Novel anatomic description of the course of the perioral artery for minimally invasive treatments

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Novel anatomic description of the course of the perioral artery for minimally invasive treatments

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본 학위논문이 나오기까지 많은 분들의 가르침과 도움이 있었습니다. 먼저 시신을 기증하신 분들의 숭고한 뜻에 경의를 표합니다. 해부학자로서 끊임없이 학문에 정진하실 뿐 아니라, 다양한 분야의 사람들과 소통하는 모습으로 저에게 많은 영감을 주시는 김희진 교수님께 감사드립니다. 교수님의 가르침과 인도로 저는 학문의 즐거움과 해부학자로서의 사명감을 배웠습니다. 연구 활동 및 연구실 생활에 있어 항상 세심하게 챙겨주신 허경석 교수님께도 진심으로 감사드립니다. 치과대학 해부학교실의 산증인으로서 모든 질문에 명쾌히 대답해주시는 교수님을 통해 짧은 시간동안 많은 부분을 배우고 익힐 수 있었습니다.

학문의 올바른 길로 인도해주시며 넓은 안목을 가질 수 있도록 많은 가르침을 주신 고기석 교수님께 감사드립니다. 사진이나 글로 표현하기 어려운 해부학적 형태를 그림으로 아름답게 표현해 주시는 윤관현 교수님께 감사와 존경을 표합니다. 그리고 연구실 선배로서 본인이 겪은 시행착오를 바탕으로 제가 겪을 어려움에 어떻게 대처할 지에 대한 실질적인 조언을 아끼지 않았던 양헌무 교수님께 감사드립니다. 연구실의 화목과 좋은 환경을 위해 늘 세심하게 챙겨주시는 강민규 선생님, 선배 해부학자로서 많은 가르침을 주신 허미선 교수님, 그리고 저의 가능성을 발견하시고 해부학분야로 이끌어주셨던 박종태 교수님께도 감사드립니다.

연구실생활을 즐겁게 할 수 있었던 것은 좋은 동료가 있었기에 가

능했습니다. 저자를 따뜻하게 배려해주고 협동하려는 자세를 잃지 않았던 든든한 파트너 이형진 선생님, 최유진 선생님께 진심으로 감사드립니다. 연구실 선배로서 많은 도움을 주었던 최다예 선생님, 배정희 선생님께도 감사드립니다. 힘든 상황에서도 웃음을 잃지 않고 연구 활동에 매진하여 저자에게 초심을 일깨워주는 총여요 선생님과 남다른 책임감으로 맡은 역할을 다하여 저자를 든든하게 해주는 이강우 선생님께도 감사를 표합니다.

학문의 길을 가는데 있어 정신적으로 지지해주었던 나의 친구 김수연 선생님께 감사드립니다. 그리고 나의 영원한 친구인 여동생 상미와 3D 그래픽 작업에 많은 도움을 주었던 막내 동생 상흔이에게도 감사를 표합니다.

마지막으로 항상 힘든 길을 선택하여 마음 졸이게 했던 고집스러운 맏딸을 지지해주신 아버지와 어머지께 감사함과 미안함을 전하며 이 논문을 바칩니다.

2015년 12월

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Abstract

Novel anatomic description of the course of the perioral artery for minimally invasive treatments

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The facial artery (FA) arises from the external carotid artery, and passes onto the face as it crosses the mandible. And FA mainly supplies the perioral region, which is bounded by the nasolabial fold, the labiomental crease and the nasal base. Thus, in this study, the perioral artery (PA) was determined as distributing to the perioral region including the trunk of FA (from the mandible margin to the ala of nose, PA trunk), the superior labial artery (SLA), the horizontal labiomental artery (HLA) and the inferior labial artery (ILA).

Dermal filler injection is a rapid way of eliminating wrinkles, smoothing acne scars, and enhancing volume. However, careless manipulation leading to PA damage during dermal filler injection could result in vascular complications such as lip and alar rim necrosis. The facial reconstruction helps a normal life for patients who have defects from cleft lip, oral cancer, and trauma. For facial reconstruction, various perioral flaps, such as the nasolabial flap, FA

musculomucosal (FAMM) flap and Abbé flaps have been performed. The success of these flap surgeries depends mainly upon the presence of an appropriate blood supply so the PA should be well grafted in the pedicle. However, most reported data about the PA does not provide delicate topographic information for minimal invasive procedure.

Thus author performed the study with the following as its objects. The first aims of this study was to elucidate the distribution pattern of PA trunk and reproduce the whole course of PA trunk as a polynomial curve analysed by image processing, and suggest accurate references for various minimally invasive clinical procedures and facial reconstruction. The second aim of this study was to describe the various distribution patterns of the vascularization on the upper and lower lip area. The final aim of the study was to clarify the definition of the ILA and HLA, and to elucidate the significance of the HLA in the vascularization of the lower lip.

For the study of reproducing the whole course of PA trunk, 59 adult hemifaces (21 bilateral and 17 unilateral; 26 males, 13 females; 46-95 years; mean age, 73 years) from 19 Korean and 20 Thai cadavers were used. For the study of the vascularization on the upper lip area, 60 hemifaces (24 bilateral and 12 unilateral; 24 males, 12 females; 46-95 years; mean age, 73 years) from 18 Korean and 18 Thai cadavers were used. For the study of the vascularization on the lower lip area, 63 hemifaces (26 bilateral and 11 unilateral; 24 males, 13 females; 46-95 years; mean age, 73 years) from 18 Korean and 19 Thai cadavers were used.

The running course of the PA trunk along the PO line (a line connecting the mandible margin to the ala of nose) exhibited two patterns: oblique (78.0%, 46/59) or vertical (22.0%, 13/59). In the oblique pattern, the PA trunk proceeded along the PO line with two or three inflections, while in the vertical pattern it ran along the PO line but then turned medially near the mouth

corner, giving off an alar branch parallel to the facial sagittal midline.

The course of the PA trunk on the face can be predicted based on the following references: the PO line, the Rh point (the ramification point of the HLA, 5~10 mm medial to the PO line at the level of the middle of the lower lip portion), the Ra point (the ramification point of the alar branch (Ra point), 5~10 mm medial to the PO line at the level of lower one-third of the upper lip portion). While the PA trunk generally ran along the PO line, the PA trunk reflected medially at the Ra and Rh points.

The branching point of SLA from FA, the S point, was located within a 1.5 cm sided square superolateral to the mouth corner. The S point may be estimated by placing a thumbnail beside the mouth corner. After the SLA branched from FA, it ran superior to the vermilion border under the orbicularis oris muscle, with a minimum depth of 3 mm. At the sagittal midline, the nasal septal branch ramified from the SLA and ran upward to the nasal septum along the sagittal midline.

The HLA can be presented in the middle of the lower lip area inferior to the mouth corner, and be inclined gradually to the lower lip border near the facial midline (46.0%). ILA diverged from the FA or SLA at the level of the mouth corner. The HLA rather than ILA could be considered as the main artery supplying the lower lip mucosa.

Key words : perioral artery, facial artery, superior labial artery, inferior labial artery, dermal filler injection, reconstructive flap surgery

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Ⅰ. INTRODUCTION

The facial artery (FA) arises from the external carotid artery, and passes onto the face as it crosses the mandible (Standring, 2008). In the previous study, the course of FA has been described as following a simple course and branching off several arteries medially. Thus, the distribution pattern of FA was commonly classified according to the termination. Koh et al. (2003) classified the distribution patterns of FA into six categories according to the termination as forehead type (4.4%), angular type (36.3%), nasal type (44.0%), alar type (3.3%), superior labial type (6.6%), and inferior labial types (5.5%) from 47 Korean cadavers. Pinar et al. also classified the FA according to the

termination as angular type (22%), nasal type (60%), alar type (12%), superior labial type (4%) and hypoplastic type (2%) from 25 Turkish cadavers (Pinar et al., 2005). Recently, the other branch of FA referred as infraorbital trunk (Lee et al., 2015) or detoured branch (Yang et al., 2014) has been continuously reported which arose from perioral region and run along the lower margin of orbicularis oculi muscle. Thus, Lee et al. classified the FA regarding the infraorbital trunk into three patterns as nasolabial pattern (51.8%), nasolabial pattern with an infraorbital trunk (29.6%) and forehead pattern (18.6%). Although there were slight differences in the classifications, the FA was commonly observed terminating after passing the ala of nose (88% of Koh et al., 100% of Lee et al., and 94% of Pinar et al) (Koh et al., 2003; Lee et al., 2015; Pinar et al., 2005). It means that FA mainly supplies the perioral region, which is bounded by the nasolabial fold, the labiomental crease and the nasal base. Thus, in this study, the perioral artery (PA) was determined as distributing to the perioral region including the trunk of FA (from the mandible margin to the ala of nose, PA trunk), the superior labial artery (SLA), the horizontal labiomental artery (HLA) and the inferior labial artery (ILA).

The anatomical knowledge of PA is significantly important in the dermal filler injection and perioral reconstruction flap surgery. Dermal filler injection is particularly popular among patients who are reluctant to undergo surgery because they represent a rapid way of eliminating wrinkles, smoothing acne scars, and enhancing volume (Cohen, 2008). However, despite the safety of dermal fillers, as demonstrated by many manufacturers, complications of dermal filler injection do occasionally arise, such as recurrent infection, nodular masses and tissue necrosis (Cohen, 2008; Daines and Williams, 2013; Kunjur and Witherow, 2013; Menon et al., 2010; Sclafani and Fagien, 2009). And careless manipulation leading to PA damage during dermal filler injection could result

in vascular complications such as lip and alar rim necrosis, (Bailey et al., 2011; Daley et al., 2012; Eversole et al., 2013; Grunebaum et al., 2009; Kassir et al., 2011; Park et al., 2011) which is considered to be one of the most serious complications of this technique (Park et al., 2011).

The facial reconstruction helps a normal life for patients who have defects from cleft lip, oral cancer, and trauma. For facial reconstruction, various perioral flaps, such as the nasolabial flap, FA musculomucosal (FAMM) flap and Abbé flaps (Goldman, 2013; Jackson, 1985), have been performed. The success of these flap surgeries depends mainly upon the presence of an appropriate blood supply so the PA should be well grafted in the pedicle.

However, the previous study of PA has been done descriptively based on the surrounding anatomical structures such as buccinator, modiolus and mouth corner (Bailey et al., 2011; Goldman, 2013; Jackson, 1985; Nakajima et al., 2002; Park et al., 1994; Pinar et al., 2005). Thus it could not explain the tortuous course and branching point of PA sufficiently for clinical application. Also, most reported data about the upper and lower lip has focused on the arterial distribution pattern, and the data do not provide delicate topographic information for minimal invasive procedure such as dermal filler injection.

Furthermore, the arterial vascularization in the lower lip area has been reported to comprise several arteries: the HLA, the vertical labiomental artery (VLA), the mental branch, and the ILA. Among these arteries, the ILA and HLA are regarded as the branches of the FA that run horizontally in the lower lip. However, the literature contains diverse descriptions of the courses of the ILA and HLA, and there is no clear standard by which to distinguish between them. This has resulted in confusion among many surgeons during reconstructive flap surgery.

It is therefore clear that a detailed understanding of PA topography is critical for complication-free dermal filler injection to the perioral area and

successful facial reconstruction. Thus the study was performed with the following as its objects.

The first aim of this study was to elucidate the distribution pattern of PA trunk and reproduce the whole course of PA trunk as a polynomial curve analysed by image processing, and suggest accurate references for various minimally invasive clinical procedures and facial reconstruction. The second aim of this study was to describe the various distribution patterns of the vascularization on the upper and lower lip area. The final aim of this study was to clarify the definition of the ILA and HLA, and to elucidate the significance of the HLA in the vascularization of the lower lip.

Ⅱ. MATERIALS & METHODS

1. Materials

In all specimens, latex solution (Neoprene, Lot No. 307L146, DuPont Co., France) with a red colouring agent (Colorant Universel, Castorama Co., France) was injected through the common carotid artery before dissection to enable clear visualization of the FA.

For the study of reproducing the whole course of PA trunk, 59 adult hemifaces (21 bilateral specimens and 17 unilateral specimens) were used. Among the specimens, 19 were from Korean cadavers (from Yonsei University College of Dentistry, Seoul, Korea) and 20 were Thai cadavers (from The Chula Soft Cadaver Surgical Training Center, Chulalongkorn University, Bangkok, Thailand). Twenty-six of the cadavers were male and 13 were female, with a mean age of 73 years (range, 46 - 95 years).

For the study of the vascularization on the upper lip area, 60 hemifaces (24 bilateral specimens and 12 unilateral specimens) were used. Among the specimens, 18 were from Korean cadavers and 18 were Thai cadavers. Twenty-four of the cadavers were male and 12 were female, with a mean age of 73 years (range, 46 - 95 years).

For the study of the vascularization on the lower lip area, 63 hemifaces (26 bilateral specimens and 11 unilateral specimens) were used. Among the specimens, 18 were from Korean cadavers and 19 were from Thai cadavers. Twenty-four of the cadavers were male, and thirteen were female, with a mean age of 73 years (range, 46-95 years).

2. Methods

The skin and subcutaneous tissue of all specimens were first removed, and then a detailed dissection was performed while taking care not to damage the underlying muscles and FA. Finally, the muscles covering PA were cut and retracted to reveal the courses of the PA.

A. The reproducing of the running course of PA trunk

With the exception of a few cases in which the PA trunk terminated before approaching the mouth corner, in most cases, the FA emerged at the mandible margin (FE point) and ascended toward to the ala of nose as the ramification point (R point) of the lateral nasal artery and the inferior alar branch. At first, the location of the R point was measured as polar coordinates: the R point [distance (ℓ) and angle (Θ)]. A plane was established by two axes parallel to the lip line and the facial sagittal midline. The origin of this plane was the lateral corner of the nasal base (NB point). Based on this plane, ℓ and Θ were measured with the aid of digital calipers (CD-15CP, Mitutoyo Co.).

The image processing of the whole course of PA trunk was done as follows (Fig. 1). A line connecting the FE and R points was defined as the perioral line (PO line). The PA trunk runs tortuously along this line, making many intersection points. The FE point was set as the origin of the PO line, and the coordinates of the various intersection points between the PA trunk and PO line and inflection points of PA trunk were measured using digital calipers. These metric data were entered in the Excel software (Microsoft, Redmond, WA, USA) and all courses of FA from FE point to R point were reproduced as graphs in this Excel software. Since the length of the PO line and the proportions of the upper and lower lip areas differ among individuals, the graphs were divided into two portions based on the lip line (cheilion to

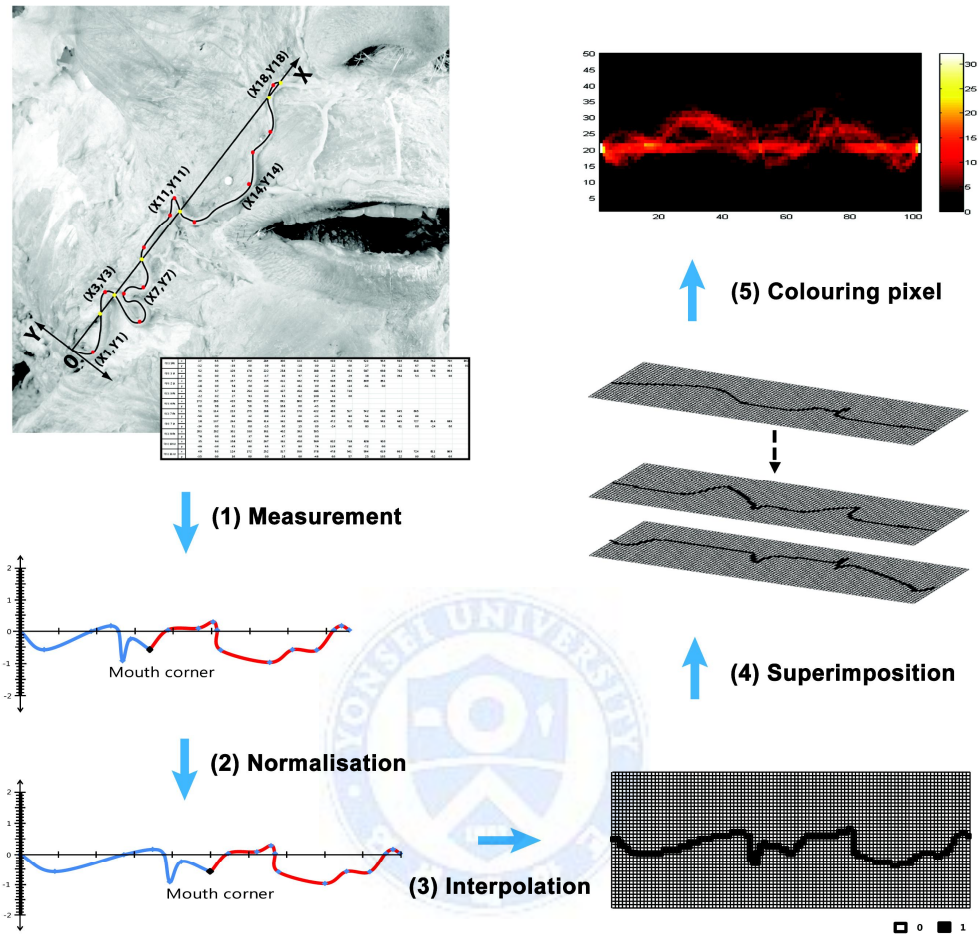

Fig. 1. Image-processing analysis of the course of the perioral artery (PA) trunk.

(1) A line connecting the FE and R points was defined as the perioral line (PO line). The FE point was set as the origin of the PO line and the coordinates of the various intersection points (yellow dots) between the facial artery (FA) and PO line and inflection points (red dots) of PA trunk were measured using digital calipers.

(2) The metric data were entered in the Excel software and all courses of

PA trunk from FE point to R point were reproduced as graphs in this Excel software.

(3) The graphs were divided into two portions based on the lip line (cheilion to cheilion), and the length of the two portions was changed to 50 mm for both.

(4) All graphs were saved as black and white bitmap images (100mm × 50 mm) and it was imported into MATLAB software. This software was programmed to convert all pixels (1 mm × 1 mm) of graph image into a binary scale (black: 1, white: 0)

(5) All binary scale of graph image was superimposed and the superimposing number could be shown as colouring pixel being set in MATLAB software.

cheilion), and the length of the two portions was changed to 50 mm for both. After then, all graphs were saved as black and white bitmap images (100mm × 50 mm) and it was imported into MATLAB (MathWorks, Natick, MA, USA) software. This software was programmed to convert all pixels (1 mm × 1 mm) of graph image into a binary scale (black: 1, white: 0) and superimpose this binary scales. Thus author could observe the superimposing number of all pixels and the superimposing number could be shown as colouring pixel being set in this software.

B. The vascularization on the upper lip area

The SLA is the main artery supplying on the upper lip and branches several nasal septal branches to the nasal septum. First of all, special attention was paid to the precise site of the origin of the SLA (the S point). And then, the muscles covering the SLA were then cut and retracted so that the course of the SLA could be followed. The distribution pattern of the SLA was classified according to its relationship with the FA as follows (Fig. 2):

Type I: The SLA and the alar branch arise directly and separately from the FA.

Type II: The SLA arises directly from the FA and then gives off the alar branch.

Type III: The SLA is the terminal branch of the FA.

Type IV: The SLA is absent.

The topographic course of the SLA was investigated using digital calipers (CD-15CP, Mitutoyo, Japan) and a protractor. First, the location of the S point was measured in polar coordinates [distance (ℓ) and angle (Θ)] relative to the plane established by two axes through the mouth corner: X axis (cheilion to cheilion) and Y axis (parallel to the sagittal midline). The distance (L) and depth (D) of the SLA from the vermilion border of the upper lip were measured

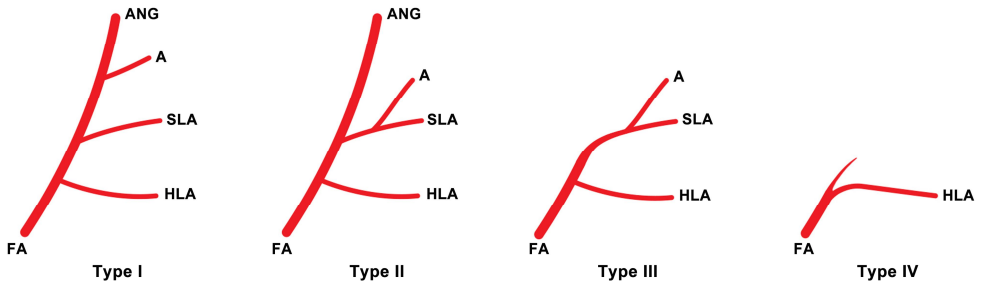

Fig. 2. Schematic diagrams of the four types of superior labial artery (SLA). Type I: the SLA and alar branch both arise directly and separately from the facial artery (FA). Type II: the SLA arises from the FA and then gives off an alar branch. Type III: the SLA is the terminal branch of the FA. Type IV: the SLA is absent. ANG, angular artery; A, alar branch.

at the following four points: the mouth corner (d1), the intermediate point between the peak of Cupid's bow and the mouth corner (d2), the peak of Cupid's bow (d3), and the sagittal midline (d4) (Fig. 3).

C. The vascularization on the lower lip area

As mentioned above, the courses of the ILA and HLA have been described in diverse way in many studies, with the ILA generally being depicted as running along the lower lip margin and the HLA as diverging prior to the ILA. However, in the present study, an artery was not always observed proceeding along the lower lip margin, and the distribution patterns of the ILA and HLA were inconsistent with this aforementioned view. Therefore, the distribution patterns of arteries in the lower lip area were classified based on the assumption that an artery traveling in the middle of the lower lip area is the HLA and an artery running along the lower lip border is the ILA.

The arterial distribution pattern of the HLA was classified into the following three types (Fig. 4):

Type I: The HLA ran horizontally and terminated at muscles or the mandibular periosteum.

Type II: The HLA curved upward to the vermilion border of the lower lip.

Type III: The HLA bifurcated into two branches upward to the lower lip and downward to the mandibular periosteal layer or lower lip muscles.

The ILA was also classified as follows (Fig. 4):

Type A: No ILA was observed running along the lower lip vermillion border.

Type B: The ILA was ramified from the FA at the level of the mouth corner.

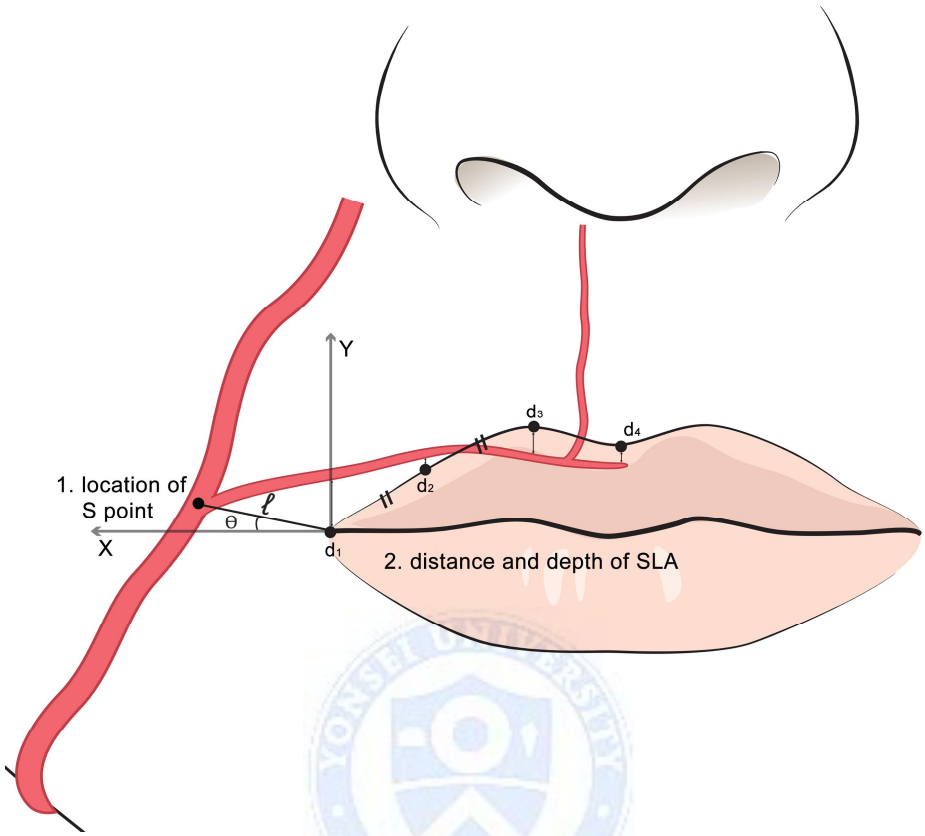

Fig. 3. Measured parameters of the course of the superior labial artery (SLA). 1. Location of the origin of the SLA (the S point): the coordinates of the origin of the SLA (S point; ℓ, Θ) were measured relative to a plane defined by two axes through the mouth corners: X axis (cheilion to cheilion) and Y axis (parallel to the sagittal midline). 2. The distance (L) and depth (D) of the SLA from the upper lip vermilion border was measured at four points: the mouth corner (d1), the intermediate point between the peak of Cupid's bow and the mouthcorner (d2), the peak of Cupid's bow (d3), and the sagittal midline (d4).

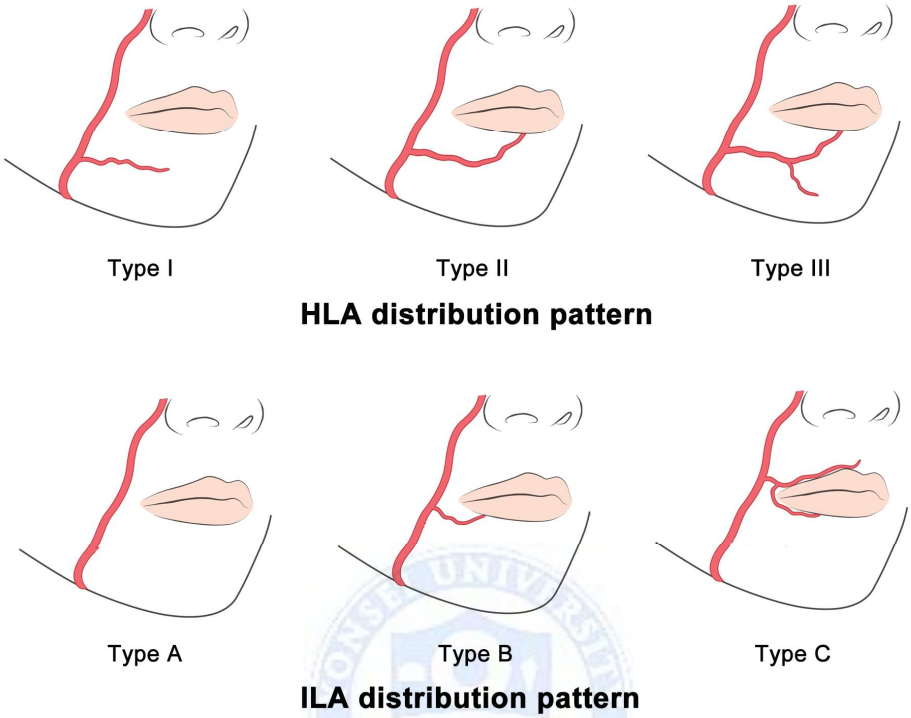

Fig. 4. Distribution patterns of the horizontal labiomental artery (HLA) and inferior labial artery (ILA). The arterial distribution pattern of the HLA was classified into three types: type I, where the HLA ran horizontally and terminated at muscles or the mandibular periosteum; type II, where the HLA curved upward to the vermilion border of the lower lip; and type III, where the HLA bifurcated into two branches upward to the lower lip and downward to the mandibular periosteal layer or lower lip muscles. The ILA was also classified into three types: type A, where the ILA was not observed running along the lower lip vermillion border; type B, where the ILA ramified from the facial artery at the level of mouth corner; and type C, where the ILA arose from the SLA and supplied the lower lip vermillion border.

Type C: The ILA arose from SLA and supplying the lower lip vermillion border.

In most cases, the HLA ran in the intermediate lower lip area under the depressor anguli oris muscle and passed through the depressor labii inferioris, orbicularis oris and mentalis muscles. The specific course of the HLA was elucidated by measuring the distances between the HLA and three points on the horizontal midline of the lower lip area (Fig. 5): inferior to the mouth corner (Lc), inferior to the midpoint between the mouth corner and the facial midline (Lv), and inferior to the facial midline (Lm). When the HLA bifurcated into two branches, the upper branch distributing to the lower lip mucosa was measured.

The lower lip mucosa near the facial midline was supplied by either the ILA or the HLA. The dominant arteries were determined by examining the arteries that terminated at the lower lip mucosa closer to the facial midline in the 26 bilateral specimens. The communication patterns of the ILA and HLA what author could definitely observe in the macroscopic scale were also investigated in these bilateral specimens.

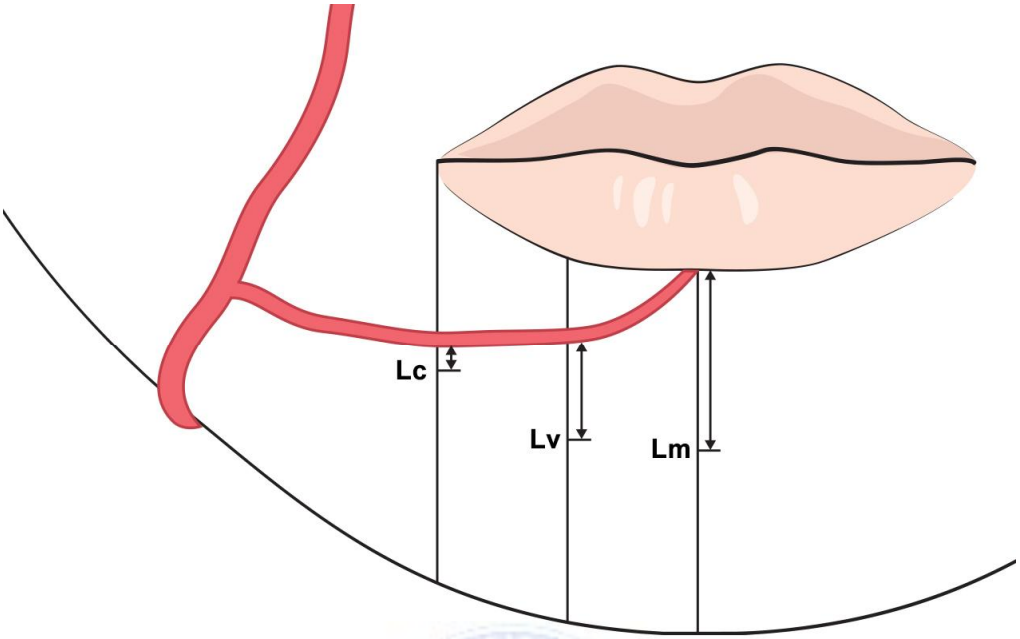

Fig. 5. Measurement of the distances between the horizontal labiomental artery from the horizontal midline between the mandible margin and the vermilion border of the lower lip at three points: inferior to the mouth corner (Lc), the midpoint between the mouth corner and the facial midline (Lv), and the facial midline (Lm).

Ⅲ. RESULTS

1. The reproducing of the running course of PA trunk

The running course of the PA exhibited two patterns: oblique (78.0%, 46/59, Fig. 6A) or vertical (22.0%, 13/59, Fig. 6B). In the oblique pattern, the PA proceeded along the PO line with two or three inflections, while in the vertical pattern it ran along the PO line but then turned medially near the mouth corner, giving off an alar branch parallel to the facial sagittal midline.

The location of the R point differed significantly between the two patterns. In the oblique pattern, the R point was located superolateral to the NB point (4.4±2.7 mm and 13.7±16.2°, mean±SD) in all except two cases. This position was close to the ala of nose. In the vertical pattern, the R point was near the NB point (2.1±2.5 mm and 0.0±0.0°) along the nasal baseline.

Two distinct inflection points in the course of the PA along the PO line appeared at the ramification points of the alar branch (Ra) and the HLA (Rh). While the coordinates of Ra clearly differed between the two PA running patterns, the location of Rh was similar in the two cases (Table 1). The two points were seen as highly overlapping areas in the superimposed image of the course of the PA (Fig. 7).

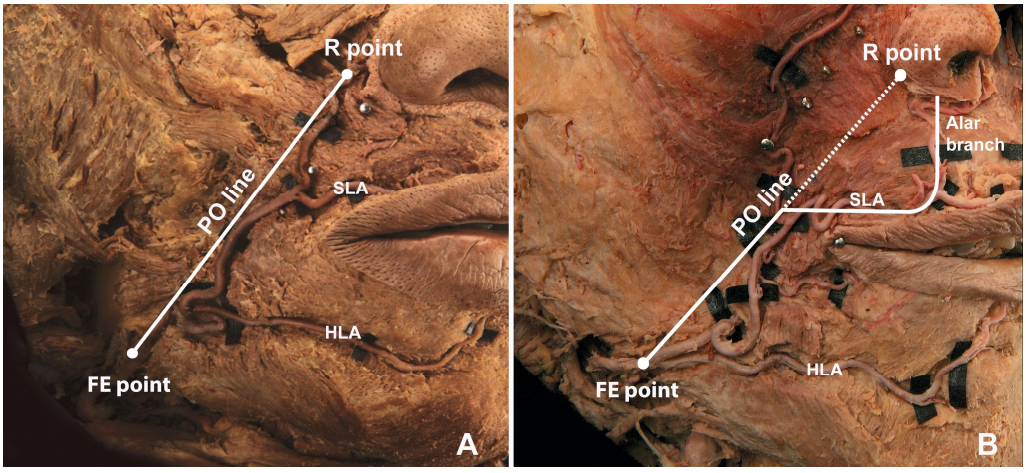

Fig. 6. The distribution patterns of the running course of the perioral artery (PA) trunk. A. Oblique pattern: the PA trunk proceeded along the perioral line (PO line) with some inflections. PO line: the perioral line connecting the facial artery emerging point on the mandible margin (FE point) and the ramification point of the lateral nasal artery and the inferior alar branch (R point). B. Vertical pattern: the PA trunk turned medially near the mouth corner after running along the PO line, giving off an alar branch parallel to the facial sagittal midline.

Table 1. Coordinates of the ramification points of the alar branch (Ra) and the horizontal labiomental artery (HLA) (Rh) based on the perioral line (PO line).

PA running pattern	Ramification point of the HLA (Rh)		Ramification point of the alar branch (Ra)	
	X (%)	Y (mm)	X (%)	Y (mm)
Oblique	23.8±7.7	6.9±6.3	65.7±5.8	6.6±4.3
Vertical	24.9±8.3	4.9±3.4	87.2±5.0	14.7±5.1
All	24.0±7.9	6.5±5.9	70.4±10.7	8.4±5.6

Data are mean±SD values.

X: Position relative to the facial artery emerging point on the mandible margin on the PO line

Y: Absolute linear distance from the PO line

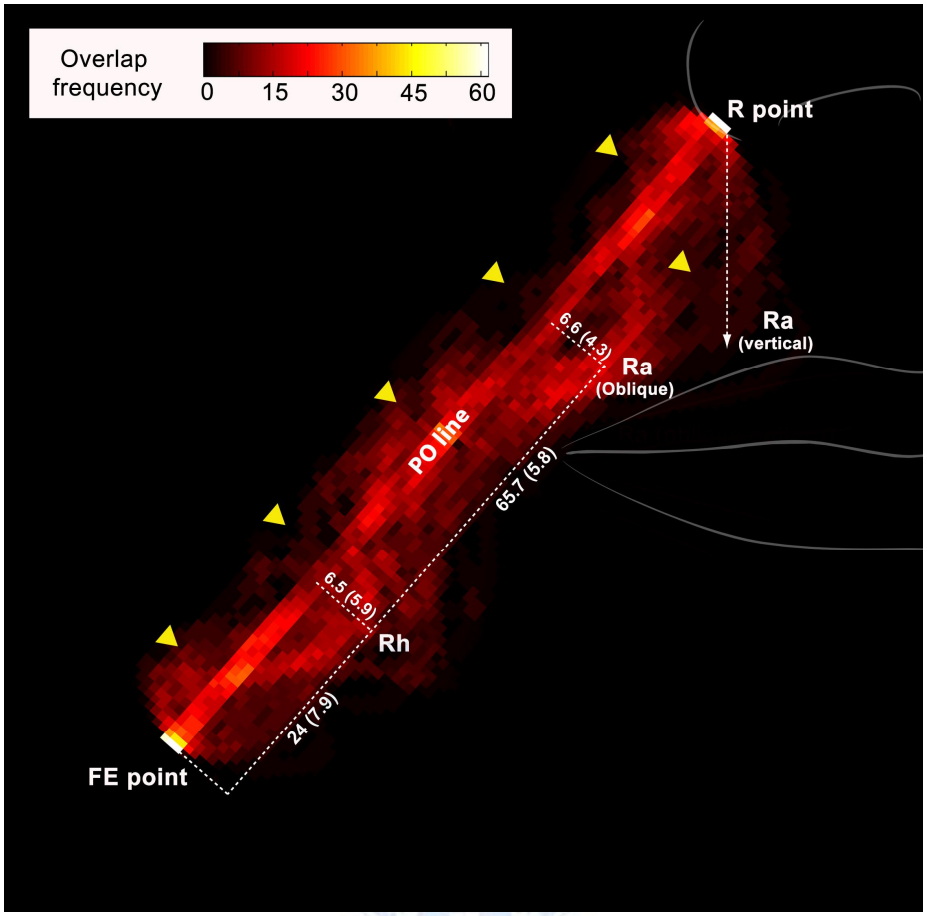

Fig. 7. References (with an overlap frequency >15) of the course of perioral artery. PO line: the perioral line connecting the facial artery emerging point on the mandible margin (FE point), R point: the ramification point of the lateral nasal artery and the inferior alar branch, Ra point: the ramification point of the alar branch (5~10 mm medial to the PO line at the level of lower one-third of the upper lip portion in oblique pattern, while in the vertical pattern it is found more medial to the PO line on the vermillion border of the upper lip), Rh point: the ramification point of the horizontal labiomental artery (5~10 mm medial to the PO line at the level of middle of the lower lip portion in both the oblique and vertical patterns)

2. The vascularization on the upper lip area

Types I - IV were observed in 56.7% (34/60), 21.7% (13/60), 15.0% (9/60), and 6.7% (4/60) of cases, respectively (Fig. 8). In type IV, the upper lip was supplied by the contralateral SLA in 5.0% (3/60) of cases, and by the infraorbital artery (IOA) in 1.7% (1/60).

The SLA sometimes gave off several nasal septal branches, which ran upward to the nasal septum (51/60, 85.0%) and were located either beneath (63.3%, 38/60) or above (21.7%, 13/60) the orbicularis oris muscle. In some cases (15.0%, 9/60) the nasal septal branches supplying the nasal septum arose from the contralateral SLA rather than the ipsilateral SLA.

The S point was located 12.1±3.1 mm (mean±SD) lateral and 42.8±26.9° relative to the mouth corner, and was located within a 1.5-cm-sided square bounded by the X and Y axes in 85% (51/60) of cases (Fig. 9).

The morphometric data regarding the relationship between SLA (D and L) and the vermilion border (d1 - d4) are given in Table 2. The SLA ran superior to the upper lip vermilion border at the mouth corner (Ld1) and the midpoint between the peak of Cupid's bow and the mouth corner (Ld2), but inferior to the vermilion border at the peak of Cupid's bow (Ld3) and the sagittal midline (Ld4). The SLA ran inferiorly to the vermilion border as it coursed medially. There were no significant differences in the depths at each of the measured po ints (i.e., Dd1, Dd2, Dd3, and Dd4).

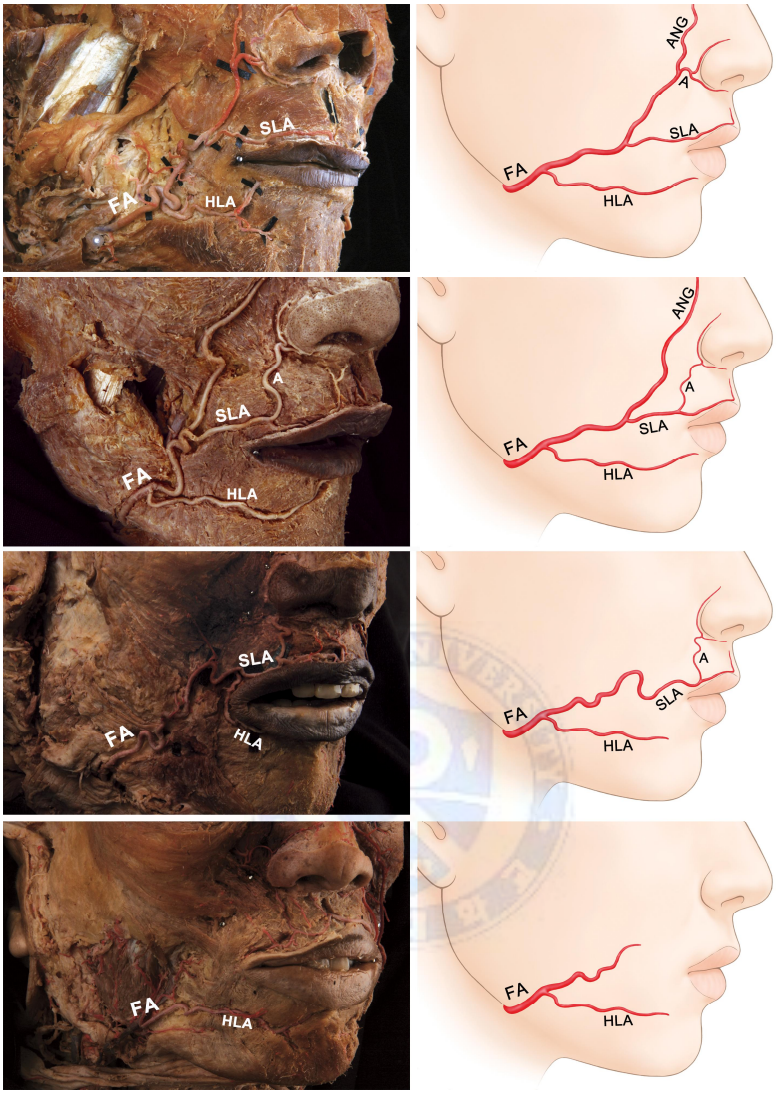

Fig. 8. Four types of the superior labial artery (SLA), defined relative to its relationship with the facial artery (FA) trunk. A. Type I (56.7%, 34/60): the SLA and alar branch arise directly and separately from the FA. B. Type II (21.7%, 13/60): the SLA arises from the FA and then gives off an alar branch. C. Type III (15.0%, 9/60): the SLA is the terminal branch of FA. D. Type IV (6.7%, 4/60): the SLA is absent. FA, facial artery; SLA, superior labial artery; HLA, horizontal labiomental artery; A, alar branch

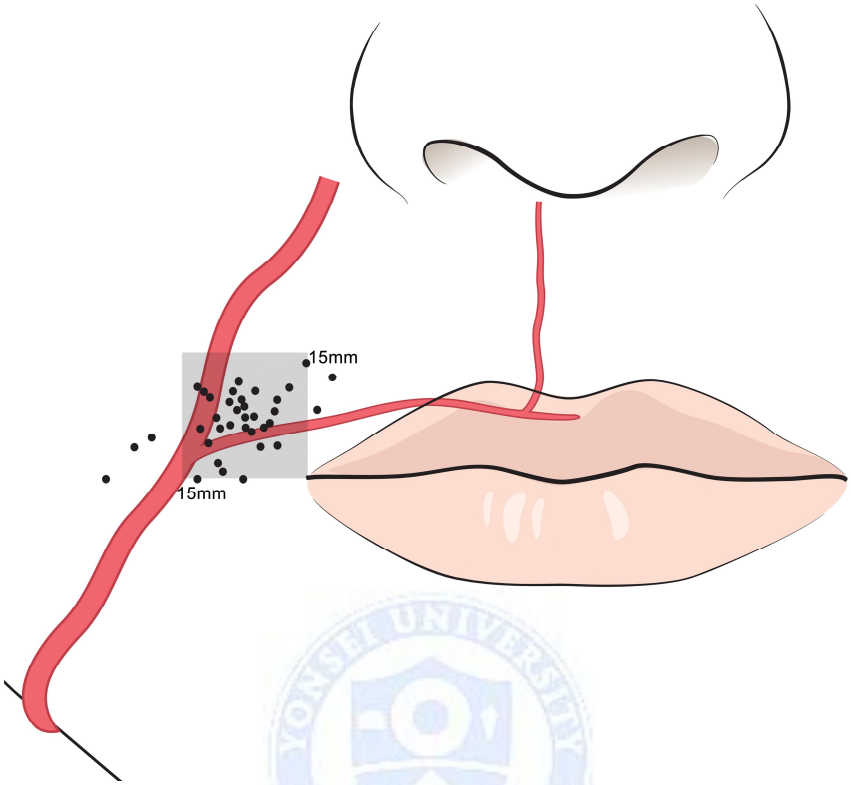

Fig. 9. Location of the S point (the origin of the SLA). The S point (black dots) was located within a 1.5-cm-sided square bounded by the X and Y axes in 85% of cases.

Table 2. Distance (L) and depth (D) of the superior labial artery from the vermillion border of the upper lip.

	L (mm)	D (mm)
Mouth corner (d1)	+8.0±2.1	3.5±1.0
Midpoint between cupid bow peak and mouth corner (d2)	+0.7±2.6	3.3±1.2
Cupid bow peak (d3)	-1.1±2.9	3.8±0.9
Sagittal midline (d4)	-0.6±3.0	3.9±1.3

The data are mean±SD values.

Positive and negative values indicate that the SLA was located superior and inferior to the upper lip vermillion border, respectively.

3. The vascularization on the lower lip area

Types I, II, and III of the HLA were observed in 52.4% (33/63), 39.7% (25/63), and 7.9% (5/63) of cases, respectively, while types A, B, and C of the ILA were observed in 52.4% (33/63), 36.5% (23/63), and 11.1% (7/63) of cases (Fig. 10).

Combining these two classifications revealed the presence of seven types:

Type IA: No ILA was found superior to a type I HLA (14.3%, 9/63).

Type IB: The ILA ran along the vermilion border of the lower lip with a type I HLA (28.6%, 18/63).

Type IC: The ILA arose from the SLA superior to a type I HLA (9.5%, 6/63).

Type IIA: The HLA ran upward to the vermilion border of the lower lip but no ILA was found (30.2%, 19/63).

Type IIB: The ILA ran along the vermilion border of the lower lip superior to a type II HLA (7.9%, 5/63).

Type IIC: The ILA arose from the SLA with a type II HLA (1.6%, 1/63).

Type III: The HLA bifurcated into two branches and no ILA was found. No type B or C ILA was observed with a type III HLA (7.9%, 5/63).

While the type II HLA ran upward to the vermilion border of the lower lip, the type I HLA and the lower branch of the type III HLA terminated in either the periosteal layer (46.0%, 29/63) or the intramuscular layer (15.9%, 10/63; Fig. 11). There were six cases (9.5%, 6/63) in which the HLA traveled to the mental foramen; in one of these six, a mental branch ran upward to the vermilion border of the lower lip (1.6%, 1/63; Fig. 12).

The distance between the HLA and the horizontal midline in the lower lip was 0.4±3.1mm (mean±SD) inferior to the Lc point, 2.1±3.6mm superior to the

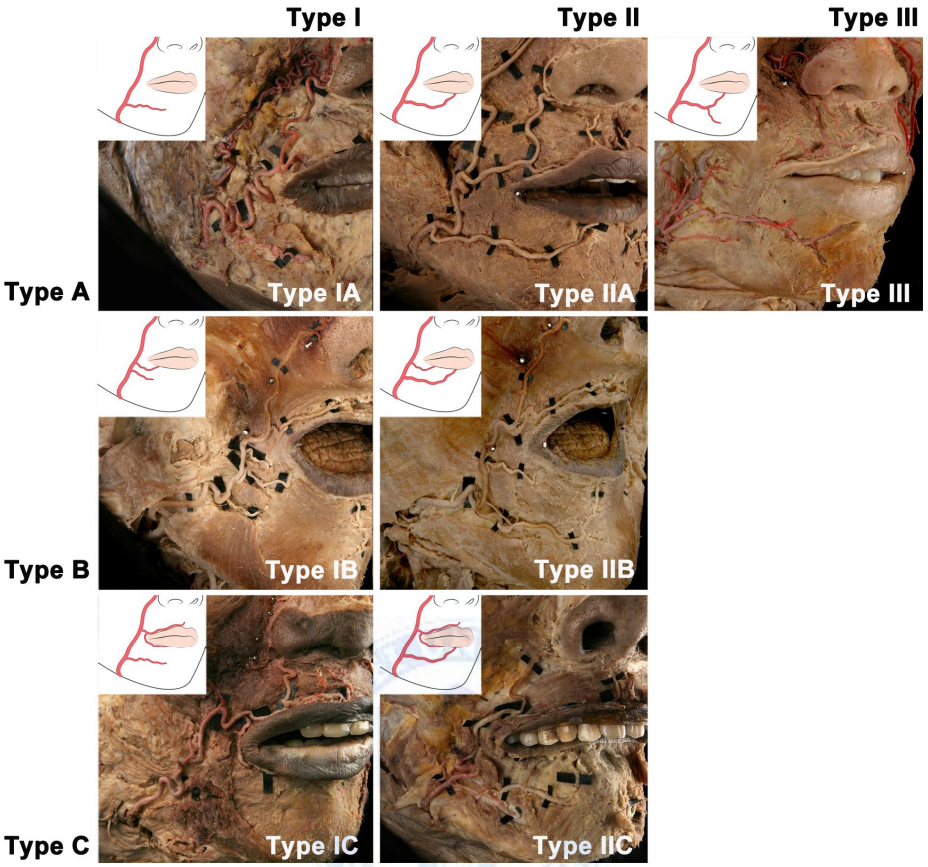

Fig. 10. Classification of the distribution pattern of the arteries in the lower lip. Combining the two classifications of the horizontal labiomental artery (HLA) and the inferior labial artery (ILA) revealed seven types: type IA where no ILA was found superior to a type I HLA; type IB where the ILA ran along the vermilion border of the lower lip with a type I HLA; type IC where the ILA was given off from the SLA superior to a type I HLA; type IIA where the HLA ran upward to the vermilion border of the lower lip, but there was no ILA; type IIB where the ILA ran along the vermilion border of the lower lip superior to a type II HLA; type IIC where the ILA was given off from the SLA with a type II HLA; and type III where the HLA bifurcated into two branches and there was no ILA.

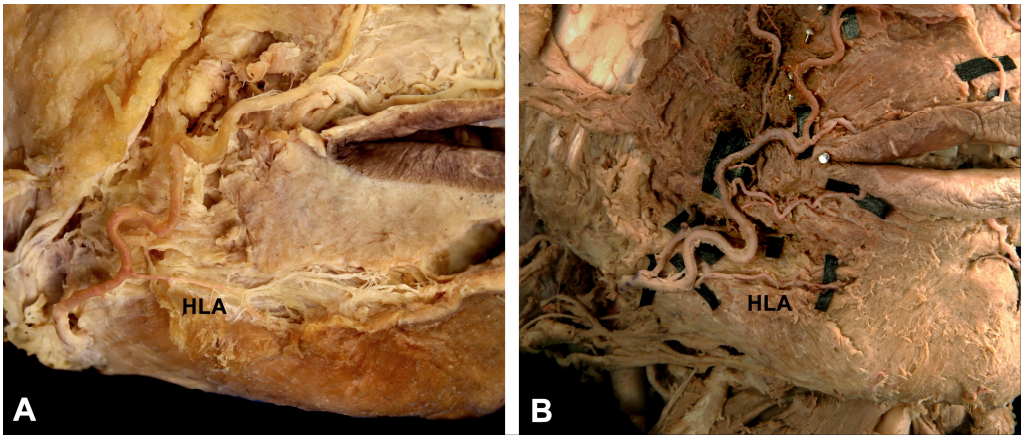

Fig. 11. The layers of types I and III horizontal labiomental artery (HLA). A: The type I HLA terminated in the periosteal layer (46.0%, 29/63). B: The lower branch of a type III HLA in the intramuscular layer (15.9%, 10/63).

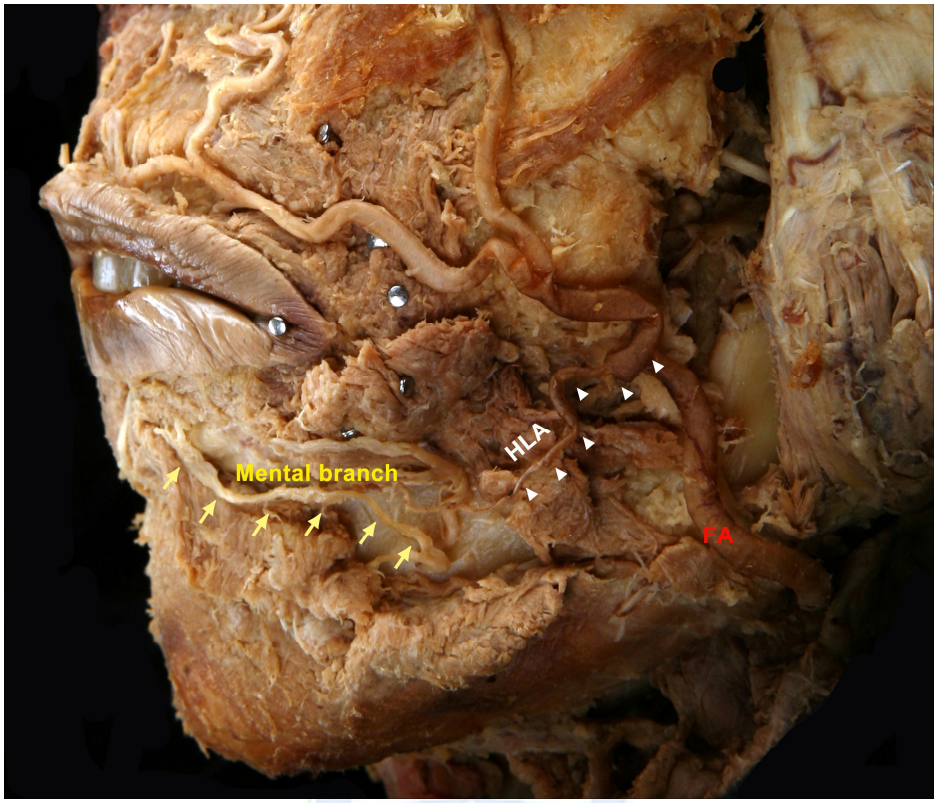

Fig. 12. A mental branch (yellow arrows) running upward to the vermilion border of the lower lip, similar to the course of the type II horizontal labiomental artery (HLA) (white arrowheads).

Lv point, and 8.7±3.3mm superior to the Lm point (Table 3). While all courses of types I and III HLA terminated before they approached the facial midline, the type II HLA reached the facial midline in 16.7% (4/24).

In most cases, the arterial distribution type differed between the two sides (73.1%, 19/26), and the lower lip mucosa near the facial midline was supplied from the ILA in type I, and from the HLA in types II and III (92.3%, 24/26). There were only two cases in which no artery was distributed in this area. The HLA on the right side supplied the lower lip mucosa near the facial midline in 50.0% (13/26) of cases (Table 4).

The HLA or ILA on both sides communicated with each other in 19.2% (5/26) of cases, but the types of communication varied. The ILA on both sides communicated near the lower lip vermillion border in 7.7% (2/26) of cases, and the HLA communicated with the ILA on the other side in 7.7% (2/26). Furthermore, there was one case (3.8%) in which the HLA on both sides communicated at the lower lip vermillion border with an inverted U shape (Fig. 13).

Table 3. Distance between the horizontal labiomental artery and the horizontal midline in the lower lip between the inferior mandible margin and the vermilion border of the lower lip.

		Lc	Lv	Lm
Type I	Termination (%)	73.5	26.5	0.0
	Distance (mm)	-0.9±3.7	0.7±5.2	
Type II	Termination(%)	4.2	62.5	16.7
	Distance (mm)	- 0.3±1.6	2.8±2.6	8.7±3.3
Type III	Termination (%)	60.0	40.0	0.0
	Distance (mm)	1.8±2.3	2.6±2.0	
Total	Termination (%)	50.8	42.9	6.3
	Distance (mm)	- 0.4±3.1	2.1±3.6	8.7±3.3

The data are mean±SD values.

Positive and negative values mean that the superior labial artery is located superior and inferior, respectively, to the upper lip vermilion border.

Lc: the point on the horizontal midline inferior to the mouth corner

Lv: the point on the horizontal midline inferior to the midpoint between the mouth corner and the facial midline

Lm: the intersection point between the horizontal midline and the facial midline

Table 4. Dominant artery on the lower lip mucosa near the facial midline.

	Right	Left	Both	No	Total
HLA	13 (50.0%)	3 (11.6%)	1 (3.8%)		
ILA	1 (3.8%)	-	2 (7.7%)	2 (7.7%)	
Both	-	-	4 (15.4%)		
Total	14 (53.8%)	3 (11.6%)	7 (26.9%)	2 (7.7%)	26 (100.%)

HLA: horizontal labiomental artery

ILA: inferior labial artery

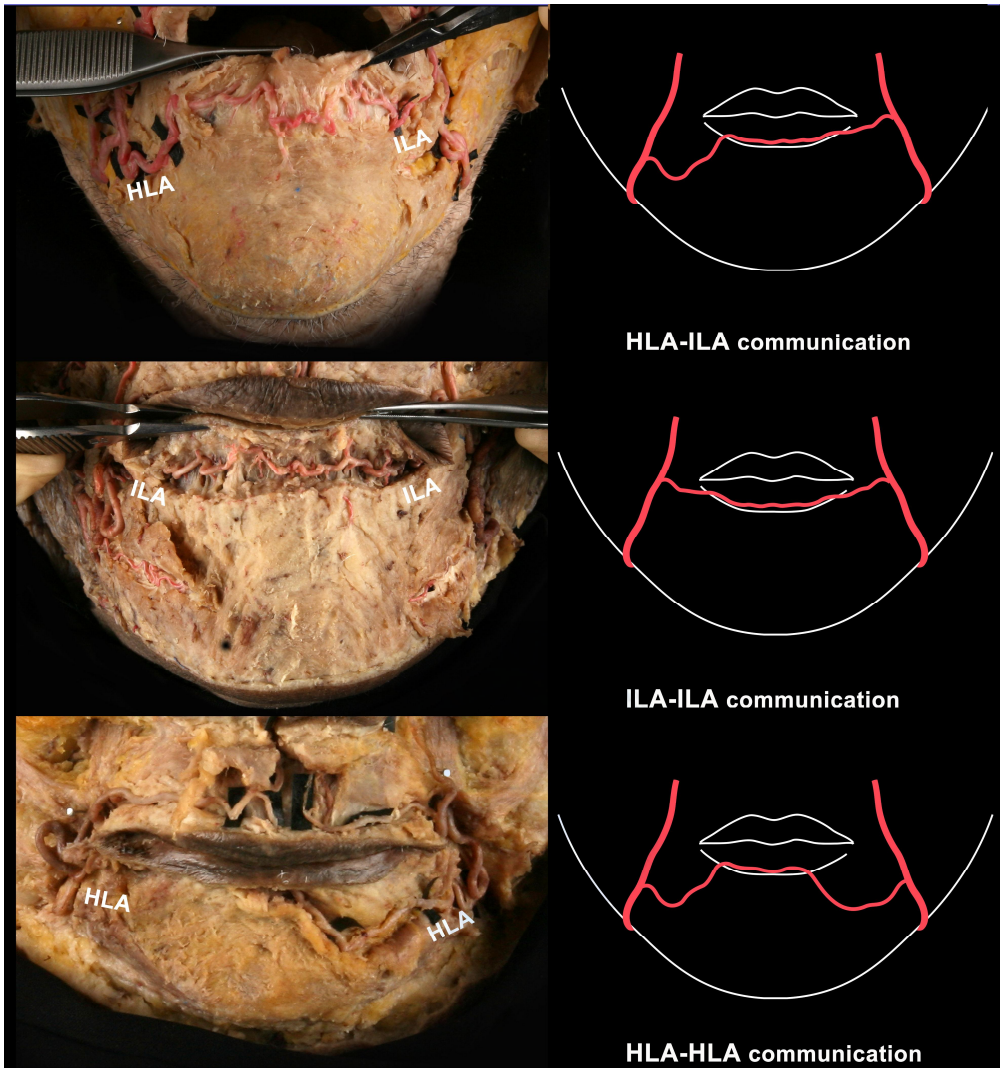

Fig. 13. Communication patterns of the horizontal labiomental artery (HLA) and the inferior labial artery (ILA) on both sides. The ILA on both sides communicated near the lower lip vermillion border in 7.7% (2/26) of cases, and the HLA communicated with the ILA on the other side in 7.7% (2/26). In addition, the HLA on both sides communicated at the lower lip vermillion border with an inverted U shape in one case.

Ⅳ. DISCUSSION

1. The reproducing of the running course of PA trunk

Image processing was used in this study to reveal the common course of the PA trunk on the face based on three reference points: the PO line, Ra point and Rh point (Fig. 7). The PO line is the line connecting the FE and the R point. There is a facial pulse that can be palpated at the FE point (at the mandibular border), and the R point can be identified as the point next to the ala of the nose. The position of the Ra point (ramification of the alar branch) differs according to the PA trunk running pattern. In the oblique pattern it is located within the upper inflection of the PA trunk at the upper lip portion, 5~10 mm medial to the PO line at the level of lower one third of the upper lip portion in oblique pattern, while in the vertical pattern it is found more medial to the PO line on the vermillion border of the upper lip (Table 1). The Rh point (ramification of the the HLA) is located at the lower inflection of the PA trunk at the lower lip, 5~10 mm medial to the PO line at the level of middle of the lower lip portion (in both the oblique and vertical patterns).

Contrary to previous topographic reports that have provided absolute values for various parameters of PA measurement (Dupoirieux et al., 1999; Koh et al., 2003; Park et al., 1994; Perkins and Sandel, 2007), the locations of the ramifications of the PA are here reported relative to clinical and anatomical reference points. References such as the PO line, Ra and Rh (used for the first time herein) are readily accessible and easily identifiable on the face, irrespective of the variability of facial dimensions, and will thus be useful landmarks for physicians prior to clinical interventions. The locations of these references were confirmed based on the overlap frequency (>15) in each

bitmap image at the PO line and two inflection points. Clinically, these references should be considered as the danger zone during the injection-based treatments.

The main difference between the two PA trunk running patterns was the location of Ra. There is a small vacant area at the upper lip below the nasal base between the two courses of PA trunk. In addition, the lateral aspect of the PO line can be considered as a clinically safe region because in all cases the PA trunk inflected medially with reference to the PO line. Based on these results, the entry point of needle or cannula during injection-based treatments should be at these two vacant areas in order to avoid vascular damage (Fig. 14).

Conversely, the danger zones identified for injection-based treatments could be applied as the safety zone for the surgical flap procedures. Given the importance of adequate vascularization of the flap pedicle, a nasolabial flap should be designed along the PO line and two inflection points (Goldman, 2013), thus including the PA trunk. The nasolabial fold is sometimes considered as a surface landmark for the location of the PA trunk (Pessa, 2012), and the nasolabial area can be used as a donor site when reconstructing defects in the perioral region (Smit et al., 2009). However, in the vertical PA trunk running pattern, the alar branch runs parallel to the facial sagittal midline, and in 22% of cases the arteries were rarely found beneath the nasolabial fold skin. Therefore, surgical flap manipulation should be implemented carefully to avoid injury to the PA trunk in the vertical pattern.

The distribution area of the PA trunk was examined in the present study using a recently developed image-processing protocol in which two-dimensional images are digitized to form arrays of finite-length binary words (Gonzalez, 2004). Medical image science is making great progress and it is possible to acquire the multi-dimensional coordinates data of various anatomical structures.

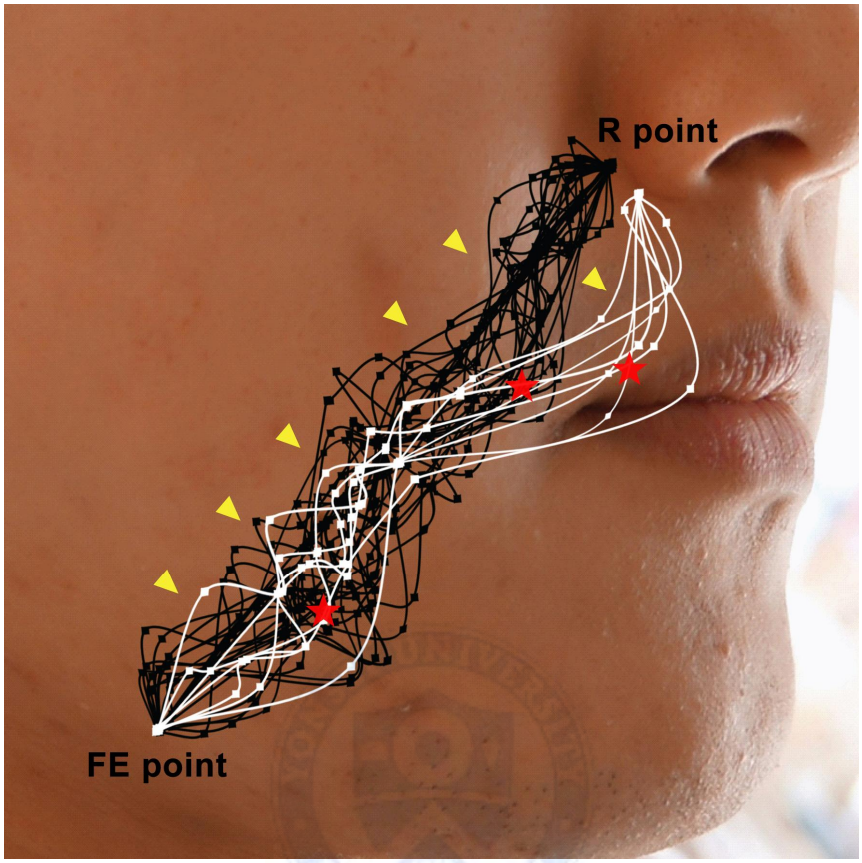

Fig. 14. The course of the perioral artery (PA) and safety zone for clinical use acquired from image processing: the PA ran along the perioral (PO) line and inflected twice near the Ra and Ri points. The position of the Ra point (ramification of the alar branch) differed according to the PA running pattern. In the oblique pattern (middle star) it is located within the upper inflection of the facial artery at the upper lip portion, 5~10mm medial to the PO line at the level of the lower third of the upper lip in oblique pattern, while in the vertical pattern (right star) it is located in the vermillion border of the upper lip under the ala of nose. The Rh point (ramification of the horizontal labiomental artery, left star) is located at the lower inflection of the facial artery in the lower lip, 5~10mm medial to the PO line at the level of the middle of the lower lip (in both the oblique and vertical patterns). The lateral aspect of the perioral line and the small empty area between the two courses of the perioral artery (arrowheads) can be considered to be clinically safe.

Wolff et al. reported that the magnetic resonance angiogram could be used to evaluate the main and small vessels in the lower leg. Furukawa et al. also visualized the FA by using computed tomographic angiography. If author apply the multi-dimensional data to the image processing protocol, author could acquire more precise positional information of anatomical structure and these findings will be helpful in various surgical and non-surgical treatments. Furthermore, this digital positional information could be accumulated and has shown the potentially wide-ranging usefulness of image-processing analysis in various research area.

2. The vascularization on the upper lip area

The findings of the present study provide information regarding the possible permutations of the courses and branches of the SLA that could be approximated on the facial skin. In 85% of cases, the S point was located within a 1.5 cm sided square superolateral to the mouth corner. After the SLA branched from FA, in most cases it ran superior to the vermilion border under the orbicularis oris muscle, with a minimum depth of 3 mm. It then coursed inferior to the vermilion border before approaching the peak of Cupid's bow. At the sagittal midline, the nasal septal branch ramified from the SLA and ran upward to the nasal septum along the sagittal midline.

This course of the SLA along the vermilion border represents important knowledge for lip augmentation using dermal filler injection. The standard procedure for upper lip augmentation involves injecting dermal filler into the submucous layer of the upper lip. Since most of the SLA appears to travel under the orbicularis oris muscle, injecting dermal filler above the orbicularis oris muscle would avoid the critical complications related to the lip-augmentation procedure. However, in 25% of cases the nasal septal

branches ran on top of the orbicularis oris muscle and the SLA ran 1 4 mm inferior to the vermilion border after passing the peak of Cupid's bow. Thus, lip augmentation near the midline should be performed carefully, with dermal filler being injected into the upper lip at a depth of 3 mm.

There are two arteries related to the nasolabial fold that are prone to damage during dermal filler injection: (1) the FA trunk in type I and (2) the alar branch in types II and III (Park et al., 1994; Standring, 2008). The FA follows a common course between the S point and the alar-facial crease in type I. On the other hand, the alar branch arose from the SLA near the mouth corner in types II and III, and ran to the alar-facial crease instead of the FA in type I. Furthermore, the FA in type II always detoured to the medial side of the orbit along the lower margin of the orbicularis oculi muscle.

In those cases in which the nasal septal branch did not arise from the ipsilateral SLA, the contralateral nasal septal branch always supplied the nasal septum. This complementary arterial distribution was found in type IV, where the SLA was absent. In such cases the vascularization from the FA was limited in the lower lip area. Thus, the ipsilateral IOA or the contralateral SLA supplying the area near the midface appeared to be more developed with regard to both diameter and length (Fig. 15).

This study examined the various distribution patterns and common courses of the SLA relative to soft-tissue landmarks such as the mouth corner and the peak of Cupid's bow, with a view to enabling successful and complication-free dermal filler injections. Also, the findings of this study show that in most cases the origin of the SLA appears to be located within a 1.5-cm-sided square superolateral to the mouth corner. This origin of the SLA may be estimated by placing a thumbnail beside the mouth corner (Fig. 16). Thus, clinicians should recognize the courses of SLA during lip augmentation and injection in depth of 3 mm. Author believe that these findings will be helpful

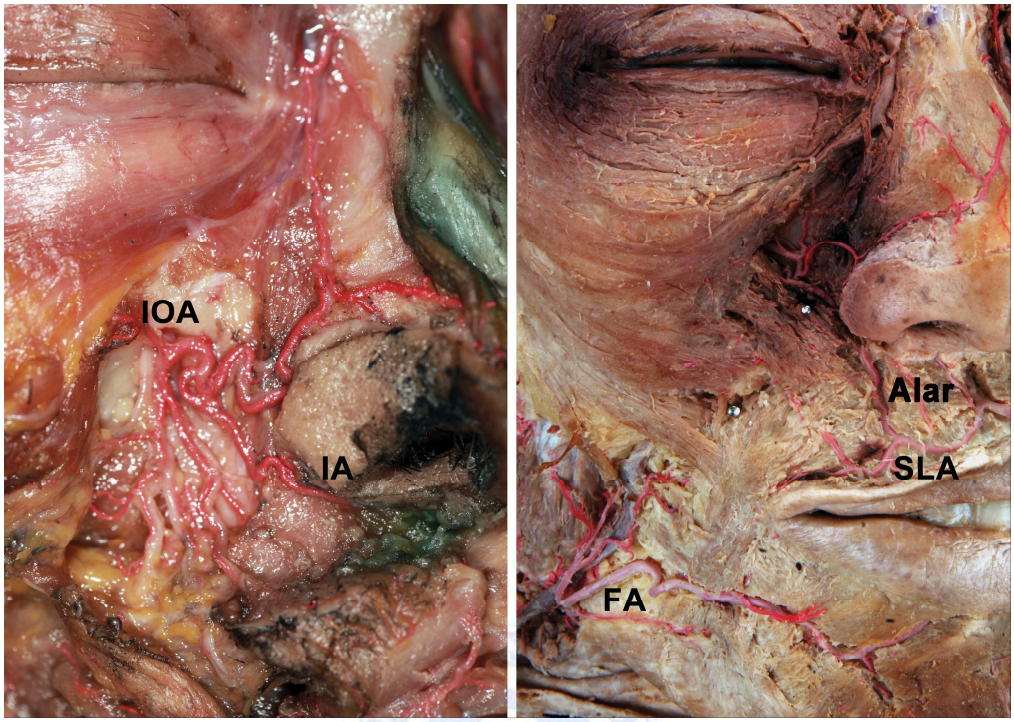

Fig. 15. Complementary arterial distribution patterns in type IV. When the SLA was absent, the ipsilateral IOA (A) or the contralateral SLA (B) supplied the midface. In both cases the supplying arteries were excessively developed in terms of both diameter and length. SLA, superior labial artery; IOA, infraorbital artery; IA, inferior alar branch; Alar, alar branch; FA, facial artery

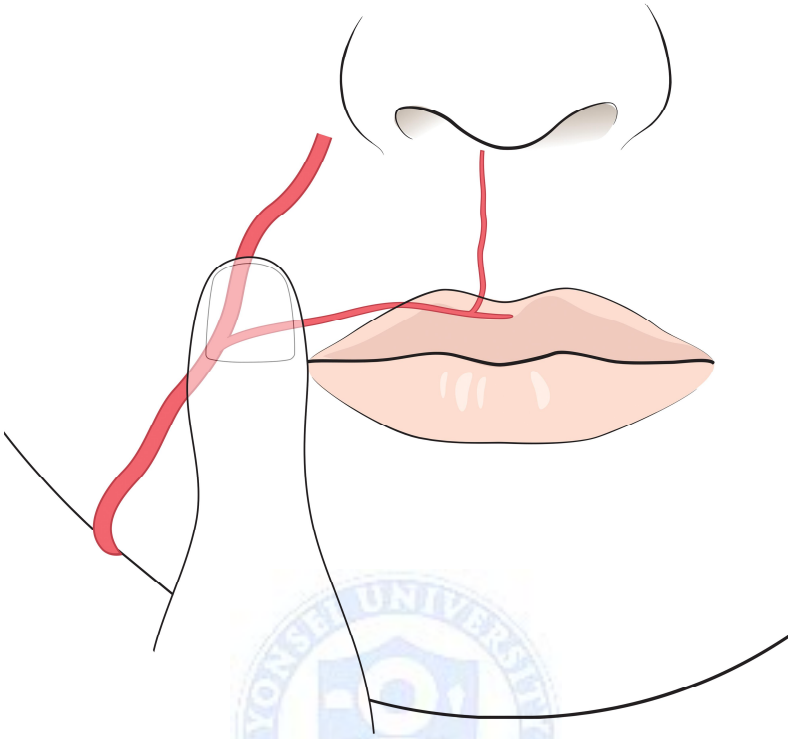

Fig. 16. The S point (the origin of the superior labial artery) may be estimated by placing a thumbnail beside the mouth corner.

not only for dermal filler injection, but also for other injectable treatments to the upper lip area.

3. The vascularization on the lower lip area

Lower lip reconstruction flap surgeries such as Abbé flap, vermilion advancement flap, and cross-lip vermilion flaps are all ILA-based flaps. (Ahmadi et al., 2012) Thus, the anatomy of the ILA has been well documented since it was thought to be the main artery supplying the lower lip, regardless of its origin is. Crouzet et al. reported that not only the classical course along the vermilion border of the lower lip but also the path running horizontally in the lower lip area and turning upward near the facial midline could be considered to be the common course of the ILA (Crouzet et al., 1998); the latter described course of the ILA corresponds to the type II HLA in the present study. Kawai classified the arterial distribution patterns in the lower lip, and initially mentioned the HLA (Kawai et al., 2004). However, only the origin of the ILA was considered in that classification, and all courses of the ILA were depicted as running along the vermilion border of the lower lip. Moreover, the HLA has been described consistently as arising from the FA near the inferior border of the mandible. Pinar et al. examined the various courses of the HLA, but they also defined the artery approaching the vermilion border of the lower lip as the ILA (Pinar et al., 2005).

On the other hand, some anatomists and surgeons have recognized that the artery traveling in the middle of the lower lip area could be something other than the ILA. Park et al. reported that a horizontal mental branch traversed the lower lip area in four cadavers (44.4%, 4/9) and that of the external diameter of the branch was larger than that of the ILA (Park et al., 1994). This branch of the FA was related to the type I HLA in the present study,

and the external diameter was also larger than that of the ILA in the present study. Edizer et al. named the artery running middle of the lower lip area as the sublabial artery, and Loukas et al. distinguished the branch supplying the periosteal layer from the ILA and named it the cortical branch (Edizer et al., 2003; Loukas et al., 2006).

Taking into account all of the aforementioned description, the artery distributing at the vermilion border of the lower lip was commonly defined as the ILA, and the artery running horizontally in the middle of the lower lip area was generally regarded as the HLA. However, this definition has some problems. First, different criteria are used for each of these definitions: the definition of the ILA is based on its distributing area while that of the HLA is based on the location of its origin. Second, these criteria are not applicable to arteries arising from the middle of the lower lip area and running upward to the vermilion border of the lower lip (type II HLA), since this artery type has characteristics of both the HLA and ILA.

The findings of the present study suggest that the artery running in the middle of the lower lip area is the HLA, and this is a reasonable assumptions based on the following considerations. First, the HLA consistently passed near to the Lc point on the horizontal midline in the lower lip area. Second, the mental branch also supplied the lower lip, similar to the type II HLA. If this type II was considered to be the ILA according to its distributing area, the mental branch would also be recognized as the ILA. Thus, the ILA and HLA should be differentiated based on the locations of their origins.

The distribution patterns of the arteries in the lower lip were classified into seven types by combining the HLA and ILA classifications. While a type B ILA was observed most frequently with a type I HLA (28.6%, 18/63), a type A ILA occurred most frequently with types II and III HLA. This suggests that if the HLA supplies the lower lip mucosa (i.e., types II and III), the ILA is

only weakly developed (type A), but if the HLA does not supply the lower lip mucosa (i.e., type I), the ILA contributes the blood supply of the lower lip (i.e., type B). Thus, the HLA could be considered as the main artery supplying the lower lip mucosa.

The present study found that the HLA arose from the FA in the middle of the lower lip area and that the ILA diverged from the FA or SLA at the level of the mouth corner. Given these distribution patterns, the flap design during lower lip reconstruction should be performed differently from the traditional method. Since the existence of the ILA is not assured near the vermilion border of the lower lip, the use of angiography is recommended before performing any related surgical intervention. Furthermore, the HLA rather than the ILA should be considered as being grafted in the pedicle. The HLA can be presented in the middle of the lower lip area inferior to the mouth corner, and sometimes (46.0%) be inclined gradually to the lower lip border near the facial midline. Thus, the surgeons should design the pedicle on the lateral side to be longer than on the medial side. Also, the donor site inferior to the mouth corner could be used as the free flap for the reconstruction of the lower lip area (Fig. 17). This study has provided an anatomical description of the arterial distribution in the lower lip and lower lip area, and the findings suggest that the main anatomic landmark for flap surgery should be the mouth corner. This information should increase the confidence of surgeons when they are harvesting lip-reconstruction flaps.

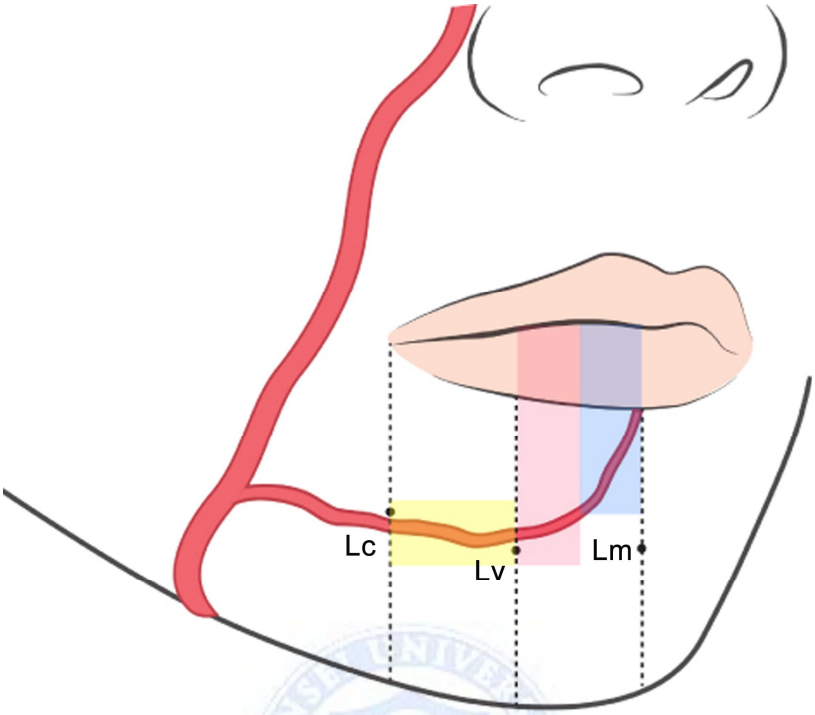

Fig. 17. The common course of the horizontal labiomental artery (HLA) and related donor site for the lower lip reconstruction. The HLA can be presented in the middle of the lower lip area inferior to the mouth corner, and sometimes be inclined gradually to the lower lip border near the facial midline. Thus, surgeons should design the pedicle on the lateral side (red box) to be longer than on the medial side (blue box). Also, the donor site inferior to the mouth corner (yellow box) could be used as the free flap for the reconstruction of the lower lip area. Lc : the point on the horizontal midline of the lower lip area inferior to the mouth corner, Lv : the point on the horizontal midline of the lower lip area inferior to the midpoint between the mouth corner and the facial midline, Lm : the point on the horizontal midline of the lower lip area inferior to the facial midline.

Ⅴ. CONCLUSION

The conclusions of this study are as follows.

1. The course of the PA (FA trunk, alar branch, SLA, ILA, HLA) on the face can be predicted when performing minimally invasive treatments based on the following references

PO line - the line connecting the emerging point of FA on the mandible margin and the ala of nose

Ra point - the ramification point of the alar branch (5~10 mm medial to the PO line at the level of lower one-third of the upper lip portion)

Rh point - the ramification point of the horizontal labiomental artery (5~10 mm medial to the PO line at the level of the middle of the lower lip portion)

S point - the origin of the SLA (a 1.5-cm-sided square superolateral to the mouth corner)

Lc point - the origin of the HLA (the middle of lower lip below the mouthcorner)

2. The SLA branched from FA at the S point, and it ran along the vermilion border under the orbicularis oris muscle, with a minimum depth of 3 mm. At the sagittal midline, the nasal septal branch ramified from the SLA and ran upward to the nasal septum along the sagittal midline.

3. The HLA arose from the FA in the middle of the lower lip area and the ILA diverged from the FA or SLA at the level of the mouth corner. And the HLA could be considered as the main artery supplying the lower lip mucosa.

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Abstract (in korean)

최소침습시술을 위한 입주위 동맥 주행에 관한 연구

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이 상 희

얼굴동맥은 바깥목동맥의 가지로서 아래턱을 감고 올라와 얼굴 전반에 분포하는 동맥이다. 특히 얼굴동맥은 입술턱끝선, 입옆팔자주름, 코를 경계로 하는 입주변에 혈류를 공급하는데, 이 부위에 분포하는 얼굴동맥의 줄기, 위입술동맥, 아래입술동맥, 가로턱입술동맥을 묶어 입주위동맥이라 한다.

필러시술은 주름, 흉터를 제거하고 얼굴연조직의 볼륨감을 높여주기 위한 미용시술이다. 하지만 필러의 혈관 내 주입은 입술 및 콧방울 괴사라는 합병증을 일으킬 수 있다. 얼굴재건을 위한 피판수술의 성공은 혈관의 적절한 이식이 매우 중요한데 이 때 입주위동맥이 이식에 많이 쓰인다. 따라서, 필러시술 및 얼굴재건수술에 있어서 입주위동맥의 해부학을 이해하는 것이 매우 중요하다. 하지만 이 동맥들의 해부학적 위치를 정확히 제시 하고 있는 선행연구는 많지 않다.

따라서 본 연구는 다음과 같은 목표를 바탕으로 시행되었다. 첫째, 구불구불하게 주행하는 입주위동맥 줄기의 경로를 다항곡선으로 재현하여 정확한 위치정보를 획득하고 최소침습시술을 위한 기준점을 제시하고자 한다. 둘째, 위입술과 아래입술에 분포하는 동맥의 주행을 기술하고자 한다. 셋째, 아래입술동맥과 가로턱입술동맥의 정의를 분명히 하고, 가로턱입술동맥의 중요성을 밝히고자 한다.

입주위동맥 줄기의 주행을 재현하기 위한 연구를 위해 19구의 한국인 성인시신과 20구의 태국인 성인시신으로부터 반쪽얼굴 59쪽 (남자 26, 여자 13; 평균연령 73세)을 사용하였다. 위입술부위에 분포하는 동맥의 주행을 연구하기 위해 18구의 한국인 시신과, 18구의 태국인 시신으로부터 반쪽얼굴 60쪽 (남자 24, 여자 12; 평

균연경 73세)을 사용하였다. 아래입술부위에 분포하는 동맥의 주행을 연구하기 위해 18구의 한국인 시신과, 19구의 태국인 시신으로부터 반쪽얼굴 63쪽 (남자 24, 여자 13; 평균연령 73세)을 사용하였다.

얼굴동맥이 아래턱을 감고 올라오는 부위와 콧방울을 이은 선을 PO line으로 설정하고 입주위동맥 줄기의 주행을 분석한 결과 두 가지 유형이 나타났다. 78%에서 입주위동맥은 PO line을 따라 주행하였으나 (oblique pattern), 22%에서 입주위동맥은 PO line을 따라 주행하다가 입꼬리부위에서 안쪽으로 꺾여 들어간 후 콧방울가지를 분지하는 형태 (vertical pattern)를 보였다.

입주위동맥 줄기의 주행은 PO line, Rh point (아랫입술부위 1/2지점, PO line으로부터 5~10mm 안쪽으로 떨어진 점), Ra point (위입술부위 1/3지점, PO line으로부터 5~10mm 안쪽으로 떨어진 점)를 기준으로 예측할 수 있다. 입주위동맥은 주로 PO line을 따라 주행하는 양상을 보이지만, Rh point와 Ra point 점에서 안쪽으로 떨어주행한다.

위입술동맥이 얼굴동맥으로부터 분지되는 지점을 S point라 하고 입꼬리를 기준으로 좌표를 계측한 결과 S point는 입꼬리의 위가쪽에 위치한 1.5cm의 사각형 안에 주로 위치하였다. 이 점은 엄지손톱의 아래쪽 경계를 입꼬리에 위치시켜 예측할 수 있다. 얼굴동맥으로부터 분지된 위입술동맥은 위입술경계를 따라 입둘레근 깊이 3mm의 깊이로 주행하다가 얼굴중심선 근처에서 코기둥동맥을 내면서 끝난다

가로턱입술동맥의 위치는 아랫입술부위 1/2 지점으로 예측할 수 있으며 46%에서 아랫입술부위를 향해 올라가는 주행을 보였다. 아래입술동맥은 입꼬리근처에서 얼굴동맥 혹은 위입술동맥에서 분지되었다. 아랫입술부위에 혈류를 공급하는 주요동맥으로 아래입술동맥보다 가로턱입술동맥이 고려될 수 있다.

핵심되는 말 : 입주위동맥, 얼굴동맥, 위입술동맥, 아래입술동맥, 가로턱입술동맥, 필러주사, 피판재건수술