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ANATOMIC VARIATIONS

Anatomical courses of the deep and superficial septal branches of the superior labial artery in the columella and nasal tip for use in clinical rhinoplasty and reconstructive surgeries

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Abstract

Purpose Understanding the detailed course of the septal branch of the superior labial artery is crucial for improving the safety and efficacy of both invasive and noninvasive nasal procedures. This study aimed to clarify the anatomical courses and variations of the deep and superficial septal branches of the superior labial artery in the columella, with particular attention paid to their clinical implications in rhinoplasty and reconstructive surgeries.

Methods The deep and superficial septal branches of the superior labial artery were examined in 40 Korean embalmed cadavers. Detailed dissections were performed to trace the course of the septal branch, measure its diameter, and document its branching patterns.

Results The deep septal branch of the superior labial artery arose from the middle portion of this artery, coursing anteriorly just below the septal cartilage. It emerged between the superior border of the orbicularis oris and the septal cartilage, ascending toward the nasal tip in 90.0% of cases. The branch divided into two main branches at the upper (27.5%), middle (5.0%), and lower (47.5%) levels of the columella. In another 10.0% of cases the branch either did not ascend to the columella or only reached the middle level. The superficial septal branch was found to anastomose with the deep septal branch at the columellar base in several cases, and its diameter varied, being thicker than the deep septal branch in some cases. The superficial septal branch also exhibited various branching patterns that contributed significantly to the vascularization of the columella and nasal tip.

Conclusion This study has yielded comprehensive anatomical data on the deep and superficial septal branches of the superior labial artery, highlighting its clinical significance in nasal surgeries and procedures. These findings offer valuable insights for optimizing procedural outcomes and minimizing complications in rhinoplasty and reconstructive surgeries.

Keywords Columella artery · Deep septal branch · Superficial septal branch · Superior labial artery · Rhinoplasty

Introduction

The columella and tip of the nose area are frequently involved in rhinoplasty and reconstructive surgeries, which makes the arterial distribution in this area an important consideration during clinical procedures [3, 7, 11]. The nasal tip and supratip of the nose area, which form the upper part of the columella, are supplied by the lateral nasal artery, the dorsal (external) nasal artery, inferior alar branch, and the septal branches of the superior labial artery [9].

The superior labial artery is a branch of the facial artery that plays a crucial role in supplying blood to the upper lip, nasal septum, and columella. Near the philtrum, the superior labial artery gives off vertical branches that divide into the superficial septal branch, which runs superficially to the orbicularis oris, and the deep septal branch, which distributes to the oral mucosa [14]. Despite its importance, the precise anatomical course and variations of the deep septal branch in relation to the columella have not been thoroughly

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investigated, which contrasts with numerous studies of the course and types of the superficial septal branch [5].

Park et al. [14] were the first to confirm that the septal branch divides into deep and superficial branches that course toward the columella. Nakajima et al. [12] and Crouzet et al. [1] subsequently further confirmed the presence of deep and superficial branches in the upper lip and philtrum areas through angiography and cadaveric dissections. These studies have provided valuable insights into the vascular anatomy of the nasal region, but they primarily focused on the superficial aspects, and so less is known about the deep septal branch.

Pinar et al. [15] confirmed that the deep septal branch ascends toward the columella to become the columellar artery, and Lee et al. [8] used histological analyses to confirm the distribution of the columellar artery, thereby providing the foundational understanding of its role in nasal vascularization. However, these studies did not extensively map the course or variations of the deep septal branch in relation to the nasal cartilage, which represents a knowledge gap that has significant clinical implications.

Jitaree et al. [4] investigated the branching patterns of the columellar artery in the columella region in a Thai population, revealing differences that could affect surgical rhinoplasty, filler rhinoplasty, and flap procedures. However, the specific location where the septal branch—which branches off from the superior labial artery—divides and its relationship with the nasal cartilage have not been thoroughly investigated. This lack of precise anatomical information necessitates further investigations to improve the safety and efficacy of procedures in the columella area.

Therefore, this study aimed to elucidate the courses, locations, and trajectories of the deep and superficial septal branches of the superior labial artery in the columella through detailed microdissections, including their positional relationships with the major alar cartilage. By performing comprehensive topographic analyses of these vascular structures, this research was designed to contribute to improved surgical techniques and outcomes in rhinoplasty and reconstructive procedures.

Materials & methods

The deep and superficial septal branches of the superior labial artery were examined in 40 Korean embalmed cadavers, consisting of 19 males and 21 females with a mean age of 73.9 years (range 33–94 years). The cadavers had been embalmed with a standard embalming solution composed of formaldehyde, ethanol, glycerin, phenol, and water, which is commonly used in anatomical studies to preserve tissue integrity. The superficial and deep septal branches were measured in 7 and 14 cadavers, respectively. In some cases blue latex was injected into the common carotid artery to enhance the visibility of the septal branches of the superior labial artery. All cadaveric specimens had no visible congenital malformations or anatomical abnormalities. The study was conducted in accordance with the ethical principles for medical research involving human subjects of the Declaration of Helsinki. All authors were well informed about the Ethical Principles for Medical Research Involving Human Subjects as detailed in the WMA Declaration of Helsinki, and confirmed that this study was consistent with that declaration. The study was approved by the Institutional Review Board (IRB) of Catholic Kwandong University (IRB number CKU-21-01-0509).

The facial muscles and the arterial branches running along the surfaces of these muscles were carefully dissected and then detached from the facial bone. Under a surgical microscope (OPMI-FC, Carl Zeiss, Oberkochen, Germany), the courses and connections of the septal branches of the superior labial artery were examined from both the anterior and posterior aspects of the nose. Dissection was started proximally at the superior labial artery and progressed distally following the columellar artery branching from the superior labial artery toward the nasal tip. Both blunt and sharp dissections were performed: superficial tissues were initially separated bluntly, followed by careful sharp dissection of vessel margins under magnification. To maintain anatomical accuracy, vessels were retained in their original anatomical positions by preserving connections to deeper surrounding tissues whenever feasible. After observing the morphologies and courses of the deep and superficial septal branches, the diameters of the arterial branches (main stems) at the upper, middle, and lower levels of the columella were measured using digital calipers (Digital Electronic Caliper, Fine Science Tools, Heidelberg, Germany).

Results

Course of the deep septal branch of the superior labial artery

The deep septal branch ascended toward the nasal tip in 36 of the 40 specimens (90.0%). Specifically, the deep septal branch divided into two main branches at different levels of the columella: upper level (27.5%, 11 cases), middle level (5.0%, 2 cases), and lower level (47.5%, 19 cases). In 10.0% of the specimens (four cases) the deep septal branch divided into two main branches deep to the orbicularis oris and ascended the columella as two separate branches (Fig. 1). The thickness of the main stem of the deep septal branch was measured for each type: the artery diameters were

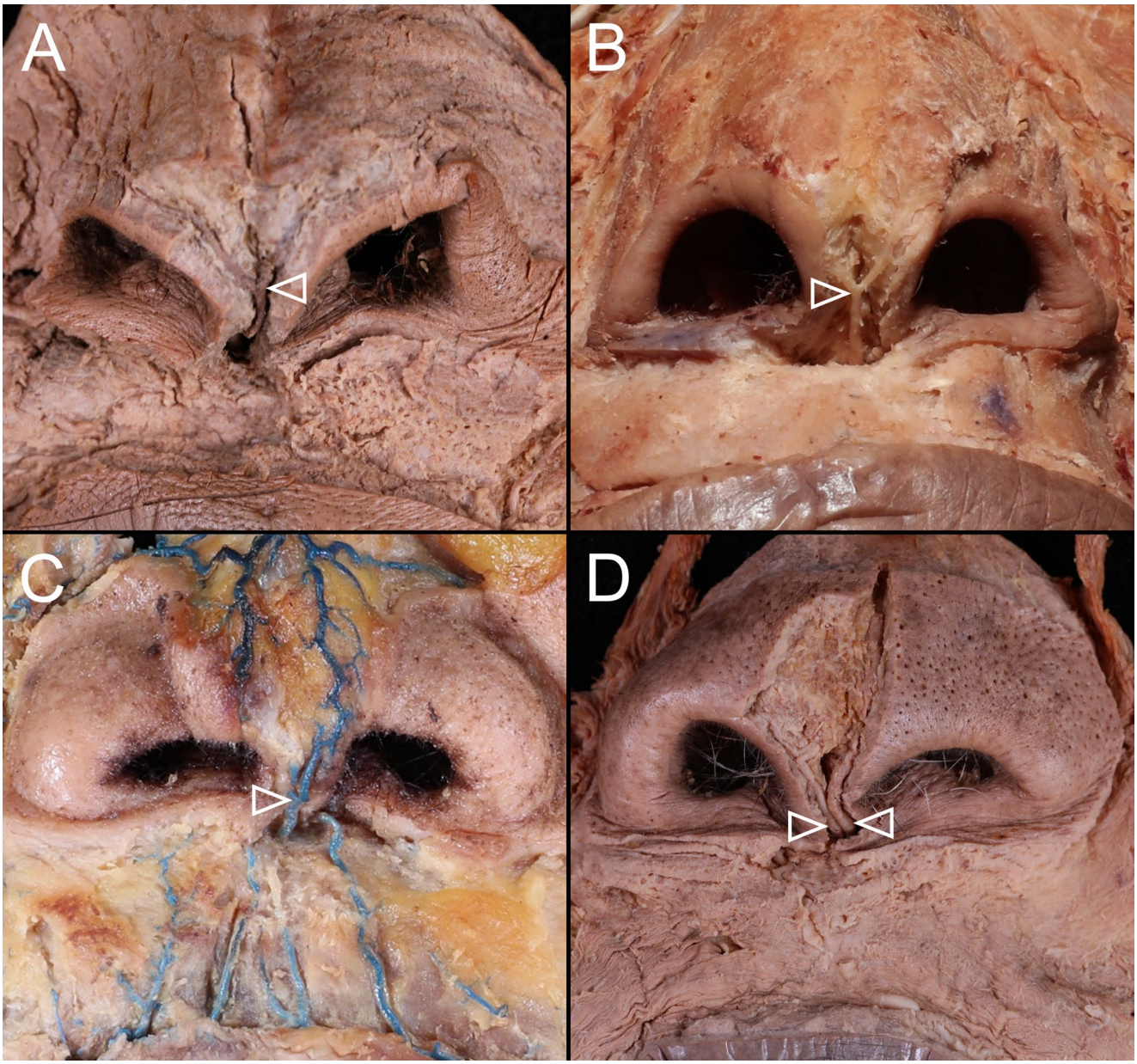

Fig. 1 Distribution patterns of the deep septal branch of the superior labial artery in the columella base (anterior-inferior view of the nose). The deep septal branch bifurcated into two branches (arrowheads) at the (**A**) upper, (**B**) middle, and (**C**) lower levels of the columella. (**D**) The deep septal branch divided into two separate branches (arrowheads) at the deep aspect of the orbicularis oris and ascended the columella

Table 1 Diameter of the deep septal branch according to the distribution type

	Upper level			Middle level			Lower level		
	Right	Stem	Left	Right	Stem	Left	Right	Stem	Left
Mean	-	0.6	-	0.6	0.8	0.7	0.4	0.7	0.5
SD	-	0.1	-	0.4	0.1	0.2	0.2	0.3	0.2
Min.	-	0.5	-	0.3	0.7	0.6	0.2	0.3	0.3
Max.	-	0.7	-	0.8	0.9	0.9	0.7	1.1	0.7

0.6 ± 0.1 mm (mean ± SD), 0.8 ± 0.1 mm, and 0.7 ± 0.3 mm at the upper, middle, and lower levels, respectively (Table 1). The main stem was thickest when it divided at the middle level, followed by at the lower level, and thinnest at the upper level.

In an additional four specimens (10.0%) the deep septal branch either did not ascend to the columella or only reached the middle level. The diameter of the deep septal branch at the columellar base was 0.2 ± 0.2 mm (range 0.01–0.35 mm). In these cases the superficial septal branch and the deep septal branch anastomosed at the columellar base, and this anastomosed branch then distributed to the columella and nasal tip. Alternatively, the deep septal branch terminated at the columellar base, with the septal branch originating from the inferior alar artery or superior labial artery ascending along the columella, bifurcating at the middle level, and coursing toward both sides of the nasal tip.

Course of the superficial septal branch of the superior labial artery

The superficial septal branch exhibited various patterns. This branch ascended to different levels of the columella: to the lower level with the deep septal branch extending to the middle level; anastomosing at the columellar base and then coursing toward the nasal tip; running alongside the deep septal branch; or originating from the inferior alar artery and extending toward the nasal tip while the deep septal branch terminated at the columellar base (Fig. 2). The diameter of the superficial septal branch was 0.2 ± 0.1 mm (range 0.14–0.31 mm) on the right side and 0.2 ± 0.1 mm (range 0.13–0.34 mm) on the left side. A middle branch was observed in one case, with a thickness of 0.22 mm.

In four specimens (10%), when the superficial septal branch extended toward the nasal tip while the deep septal branch terminated at the columellar base, the former branch exhibited a pattern similar to that of the latter, bifurcating at the middle level of the columella. The diameter of the superficial septal branch was 0.4 ± 0.1 mm (range 0.32–0.42 mm) at the stem, 0.3 ± 0.2 mm (range 0.06–0.38 mm) on the right side, and 0.3 ± 0.1 mm (range 0.14–0.40 mm) on the left side.

Discussion

Various rhinoplasty procedures such as septal reconstruction, using a columellar strut, septoplasty, dorsal augmentation, and cartilage grafting require incisions to be made in the columella area [6, 10, 13, 17]. There are two approaches: (1) in the open approach a horizontal incision is made on the central columellar pillar and columellar base to expose the cartilage, and (2) in the bidirectional exposure method an incision is made inside the nostrils along the margin of the major alar cartilage [2]. In this incision site, the columellar artery branching from the superior labial artery is of great interest due to its involvement in the vascularization of the columella. The superficial septal branch courses superficially to the orbicularis oris and continues to the nasal septum, while the deep septal branch originates from the posterior part of the orbicularis oris, emerging at the columellar base and running toward the columella (Fig. 3).

The distribution patterns of the deep septal branches to the columella exhibited various morphological features. These branches arose as two separate branches from the beginning (10.0%) that distributed to both sides of the nose, or they emerged as a single branch anteriorly at the columellar base and then divided into two branches at the upper (27.5%), middle (5.0%), or lower (47.5%) levels of the columella (Fig. 1). Given that most incisions are made between the columellar pillar and columellar base, our results suggest that in most cases the deep septal branch would have already bifurcated into two branches [2, 6, 13, 17]. The diameters of the superficial and deep septal branches were 0.2 ± 0.1 mm (range 0.13–0.34 mm) and 0.6 ± 0.2 mm (range 0.18–1.05 mm), respectively. Except in cases where the deep septal branch did not extend to the columella and nasal tip, this branch was more dominant than the superficial septal branch. These findings are consistent with those of previous studies [12, 14, 15].

In four cases (10%), where the deep septal artery did not extend to the nasal tip, it terminated at the columellar base, and the superficial septal artery continued toward the nasal tip. The superficial septal artery typically branched from the superior labial artery and continued to the columella, but there were cases where it branched from the inferior alar artery (Fig. 2D). In these cases the superficial septal branch bifurcated at the middle level of the columella, similar to the deep septal branch, and coursed toward both sides of the nasal tip. The stem diameters of the superficial and deep septal branches were 0.4 ± 0.1 mm (range 0.32–0.42 mm) and 0.2 ± 0.2 mm (range 0.01–0.35 mm), respectively, indicating that the superficial septal branch was thicker.

Incisions are often made in the columellar base and central columellar pillar area during open (external) rhinoplasty [2, 6, 13]. In particular, the columellar base, which is where the columella connects to the upper lip, is also frequently utilized in nonsurgical procedures [6, 10]. Thus, understanding the vascular distribution in this region is therefore crucial for optimizing procedural outcomes and minimizing complications. Clinically, the findings of this study underscore the importance of understanding the detailed vascular anatomy of the columellar region during both surgical and nonsurgical rhinoplasty. The columellar artery, a branch of the superior labial artery, typically courses along the columellar base and ascends toward the nasal tip. It commonly bifurcates into superficial and deep septal branches, with the superficial branch running just beneath the dermis and the deep branch traveling deeper along the septal cartilage,

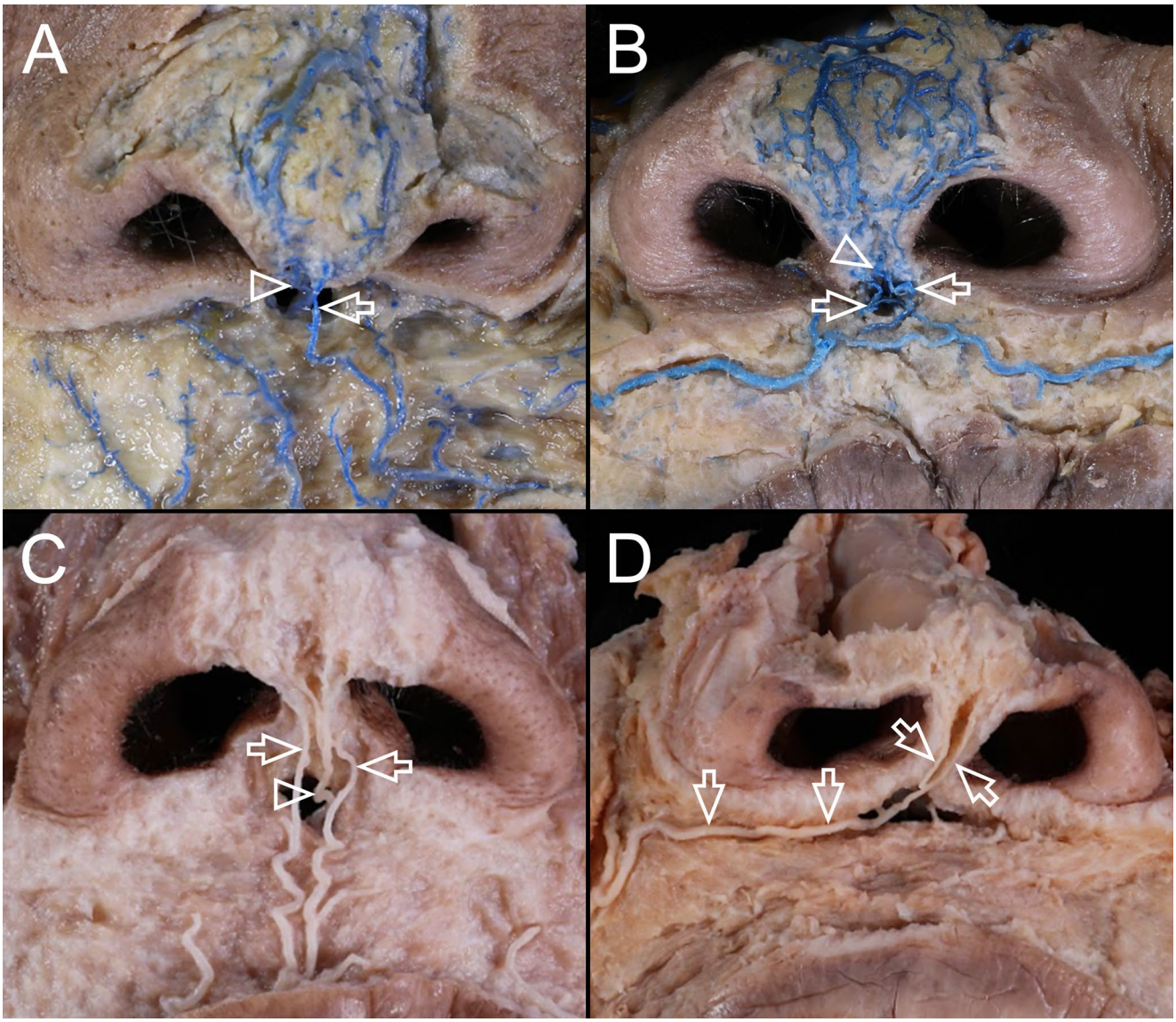

Fig. 2 Various arterial anastomosis patterns of the superficial septal branch of the superior labial artery (anterior-inferior aspect of the nose). (**A**) The superficial septal branch (arrow) ascended to the lower level of the columella, while the deep septal branch (arrowhead) extended to the middle level of the columella. (**B**) The left and right superficial septal branches (arrows) and the deep septal branch (arrowhead) anastomosed at the columella base and then coursed toward the nasal tip. (**C**) The superficial septal branches (arrows) on both the left and right ran alongside the deep septal branch (arrowhead). (**D**) The superficial septal branch (arrows), originating from the inferior alar artery, extended toward the nasal tip, while the deep septal branch terminated at the columella base

either above or beneath the orbicularis oris muscle. Notably, the deep septal branch was present in approximately 90% of specimens in this study. These regions, therefore, represent critical landmarks that surgeons should take into account to avoid inadvertent vascular injury during transcolumellar incisions or filler injections [4, 7]. Injury to these branches may compromise the vascular supply to the nasal tip, leading to potential complications such as tissue necrosis or poor wound healing [4]. Proper anatomical knowledge of these branches may help reduce such risks and improve surgical and aesthetic outcomes.

In interpreting these results, the difference in sample sizes between the deep and superficial septal branches was primarily due to variations in anatomical preservation. The superficial septal branches, being more delicate and located more superficially, were more susceptible to damage during dissection, which limited the number of specimens suitable for precise measurement. In contrast, the deep septal branches were located in a more protected anatomical position, allowing for better preservation and a larger number of measurable samples. While this discrepancy in sample sizes may affect the generalizability of certain quantitative

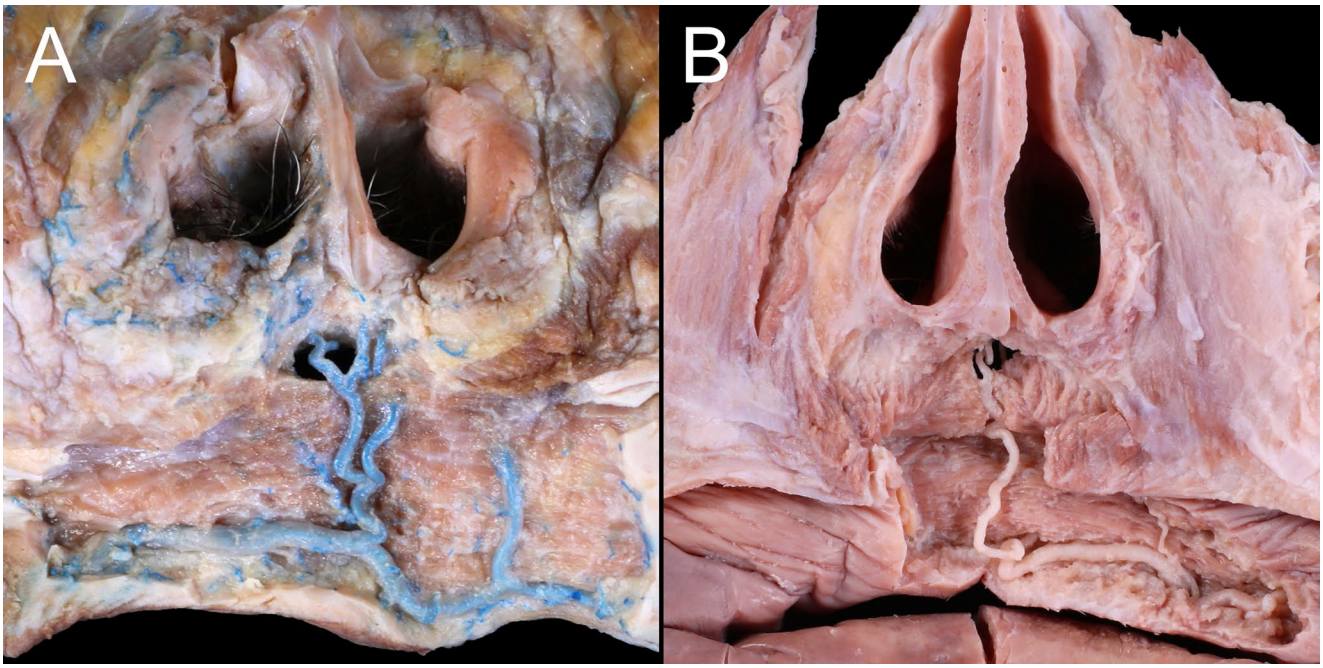

Fig. 3 Distribution pattern of the superior labial artery at the posterior aspect of the orbicularis oris. (**A**) Typically, it ran along the posterior aspect of the orbicularis oris. (**B**) It also coursed between the fibers of the orbicularis oris (orbicularis oris fibers retracted along the deep branch of columellar artery)

findings, the anatomical variations observed in this study remain valid and clinically relevant. This study was designed as a cross-sectional observational investigation, and not for statistical hypothesis testing or power analysis. The primary goal of this study was to provide a detailed anatomical description of the courses and variations of the deep and superficial septal branches of the superior labial artery. Nevertheless, future studies with larger and more statistically powered sample sizes would be valuable for further validation of these findings.

In addition, this study had limitations, including some related to anatomical differences in nostril shape and in the width and length of the columella between populations of Eastern Asian origin and those of Western European origin. Specifically, populations of Eastern Asian origin tend to have a mesorrhine type with a shorter, wider nose, which affects the width and length of the columella, while populations of Western European origin typically exhibit a leptorrhine type with a longer, narrower nose [16]. Future studies should conduct comparative investigations to these populations in order to gain a better understanding of how these variations might impact both surgical and nonsurgical outcomes.

Conclusions

This study confirmed the presence and course patterns of the deep and superficial septal branches of the superior labial artery and their positional relationships with the superficial septal branch in the columellar base and central columellar pillar. This new anatomical information could serve as the clinical foundation for both reconstructive and aesthetic procedures. By improving our understanding of columellar vascularization, this research will contribute to the development of techniques that are more precise and effective, thereby improving the safety and efficacy of both invasive and noninvasive rhinoplasty and other nasal procedures.

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Author contributions HJP: conceptualization, methodology, investigation, formal analysis, visualization, writing– original draft, and writing– review & editing; MSH: conceptualization, methodology, investigation, formal analysis, project administration, supervision, visualization, writing– review & editing; All authors have read and agreed to the published version of the manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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