Morphometrical Aspect on Angular Branch of Facial Artery

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Abstract: Anatomic variability and anastomosis of the angular artery of the facial artery with the other arteries are important for both anatomists and surgeons. In particular, the angular artery is a significant landmark in dacryocystorhinostomy. Because of variations on anatomy of the angular artery, there are limited numbers of anatomic studies on the flaps of facial region. Hence, the aim of the cadaveric study was to evaluate the anatomic features of the angular artery in detail to help surgical procedures.

The artery was represented under ×4 loop magnification in 32 sides of 16 formalin-fixed adult cadavers. The angular artery's position, diameter, and branch patterns relevant to the nose arterial supply were evaluated. The facial artery ended symmetrically in 10 (62.5%) of the cadavers. The facial artery was terminated as angular artery in all of the cases. The types of the angular artery were as follows: classical angular type in 8 cases (25.0%), nasal type in 15 cases (46.9%), alar type in 4 cases (12.5%), and labial type in 5 cases (15.6%) on the facial halves. We studied the topographic anatomic features of the angular artery for increasing reliability of the flaps on the region. The angular arterial anatomic details are critical and essential for surgical cosmetic and functional results.

Key Words: Angular artery, anatomy, flap, reconstruction

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The nasal region is frequently injured by trauma, malignant disease, congenital anomalies, and other nose pathologies. The major treatment methods of these pathologies are surgical approaches. Anatomic features of the angular artery (AA) are of importance for the surgical approach of these pathologies. The facial artery (FA) gives branches to the neighboring muscles and skin of the facial region. After the superior labial artery, the FA ends as a terminal branch called as AA.[1] Variation of AA should also be considered during planning flaps. For example, the forehead flap could be used safely and effectively to repair the large external nasal defects. For successful performances on invasive procedures of the nose and related structures, it is essential to be aware of the underlying vascular anatomy.[2–4] The arterial anastomoses of the related region are also important for surgical safety. On the basis of our anatomic observations and definitions from relevant literature, varied surgical procedures may be designed with detailed anatomic knowledge on the arterial structure of the facial region.[2–5] The apprehension of the AA leads to a safe and more effective surgical procedure for the restoration of the nose or facial defects. However, in the literature, there is a lack of detailed anatomic description on the AA. The aim of the study was to perform a detailed analysis on the origin, the location, size, course, connection patterns, and distributions, as well as surrounding relationships of the AA.

MATERIALS AND METHODS

Dissections were carried out from superficial to deep levels through tangential dissection of skin, subcutaneous fat, and muscle layers. The distribution of the FA and its angular branch was investigated for each cadaver. The vascular anatomy of the nasal dorsum and paranasal region was revealed under ×4 loop magnification in 32 sides of 16 (2 women, 14 men; age range, 49–80 y) formalin-fixed adult cadavers. A Vernier caliper (1/20 mm; Kanon Instruments, Tokyo, Japan) was used to record all measurements. None of the dissected cadavers had a history of trauma, congenital facial malformation, and surgery. The distribution of the FA and its angular branch was investigated for each cadaver through tangential dissection of skin, subcutaneous fat, and muscle layers step by step (Figs. 1–3). After the division point of the superior labial branch of FA, the course of the AA along the nasolabial fold was accepted as the classical angular type of AA. If the course was along the inferior margin of nostril on its ascent toward the columellar base, it was called as the alar type of AA. The nasal type of the AA course was along the superior margin of nostril on its ascent toward the dorsum nasi. The labial type of the AA course was along the inferior margin of nostril on its ascent toward the upper lip. The hypoplastic type of AA was rudiment form. The evaluating parameters of the AA were as follows: (1) the location, (2) the origin, (3) the diameter of the artery at its origin and also ending pattern, (4) the length of the artery at its origin, (5) anastomosing pattern and its branches, (6) the localization features of the artery according to neighboring structures, as well as (7) the distance between the origin point of the artery and significant surgical landmarks of the region.

RESULTS

The FA ended symmetrically in 10 (62.5%) of the cadavers. The FA was terminated as AA in all of the cases. The types of the AA were as follows: classical angular type in 8 (25.0%) cases, nasal type in 15 cases (46.9%), alar type in 4 cases (12.5%), and labial type in 5 cases (15.6%) on the facial halves. We did not observe a hypoplastic type of the AA. The course of the artery was predominantly linear, although tortuosity was common in the proximal segments of the artery. The AA anastomosed with the dorsal nasal artery in all of the cases. The AA also anastomosed with the inferior medial palpebral

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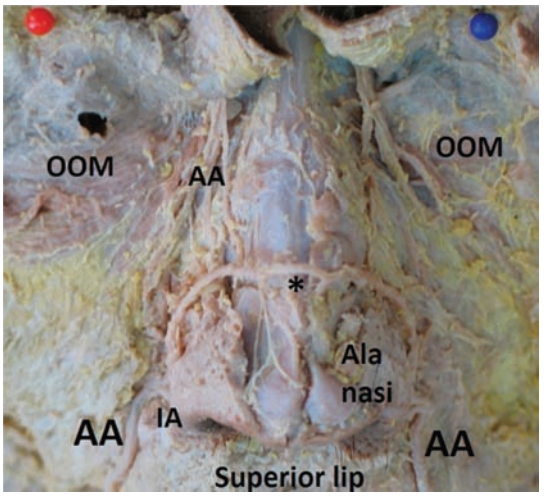


FIGURE 1. Symmetric appearance (indicated by asterisk symbols) of the AA and its relation on the neighboring structures. IA indicates inferior alar branch; OOM, orbicularis oculi muscle.

arteries in 24 cases (75%), the supratrochlear artery in 6 cases (18.8%), and the infraorbital artery in 5 cases (15.6%). A detailed anatomic evaluation on the AA of the cadavers is given in Table 1. The anatomic features of the nasal region on the cadavers are shown in Figures 1 to 3.

DISCUSSION

The nasal region is frequently affected by malignancies, trauma, and congenital anomalies. Regional anatomy is important for surgeons during the reconstruction of nasal defects so that successful functional and aesthetic outcomes could be acquired.[4] Traumatic AA aneurysms are not common. However, the arterial anatomy of the facial region has crucial importance during the coagulation of peripheral aneurysms using intralesional obliteration methods, arterial ligation, or percutaneous contrast agent infusion during

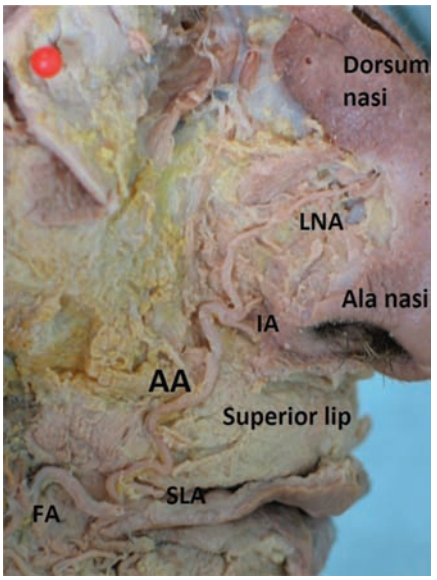


FIGURE 2. Arterial branching pattern of the nasal region. IA indicates inferior alar branch; LNA, lateral nasal artery; SLA, superior labial artery.

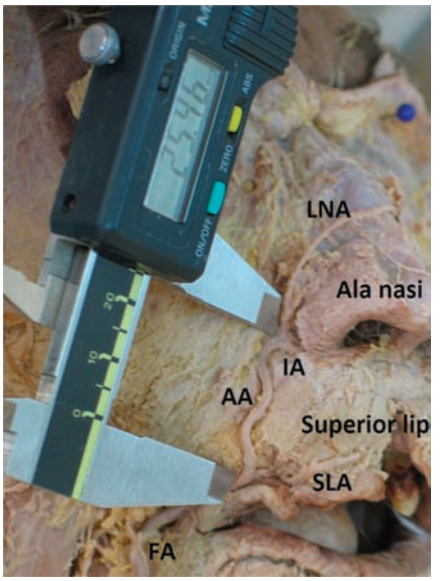


FIGURE 3. Demonstration on the AA while measuring the cadaver. IA indicates inferior alar branch; LNA, lateral nasal artery; SLA, superior labial artery.

imaging.[6] Tip, alae, and dorsum defects of the nose after basal cell or squamous cell carcinomas, malignant melanoma resection, and the like were reported by several authors.[7,8] Nasolabial island flap might be considered where the defect was placed on the course of AA during reconstruction of the lower nose and medial cheek defects.[9] Brunetti et al[10] claimed that, although FA perforator flaps had been popularized for the reconstruction of perioral, perinasal, and nasal defects, to date, the clinical use of AA perforator flaps had never been reported. They mentioned that the reliability of the AA perforator flap in case of reconstruction of small to moderate size defects involves medial canthal and upper nasal sidewalls subunits. They preferred to start dissection at the medial border of the flap lying in the nasolabial fold. According to the literature, the occurrence of course variations or absences of the artery were reported.[11,12]

Clinically, anatomic variation and anastomosing pattern of the facial arteries and their branches must be recognized to obtain flap success.[11]

Saban et al[12] evaluated the nasal arterial vasculature by Doppler ultrasound to find out an arterial tree. Anatomic variability of the artery may be characterized through the absence of the facial-to-angular artery continuation. Vasilic et al[3] claimed that absence of the facial-to-angular artery continuation occurred in 28% of hemifaces. In contrast, the facial-to-angular artery continuation existed on each of the cadaver in the current study. Hou et al[2] dissected 22 hemifaces derived from 11 formalin-fixed cadavers and described observation on variations of the AA regarding the distribution patterns. They claimed that the course of the AA along the nasojugal fold was constant. The artery gave its branches into the upper two thirds of the lateral nasal region and anastomosed with the other vascular branches on the dorsal nasal region. Differerent from the anatomic terminology, Pinar et al[13] described many types of the terminal branches of the FA named as *angular facial*, *nasal facial*, *alar*, *superior labial*, and *hypoplastic* branches. They declared that the FA was asymmetric in 32% of 25 heads. It terminated as angular facial branch in 22%, as nasal facial branch in 60%, as alar branch in 12%, as superior labial branch in 4%, and as hypoplastic branch in 2% facial halves. In contrast to the study, the classical anatomic textbook noted that, after division of the superior labial artery, the FA was named as the AA. Sometimes, the FA did not reach the

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TABLE 1. Morphometrical Data on AA and Its Lateral Nasal Branch and Muscular Branch to OOM

	Right			Left		
Parameters of AA	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Distance between anastomosing point of AA with STA and lateral palpebral ligament	50.0	51.0	50.5	54.0	55.0	54.5
Distance between anastomosing point of AA with STA and medial palpebral ligament	20.0	21.0	20.3	20.0	25.0	23.7
External diameter of AA (after dividing SLA)	0.5	1.4	1.0	0.6	1.3	1.0
Length of AA	28.0	53.0	44.8	27.8	53.4	44.4
Length of AA between origin points of SLA and IA	18.4	32.0	26.3	18.2	32.4	25.5
Distance from labial commissure to the origin point of AA (lateral)	3.0	17.0	9.4	3.0	19.0	10.0
Distance from labial commissure to the origin point of AA (superior)	7.0	25.0	13.6	6.0	23.0	12.6
Distance between the origin point of AA and glabella	59.0	85.0	75.2	61.0	83.0	75.0
Distance between the ending point of AA and glabella	57	83	70.4	55	82.1	70.3
Distance between the ending point of AA and medial canthus	43.0	65.0	57.2	53.0	66.1	59.3
Lateral nasal branch						
Diamater at origin point	0.8	1.4	1.0	0.8	1.4	1.0
Length	12.0	14.4	13.2	11.0	14.5	12.7
Distance between the junction point of infero-lateral nasal alar commissure of nose and origin point of lateral nasal branch of AA	11.0	24.0	15.7	13.1	27.0	14.1
Diamater at origin point	0.4	0.5	0.5	0.3	0.5	0.5
Length	6.3	8.5	7.8	6.4	9.0	8.1
Distance between junction point of infero-lateral nasal alar commissure of nose and origin point of Muscular branch of AA to OOM	10.0	20.0	15.3	10.2	20.0	15.3

IA, inferior alar branch; Max, maximum; Min, minimum; OOM, orbicularis oculi muscle; SLA, superior labial artery; STA, supratrochlear artery.

medial orbital angle in 42% and may end superior or inferior labial arteries as a variation.[14] A new denomination of authors is not consistent regarding the ordinary anatomic knowledge. In addition, Pinar et al[13] declared that the angular facial branch anastomosed between the superficial ascending artery and the inferior alar branch. Also, the AA anastomosis with the inferior periorbital arteries had been demonstrated by Edizer et al.[15] They also pointed out that the alar branch existed in 79% of 28 halves. Koh et al[16] found that 54.5% (24/44) of the FA had symmetric distribution. Half of the FA (12/24) ended as the AA, 45.8% (11/24) of them ended as the lateral nasal artery, and 4.2% (1/24) of them ended as the inferior labial artery. Furukawa et al[17] investigated anatomic variations of the FA according to its termination pattern. Accordingly, if the FA ended proximal to the superior labial artery, it was named as type 1; if the FA terminated distal to the superior labial artery near the nasolabial fold, it was named as type 2; as a classical course, if the FA extended to the lateral nasal-alar or the angular branch, it was named as type 3; if the FA showed duplex with a dominant lateral angular branch, it was named as type 4. Loukas et al[18] examined 284 hemifaces derived from 142 formalin-fixed cadavers and declared a detailed observation of variations on the FA regarding the distribution patterns categorized into 5 types (A–E): type A (47.5%), the FA bifurcated into the superior labial and the lateral nasal (the latter gives off an inferior and a superior alar and ends as the angular); type B (38.7%), similar to type A, except that the lateral nasal terminated as the superior alar (the AA was absent); type C (8.4%), the FA terminated as the superior labial; type D (3.8%), the AA arose directly from the facial arterial trunk rather than as termination of the lateral nasal, with the FA ending as the superior alar; and type E (1.4%), the FA terminated as a rudimentary twig without providing any significant branches. In addition, various cadaveric studies using intravascular dye injection followed by radiography were declared to delineate the anatomy of the FA in the literature. Mitz et al[19] showed that, in 78% of dissections, the FA terminated as the lateral nasal artery, whereas only 4% terminated as the AA. Nakajima et al[20] claimed that the AA was identified in 72%. Niranjan et al[21] described an angular termination of the FA in 68% of the specimens. Different from the other studies, we accepted the fact that, after branching the superior labial artery, the FA ends as the AA depends on classical textbooks' information.[14,22,23] We described types of the AA such as the classical type, the nasal type, the alar type, and the labial type according to its course. We also defined the anastomosing pattern of the artery with the neighboring arteries. In addition, we firstly measured the distance between the origin of the artery and its related anatomic landmarks. We also evaluated the anatomic features on the lateral nasal branch and the muscular branch to the orbicularis oculi muscle for the first time. Probable causes of the differences between the results of the studies may be technological improvement on the radiologic systems these days, differences in sample range, or racial causes as well as confusion about the definition of the angular arterial nomination and course. The other reason of the ratio and nomination discordance on the AA among the studies may be confusion about nomenclature classification on termination naming of the FA on some studies.[13] We think that, before delving any further into a matter on the study design, correct and accurate anatomic terminology is essential. Detailed anatomic investigations and accurate terminology require a large sample range so as to improve preoperative vascular mapping for facial reconstructive operations and also to obtain reliable, clear anatomic and clinical outcomes.

Our study had some limitations because the arterial mapping and classification of the AA were only based on cadaveric evaluation. We need comparative results with other techniques, such as computed tomographic angiography findings, digital subtraction angiography, magnetic resonance angiography, and the like. On the basis of our anatomic observations and in the light of descriptions from the literature, different surgical planes for the approach on the AA might be applied. Our anatomic findings may help alleviate bleeding complications during flap surgery and potential injuries of the arterial structures of the nose during surgical procedures in the region.

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