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Brief communication (Original)

Determining safe entry sites for filler injections on the lateral canthal vertical line: anatomical study of the midface arterial perforators in soft embalmed cadavers

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Background: Filler injections are frequently associated with vascular complications.
Objectives: To investigate the course and location of the middle-midface perforators to establish safe cannula entry sites for filler injections.
Methods: The middle-midface was studied using 28 hemiface specimens from soft embalmed Thai cadavers at the Faculty of Medicine, Chulalongkorn University. Investigations were performed following injection of red latex.
Results: Middle-midface perforators were classified into 3 groups according to their origin. These perforators originated from the buccal branch of the facial artery (57%); the parotid artery (25%); or directly from the facial artery (18%). The distance between the buccal artery perforator (level with the upper alar crease) and the lateral canthal (Y axis) line was 2.6 (SD 6.0) mm and Frankfort's horizontal (X axis) lines was –16.4 (5.4) mm. The distance between the parotid artery perforator and the lateral canthal vertical line was 4.2 (10.8) mm and Frankfort's horizontal line was –13.9 (3.4) mm. The distance between the facial artery perforator and the lateral canthal vertical line was 11.2 (10.8) and Frankfort's horizontal line was –16.0 (5.3) mm.
Conclusions: A single long perforator was identified along the lateral canthal vertical line. This most commonly originated from the buccal branch emerging from the facial artery. Therefore, we recommend a cannula be inserted at the Beut site 2 cm inferolateral to the lateral canthus. This injection site is recommended as a safe to avoid injury to the middle-midface perforator.

Keywords: Facial artery perforator, filler injection technique, injectable filler complications, midface volumization

Using injectable fillers for facial rejuvenation is a new concept that has become a well-accepted standard in aesthetic practice. Many people give precedence to their appearance and wish to have an expressive and youthful appearance. Understanding the cause of facial aging has improved. Facial aging is associated with a facial tissue volume deficit from the craniofacial skeleton, fat, or skin. Loss of volume in the midface results in many changes that are associated with the facial aging process. The tear trough and lid–cheek junction become more visible, while the malar region flattens and descends. Dermal filler injection is a nonsurgical cosmetic procedure and is available at a reasonable cost. It can minimize wrinkles or creases within the facial skin effectively and apparent rejuvenation is achieved as a favorable outcome [1-4].

There is a cannula entry site for filler injection at the midface recommended by Beut that can restore the facial defect resulting from aging. In clinical practice, filler techniques have been improved by using an entry point 2 cm inferolateral to the lateral canthus as a soft tissue landmark to improve the prezygomatic space and the lateral part of the zygoma [2].

There are frequently vascular complications associated with this filler injection such as bruising, swelling, and ecchymosis [5]. These are not fatal complications, but they remain clinically important as they can result in patient dissatisfaction and social embarrassment [6]. These complications may involve the perforator artery, which is the major supply in each skin region, which may become injured by the entry site of the needle [7].

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Previous studies have focused on perforators in several regions of the face such as the nasolabial, perioral, and superficial temporal regions, where reconstructive flaps are applied [7-10]. None of these studies have investigated perforators in relation to filler injections. To our knowledge, there are no existing studies that have investigated the middle midface region. Therefore, we have focused on the middle part of the midface. Knowledge of the anatomy of the midface perforators is necessary to achieve an optimal and safe outcome for clinical manipulations during injectable treatments in the midface.

The objectives of this study were to locate the middle midface perforators and investigate their anatomical features. We sought to achieve this by accurately locating the site associated with the lateral canthal vertical line and Frankfort's horizontal line at 4 differing levels (the upper and lower alar crease, the oral commissure, and perforator origin). This information will help plastic surgeons to ascertain the location of the middle midface perforators, so that vascular complications caused by accidental injections during the filler procedure can be avoided.

Materials and methods

This study was exempted from full review by the Institutional Review Board (IRB) ethics committee at the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (certificate of exemption No. 023/2015; IRB No. 607/58). Written informed consent for publication of photographs was obtained from the nearest living relatives and the living model. We dissected 28 hemiface specimens (14 men, 14 women) of soft embalmed Thai cadavers in the Chula Soft Cadaver Surgical Training Center of the Faculty of Medicine, Chulalongkorn University and King Chulalongkorn Memorial Hospital. The average age of these cadavers at death was 78 years ranging from 47 to 92 years. Red latex was injected into the entire specimen before dissection to display contrast within anatomical structures.

We dissected 28 facial arteries after vascular injection to study the middle midface perforators and their distance from the standard axis, diameter, depth, length, and pattern. The middle midface was considered as the area between the midpupillary line and the vertical line at the anterior end of the zygomatic arch.

First, a descending vertical incision was made at the center of the face (from the forehead to the mentum) and 2 incisions perpendicular to this initial incision were also made: one extending from the palpebral fissure towards the auricle, and the second from the oral commissure to the lateral side of the face (**Figure 1**). Subsequently, the skin was reflected in as thin a layer as possible, to retain terminal perforators, which were visible at the subcutaneous layer. The perforators were identified and cleaned to their termini. Care was taken to avoid damage to these arteries. We classified 3 types of perforators according to their main arterial origin: the *buccal artery perforator* originating from the buccal branch of the facial artery before it supplies the buccinator, the *parotid artery perforator* originating from the parotid artery in the parotid gland that branches from the external carotid artery, and the *facial artery perforator* originating directly from the facial artery.

At the midface, the pattern in which the perforator was located was compared relative to the lateral canthal vertical line and perpendicularly to Frankfort's horizontal line. The diameter and depth of the middle midface perforator from the skin to its origin and length from the main branch to its terminal were also measured. The distance between the perforator to the standard axes was also measured. The X axis has been established as the Frankfort's horizontal line, whilst the Y axis as the lateral canthal line (**Figure 2**).

The origin and distance of the perforator from the X and Y axes using 4 (X, Y) coordinates were measured. The first marked at the perforator's origin (X_0, Y_0), the second at the oral commissure (X_1, Y_1), the third at the lower alar crease (X_2, Y_2), and the fourth at the upper crease (X_3, Y_3) respectively (**Figure 2**).

Statistical analysis

We compared differences between the sexes using a Student *t* test for normally distributed data, and a Mann–Whitney *U* test to examine the distribution of abnormal perforators. Results are reported as means (standard deviation, SD). We considered $P < 0.05$ to be significant.

Results

We found that the main arteries providing the long perforators ran within the subcutaneous fatty tissues and were also superficial, ascending parallel to the lateral canthal vertical line and terminating near the lower eye lid to supply the muscles and skin in firmly attached areas of the face, so that gliding was either prevented or reduced.

The perforators can be divided into 3 categories depending on the main arteries from which the perforators originate (**Table 1**) (**Figure 3**). The buccal artery perforator (Type I) could be found in most hemiface specimens, and the perforators originated from the buccal branch of the facial artery. The parotid artery perforator (Type II) originated from the parotid artery, and was found in about a quarter of the hemiface specimens. The facial artery perforator (Type III) arises directly from the facial artery, and was found in less than 20% of 28 hemiface specimens. The diameter of the arteries is shown in **Table 2**.

The buccal artery perforator was located in the cheek region and crosses 3 levels from its origin to the oral commissure, lower alar crease, and level of the upper alar crease. The distance from its origin in relation to the lateral canthal line and Frankfort's horizontal line is shown in **Table 2** (**Figure 4A**). The distance at the level of the oral commissure, lower alar crease, upper alar crease, and various diameters and depths are shown in **Table 2**.

The parotid artery perforator, has its origin located above the oral commissure level; consequently, this perforator crossed 2 levels from its origin to the lower alar crease and upper alar crease level. The distance from its origin in relation to the lateral canthal vertical line and in relation to Frankfort's horizontal line (axis Y_0) are shown in **Table 2** (**Figure 4B**). The distance at the level of the lower alar crease (axis X_2) and axis Y_2, the upper alar crease level (axis X_3) and axis Y_3, diameter, length, and depth of this perforator are shown in **Table 2**.

The facial artery perforator crossed 3 levels from its origin to the oral commissure, lower alar crease, and upper alar crease. The distance from its origin in relation to the lateral canthal line (axis X_0) and Frankfort's horizontal line (axis Y_0) are shown in **Table 2** (**Figure 4C**). The distance at the level of the oral commissure, the lower alar crease level (axis X_2), and the upper alar crease level (axis X_3), diameter, length, and depth of this perforator are shown in **Table 2**.

Table 1. Origin patterns of the perforators at the middle midface region

Type / Sex/ side	I. Buccal artery		II. Parotid artery		III. Facial artery	
	n	%	n	%	n	%
Male	9	64	4	29	1	7
Female	7	50	3	21	4	29
Left	7	50	3	21	4	29
Right	9	64	4	29	1	7
Total	16	57	7	25	5	18

Table 2. Anatomical measurements of the middle midface perforators

Measurements	Buccal artery perforator mean (SD) mm	Parotid artery perforator mean (SD) mm	Facial artery perforator mean (SD) mm
Distance of the perforator at the upper alar crease			
X_3	2.6 (6.0)	4.2 (10.8)	11.2 (10.8)
Y_3	–16.4 (5.4)	–13.9 (3.4)	–16.0 (5.3)
Distance of the perforator at the lower alar crease			
X_2	1.0 (8.7)	7.4 (9.4)	8.4 (13.2)
Y_2	–33.0 (4.5)	–27.3 (7.2)	–27.4 (2.9)
Distance of the perforator at the oral commissure			
X_1	–4.2 (7.4)	–	7.3*
Y_1	–57.8 (5.9)	–	–52.8*
Distance of the perforator at its origin			
X_0	–2.8 (11.0)	21.1 (7.2)	7.7 (10.6)
Y_0	–57.1 (9.2)	–32.4 (11.5)	–54.7 (13.3)
Diameter of the perforator at the origin	0.9 (0.2)	0.8 (0.3)	0.7 (0.1)
Length of the perforator	72.3 (18.7)	58.6 (13.5)	72.0 (12.5)
Depth of the perforator at the origin from the skin	4.1 (1.0)	4.2 (1.4)	4.7 (2.0)
Diameter of the main artery	1.1 (0.3)	1.1 (0.4)	1.3 (0.4)

***No standard deviation**

We found that the buccal branch always runs close to the lateral canthal line vertically to supply the lower eye lid in approximately 75% of the specimens. The parotid artery perforator has only one branch in the left hemiface, which runs to supply the lower eye lid. This perforator does not run parallel to the lateral canthal vertical line. The parotid artery perforator deviates because there were 4 branches running across the lateral canthal line at the lower alar level in 4 of 7 specimens. There were 2 facial artery perforators crossing the lateral canthal line between the lower eye lid and tip of the nose level. The diameter of the buccal branch shows a significant sex difference (P = 0.018), the buccal branch diameter in men was larger than in women. However, the buccal artery perforator diameter in men was significantly larger than it was in women (P = 0.019). **Table 2** shows the standard deviation of distance X is greater than the mean of distance X because it was defined by vectors when compared with the lateral canthal vertical line (LCVL). If the perforator is medial to LCVL, it was defined as negative. If it was lateral to LCVL, it was defined as positive. There were both negative and positive perforators present. Accordingly, distance X has a wide distribution. Moreover, the mean distance X is not great because the data was calculated using vectors.

Figure 1. The incision line was made vertically down the center of the face, and 2 incisions were made perpendicular to this initial incision.

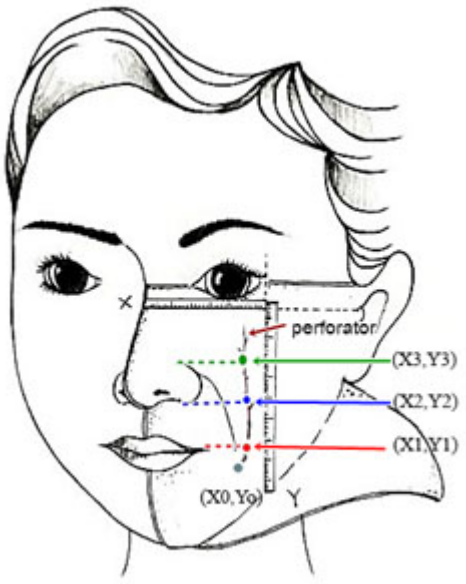

Figure 2. Measurement of the distance of the perforator to the standard axis. The X axis as the Frankfort's horizontal line, the Y axis as the lateral canthal line.

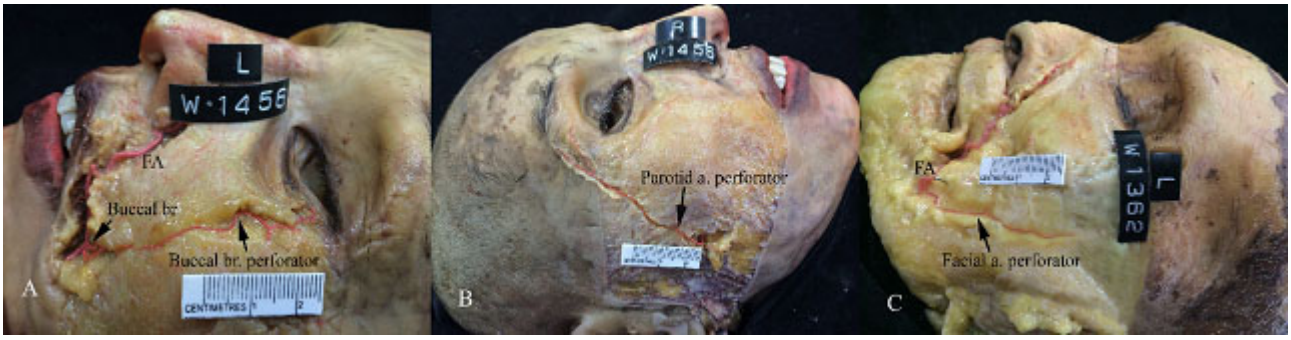

Figure 3. The 3 types of middle midface perforators according to their main arterial origin. **A:** Buccal artery perforator, **B:** Parotid artery perforator, and **C:** Facial artery perforator branches from facial artery (FA). With written permission from the nearest living relatives for publication of these photographs in this article.

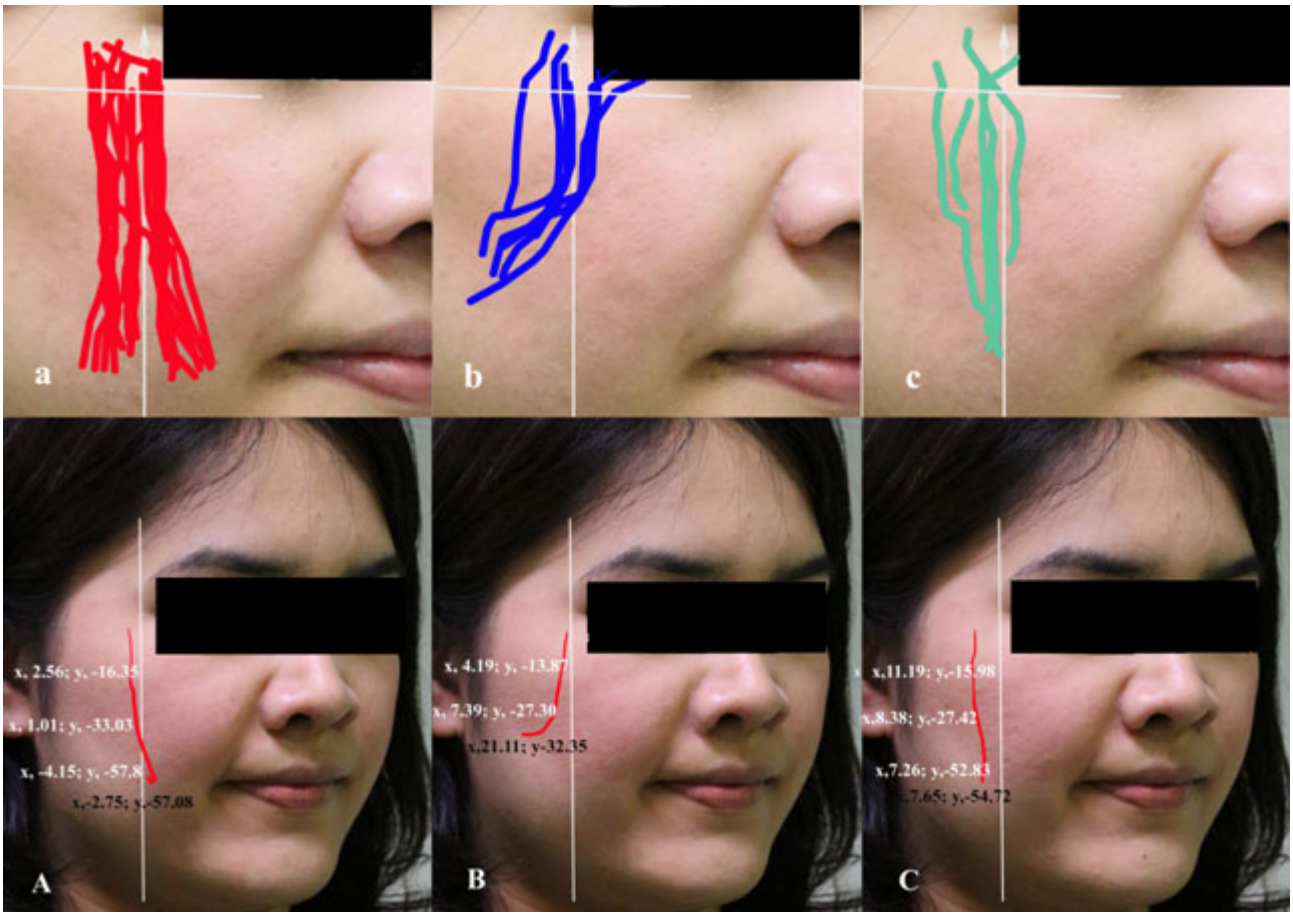

Figure 4. Location of the 3 types of perforator arteries. On the upper panels, we show all the middle midface perforators on a standard face (a) 16 specimens, type I or buccal artery perforator, (b) 7 specimens, type II or parotid artery perforator, (c) 5 specimens, type III or facial artery perforator. On the lower panels, we show the mean location of the 3 types: A: buccal artery perforator, B: parotid artery perforator, and C: facial artery perforator within 4 levels (origin of the perforator, oral commissure, lower alar, and upper alar). The X axis is Frankfort's horizontal line; and the Y axis is the lateral canthal line. With written permission from the model to publish these photographs.

Discussion

Previous studies have failed to investigate perforators along the lateral canthal line, although studies that have investigated perforators in other areas exist. These previous studies have been associated with reconstructive flaps in the near regions, such as the perioral and the nasolabial regions. They studied the number, diameter, and length only. Ng et al. [11] studied facial artery perforators in the nasolabial region and found that the average number of these perforators was 4 (SD 2), the average length was 14.1 (SD 3.5) mm and the average diameter was 0.9 (SD 0.2) mm. Hofer et al. [7] studied the perforators in the perioral region, and showed that facial artery perforators were distributed in a large range of from 3 to 9 per facial artery. The average perforator length was 25.2 mm (range, 13 to 51 mm). The average perforator diameter was 1.2 mm (range, 0.6 to 1.8 mm). Qassemyar et al. [9] studied the nasolabial sulcus perforator that branched from the facial artery and above to the mandible. In their study the average length of the nasolabial perforator was 12.06 cm. The average number of perforators greater than 0.5 mm per facial artery was 5.05. The mean diameter of the perforators was 0.96 mm.

The present study investigated the course and anatomical features of the perforator arteries along the lateral canthal vertical line. By contrast with previous studies, we found the number of middle midface perforators was less than the perforators in the nasolabial and perioral regions. We found only one perforator in the middle midface along the lateral canthal vertical line. The mean length of the middle midface perforator was longer than the perforators in the nasolabial or perioral region. Our study revealed the mean diameter of middle midface perforator was smaller than that previously reported from studies of European cadavers. This suggests that ethnicity may be associated with the size of these perforators.

Considering the cannula entry site at 2 cm inferolateral to the lateral canthus recommended by Beut, this entry site approximates at the upper alar level in our study, and is 2 cm distant to the lateral canthal vertical line. We conclude that this recommended injection site can reduce the risk of injury to the middle midface perforator because our results show that the buccal artery and parotid artery perforators constitute the majority of the perforators in the middle midface region. They were located proximal to the lateral canthal vertical line. In addition, we found only one facial artery perforator from a total of 28 middle midface perforators that were located laterally to lateral canthal line by about 2.1 cm (**Figure 4C**). Therefore, we consider that this cannula entry site is safe and its use poses a low risk of injury to the middle midface perforators.

We performed dissections on the cadavers focusing only on the middle of the midface along the lateral canthal line. We consider that this line is important for filler injections in the midface because clinicians can have access to a wider area of the midface compared with other injection points. A limitation of this study was that we focused our locations primarily at 4 levels (origin, oral commissure, lower alar crease, and upper crease). Future studies should expand the area to cover the entire midface.

Conclusion

The middle midface perforator is a single long perforator artery along the lateral canthal vertical line, which stems most abundantly from the buccal branch of the facial artery. It has the largest diameter and is the longest compared to the other 2 types. The cannula entry point recommended by Beut at 2 cm inferolateral to lateral canthus is a safe injection by which to avoid injury to the middle midface perforator.

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Conflict of interest statement

The authors declare that there is no conflict of interest in this research.

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