

Cross-sectional Study

A vascular anatomical study of the anterolateral thigh flap in the Vietnamese's adult cadavers

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ABSTRACT

Background: The aim of this study was to confirm the morphometry of the anterolateral thigh (ALT) pedicle and the location of the perforators in the adult Vietnamese population.

Material and methods: Forty dissections of the thigh were carried out in 20 Vietnamese dedicate cadavers. Including 13 cadavers were fixed by Formalin and 7 cadavers were fixed by fridge. The number, origin, location of the perforators and the diameter of the ALT pedicles were studied and measured.

Results: The length of the thigh was 39.9 ± 2.8 cm. 39/40 cases (97.5%) were a perforator of a 4 cm circle drawn at the midpoint thigh. There were 161 perforators. In 82.7% of perforators were musculocutaneous perforators and 17.3% perforators were septocutaneous perforators. There were 5 types of vascular pedicles. Type 1: the perforators originated from the descending branch were 65%; Type 2: from the oblique branch were 22.5%; Type 3: from the transverse branch were 5%; Type 4: from profunda femoris were 5%; Type5: from femoral artery were 2,5%. The average length of the flap pedicle was 11.6 ± 2.4 cm, the diameter of the artery was 2.51 ± 0.52 mm, the vein was $2.95 \pm 0,56$ mm and $2.18 \pm 0,46$.

Conclusion: The ALT flap is a constant vascular supply, a long pedicle with a suitable diameter for anastomoses. The ALT can be harvest widely and reliable with a perforator of a 4 cm circle drawn at the midpoint thigh.

1. Introduction

The anterolateral thigh flap was the first described in 1984 by Song et al. and the other studies of the other authors [1–3]. All the authors found that the ALT flap was supplied by the perforators arising from the branches of the lateral circumflex femoral artery (LCFA). However, there was a difference between the studies. In the recent years, ALT flap has been widely used for the reconstruction of various defects because the advantage of the ALT flap: A long and large diameter pedicle, low donor site morbidity, large skin paddle and can utilise combination of skin, fat, fascia, muscle. This flap still remains disadvantage: it has variable anatomy of vascular pedicle so difficult dissection. The knowledge of the anatomy of the LCFA is suggested for the clinicians planning surgery. Therefore, we carried this study whose purpose was to confirm the morphometry of the ALT pedicle and the location of the perforators in the adult Vietnamese population.

2. Materials and methods

2.1. Materials

The study was dissected in 40 intact thighs of 20 mature Vietnamese cadavers at the Anatomy Department, Ho Chi Minh City Medicine and Ho Chi Minh Pharmacy University in May 2019. Including 12 male cadavers, 8 female cadavers, average age of 70 ± 16 years (range, 33–95 years) in which 13 cadavers were fixed by using the formalin of 10%, 7 fresh cadavers were firstly fixed in the fridge with the temperature at -30 °C, after that maintained at a temperature at -12 °C to -15 °C when using.

2.2. Methods

Cross - sectional observational study.

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2.3. Process of dissection

The all cadavers were lied supine on the operating table.

A reference line was drawn from the anterior superior iliac spine (ASIS) to superior lateral border of the patella. This line was separated into 10 line segments. Draw the circle having a radius of one line segment at the center of this line.

Divide the skin according to anterior thigh, determine perforators of anterolateral thigh and opposite in skin (Fig. 2).

Restrodissected from perforators to the main pedicle: descending branch (DB), oblique branch (OB) and transverse branch (TB) of the LCFA, after revealing the LCFA to the origin and the profunda femoris (Figs. 1 and 3).

For fresh cadavers, inject Methylene blue to pedicle flaps to determine the area of blue skin (Fig. 4)

2.3.1. Qualitative index

- Origin of LCFA
- Branches of LCFA
- Perforators of ALT flap from transverse branch, oblique branch and descending branch (musculocutaneous perforator or septocutaneous vessels) and another branch.
- Distribution of perforators, determination of location of perforators in thigh by each line segment.

2.3.2. Quantitative index (units: mm, cm)

- Length of thigh (from ASIS to superior lateral border of the patella), length of line segment.
- Length of pedicle flaps:
- Diameter of vascular was determined in the origin of pedicle flaps.
- Area of Methylene blue thigh in fresh cadavers.

3. Result

- The length from ASIS to the superior lateral aspect of the patella was $39,9 \pm 2,8$ cm (from 35 cm to 44,5 cm), mean length of one line segment is 3,99 cm (≈ 4 cm). Therefore, the radius of the circle whose center was the midpoint of the line from the ASIS to the superior lateral aspect of the patella was 4 cm.



Fig. 1. The perforators.



Fig. 2. The positions of perforators were marked in skin.



Fig. 3. Restrodissect from perforators to main pedicle.

3.1. Perforators

- In 40 thighs have 161 perforators. In inclusion, the right side has 83 perforators and the left side has 78 perforators. The numbers of perforators in the thigh are mean of 4,1 perforators (from 1 to 6 perforators), the rate of musculocutaneous perforators is 82,7%, septocutaneous vessel is 17,3% in total of perforators.

In Diagram 1, the perforators mostly concentrated in segments: 5, 6, 7 and 8. In 40 dissected flaps, 39/40 (97,5%) flaps have perforators that located in the central circle. In Diagram 2, the majority of septocutaneous perforators were found in segments: 3, 4, 5 and the majority of musculocutaneous perforators were found in segments: 6, 7, 8.

3.2. Origin of vascular pedicle of flap

- Originating from the LCFA with 37/40 specimens, account to 92,5%.
- Directly originating from the profunda femoris with 2/40 specimens, account to 5%.
- Originating from the femoral artery with 1/40 specimens, account to 2,5%.

Type of vascular pedicle of flap: We have seen 5 types of vascular pedicle of flap:

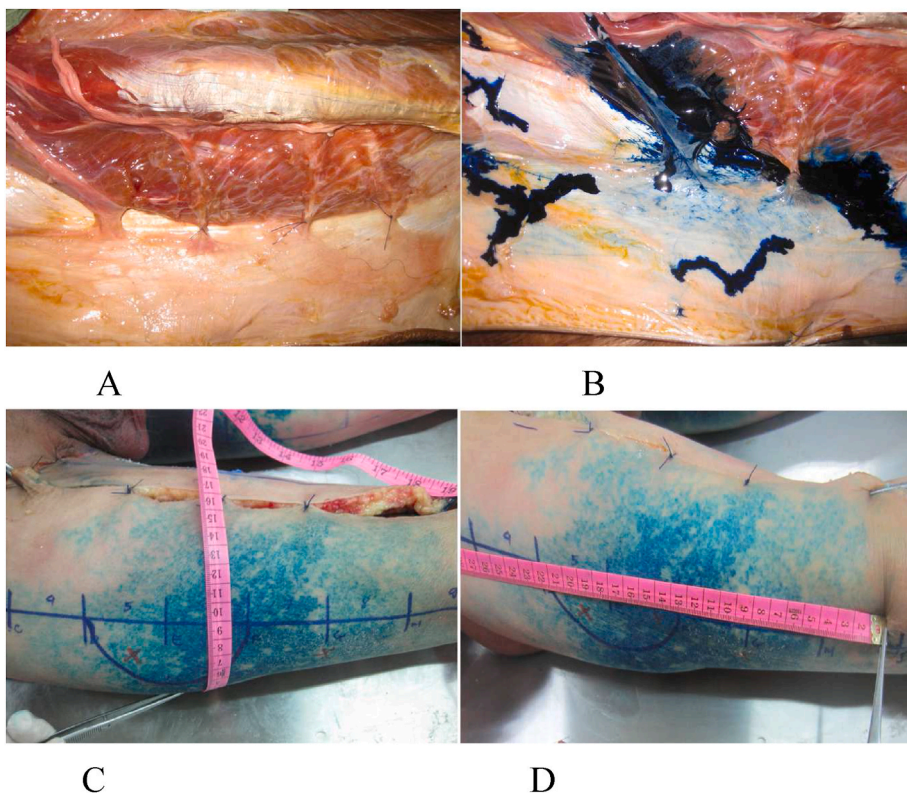


Fig. 4. Inject Methylene blue in to pedicle flaps
 A: Exposed of pedicle
 B: Inject Methylene blue in to pedicle
 C, D: The area of Methylene blue in the thigh.

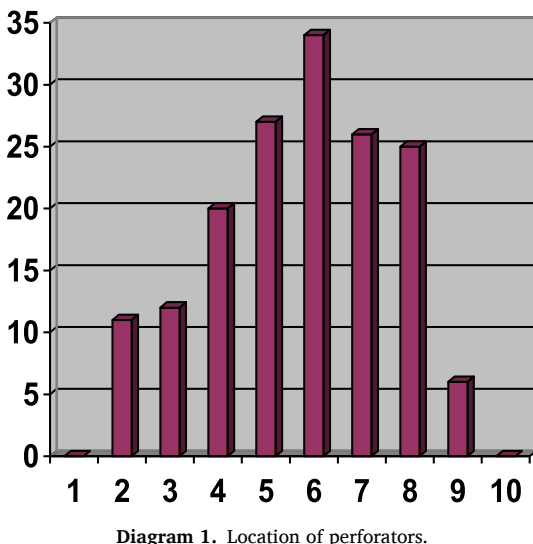


Diagram 1. Location of perforators.

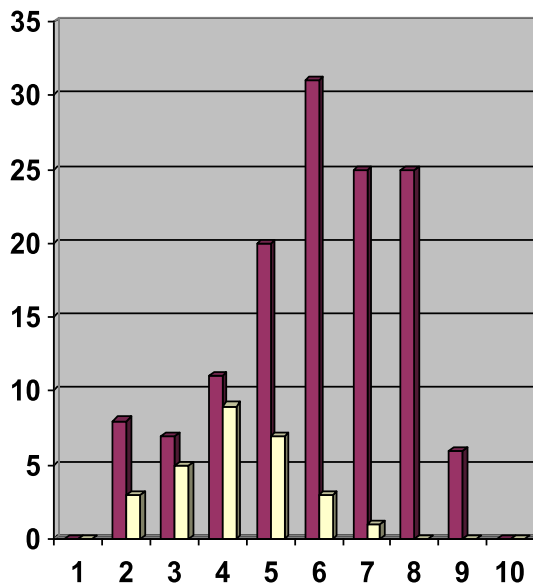


Diagram 2. Distribution of perforators: █ septocutaneous perforators, █ musculocutaneous perforators.

- Type 1: vascular of flap is perforator having origin from the descending branch of LCFA (26/40 specimens, account to 65%).
- Type 2: vascular of flap is perforator having origin from the oblique branch of LCFA (9/40 specimens, account to 22,5%).
- Type 3: vascular of flap is perforator having origin from the transverse branch of LCFA (2/40 specimens, account to 5%).
- Type 4: vascular of flap is perforator having origin from the profunda femoris (2/40 specimens, account to 5%)
- Type 5: vascular of flap is perforator having origin from the femoral artery (1/40 specimens, account to 2,5%).

3.3. Composition, length, diameter of vascular pedicle of ALT flap

Composition of vascular pedicle of ALT flap: Vascular pedicle of ALT

flap having one artery and one vein accounts to 10/40 specimens (25%). There is no abnormal case in composition of vascular pedicle of flap.

Length of vascular pedicle of ALT flap: Vascular pedicle of flap has a length of $11,6 \pm 2,4$ cm (with sample $n = 40$), in which the longest is 16,5 cm and the shortest is 5,7 cm.

Diameter of vascular pedicle of ALT flap: The diameter of artery is $2,51 \pm 0,52$ mm (from 1,8 - 3,7 mm), big vein is $2,95 \pm 0,56$ mm (from 2,2 - 4,6 mm), small vein is $2,18 \pm 0,46$ mm (from 1,2 - 3,2 mm).

The area of Methylene blue in the thigh has the length of $22,86 \pm 3,65$ cm (from 16 to 29 cm), the width of $12,43 \pm 1,91$ cm (from 10 to

15 cm).

4. Discussion

The type of perforator: In the perforator flap classification, there were 3 types of perforators: direct cutaneous perforator, musculocutaneous perforator and septocutaneous perforator. The ALT flap was first reported in 1984 by Song and co-authors as a septocutaneous perforator – based flap (all perforators of the ALT flaps were septocutaneous perforators) [4]. However, in the later studies, the ratio of musculocutaneous to septocutaneous perforators had changed much. Xu et al. (1988) reported that 60% perforators supplied blood for ALT flaps were musculocutaneous perforators and 40% perforators were septocutaneous [5]. Some other studies even reported the higher ratio of musculocutaneous perforators; example: Kuo YR et al. (2001), 86.4% musculocutaneous perforators and 13.6% septocutaneous perforators [3]; Wei FC et al. (2002), 87.1% musculocutaneous perforators and 12.9% [6]. In our study, 82.7% perforators were musculocutaneous perforators and 17.3% were septocutaneous perforators.

The average number of perforators per flap: Choi et al. (2007), 4.2 perforators per thigh [7]; Tansatit T. et al. (2008), 2.8 perforators per thigh [8]. The present study found 4 perforators per thigh.

The location of the perforator: Wei FC et al. (2002) determined the location of the perforator near a 3 cm radius circle drawn at the midpoint of a line connecting the ASIS and the superior lateral aspect of patella [6]. With a 3 cm radius circle, Xu et al. (1988) found the perforator in 92% cases [5]. With a 5 cm radius circle, Yildirim et al. (2003) found the perforator in 100% cases [9]. Valdatta et al. (2002) found the perforator in 96% cases [10], Malhotra et al. (2008) found the perforator in 96% [11]. Wolff et al. (1992) reported that there was always a perforator in a 4 cm radius circle [12]. Our present study findings were similar to several above authors. In a circle drawn at the midpoint of a line connecting the ASIS and the superior lateral aspect of patella with a radius was 1/10 of the length of thigh (the average radius was 4 cm), we found the perforator in 97.5%.

The type of the pedicle: The ALT flap was blood supplied by the perforators that mostly arose from the descending branch and the transverse branch of the lateral circumflex femoral artery. Besides that, the minority of perforators arose from the femoral artery, superficial femoral artery and profunda femoris artery. Shieh SJ et al. (2000) reported that perforators arose from the transverse branch in 32.4% cases (27% musculocutaneous perforators and 5.4% septocutaneous perforators) and from the descending branch in 67.6% (56.8% musculocutaneous perforators and 10.8% septocutaneous perforators) [2]. Kimata et al. (1998) reported 8 types of pedicle; in type 1, 2, 3: perforators arose from descending branch in 59/70 flaps (84.3%); in type 4, 5, 6: perforators arose from transverse branch in 9/70 flaps (12.9%); in type 7: perforators arose from profunda femoris artery in 1/70 flaps (1.4%); in type 8: perforators arose from femoral artery flaps (1.4%) [1]. In our study, we saw 5 types of the pedicle. Type 1: the perforators originated from the DB in 26/40 cases (65%); Type 2: the perforators originated from the OB in 9/40 cases (22.5%); Type 3: the perforators originated from TB in 2/40 cases (5%); Type 4: the perforators originated from profunda femoris artery in 2/40 cases (5%); Type 5: the perforators originated from the femoral artery in 1/40 cases (2.5%). Therefore, the majority of perforators arose from the DB and OB (in 87.5%). Our study findings were similar to several authors, Kimata, Shieh S.J.

The length of the pedicle: Wei et al. reported that the pedicle length was from 8 to 16 cm in which the artery had the average diameter of 2.1 mm and the vein had the average diameter of 2.3 mm [6]. The present study reported that the average length of the pedicle was 11.6 ± 2.4 cm (5.7–16.5 cm), the average diameter of the arteries was 2.51 ± 0.52 mm (1.8–3.7 mm). Usually the pedicle had one artery accompanied by two veins in 30/40 cases. The pedicle had one artery and one vein in 10/40 cases. The average diameter of the smaller veins was 2.18 ± 0.46 mm (1.2–3.2 mm). The average diameter of the bigger veins was 2.95 ± 0 ,

56 mm (2.2–4.6 mm). So, the ALT flap had a long pedicle length with big vessel diameter that was suitable for anastomosis.

The size of the flap: Koshima reported that the ALT flap was harvested with the 35 cm maximum length and the 25 cm maximum width [13]. In medical literature searching, the maximum length of the ALT flap was 38 cm. In our study, through Methylene blue injection into the pedicle to identify the blood supply, the length area of Methylene blue in the thigh ranged from 20 to 27 cm and the width ranged from 12 to 15 cm, the maximum size of area of Methylene blue in the thigh was 27×15 cm.

5. Conclusion

The average length of the thigh was 39.9 ± 2.8 cm. In 97.5% of the dissections, the perforators concentrated within a 4 cm radius circle drawn at the midpoint of a line connecting the ASIS and the superior lateral aspect of patella. 82.7% of perforators were musculocutaneous perforators and 17.3% of perforators were septocutaneous perforators. The perforators mostly originated from the DB in 65%, from the OB in 22.5%. The average length of the ALT flap pedicle was 11.6 ± 2.4 cm, the average diameter of the artery was 2.51 ± 0.52 mm and the average diameter of the bigger vein was 2.95 ± 0.56 mm. The maximum size of Methylene blue in the thigh was 27×15 cm.

Ethical Approval

Ethical approval was obtained from institutional review board of local faculty and the participating hospital.

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Author contribution

Ngo Thai Hung: study concept, data collection, data interpretation, and writing the paper.

Le Van Doan: data collection, data interpretation and writing the paper.

Vu Huu Trung: data interpretation and writing the paper.

Nguyen Van Cuong: data interpretation and writing the paper.

Consent

None.

Registration of Research Studies

Name of the registry:

Unique Identifying number or registration ID:

Hyperlink to your specific registration (must be publicly accessible and will be checked):

Guarantor

Ngo Thai Hung.

Le Van Doan.

Declaration of competing interest

The authors declare that there is no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2022.103416>.

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