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Anatomical Variations in the Course of Labial Arteries: A Literature Review

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Souphiyeh Samizadeh, BDS, BSc, MJDF, RCS (Eng), PGCert (Clin Edu), MSc (Aesth Med); Ali Pirayesh, MD, MRCS, FCC (Plast); and Dario Bertossi, MD, TGATS, IT

Abstract

Background: Nonsurgical lip enhancement using dermal fillers is a very popular procedure. The trend for enlarged lips has been popularized by media and social media. The lips have considerable aesthetic and functional importance, in addition to having a complex anatomy. Serious complications, including vascular compromise or occlusion leading to cutaneous necrosis and blindness, can occur as the result of lip enhancement using dermal fillers. Therefore, aesthetic practitioners require an in-depth understanding of the anatomy and vasculature of the lips and the perioral area prior to providing lip enhancement using dermal fillers.

Objectives: This literature review aimed to summarize existing data describing the origin, path, and depth of the superior and inferior labial arteries, and to help aesthetic practitioners in providing safer injections to the lips.

Methods: A literature search was carried out to summarize the available data describing the origin, path, and depth of the labial arteries.

Results: Analysis of the literature revealed that the labial arteries display great variability with respect to path (distribution), presence, and location.

Conclusions: Increasing the volume of lips through injections of dermal filler needs to be undertaken with caution, and awareness of the anatomical variation in artery location and path is a crucial concept that is essential when injecting the lips.

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Various types of dermal fillers are popular for nonsurgical facial volumization, enhancement, rejuvenation, or contouring. Among the dermal fillers currently available, hyaluronic acid is the most widely used material due to its temporary nature, degradability, and favorable safety profile.[1] The most frequent location for facial volumizing procedures is reported to be the lips.[2-5] Possible complications of cosmetic facial injections that have been reported in the literature include vascular compromise, occlusion, and, in severe cases, blindness.[6-8] The scarcity of reports of such problems following injection of the lips could be explained by underreporting of complications internationally, and by contralateral blood supply compensating for minor vascular occlusions. As such, these complications may occur more frequently than are clinically observed or reported in the literature and with less clinical or aesthetic impact.[8,9]

An in-depth understanding of the precise position and course of the superior (SLA) and inferior (ILA) labial arteries within the upper (UL) and lower lip (LL) is critical for safe injection and prevention of complications.

Dr Samizadeh is a Dental Surgeon and Visiting Associate Professor, Great British Academy of Aesthetic Medicine, London, UK. Dr Pirayesh is a plastic surgeon in private practice in Amsterdam, The Netherlands. Dr Bertossi is a Maxillofacial and ENT Surgeon, University of Verona, Verona, Italy.

Corresponding Author:
Dr Souphiyeh Samizadeh, 9 Devonshire Mews, London W4 2HA, UK.
Email: info@baamed.co.uk; Twitter: @drssamizadeh

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Specifically, the anatomical relationship of the SLA and ILA with soft tissue landmarks, in particular the oral commissure (OC), oral mucosa (OM), and the vermilion, should be understood. It must also be appreciated that the facial vasculature is highly variable between individuals. This literature review therefore aimed to summarize existing data describing the origin, path, and depth of the SLA and ILA to help aesthetic practitioners in providing safer injections to the lips.

METHODS

Data Sources and Selection Criteria

PubMed was searched for articles in English reporting on the following topics: arterial structure of the face, computed tomography (CT) angiograms, anatomical cadaveric studies of the facial artery (FA), and surgical studies of the FA (reconstructive flap surgery, orthognathic surgery, or minimally invasive surgery, injectables). This review excluded case reports, letters to the editor, conference papers, duplicate publications, previous review articles on specific arteries, animal studies, and non-English-language studies. The search was conducted using the following keywords: "superior labial artery," "labial artery anatomy," "perioral arteries," "vascular anatomy of the perioral region," and "inferior labial artery" with publication time range of April 1980 to April 2018. The abstract and purpose of all articles meeting the inclusion criteria were reviewed, and the papers selected for inclusion were reviewed in full.

Dissections took place at the ICLO Centre and Foundation, Verona, Italy. Cadavers were sourced from the United States. All authorisations were obtained from University of Verona with an official agreement from the University Dean. The study conforms to the Declaration of Helsinki.

RESULTS

The search resulted in a total of 7202 publications, of which 20 studies met the selection criteria and were included in this review (Table 1).

The Vascular Supply

The FA extends from the external carotid artery, curves around the body of the mandible, and gives off branches to the masseter and depressor anguli oris muscle.[10] Significant anatomical variation in the course of the FA, in particular distal to the OC, has been demonstrated by several cadaveric studies.[10-13] The FA gives off perioral branches near the OC with the SLA and ILA, showing a high variability in presence and course.[11,14-16]

The Facial Artery

The FA has been classified by various authors based on the use of a number of categorization schemes according to its terminal branches. The results are summarized in Table 2.

The Superior Labial Artery

There is a consensus in the literature that the SLA is the main arterial supply of the UL and follows a tortuous route.[15,17-20] Park et al[21] reported a bilateral presence of the SLA in 90% of cases which gave off superficial and deep septal branches. Mağden et al[18] reported that the SLA can occur in dissimilar locations unilaterally and bilaterally with branches showing variability, and reported bilateral presence in 71% and unilateral in 29% of the cases. In the study by Fukurama et al,[22] the SLA was visible on only the right side in 30.3%, on the left side in 10.6%, and bilaterally in 53% of their cases. Tansatit et al[19] reported that although the SLAs were mainly found to be bilateral, they were asymmetric in size and course. Furthermore, a unilateral SLA was found to be predominantly on the right side and a submucosal arterial cascade at the level of the vermillion-mucosa junction in the UL was reported. Lee et al[15] classified the distribution patterns of the SLA into 4 types according to its relationship with the FA. In the absence of the SLA, the UL was reported to be supplied by the contralateral SLA in 5%, and by the inferior orbital artery in 1.7% of cases. In 85% of the cases, the SLA gave off several nasal septal branches. It also ran superiorly to inferiorly from the OC to the midpoint with no significant difference between the sexes in the topography. This is similar to results from the study by Loukas et al[11] which reported no differences in morphological, topographical, or morphometrical parameters of the SLA according to age, race, sex, or region. Tansatit et al[23] reported that the SLA was usually larger on one side, with one side being twice the size of the other in two specimens, and entered the vermillion zone through the orbicularis oris (OO) in the lateral or middle segments of the lip. The classifications are summarized in Table 3 and a summary of the findings for the SLA is given in Table 4.

SLA: Origin

The origin of the SLA is usually reported relative to the OC. The FA was reported to pass on average 15.5 mm lateral to the OC by Pinar et al,[10] 1.5 mm by Park et al,[21] and 12.1 mm by Mağden et al.[18] Tansatit et al[19] reported a direct origin of the SLA from the FA in the nasolabial fold.

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Table 1. Summary of Studies Included in the Review

Reference	Date	Methods	Cases	Demographics
Cotofana et al[9]	2017	Dissection Computed tomographic imaging	N = 193 head specimens	F: 56.5% M: 43.5% Caucasian
Tansatit et al[23]	2017	Soft embalmed cadavers Red latex injection 22G cannula	N = 15	NA
Lee et al[14]	2015	Dissection Red latex injection	N = 60 hemifaces (24 bilateral specimens 12 unilateral specimens)	M: 24 F: 12 Korean: 18 Thai: 18
Tansatit et al[19]	2014	Soft embalmed cadaver dissection Latex injection	N = 26	M: 13 F: 13
Furukawa et al[22]	2013	Computed tomographic angiography Nonionic contrast agent injection	N = 94	NA
Ahmadi et al[27]	2012	Fresh cadaver dissection	N = 12	Male
Al-Hoqail and Meguid[20]	2008	Different facial-side Formalin-preserved cadavers	N = 14	European Asian African M: 12 F: 2
Loukas et al[11]	2006	Cadaver dissection Fixed in formalin-phenol-alcohol solution	N = 284 adult hemifaces (142 formalin fixed cadavers)	M: 210 F: 74
Pinar et al[10]	2005	Cadaver dissection Red latex injection	N = 25 (50 half heads)	M: 25 Turkish
Mağden et al[18]	2004	Cadaver dissection Silicone rubber injection	N = 14	M: 12 F: 2
Koh et al[12]	2003 2002	Cadaver dissection	N = 44 bilateral specimens N = 3 unilateral specimens	M: 33 F: 14 Korean
Gardetto et al[38]	2002	Cadaver dissection Formalin preserved and fresh	N = 31 (62 hemifaces)	M:15 F:12 Unknown: 2
Nakajima et al[13]	2002	Fresh cadavers Radiographic study Lead oxide-gelatin mixture injection	N = 19 Radiographs of 25 facial arteries	NA
Schulte et al[24]	2001	Fresh frozen cadaver dissection Red latex injection	N = 9	M: 4 F: 5
Dupoirieux et al[34]	1999	Cadaver dissection (heads) Red latex dye injection	N = 10 heads	NA
Crouzet et al[17]	1998	Cadaver dissection Winckler liquid and gelatine minium injection	N = 21	NA
Niranjan[36]	1998	Cadaver dissection	N = 25 faces (50 hemifaces)	NA
Hu et al[42]	1993	Radiography, corrosion cast, histological	N = 17 fresh cadavers	NA
Park et al[21]	1994	Cadaver dissection Pre-dissection red latex injection	N = 9	NA
Midy et al[25]	1986	Cadaver dissections Hydrotomy and formolization Injection with colouring agent or radio-opaque substance	N = 40	NA

F, female; FA, facial artery; ILA, inferior labial artery; LL, lower lip; M, male; NA, not available; NLF, nasolabial Fold; OO, orbicularis oris; OM, oral mucosa; SLA, superior labial artery; UL, upper lip.

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Table 2. Summary of Information About the Facial Artery

FA	Midy et al[35]	Niranjan[36]	Dupoirieux et al[34]	Nakajima et al[13]	Koh et al[12]	Pinar et al[10]	Loukas et al[11]	Kulkarni and Geetha, 2013[41]	Furukawa et al[22]
Symmetry	—	68%	—	—	54.5%	68%	—	—	50%
Classification according to the terminal branches	Angular: 27.5% Nasal: 30% Labial: 40% Abortive: uncommon, found in 1 case	Angular: 68% Lateral nasal: 26% Superior labial: 4% Alar base: 2% Long course: 10%	Type 1 = angular: 20% Type 2 = nasal dorsal: 45% Type 3 = coronal labial: 35% Type 4 = double: 0% Type 5 = weak: 0%	Bifurcated into the lateral nasal and SLA: 88% Angular artery after branching off into the SLA and the lateral nasal artery: 8% Branched off from the SLA: 4%	Forehead: 4% Angular: 36% Nasal: 44% Alar: 3% Superior labial: 7% Inferior labial: 6%	Nasal facial vessel: 60% Angular facial vessel: 22% Alar vessel: 12% Superior labial vessel: 4% Hypoplastic type: 2%	Bifurcation into SLA and lateral nasal: 86.2% Terminated as SLA: 8.4% Angular artery—directly from facial arterial trunk: 3.8% Rudimentary twig—no significant branches: 1.4%	Angular artery 36% Lateral nasal artery 44% SLA 20%	Short course: terminated proximal to the SLA: 34.2% Intermediate course: terminated distal to the SLA, near the NLF: 39.6% Classic course: extended to the lateral nasal ala beyond the nasolabial fold with an angular branch: 24% Duplicated lateral angular branch as a main terminal branch: 2.1%
Comments	—	—	—	Used the classification established by Mitz et al	—	—	—	Each category was further subdivided	—

FA, facial artery; NLF, nasolabial fold; SLA, superior labial artery.

Table 3. Classification of the Superior Labial Artery

Authors	Summary of the findings
Lee et al[15]	SLA classification: • Type I: SLA and the alar branch—directly and separately from the FA: 56.7% • Type II: SLA—directly from the FA and then gives off the alar branch: 21.7% • Type III: SLA—the terminal branch of the FA: 15% • Type IV: SLA absent: 6.7% Contralateral SLA in 5% The infraorbital artery in 1.7 %
Furukawa et al[22]	SLA classification: • Type 1: FA terminates proximal to the SLA • Type 2: FA terminates distal to the SLA near the NLF • Type 3: FA extends to the lateral nasal-alar or angular branch • Type 4: FA shows duplex with dominant lateral angular branch
Al-Hoqail and Meguid[20]	Anatomic variations of SLA were classified into types I to VIII

FA, facial artery; NLF, nasolabial fold; SLA, superior labial artery.

The position of the origin of the SLA relative to the OC has been reported as follows by various studies (Figure 1):

- Superior in 72.3% and at the level of in OC 27.7%[10]
- Inferior in 70%, superior in 25%, and at the level of the OC in 5%[11]
- Superior in 78.6% and at the level of OC 21.4%[20]
- 1.5-mm-sided square superolateral to the OC in 85%[15]
- 12.1 mm and at the level of, or superior to, the OC[18]
- Superior to the OC and entering the UL 5-9 mm above the OC[19]

SLA: Diameter

The diameter of the SLA at its origin was reported to be 1-2 mm by Park et al,[21] 1 mm (0.3–1.6 mm) by Crouzet

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Table 4. The Distance Between the OC and the FA and the Origin of SLA, the Position/Depth of the SLA, and its Average Diameter as Reported by Various Studies

Reference	Distance between the OC and the FA and the origin of theSLA	Origin in relation to the oral commissure, %			Average external diameter, mm	Course	Depth, %		
		Superior	Level	Inferior			SubM	InM	SubC
Mağden et al[18]	12.1 mm (range: 4–19 mm)	—	—	—	1.3	—	—	—	—
Pinar et al[10]	15.5 mm (range: 9.0–20.2 mm)	72.3	27.7	0	1.6	—	50	50	0
Schulte et al[24]	15.7 mm	—	—	—	—	—	81	19	0
Nakajima et al[13]	—	—	88	—	—	—	—	—	—
Cotofana et al[9]	—	—	—	—	—	—	78.1	17.8	2.6
Yang et al[31]	—	—	—	—	—	—	77.2	18.7	2.1
Loukas et al[11]	13.5 mm	25	5	70	—	Tortuous	84.8	15.2 (partially)	0
Al-Hoqail and Meguid[20]	—	78.6	21.4	—	1.8	Tortuous	—	—	—
Lee et al[15]	1.5-mm-side square superolateral	—	—	—	—	Superior to the VB under the OO with a minimum depth of 3 mm	—	—	—
Tansatit et al[19]	SLA entered the upper lip 5–9 mm above OC	—	—	—	—	Tortuous	—	—	—
		—	—	—	1.1	Between the OM and the OO just above the vermilion-mucosa junction	—	—	— —
Tansatit et al[23]	—	—	—	—	1.5	Tortuous course; near the midline, SLA was closer to the VB	—	—	—
Park et al[21]	15 mm	—	—	—	1.2	—	—	—	—
Phumyoo et al[43]	15.3 mm	—	—	—	—	—	—	—	—
Qassemyar et al[44]	10–20 mm	—	—	—	—	—	—	—	—
Lohn et al[37]	14 mm	—	—	—	—	—	—	—	—
Squaquara et al[45]	13.8 mm	—	—	—	—	—	—	—	—

InM, intramuscular; OM, oral mucosa; OO, orbicularis oris; SubC, subcutaneous; SubM, submucosa; UL, upper lip; VB, vermillion border.

et al,[17] 1.6 mm by Pinar et al,[10] 1.3 mm by Mağden et al,[18] 1.1 ± 0.3 mm by Tansatit et al[19] in their earliest published study, and 1.5 ± 0.5 mm at the vermillion border in Tansatit et al's most recent study.[23]

SLA: Depth

There is consensus in the literature that the SLA follows a tortuous course.[10,11,23] Pinar et al[10] reported that the SLA anastomosed with the opposite SLA in the middle of the UL in the vermilion in all their specimens. In an equal number of specimens the anastomosis of the SLA ran between the OM and the OO, and within the muscle. Notably, none ran between the muscle and the skin. In Pinar et al's study, the SLA was found to bifurcate at the UL with variable location in 36.7%. The branches were found to run between the OM and the OO or within the muscle. Cotofana et al[9] reported the SLA ran at the level of the vermillion border of the UL, sometimes undergoing a change of plane during its course;

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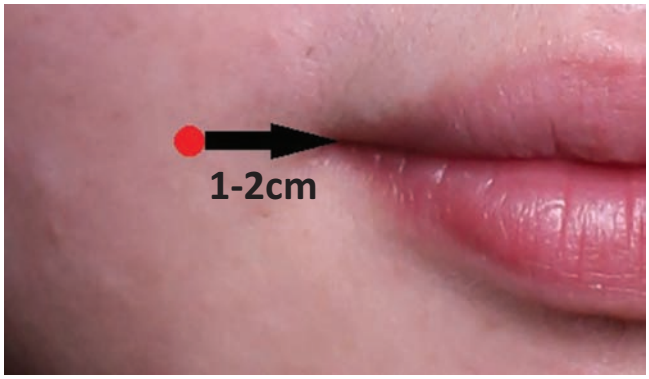

Figure 1. This image represents the origin of the SLA according to the included studies. The FA was reported to pass on average 15.5 mm lateral to the OC by Pinar et al,[10] 1.5 mm by Park et al,[21] and 12.1 mm by Mağden et al.[18] Tansatit et al[19] reported direct origin of the SLA from the FA in the nasolabial fold. Taking the findings of the included studies into consideration, on average the FA is found superior to the OC in 59%, at the same level as OC in 36%, and inferior to the OC in 35%. FA, facial artery; OC, oral commissure; SLA, superior labial artery.

in 71% of the cases there was no change of plane, in 16% it changed plane once, and in 13%, the SLA changed plane twice. In addition, the position of the SLA was found to be submucosal, intramuscular, and subcutaneous in 77.2%, 18.7%, and 2.1% of the specimens, respectively. Lee et al[15] reported that the SLA was positioned superior to the upper vermilion border at the OC and ran under the OO at a minimum depth of 3 mm at the midpoint between the OC and the peak of the Cupid's bow. The SLA ran inferior to the vermillion border (1–4 mm) between the peak of the Cupid's bow and the midline with no significant difference in the depth from the OC to the midpoint. Loukas et al[11] reported that there were minor variations in the depth and layers through which the SLA travelled on the UL; the SLA travelled between the OO and the OM in the majority of cases (84.8%), and in 15.2% of the cases it was partially invested by the OO. Schulte et al[24] reported that the SLA ran along the UL with the OO, anastomosed with the contralateral artery, and gave off septal branches that ran vertically or obliquely to the nasal septum, and within 10 mm of the vermillion border medial to the OC. The SLA was found to be between the OM and OO in the midline in the majority of the specimens and within the OO in a minority of the specimens; none were found between the muscle and the skin. Tansatit et al[19,23] reported that in 69.2% of their specimens the SLA ran between the OM and the OO above the vermillion-mucosa junction, and anastomosed with the contralateral artery. It gave off perpendicular subcutaneous branches to the nasal ala and the septum, and perpendicular mucosal branches on the mucosal aspect of the lip. Although small branches of the SLA gave off direct cutaneous perforators, none were between the skin and the muscle. Tansatit et al also reported the depth of the SLA from the skin (4.5 ± 0.8 mm), OM (2.6 ± 0.3 mm), and the lower margin of the UL (5.6 ± 1.2 mm). In a separate study, the SLA was reported to have coursed posteriorly in any of the following layers; the submucosal layer, very close to the submucosal plane, or within the deep fibers of the OO. Near the midline, the artery was reported to come close to the vermillion border and gave off superficial and deep terminal branches. A summary of the findings reported for the SLA are summarized in Table 5 and Figure 2.

Summary of Findings

Taking the included studies into consideration, the SLA follows a tortuous route; on average it is found superior lateral to the OC in around 59% of cases, at the same level as OC in 36%, and inferior lateral to the OC in 35%. The SLA is typically distributed between the following layers:

- 75.98% submucosal
- 24.14% intramuscular
- 0.94% subcutaneous

Relative to other layers, the safer layer for injections is subcutaneous. The average external diameter of the SLA is 1.42 mm. Therefore, small-gauge sharp needles or cannulas are more likely to cause accidental intravascular injection.[25]

The Inferior Labial Artery

The ILA is reported in the literature to be the main arterial supply of the LL by various studies.[10,20,26] Pinar et al[10] reported a unilateral presence of the ILA in 10% and bilateral in 90% of their specimens. Al-Hoqail and Meguid[20] found the ILA to be a single vessel with a tortuous horizontal course. Edizer et al[26] found the ILA unilaterally and bilaterally in 64% and 36% of specimens, respectively. They identified the sublabial artery in 71% of the specimens, and this always existed with the ILA, with only 2 cases having end-to-end anastomosis between bilateral ILA. Furukawa et al[22] reported the ILA was visible on only the right side in 47.3% of specimens, on the left side in 16.5%, and bilaterally in 16.5% of the cases. Lee et al[14] classified the ILA into 3 types. Tansatit et al[19] reported that in 11.5% of the cases, the aberrant ILA originated from a common trunk with the SLA, and ran directly along the vermilion-mucosa junction within the OO (Table 5).

ILA: Origin and Diameter

The origin of the ILA was reported to be diverse.[10] Tansatit et al[19] reported the mean diameter of the ILA as 1.3 ± 0.2 mm. The position of the origin of the ILA was reported by various studies:

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Table 5. Information Regarding ILA

Reference	Comments	Average external diameter, mm	Origin in relation to the oral commissure, %			Depth, %		
			Superior	Level	Inferior	SubM	InM	SubC
Ahmadi et al[27]	The mean distance between the ILA and the vermillion surface: 2.42 ± 1.67 mm	—	—	—	—	77.27	Superficial 13.64	—
Schulte et al[24]	The percentages provided are for near the midline	—	—	—	—	87	13	0
Cotofana et al[9]	Respective arterial position	—	—	—	—	78.1	17.3	1.7
	The position of the arteries in the midline	—	—	—	—	63.7	28.5	3.1
Pinar et al[10]	The main artery of the lower lip Unilaterally: 10% Bilaterally: 90%	1.31	8	60	22	Mainly	—	—
Al-Hoqail and Meguid[20]	The main arterial supply of the lower lip: —ILA —horizontal and vertical labiomental arteries ILA formed a common trunk with SLA in 28.6% Tortuous course	1.4	21.4	35.7	42.9	—	—	—
Crouzet et al[17]	Origin relatively constant, below the OC	—	—	—	Mainly	—	—	—
Edizer et al[26]	The main artery of the lower lip Depth: from the anterior surface of the lip: 6.4 mm From the superior surface of the lip: 5.9 mm From the posterior surface of the lip: 4.8 mm The distance between the OC and the FA and the origin of ILA: 23.9 mm	1.2	—	—	—	—	—	—
Furukawa et al[22]	Visible: on only the right side in 47.3%; on the left side in 16.5%; bilaterally in 16.5%	—	—	—	—	—	—	—
Tansatit et al[19]	—	1.3 ± 0.2	—	—	—	—	—	—

FA, facial artery; ILA, inferior labial artery; InM, intramuscular; OC, oral commissure; SubC, subcutaneous; SubM, submucosa.

- Diverse, between the lower margin of the mandible and the OC, external diameter: 1.31 mm (average); relative to OC: superior, inferior, and at the angle of mouth in 8%, 22%, and 60%, respectively.[10]
- Relative to OC: superior, at the same level, and inferior in 21.4%, 35.7%, and 42.9%, of cases respectively; and the ILA and SLA formed a common trunk at the origin in 28.6% of the cases.[20]
- Variable between the OC and the lower border of the mandible, external diameter of 1.2 to 2.0 mm.[21]
- Mainly came off the FA near the OC, highly variable between individuals.[24]
- Relative to the OC: 23.9 mm and 23.7 mm from the lower border of the mandible with an external diameter of 1.2 mm.[26]

ILA: Depth

Schulte et al[24] reported that the ILA was 15 mm from the free margin of the lip medial to the OC and within the vermilion in the center and at the midline of the lip. Near

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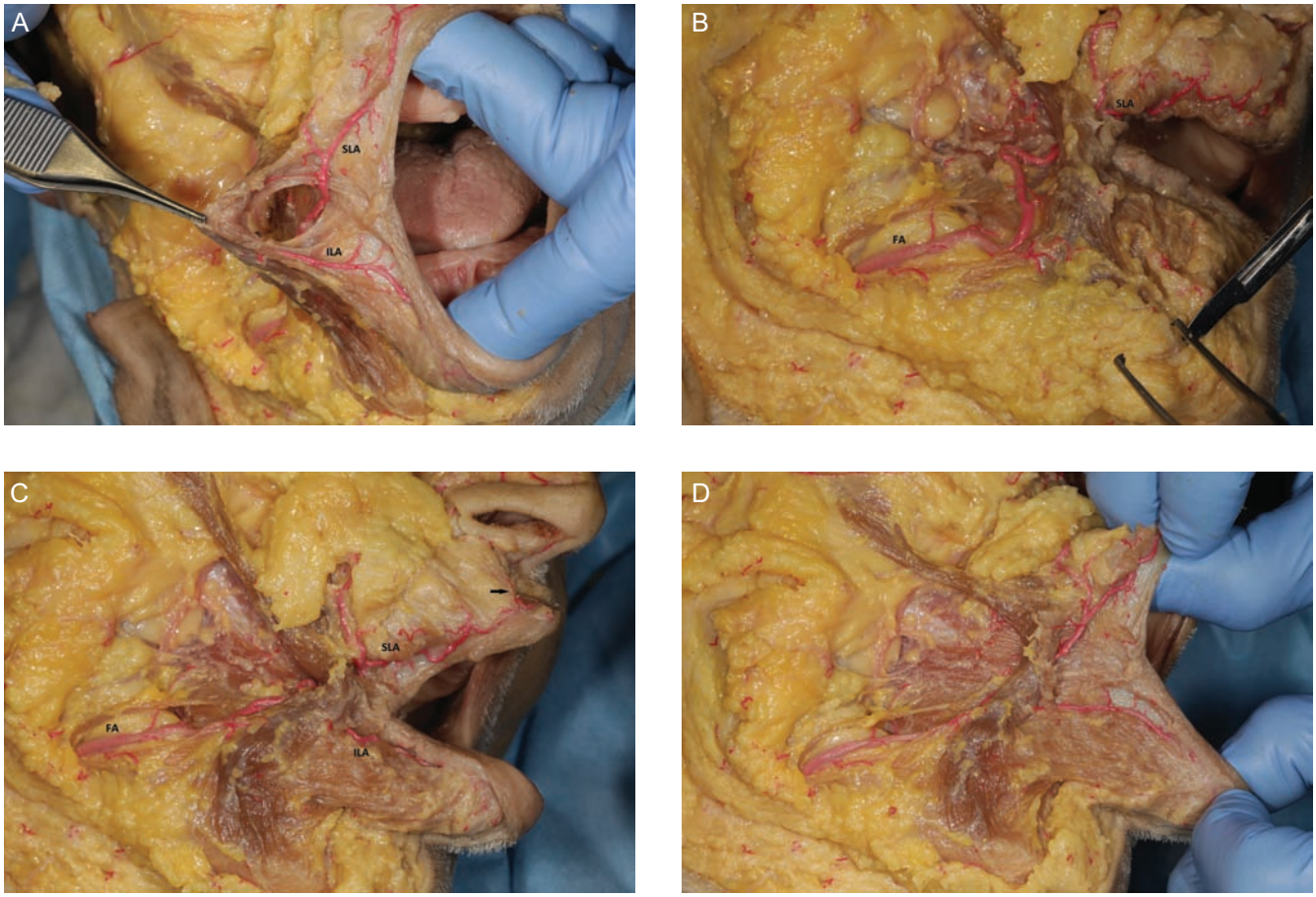

Figure 2. (A, B, C, D) The varied origin of the SLA and ILA, and their inconsistent presence, location, and route. The SLA and ILS both follow a tortuous route and change layers throughout their course. Black arrow: SLA giving off septal branches that ran vertically to the nasal septum. Both the SLA and ILA give off smaller branches throughout their course. ILA, inferior labial artery; SLA, superior labial artery.

the midline, the ILA was reported to be found mainly between the OM and OO, within the muscle in a minority of specimens, and none was not observed between the muscle and the skin. Edizer et al[26] reported the mean depth of the ILA from the anterior, superior, and posterior surfaces of the lip to be 6.4 mm, 5.9 mm, and 4.8 mm, respectively. Pinar et al[10] reported that the ILA entered the LL immediately after separation from the FA and was found between the OM and the OO. Various arterial distributions in the LL, including bilateral ILA anastomosing end-to-end, or anastomosis of the ILA with the submental artery, were reported. Ahmadi et al[27] reported the mean distance between the ILA and the vermillion surface as 2.42 ± 1.67 mm. The ILA was found in the submucosal layer in 77.27% and in the superficial muscular layer in 13.64% of specimens. Tansatit et al[19] reported that the average depth from the skin is 4.7 ± 1.0 mm, and from the OM reflection 2.3 ± 1.5 mm. Cotofana et al[9] reported that the ILA was mainly inferior to the vermillion border with no change in plane during its course in 67% of cases, with fewer examples showing a change of course once (9%) and twice (23%). The position of the ILA was submucosal, intramuscular, and subcutaneous in 63.7%, 28.5%, and 3.1% of cases, respectively. Tansatit et al[23] reported the ILA to be 1.3 ± 0.3 mm in diameter, running in the submucosa along the vermilion zone, and found 2 mm from the vermillion border. At the middle third of the vermillion zone the ILA entered the vermilion border.

Summary of Findings

Taking the included studies into consideration, the ILA follows a tortuous route; on average it is found superior lateral to the OC 15% of the time, at the same level as OC 48% of the time, and inferior lateral to the OC 32% of the time. The ILA is found in the following layers on average:

- 77% submucosal
- 18% intramuscular
- 2% subcutaneous

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Relative to other layers, the safest layer for injections is subcutaneous. The average external diameter of the SLA is 1.3 mm.

The Labiomental Artery

Labiomental branches coming off the ILA (not necessarily directly from the FA) have been reported with an irregular course, extending to the submental region, and the vertical and horizontal branches anastomosed when both present.[10,19,21,24] The horizontal and vertical labiomental arteries, in addition to the ILA, were reported to be the arterial supply of the LL in a study by Al-Hoqail and Meguid.[20] Lee et al[28] classified the labiomental artery based on its position in the LL area.

DISCUSSION

The main artery of the face is the FA. In cases where the FA is poorly developed, the region is supplied by other vessels (contralateral FA if better developed, or the transverse facial, infraorbital, or ophthalmic artery of the ipsilateral side).[10,29] Variation of the FA and its emerging vessels must be considered when planning surgical and nonsurgical facial treatments. Knowledge of the location of the perioral vessels and easily identifiable landmarks will aid in avoiding complications. This is particularly critical for the application of volumizing materials to the lips and face. This review summarized existing literature describing the course and position of the perioral arteries.

The FA emerges at the margin of the mandible, and as it approaches medially it becomes superficial, and has a variable course and terminating branches. The average horizontal distance of the FA from the OC is approximately 12-15 mm.[18,30] Although the relative position of the main trunk of the FA is varied, its course is reported to be confined within the proximity of the nasolabial fold.[31] The UL is supplied by the SLA (main), the subseptal arteries, and the subalar arteries.[17] The LL is supplied by the ILA (main), and the horizontal and vertical labiomental arteries.[17,20] The SLA and ILA are absent in some cases, and also follow a tortuous route and varied course. These vessels, unilaterally and bilaterally, can occur in different locations, and the branches show inconsistency between individuals.[18] There is also a significant difference between the SLA and ILA regarding the dominant pattern.[22] Both Furukawa et al[22] and Koh et al[12] reported that the ILA was dominant on the right side. Edizer et al[26] concluded that this region lacks a consistent arterial distribution. The ILA and other potential arteries supplying this region can be found in various locations unilaterally or bilaterally and their diameter and length may vary between individuals.

Although the course of the SLA is varied, it can be concluded from the published data surveyed in this review that in the majority of cases the SLA and ILA run in the submucosal layer (between OO and OM) and are less likely to be found subcutaneously. The SLA presents more superficially in the midline. This is of particular importance for the volumetric enhancement of the UL and Cupid's bow region.[9] However, overall these anatomical variations in the course of the FA and its emerging vessels affect the practitioners' ability to use certain landmarks and injection depths with certainty.

According to the studies included in this review, the external diameter of the SLA varies from 0.3 to 3 mm.[10,18,20,21] In contrast, the outer diameters of the 27G and 30G needles that are typically used for lip enhancement using dermal fillers are 0.4 mm and 0.3 mm, respectively. Therefore, it is more likely that a practitioner may penetrate the lumen of an artery with a small-gauge sharp needle.

Cotofana et al[9] explain that the variability of the course of the SLA and ILA, and in particular the SLA, can be explained by looking at the process of embryogenesis. The formation of the SLA and ILA occurs prior to the formation of the OO. This results in the muscle precursor cells having to form around vessels that have already been established. As such, there is a high variability in the migratory pathway of the muscle precursor cells. In comparison to the LL, in the UL the muscle precursor cells form a thicker layer. In addition, fewer cells are present in the midline in both lips.[32] This explains the width and thickness of both lips and different patterns of vasculature observed in the paramedian and midline locations.

The greatest difficulty in performing this review was the highly heterogeneous nomenclature used by the included studies. For example, the terms "submental" and "sublabial" arteries were used interchangeably in some studies.[21,26] The terms "abortive" or "rudimentary" were both used when the artery was not present.[33-35] For the "lateral nasal branch," the terms "nasal branch," or division into "nasal branch" and an "alar branch" were also used in various studies.[10,12,36-38] This was further complicated as some authors classified the arterial supply and named some of the branches.[10,12,39] In this regard, Koh et al[12] mentioned the importance of correct use of nomenclature. The ILA and HLA are the branches of the FA and run horizontally in the LL. The vertical labiomental artery is, however, described as a branch of the submental artery and ascends from the inferior mandible margin.[20,21,40]

Literature reviews provide strong key insights into a specific topic. However, limitations of this paper include exclusion of non-English-language papers, and the limited number of papers available on this topic. Papers with such a specific focus on facial arteries without deviation into other topics were also rare. Moreover, there has been a lack of comprehensive studies that report on the

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relationships between surface anatomical landmark and deeper structures.

Recommendations

1. It should be kept in mind that SLA and ILA are highly variable in occurrence, course, and depth; therefore, each injection into the lips carries a high risk.
2. In some cases, the SLA or ILA are only present unilaterally, supplying the area and tip of the nose.
3. It is not very likely for the SLA to be found subcutaneously at the vermillion border.
4. Subcutaneous and intradermal injections on the vermillion border and lateral lips are recommended. Therefore, superficial injections on the lateral lips are relatively safer.
5. The vasculature is mainly superficial in the midline and Cupid's area, and superficial injections in this area carry a high risk.
6. The origin of the SLA is usually 1.0-1.5 mm lateral to the oral commissure.
7. With aging, fat pad, and muscular changes, the lips become thinner, and the risk of intravascular injection hence increases; more cautious assessment and injections are therefore recommended.
8. Small-gauge sharp needles or cannulas are more likely to cause accidental intravascular injection.
9. Blunt microcannulas, above 27G, reduce, but do not eliminate, the risk of intravascular injection.
10. Aesthetic practitioners using dermal fillers must have the competency to diagnose potential complications promptly and be prepared to manage possible immediate vascular complications. We recommend having at least 2 vials of hyaluronidase available in the treatment room to ensure immediate emergency care if necessary. This is of particular importance when treating high-risk areas including lips and the perioral region. The expiry date and number of available vials should be checked on a regular basis.

CONCLUSION

The labial arteries display high variability with respect to path (distribution), presence, and location. Furthermore, the entire vascular network of this region displays significant heterogeneity between individuals. Lip enhancement using volumizing agents requires advanced anatomical knowledge of this region, and an appreciation of the inherent anatomical variability. In particular, awareness of anatomical variations in artery location is a crucial concept, and is essential when injecting the lips. Notably, increasing the volume of the UL or contouring the Cupid's bow needs to be undertaken with caution. The application of specific products into the respective layers of the lip also needs to be carried out mindfully with regards to the anatomy of the area. Anatomical variation in the arterial vascular pattern must be respected to reduce the risk of vascular complications such as cutaneous necrosis and irreversible blindness, which is the most severe complication associated with such procedures and can occur even in the hands of experienced clinicians. This comprehensive review of the available literature on the human lip vascular system revealed the arteries to be highly variable, with a low level of symmetry. However, mapping common patterns of the labial arteries and a consensus on this would be of great clinical value.

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