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Patterns of Skin Ischemia After Nasolabial Fold Filler Injection

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Abstract

Background Skin ischemia is a severe complication of nasolabial fold (NLF) hyaluronic acid filler injections. The specific patterns, distribution, and extent of skin necrosis remain poorly understood. The aim of this study is to provide new insights into skin necrosis following NLF injections by analyzing clinical cases and facial anatomy.

Methods A retrospective review of patients with skin ischemia after NLF injections was conducted. Computed tomography angiography and anatomical dissections were performed on cadavers to study the facial artery.

Results Twelve patients with skin ischemia were identified. Three patterns of skin ischemia were observed: Pattern I, NLF+Nose pattern (75%): Skin ischemia affects the nasolabial fold and the entire nose, with the alar, nasal tip, and dorsum being the most affected subunits. Pattern II, NLF+partial nose pattern (16.7%): Skin ischemia involves the nasolabial fold and the lower two-thirds of the nose, primarily affecting the nasal tip and alar, without extending beyond the rhinion. Pattern III, NLF+infraorbital area pattern (8.3%): Skin ischemia is observed in the nasolabial fold and infraorbital region, which may be attributed to the presence of a detoured facial artery. Anatomical studies revealed the course and branches of the facial artery, explaining the distribution of skin ischemia. The skin ischemia may be associated with the perforators of the superficial fat compartments.

Conclusion Skin ischemia following NLF injections can manifest in three distinct patterns, involving various facial regions. Understanding the anatomy of the facial artery and its branches is crucial for preventing and managing this complication.

Level of Evidence V This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Nasolabial fold · Hyaluronic acid filler · Skin ischemia · Facial artery · Anatomical study

Introduction

The use of hyaluronic acid (HA) fillers for facial contouring has significantly increased, resulting in their dominant position in the esthetic market in the past years [1]. According to the International Society of Aesthetic Plastic Surgery (ISAPS), there were 4.3 million hyaluronic acid injections performed in 2022 worldwide [2]. Although complications from soft tissue fillers are rare, the surge in procedures has resulted in a higher incidence of these issues.

Nasolabial fold (NLF) is the most frequently targeted injection site and also the area with the highest risk for skin ischemia events [3], cause the facial artery are close to NLF [4]. The facial artery arises in the carotid triangle from the external carotid artery, and it then curves upward over the mandible at the antero-inferior angle of the masseter, moves forward and upward across the cheek to the

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mouth's angle, ascends along the nose's side, and ends at the eye's medial commissure as the angular artery [5]. It branch off horizontal labiomental artery [6], superior and inferior labial arteries [7], lateral nasal artery [8], angular artery [9], and supratrochlear artery [10]. Additionally, a unique pattern, known as the detoured facial artery, is located slightly inferolaterally to the ipsilateral infraorbital area [11]. Anatomical variations can cause skin ischemia in the chin, nasolabial fold, lips, nose, infraorbital area, and forehead when facial arteries are injured. Despite extensive research on the facial artery, the specific patterns, distribution, and extent of facial skin necrosis due to vascular occlusion from fillers remain poorly understood.

Our department specializes in filler complications, with over 10 years of experience in facial anatomy and treating its complications. We focus on preventing and managing vascular complications post-injection [12].

So in this study, we systematically reviewed the patients who were treated at our department for skin ischemia associated with NLF hyaluronic acid filler injections. In addition, we analyzed the facial artery through anatomical dissection of specimens, CTA, 3D reconstruction visualization, combining these with patterns and distribution of skin ischemia to provide new insights into skin necrosis.

Material and Methods

Study Setup

We reviewed our medical records from January 1, 2008, to May 31, 2024, to identify patients treated for vascular complications from NLF hyaluronic acid filler injections. For each case, we examined demographics, medical history, prior filler use, photographs, imaging reports, and laboratory results. Soares DJ [3] developed the facial artery, ophthalmic artery, distal external carotid artery, internal maxillary artery (FOEM) facial angiosome scoring system, and grading scale for filler-induced facial skin ischemia. All photographs underwent review and were independently evaluated by three board-certified facial plastic surgeons.

Computed Tomography and Anatomical Dissection

A total of 156 Chinese Han cadaveric heads (59 males and 97 females) were voluntarily donated by Southern Medical University (Guangzhou, China). The mean age was 43.1 years (range: 18–69 years). All donors provided informed consent for their bodies to be used in medical education and research. This study complies with the Cadaver Dissection Regulations of the China Ministry of Health.

The CT contrast process was slightly modified from a previously reported method [13, 14]. Forty grams of lead oxide was mixed with 5 ml of red dye and 100 ml of latex, stirred continuously, and filtered to remove large particles. The lead oxide contrast media was infused into cadaveric heads via the external carotid artery (ECA), internal carotid artery (ICA), facial, and superficial temporal arteries. A 64-row spiral CT scanner was used after each injection under the same conditions: 120 kV tube voltage, 250 mA effective tube current, 140 HU data acquisition trigger, 500 $\times$ 600 mm field of view, and 1024 $\times$ 10 $\times$ 24 pixels slice size above the baseline. The slice thickness was 0.8 mm, with a 0.4 mm increment between slices.

Dissection was performed meticulously through each facial soft tissue layer to reveal the course of the facial artery and its branches [10].

Results

Clinical Cases Analysis

Our retrospective review of medical records identified 12 consecutive referral patients with skin ischemia after nasolabial fold augmentation using only hyaluronic acid fillers, which including 11 females and 1 male (Table 1).

All patients exhibited signs of skin ischemia in the nasolabial fold area, and the angulonasal (AN), frontonasal (FN), and superior labiofacial (SLF) were the most common areas of skin ischemia (Fig. 1). Among 12 patients, 11 patients developed complications of nasal skin ischemia. The alar, nasal tip, and dorsum are the three subunits most affected (Fig. 2).

The skin lesions are classified into three categories: (1) NLF+Nose pattern, where the nasolabial fold and the entire nose are affected; this is the predominant pattern, observed in nine out of 12 patients (75 percent). (2) NLF + partial nose pattern, where the nasolabial fold and the lower two-thirds of the nose are affected, seen in two out of 12 patients (16.7 percent). (3) NLF+IO pattern, involving the nasolabial fold and the infraorbital area, noted in one out of 12 patients (8.3 percent).

For NLF+Nose pattern, dorsum, alar, and tip always showed livedoid skin discoloration, and the affected region displayed extensions over the midline that reached the contralateral nose (Fig. 3).

For NLF+Nose pattern, skin ischemia was also observed in the upper lip region in four patients. The ischemic area of the skin is concentrated on one side of the white lip and generally does not extend beyond the philtrum ridge (Fig. 4). In addition to ischemic manifestations in the nasolabial fold and nose, one patient's upper and lower lips are also affected (Fig. 5). Apart from ischemic

Table 1 Profiles of the 11 consecutive patients with skin ischemia

Patient	Sex	Age(yr)	Injection site	FOEM	Skin complication in nose
1	F	33	NLF(Bilateral)	FN, AN	Dorsum, Tip, Right alar, Columella
2	F	36	NLF(Left)	AN	Tip, Left alar
3	F	27	NLD(Right)	AN, IO	None
4	F	23	NLF(Bilateral)	FN, AN, SLF	Dorsum, Tip, Right alar
5	F	31	NLF(Bilateral)	FN, AN, SLF, IO	Dorsum, Tip, Left alar
6	F	29	NLF(Left)	FN, AN	Dorsum, Tip, Left alar
7	F	28	NLF(Bilateral)	FN, AN, SLF	Dorsum, Tip, Right alar
8	M	40	NLF(Right)	FN, AN, SLF	Dorsum, Tip, Right alar
9	F	52	NLF(Right)	AN, IO	Bilateral alar
10	F	33	NLF(Bilateral)	FN, AN, SLF	Dorsum, Tip, Bilateral alar, Columella
11	F	35	NLF(Bilateral)	STR, FN, AN	Dorsum, Tip, Bilateral alar, Columella
12	F	30	NLF(Bilateral)	FN, AN, SLF,ILF	Dorsum, Tip, Bilateral alar

F female, *M* male, *NLF* nasolabial fold, *FOEM* facial artery, ophthalmic artery, distal external carotid artery, and internal maxillary artery domain angiosome scoring system; *FN* Frontonasal, *AN* Angulonasal, *IO* Infraorbital, *SLF* Superior Labiofacial, *STR* Supratrochlear

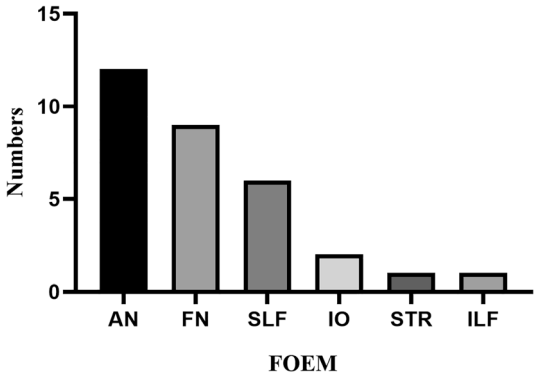

Fig. 1 Cases of skin ischemia induced by fillers according to affected facial segments. *FN* Frontonasal, *AN* Angulonasal, *IO* Infraorbital, *SLF* Superior Labiofacial, *STR* Supratrochlear

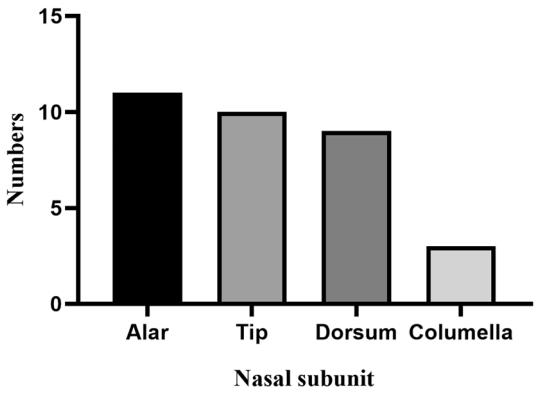

Fig. 2 Cases of skin ischemia induced by fillers according to affected nasal subunit

signs in the nasolabial fold and nose, two patients also exhibit involvement of infraorbital region (Fig. 6) and forehead region (Fig. 7), respectively.

Two patients showed the ischemic signs on the nasolabial fold and the lower two-thirds of the nose and the ischemia primarily affects the nasal tip and alar, and does not extend beyond the rhinion (Fig. 8). Patient 3 showed the ischemic signs on the nasolabial fold and infraorbital region when she accepted the injection of right nasolabial fold (Fig. 9).

Anatomical Specimen Analysis

That facial artery is situated nearly adjacent to the nasolabial groove and the nose, following an almost straight upward course [4, 8], that is why all the patients present skin ischemia in the NLF. However, there are also various ramifications of the facial artery, such as a detoured facial artery which distributes throughout the infraorbital region away from the nose with an inflection (Fig. 10). This is also a possible cause of complications in the infraorbital region (Fig. 9).

Anatomy of NLF + Nose Pattern

The LNA consistently branched at the alar sulcus and followed an arc-shaped course to the nasal tip, traveling in or above the musculoaponeurotic layer of the nose's cartilaginous part [15]. The nasal ala and nasal tip are the two subunits with the highest incidence of skin ischemic complications, indicating that the lateral nasal artery has been compromised. However, in the nasal region, the blood vessels from both sides form anastomotic branches at the midline. This explains why skin necrosis is often more severe on the one side, and the ischemic area may cross the midline to reach the contralateral skin. Due to the blood supply from the other side, the extent and severity of

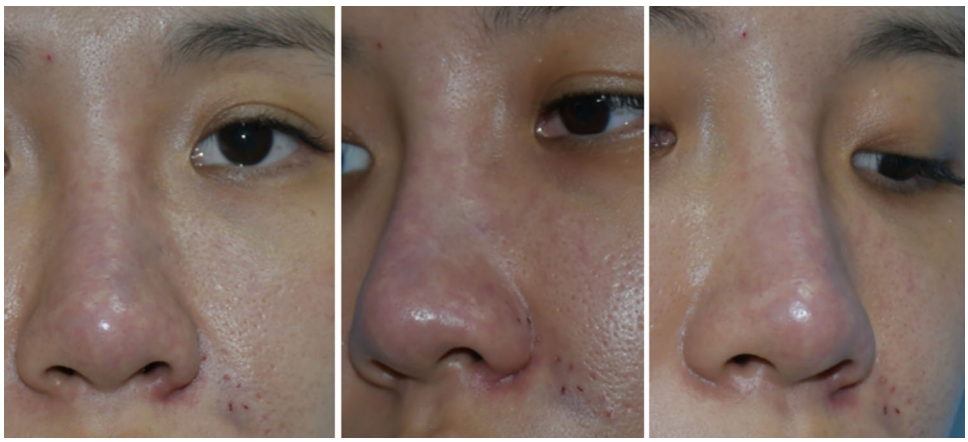

Fig. 3 Pattern 1: NLF+Nose pattern, Patient 6 presented skin ischemia on the dorsum, left alar, tip and left nasolabial fold

Fig. 4 Pattern 1: NLF+Nose pattern, Patient 10 presented skin ischemia in the nasolabial fold, nose and upper lip

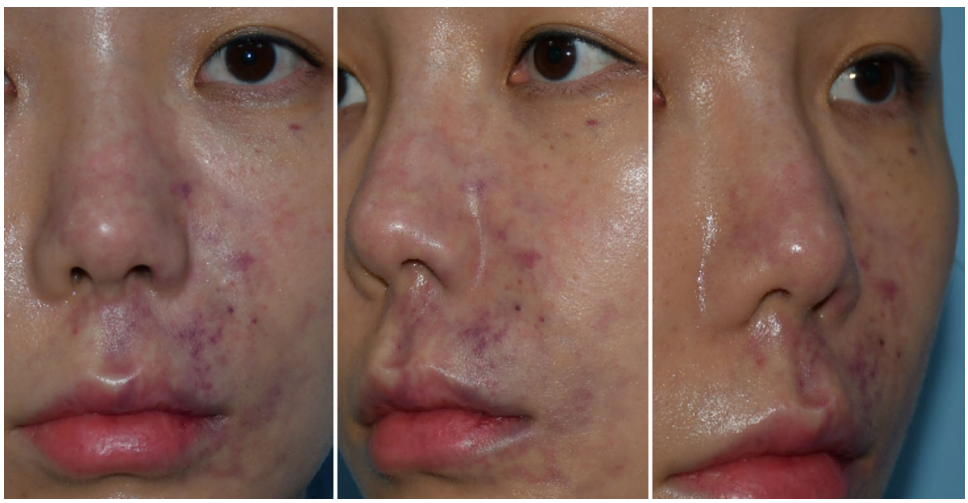

Fig. 5 Pattern 1: NLF+Nose pattern, Patient 12 presented skin ischemia on the nasolabial fold, nose, upper lip and lower lip

ischemia on the contralateral side are usually milder (Fig. 11). Dorsal nasal artery, originating from the ophthalmic artery, situated superficial to the muscular layer on the nasal bone and ran inferolaterally on the nasal dorsum and communicated with the lateral nasal artery from the facial artery [16]. Additionally, the dorsal nasal artery gives off perforators to the subcutaneous fat layer and skin, which explains the presence of ischemic manifestations on the nasal dorsum (Fig. 11). The columellar artery anastomoses with LNA and forms the vascular plexus at nasal tip

Fig. 6 Pattern 1: NLF+Nose pattern, Patient 5 presented skin ischemia in the nasolabial fold, nose and infraorbital region

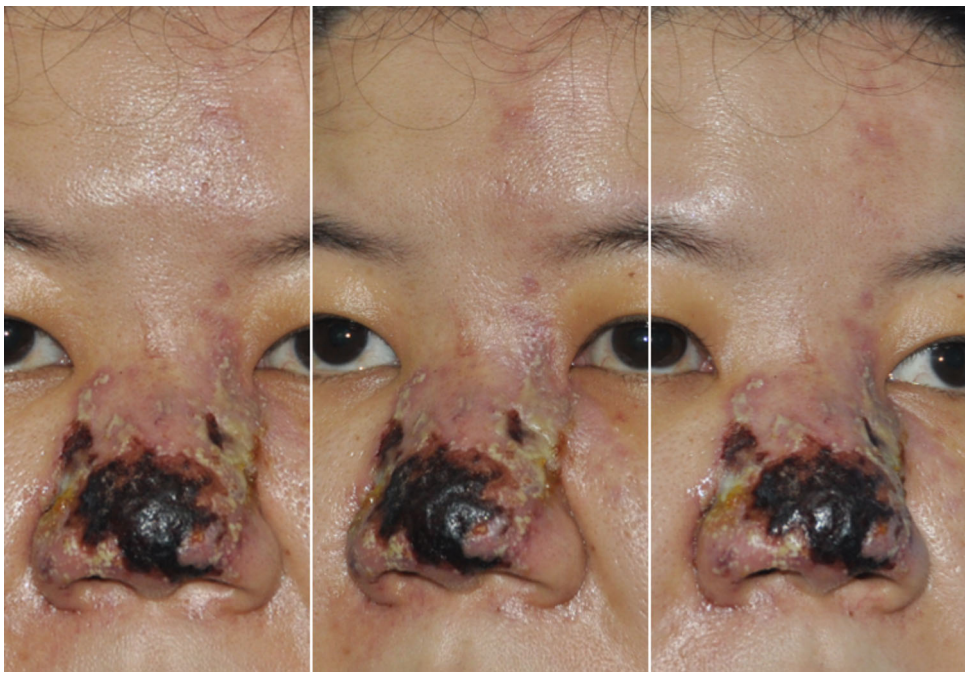

Fig. 7 Pattern 1: NLF+Nose pattern, Patient 11 presented skin ischemia in the nasolabial fold, nose and forehead region

Fig. 8 Pattern 2: NLF + partial nose pattern, Patient 2 presented skin ischemia in the nasolabial fold, nasal tip and alar

Fig. 9 Pattern 3: NLF+IO pattern, Patient 3 presented skin ischemia in the nasolabial fold and infraorbital region

Fig. 10 Patterns of facial artery. There was only a nasolabial trunk *(left)*; There was only a detoured feature *(center)*; There were both detoured topography and nasolabial trunk originated from the facial artery *(right)*; *FA* facial artery, *SLF* superior labial artery, *NLT* nasolabial trunk, *LNA* lateral nasal artery, *AA* angular artery, *PCA* paracentral artery, *DFA* detoured facial artery, *DNA* dorsal nasal artery, Asterisk indicate the perforator of DFA, Arrow indicate the anastomosis between the DFA and infraorbital artery

Fig. 11 Anatomy of nasal arteries. In the subcutaneous fat layer, a vascular network formed by perforator originating from the named arteries can be observed *(left)*. The nasal dorsal artery anastomoses with the lateral nasal artery. The former is responsible for the blood supply of the upper two-thirds of the nose, while the lateral nasal artery supplies the lower one-third. *LNA* lateral nasal artery, *DNA* dorsal nasal artery, *IAbr* inferior alar branch, *SAbr* superior alar branch, Asterisk indicate anastomosis of the bilateral arteries, Arrow indicate the perforators of DNA

[17]. This may also explain why the columella is less likely to present with ischemic manifestations because it has a dual blood supply (Fig. 12).

Anatomy of NLF + Partial Nose Pattern

The dorsal nasal artery is not a constant artery, and the typical dorsal nasal artery pattern was a single large, long artery descending on the nasal dorsum or side, anastomosing with the lateral nasal artery unilaterally or bilaterally [18]. In the absence of bilateral dorsal nasal arteries, only a small branch from the lateral nasal or angular artery supplied the middle third of the nose (Fig. 13), and this may explain why some patients have skin necrosis limited to the lower two-thirds of the nose (Fig. 8).

Anatomy of NLF+IO Pattern

The detoured facial artery arose lateral to the mouth corner, ascended superomedially to the infraorbital area, and terminated as the angular artery, anastomosing with an ophthalmic artery branch. According to Cong's study [11], 2 main topographic variations of the facial artery were identified: Type I had both detoured topography and a

nasolabial trunk originating from the facial artery, while type II exhibited only a detoured feature. Also, the detoured artery gives off perforators to the subcutaneous fat layer and skin, so when the detoured artery is injured during injection, it may lead to skin ischemia complications in the infraorbital region (Fig. 10).

The Philips three-dimensional computed tomographic scan provides a radiological differentiation of the soft tissue, categorizing it into two distinct layers: the superficial layer, represented by the yellow color (Fig. 14), and the deep layer, depicted in pink (Fig. 14). This arbitrary color coding allows for a clear visual distinction between the two tissue planes. In the subcutaneous fat layer, we can observe a vascular network formed by relatively superficial and well-known vessels such as the angular artery, supratrochlear artery, and perforating branches. In contrast, the deep layer contains the main supplying arteries of the face, including the facial artery, ophthalmic artery, and superficial temporal artery. The vascular adverse events manifest as livedo skin patterns may indicating the involvement of perforators.

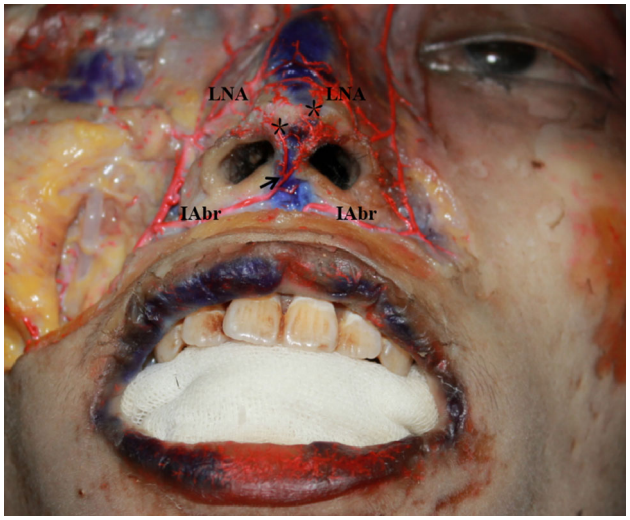

Fig. 12 Anatomy of columellar artery. The columellar artery located at the subcutaneous fat layer and anastomose with the superficial nasal arteries; Arrow indicate the columellar artery; Asterisk indicate anastomosis between columellar artery and LNA; *LNA* lateral nasal artery, *IAbr* inferior alar branch

Facial Artery Pattern

This study analyzed 224 hemifaces from 118 cadavers. The facial artery exhibited four patterns: the superior labial pattern, observed in 4.02% (9/224) of hemifaces, where the artery terminated as the superior labial artery; the nasolabial trunk pattern, found in 65.63% (147/224), where the artery followed the nasolabial fold, branching into the lateral nasal or angular artery; the infraorbital trunk pattern, present in 7.14% (16/224), with the artery ascending superomedially to the infraorbital region and ending as the angular artery; and the combined nasolabial and infraorbital trunk pattern, observed in 23.21% (52/224), where the artery branched into both trunks lateral to the mouth corner, converging to terminate at the angular artery (Fig. 15 and Table 2).

Discussion

In recent years, the surge of the "beauty economy" has propelled China's cosmetic and plastic surgery sector into a phase of remarkable growth, marked by an ever-increasing market scale and a surge in consumer interest [19]. Nonetheless, this burgeoning industry is marred by significant regulatory disarray, notably the prevalence of

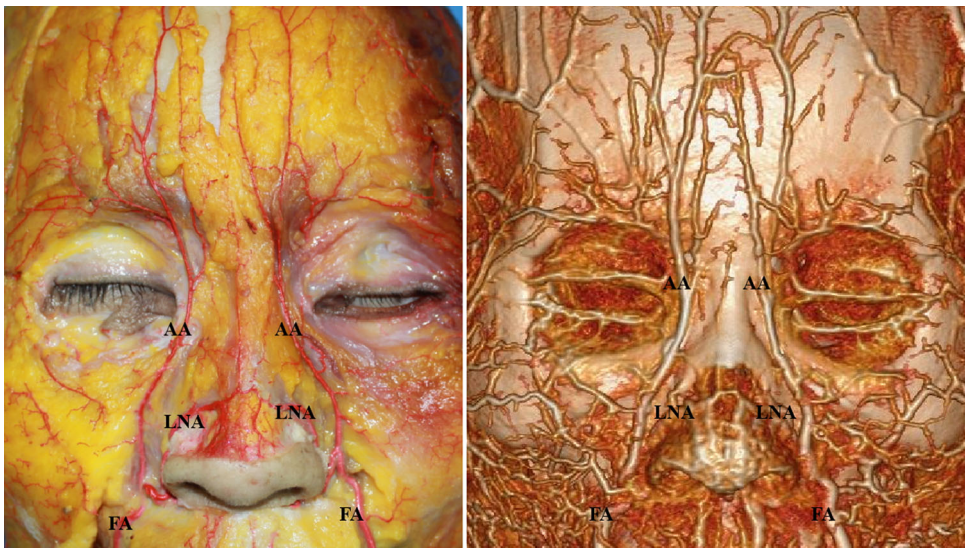

Fig. 13 In the absence of bilateral dorsal nasal arteries, only a small branch from the lateral nasal or angular artery supplied the middle third of the nose

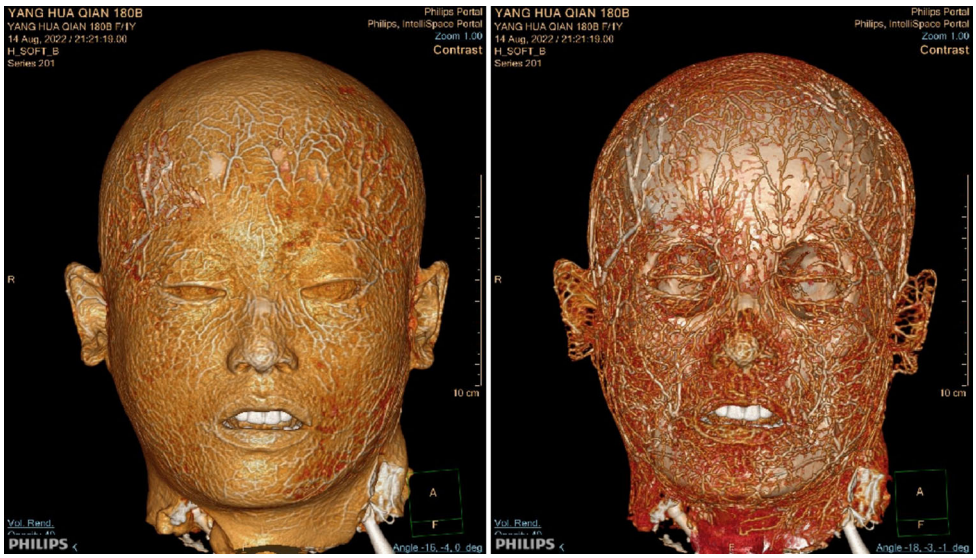

Fig. 14 Philips three-dimensional computed tomographic scan radiologically stratifies the soft tissue into the superficial (*left*) versus deep (*right*) layers, which are arbitrarily colored yellow versus pink, respectively

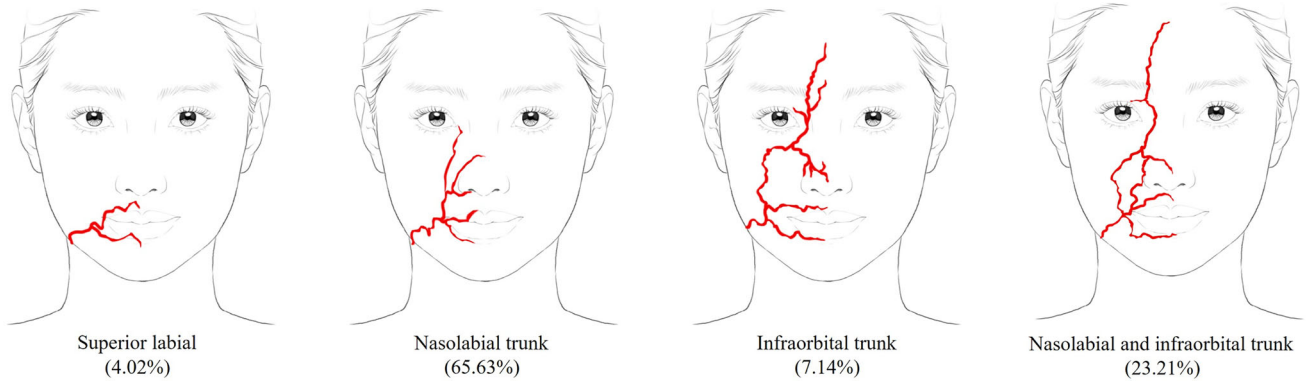

Fig. 15 Four patterns of the facial artery

Table 2 Percentage of facial artery pattern

Pattern	Right	Left	Total(%)
Superior labial	6	3	9 (4.02)
Nasolabial trunk	81	66	147 (65.63)
Infraorbital trunk	8	8	16 (7.14)
Nasolabial and infraorbital trunk	23	29	52 (23.21)

"unlicensed esthetic medical practices" (UAE), which severely compromises consumer health and safety [20].

The Chinese Medical Beauty White Paper reveals that certified medical practitioners and accredited clinics constitute merely 24% and 12% of the beauty sector, respectively [21]. Unlicensed esthetic entities often engage in deceptive practices, such as overstating therapeutic outcomes and falsifying practitioner credentials, clinic accreditations, and accolades, thus deceiving consumers [22]. Moreover, these establishments frequently lack essential medical expertise and competencies. Their surgical settings and apparatus often fall short of sanitary benchmarks, resulting in a high incidence of botched procedures and medical mishaps, thereby exposing consumers to considerable safety hazards.

In the realm of injectable cosmetic procedures, a physician lacking professional medical knowledge and skills is likely to contribute to an increased incidence of related complications. Vascular ischemic complications, including blindness and tissue necrosis, represent the most severe risks associated with soft tissue filler injections, primarily caused by either the direct intravascular injection of the filler material or the compression of arteries by the filler [23]. Necrosis is a complication that has been reported with each type of filler at a rate of between 0.001% and 0.003% [23]. Previous study shown the most frequently reported site for necrosis was the nose, accounting for 29.1% of cases, followed by the nasolabial fold at 14.7% [24].

The nasolabial fold, a crease extending from the ala of the nose to the cheilion area, is a significant facial feature that deepens with age. Surgical interventions are often performed to reduce the nasolabial fold and rejuvenate the face, as a deep nasolabial fold is associated with an older appearance [25]. Dermal filler injection is a minimally invasive technique for nasolabial fold correction, yielding excellent cosmetic outcomes. However, improper injection techniques in the nasolabial fold area can lead to serious complications. Numerous studies have investigated these adverse events and their prevention [26].

Meanwhile, to reduce complications associated with nasolabial fold injections, extensive research has been conducted on the facial artery (FA), focusing on its pathway, location, length, depth, gauge, anastomosis with other arteries, and relationship with superficial landmarks. These studies have employed various techniques, including conventional dissection, computed tomography angiography (CTA) in cadavers and living subjects, and ultrasound imaging [27].

Even so, the precise patterns, distribution, and extent of facial skin necrosis caused by filler-induced vascular occlusion are still not well understood. Therefore, this study aims to provide a deeper understanding of skin necrosis following nasolabial fold injections by summarizing the types of related complications and considering the anatomy of the facial artery.

Each facial area is supplied by perforators branching from the main facial arteries, forming perforasomes, angiosomes, or territories of a perforator [28]. These anatomical units include skin, fat, bone, and muscle. The perforasomes of main facial arteries have been well studied due to their crucial role in designing various skin flaps for reconstructive surgery [29]. Recently, Leonie [30] showed that the vascular adverse events may reflect the involvement of the perforators. For nasolabial fold injections, the facial artery is the most important and easily injured blood vessel. Along its course, the facial artery gives off numerous branches, including the superior and inferior labial arteries, lateral nasal artery, angular artery, and even the paracentral artery. Therefore, theoretically, once the facial artery is embolized, the vascular territories of the facial artery and its branches may present with skin ischemia.

In this retrospective study, skin ischemia caused by NLF injection involved the perioral, nasolabial, nasal, and medial periorbital regions, occasionally extending to the forehead (Figs. 3, 6, 7, 8 and 9).

The present study has several limitations that should be acknowledged. Firstly, the limited sample size may not comprehensively represent the full spectrum of skin ischemia types following nasolabial fold injection. Secondly, the interpretations of the associated complications are based on speculative inferences drawn from photographic evidence and anatomical knowledge, as the patients did not undergo diagnostic imaging modalities such as ultrasound or computed tomography angiography to definitively identify the specific compromised vasculature.

Conclusion

Skin ischemia following NLF injections can manifest in three distinct patterns, involving various facial regions. The skin ischemia may indicating the involvement of perforators. Understanding the anatomy of the facial artery and its branches is crucial for preventing and managing this complication.

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Declarations

Conflict of interest The authors declare that they have no conflicts of interest to disclose

Informed Consent The patient signed a consent form for the use of the photograph.

Ethical Approval The study protocol was approved by the Institutional Review Board of the hospital.

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