for surgeons. Most of these defects were reconstructed with a pedicled skin flap from adjacent areas<sup>9</sup>. In the past two decades, the use of free tissue transfer of microvascular free flaps has become

common. In these flaps, one part of the patients own body is transferred to another region and because the vessels from donor site is transferred to recipient site, we call them ((Free))<sup>10, 11</sup>.

In our review of ALT flap, most of the perforators were musculocutaneous that passed through VL muscle. This finding was similar to Valdatta and Smith<sup>12, 13</sup>. Designing of ALT flap based on musculocutaneous perforators and including a cuff of VL muscle to protect these perforators from damaging during dissection, can be helpful in flap survival. This was mentioned in a study on cadavers<sup>14</sup>. However, septocutaneous perforators also exist in few percent of ALT flaps and because of easier dissection compared to musculocutaneous perforators, their integrity can be assessed during and after flap harvesting. In our study, septocutaneous perforators consisted 33.3% of overall perforators.

Most of the perforators in our study were from descending branch of LCFA and only two perforators were from transverse branch of LCFA. This was similar to another study<sup>15</sup>.

When perforators originate only from descending branch, dissection of flap is easier, because there is no need to extend the dissection to find the transverse branch and so, the flap harvesting procedure will be faster.

The mean length of vascular pedicle in our species was 10.17 cm, which is similar to other studies. For example in a study this value was 11.4 cm<sup>16</sup>. Racial differences, technique of surgery and surgeon's decision during surgery can affect the pedicle length. Racial differences as an influencing factor on vascular anatomy of region is stated<sup>9</sup>.

In our study, the mean diameter of artery of vascular pedicle was 2.7 mm and the mean diameter of vein was 3.79 mm. This diameter of artery and vein make the anastomosis of them to head and neck vessels easier. There is no similar study which evaluates the diameter of vessels of vascular pedicle in ALT flap as a determinant factor on be suitable of them for anastomosis in head and neck area and most of studies evaluate the vascular pedicle length and sometimes the diameter of perforators<sup>17</sup>.

The diameter of vessels of vascular pedicle is important because microvascular anastomosis practices usually done on the vessels with 0.8-1.5 mm diameter on animals and presence of artery and vein with such a diameter can make the anastomosis easier for a trained surgeon<sup>18</sup>.

The mean distance of perforators was 24.75 cm and according to mean distance of ASIS-Patella (44.6 cm), considering the midpoint of ASIS-Patella distance and drawing a circle with 5cm radius around this point, can help in finding the proper perforators.

According to Kimata et al, in 5.4% of designed flaps there were no perforators<sup>15</sup>. In our study, we did not find any perforator in one case. In surgical procedures on patients, in this situations that there is no perforator in anterolateral side of leg, treatment plan can be changed to anteromedial thigh flap or other leg can be used to harvest an ALT flap.

One of the problems we may encounter during flap harvesting is very fatty leg that makes the flap harvesting harder. We had one case with huge and fatty leg that flap harvesting and finding the perforators was harder than other samples.

Another problem that we had during flap harvesting was the presence of femoral nerve adjacent to descending branch of LCFA. The nerve was very close to descending branch in some cases and it was ruptured due to dissection and traction. Lots of studies reported the presence of this nerve adjacent to descending branch and emphasized on carefully dissection in this area to prevent damages to it<sup>4, 12, 19</sup>.

## CONCLUSION

The skin perforators supplying the ALT flap showed significant variability in number, location and course. The cadaveric study could enhance the anatomic knowledge and operative skills of ALT flap harvesting.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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