Ultrasonographic Anatomical Changes in the Nasal Vasculature after Rhinoplasty: Analysis of a Series of Cases

Nicolás Heredia, MD[1], Gabriela Menjívar, MD[2], Claudia González, MD[3], Roxana Cobo, MD[4], Jorge Espinosa-Reyes, MD[5], Juan Gabriel Camacho, MD[6], Juan Fernando Muñoz, MD[7]

[1]Department of Otolaryngology and Facial Plastic & Reconstructive Surgery, The Face & Nose Institute, Bogotá, D.C, Colombia, [2]Department of ENT and Facial Plastic Surgery, The Face & Nose Institute, El Salvador, [3]Radiologist Private practice, Chair of the Dermatology Ultrasound Community Group, American Institute of Ultrasound in Medicine (AIUM), Maryland, USA, [4]Department of Otolaryngology and Facial Plastic & Reconstructive Surgery, Private Practice Cali, Valle del Cauca, Colombia, [5]Department of Otolaryngology and Facial Plastic & Reconstructive Surgery, The Face & Nose Institute, Private Practice Clínica INO, Bogotá D.C., Colombia, [6]Department of Otolaryngology and Facial Plastic & Reconstructive Surgery, The Face & Nose Institute, Private Practice Bogotá, DC, Colombia and [7]Department of Otolaryngology and Facial Plastic & Reconstructive Surgery, The Face & Nose Institute, Private Practice Medellín, Colombia

Abstract: It is known that surgical procedures can change the vascularization of the face, and these changes can be related in the course and depth of vessels, increasing the risk for complications with injectable products. The goal of this work is to objectively demonstrate the course and variation of these vascular structures through Doppler ultra-sonographic monitoring. In this research 9 patients were studied, of which 7 completed the study. The presurgical ultrasound study detected anatomical variations like agenesy of the angular artery and dorsal nasal artery in 11.12% of tha patients. The post surgical evaluation detected 85.71% of vascular changes mainly in the nasal arteries. This findings confirm the importance of practicing ultrasonographis evaluation in patients with rhinoplasty, previous to practicing new filler injections in the face.

Keywords: Rhinoplasty, Fillers, High Resolution Ultrasound, Duplex, Doppler Color, Vascular Anatomy.

1. INTRODUCTION

Doppler ultrasound (DUS) is being promoted as a first-line imaging technique in aesthetic medicine. DUS can identify the location and depth of subcutaneous structures, as well as their three-dimensional (3D) anatomical relationships, the course of veins and arteries, and the location and type of material if there is previous filler treatment [1], It can be used in office settings as a safe, non-invasive method for vascular evaluation in real time, allowing vascular variations to be visualized before performing a filler treatment, for prevention, and even for the treatment of complications. [2,3]

The literature describes that there are variations in the course of each artery and that they can be acquired after trauma, surgery or non-surgical procedures on the face. [3,4]

Rhinoplasty is one of the most performed aesthetic surgical procedures worldwide and continues to increase [5]. The surgical plan, as well as its result, which is directly related to the configuration of the anatomical structures in the nose. [6] Previous studies mention the application of ultrasonographic studies to nasal anatomy. Stenner et al. were able to visualize the preoperative and follow-up surgical modifications of the treated nose, [6,7] but not if there is actually an alteration in the facial vascularization after rhinoplasty, generating a potential increase in the number of complications for the use of fillers; post-rhinoplasty may be a clear indication to perform a Ultrasound prior to performing facial procedures to reduce the incidence of these adverse effects.

Today, fillers remain one of the most performed non-surgical aesthetic procedures in the world [8] and knowledge of normal facial vascular variations becomes more important to prevent catastrophic complications from cosmetic procedures, as well as to provide guidance for surgical planning. [9]

It is better to prevent vascular complications than to treat them. When filler material is injected directly into the lumen of a vessel, adverse vascular events can occur, leading to skin necrosis and, in the worst cases, blindness. To avoid this, it is essential to know the vascular anatomy and the variations in the path of each artery.[10]

Our objective was to perform a pre- and post-ultrasound study to document, with high-resolution ultrasound, the changes in the vascular anatomy that can be generated after performing rhinoplasty.

2. MATERIAL AND METHODS

We designed a descriptive, prospective study of a case series of 9 patients over 18 years of age, with an indication for primary rhinoplasty to evaluate vascular anatomy before and after the procedure, from August 2023 to May 2024. Doppler ultrasonography was performed by the same radiologist with expertise in dermatological ultrasound with 14 years of exclusive dedication in this area. The studies were performed with a high-resolution linear transducer multifrequency golf stick of 8-18 MHz with grayscale evaluation and color duplex Doppler, following the guidelines established for this type of study. The morphology of nasal cartilages and skin layers was evaluated in grayscale, in the Doppler analysis the following were included: angular arteries, dorsal nasal arteries, intercanthal vein, columellar arteries, lateral nasal arteries. The primary rhinoplasty was performed by two facial plastic surgeons with experience of more than 25 years. All patients have informed consent to participate in the study. The exclusion criteria were previous rhinoplasty, previous facial surgery, nasal trauma, history of use of fillers in the facial and nasal region.

Table 1: Pre surgical Results.

P	G	A	Rhinoplasty Approach	Presence Angular Artery	A. Angular Localization		Transverse Diameter (mm) A. Angular		Peak Systolic Velocity (cm/sec)		Spectral Curve	Depth Dorsal Nasal Artery (mm)		Anatomical variant: Interc anthal vein	Detection Columellar Artery at nasal tip	Presence of vasculature in alar cartilages.
					Right	Left	R	L	R	L		R	L			
1	M	19	Open	yes	Superficial/ Subdermal	Superficial/ Subdermal	2.5	2.5	16	16	normal	1.3	1.3	yes	no	no
2	F	32	Close	yes	Superficial/ SMAS	Superficial SMAS	1.3	1.3	18.83	18.83	normal	2.4	2.4	no	yes	no
3	F	23	Open	yes	Superficial/ SMAS	Superficial SMAS	1.3	1.3	28	28	normal	1.2	1.2	no	no	no
4	F	45	Open	yes	Superficial/ SMAS	Superficial SMAS	1.4	1.4	11.8	11.8	normal	1.3	1.3	no	yes	no
5	M	24	Open	yes	Deep/SMAS	SMAS profunda	1.7	1.7	20.8	20.8	Normal	0.9	0.9	yes	yes	no
6	F	19	Close	No	Superficial/ SMAS	Agenesis	1.0	Agenesia	28	28	normal	1.4	Agenesis	yes	yes	no
7	M	31	Open	yes	Superficial/ SMAS	Superficial SMAS	1.1	1.1	18.8	18.8	normal	0.7	0.7	no	yes	no
8	F	28	Open	yes	Superficial/ SMAS	Superficial SMAS	1.6	1.6	26	26	normal	1.4	1.4	no	no	no
9	F	23	Close	yes	Superficial/ SMAS	Superficial SMAS	1.4	1.4	26	26	normal	1.2	1.2	no	yes	no

Table 2: Post surgical Results.

P	G	E	Surgical Approach	Presence Angular Artery	A. Angular Localization		Transverse Diameter (mm) A. Angular		Peak Systolic Velocity (cm/sec)		Spectral Curve	Depth Dorsal Nasal Artery (mm)		Anatomical variant: Intercanthal vein	Detection Columellar Artery at nasal tip	Presence of vasculature in alar cartilages.	Other vascular changes
					R	L	R	L	R	L		R	L				
1	M	19	Open	Yes	Supraperiostic	Deep SMAS Tortuos curse and multiple handle appearance	3.9	3.9	16	16	Normal	3.5	3.5	No	Yes	No	No
2	F	32	Close	Yes	Superficial SMAS	Tortuous Subdermal	1.5	1.5	16	16	Normal	1	1	No	Yes	No	-Hypovascularity in the dorsal nasal Artery territory with almost undetectable flow in the third mid-nasal. -Restores flow to the nasal tip with a transverse vessel and prominent angisome. - Dominance of the Right lateral nasal artery with an increase in size compared to with contralateral
3	F	23	Open	Yes	Superficial SMAS course with handle appearance	Superficial SMAS course with handle appearance	0.9	0.9	16	16	Normal	1.2	1.2	No	Yes	No	-Hypovascularity in the dorsal nasal Artery territory with almost undetectable flow in the third mid-nasal. -Restores flow to the nasal tip. - Dominance of the Right lateral nasal artery with an increase in size compared to with contralateral.

4	F	45	Open	Yes	Superficial SMAS	Superficial SMAS	1.3	1.3	20	20	Normal	1.4	1.4	No	Yes	No	-Hypovascularity in the dorsal nasal Artery territory with almost undetectable flow in the third mid-nasal. -Restores flow to the nasal tip with a transverse vessel and prominent angisome. - Dominance of the Right lateral nasal artery with an increase in size compared to with contralateral
5	M	24	Open	Yes	Deep SMAS	Deep SMAS	1.3	1.3	27	27	Normal	1.8	2.4	Yes	Yes	No	-Hypovascularity in the dorsal nasal Artery territory with almost undetectable flow in the third mid-nasal. -Restores flow to the nasal tip with a transverse vessel and prominent angisome. - Dominance of the Right lateral nasal artery with an increase in size compared to with contralateral
6	F	19	Close	No	Superficial SMAS	Agenesis	1	-	16	-	Normal	0.5	Agenesia	Yes	Yes	No	Right Dorsal nasal Art. Is superficialized. -Hypovascularity in the dorsal nasal Artery territory with almost undetectable flow in the third mid-nasal. -Restores flow to the nasal tip with a transverse vessel and prominent angisome. - Dominance of the Right lateral nasal artery with an increase in size compared to with contralateral.
7	M	31	Open	Yes	Superficial SMAS	Tortuos hypodermic course	1.9	0.9	17	37	Normal	1.2	1.4	No	Yes	No	-Hypovascularity in the dorsal nasal Artery territory with almost undetectable flow in the third mid-nasal. -Restores flow to the nasal tip with a transverse vessel and prominent angisome. - Dominance of the Right lateral nasal artery with an increase in size compared to with contralateral.

3. PRE-SURGICAL RESULTS

In a series composed of 9 cases with ultrasound evaluation prior to performing primary rhinoplasty and after said procedure, it was carried out to analyze if vascular anatomical variations were observed, concluding this study 7 patients with control ultrasound. The study population, composed mostly of women in two-thirds and one-third of men; The variables evaluated: Angular, Dorsal Nasal and Columellar Arteries are described in Table 1.

The mean age of the patients evaluated was 27 years (±Standard deviation [SD]: 8.18, range: 19–45). Of the 9 patients who started the study, the presence of a right angular artery was observed in 100%; Left angular artery in 89% of patients, highlighting that one (11.12%) of the patients presented agenesis of the left angular and left dorsal nasal artery. The location of the angular artery was represented in 78% SMAS/Superficial, SMAS/deep and Subdermal and 11 % (respectively) (Chart 1). The transverse diameter of the right angular artery showed an average of 1.47 mm (±0.44) and the left side of 1.53 mm (±0.65) with a range of 1-2.5 mm. The peak systolic velocity ranged from 11.8 cm/sec to 28 cm/sec with an average of 21.58 cm/sec. The dorsal nasal artery was presented at an average depth of 1.31 mm on the right side and 1.3 mm on the left side (±0.47, respectively). In 3 patients, an anatomical variant of the intercanthal vein was observed, this measurement being at the level of the radix in the intercanthal line, the remaining 6 did not present it. Doppler ultrasound evaluation revealed detection of the Columellar artery at the nasal tip in 55.55% of patients and absence of vascularity at the level of the alar cartilages in all patients. The spectral curve in all cases was found normal.

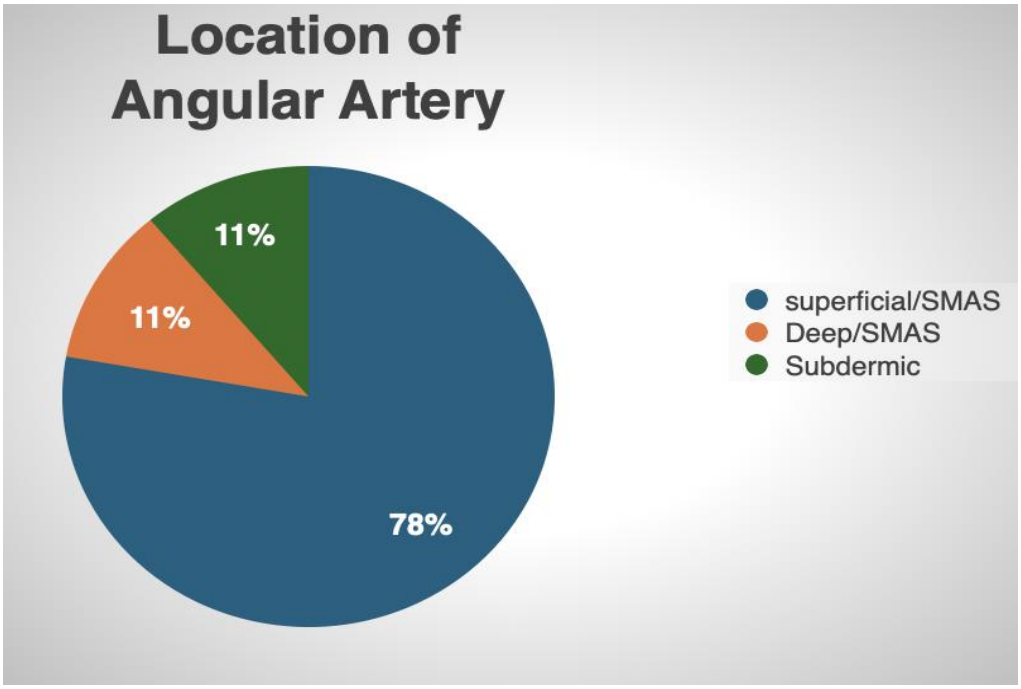

Chart 1: Location of the Angular Artery prior to rhinoplasty.

4. POST-SURGICAL RESULTS

At the end of the study, 2 patients did not undergo postoperative evaluation. The variables described are shown in Table 2. It was performed in 6 patients Open Rhinoplasty and in 3 patients Closed approach. We were able to observe in the 7 patients who completed the study, 4 (57 %) of them presented changes in the location of the Angular artery , one patient presented a subdermal change to Supraperiosteal on the right side and in the left to Deep/SMAS; A change from superficial/SMAS to subdermal location with a tortuous path on the left side was observed in one patient; A change in ASA onset and a change from superficial to hypodermic SMAS with a tortuous path in the left angular artery (Chart 2). The transverse diameter of the Angular Artery changed in 3 (43%) patients with an increase in diameter, 3 patients (43%) decreased and one (14%) maintained the same diameter (Chart 3). Dorsal artery depth increased in 4 (57%) patients (Chart 4) (Figure 1,2,3). All patients had the presence of a columellar artery at the nasal tip on postoperative ultrasound, of which 2 patients did not present on preoperative ultrasound. No presence of vascularity in the alar cartilages was observed in any patient. In 42.86% of the patients, an increase in the postoperative peak systolic velocity was described. On the other hand, hypovascularity was observed in 85.71% in the territory of nasal dorsal arteries with almost no undetectable flow in the nasal middle third that restores nasal flow at the tip with transverse vessel and prominent nasal angiosome at the tip. It was also observed that in both open and closed approaches, there were postoperative changes in vascular anatomy.

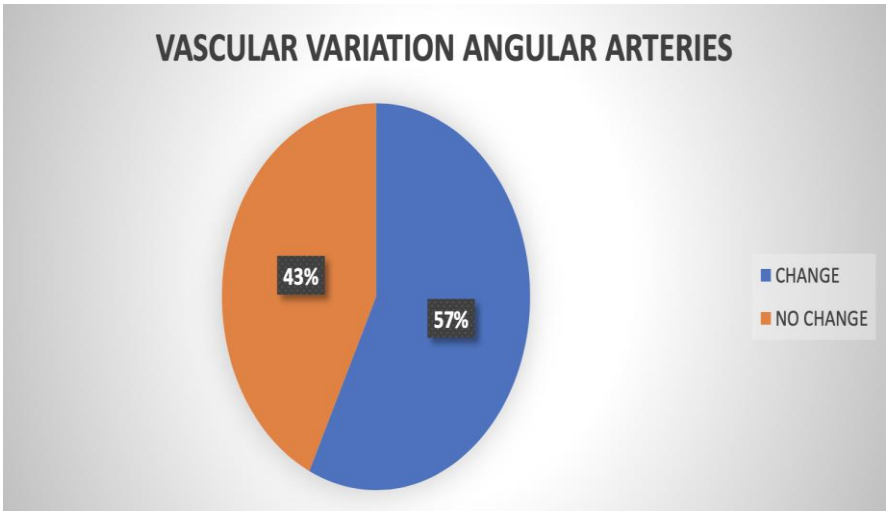

Chart 2: Vascular changes of the Angular Artery, presence of vascular changes in 57% of the patients, one patient presented sub dermal to supra periosteal change on the right side and on the left to SMAS/deep; A change from SMAS/Superficial to sub dermal location with a tortuous course on the left side was observed in one patient; A change in appearance in ASA and a change from SMAS/ superficial to Hypodermic with a tortuous course in the left Angular artery.

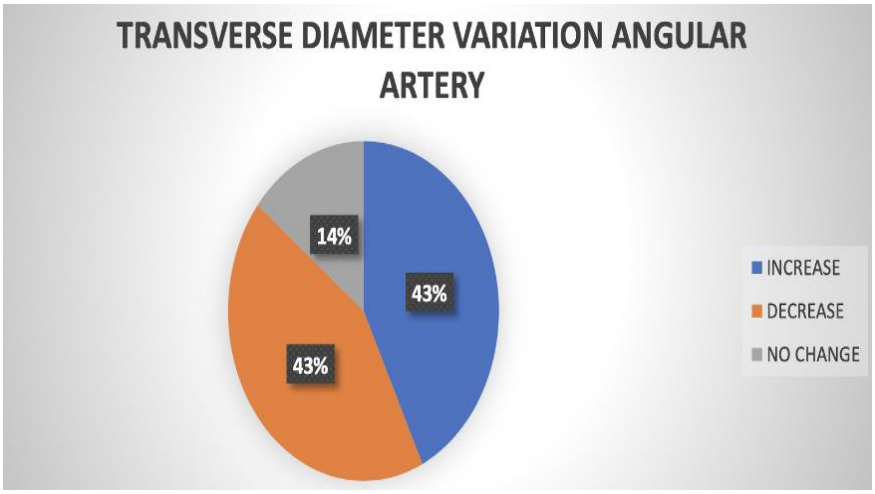

Chart 3: Changes in the diameter of the Angular Artery, increase in diameter in 43%, decrease in diameter in 43%, and no change was observed in 14%.

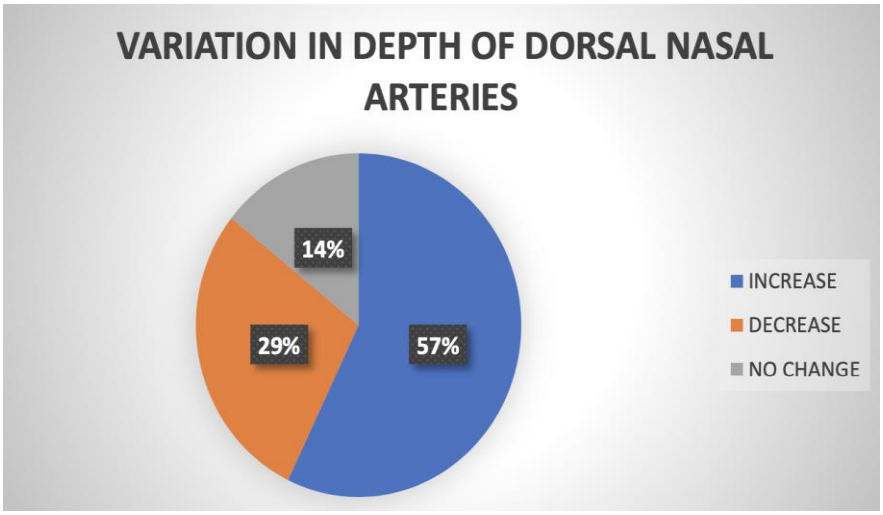

Chart 4: Variation in the depth of the Dorsal Artery, an increase in depth was observed in 57%, a decrease in depth in 29% and no change in 14%

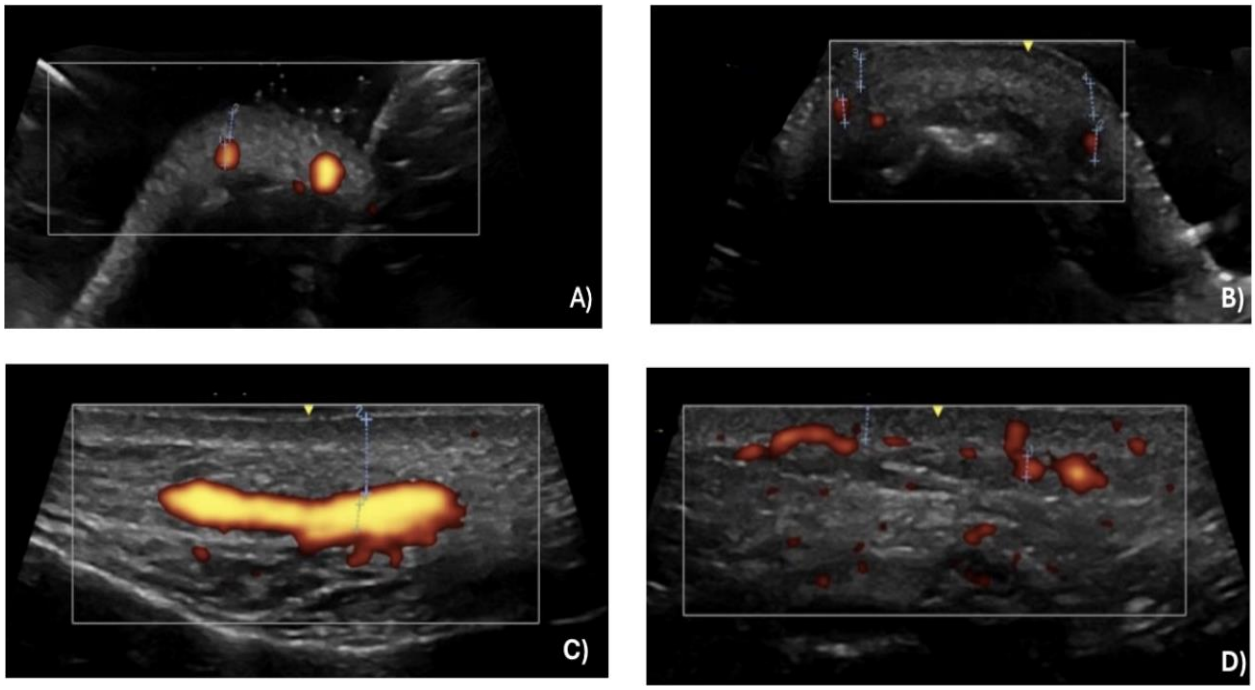

Figure 1: A) Preoperative axial image, middle nasal third, Power Doppler study, demonstrates the location of dorsal nasal arteries, the left one is deeper and more prominent compared to the contralateral one. B) Postoperative axial image, middle nasal third, Power Doppler study, demonstrates location of the dorsal nasal arteries, both arteries deeper compared to the preoperative study, there is also a decrease in their caliber compared to the same study. C) Preoperative axial image left Nasolabial fold, Power Doppler study, demonstrates the location of an angular artery in SMAS of normal caliber and course. D) Postoperative axial image left nasal crease, Power Doppler study, demonstrates a clear change in the morphology of the angular artery, which becomes tortuous, irregular, superficial and discontinuous.

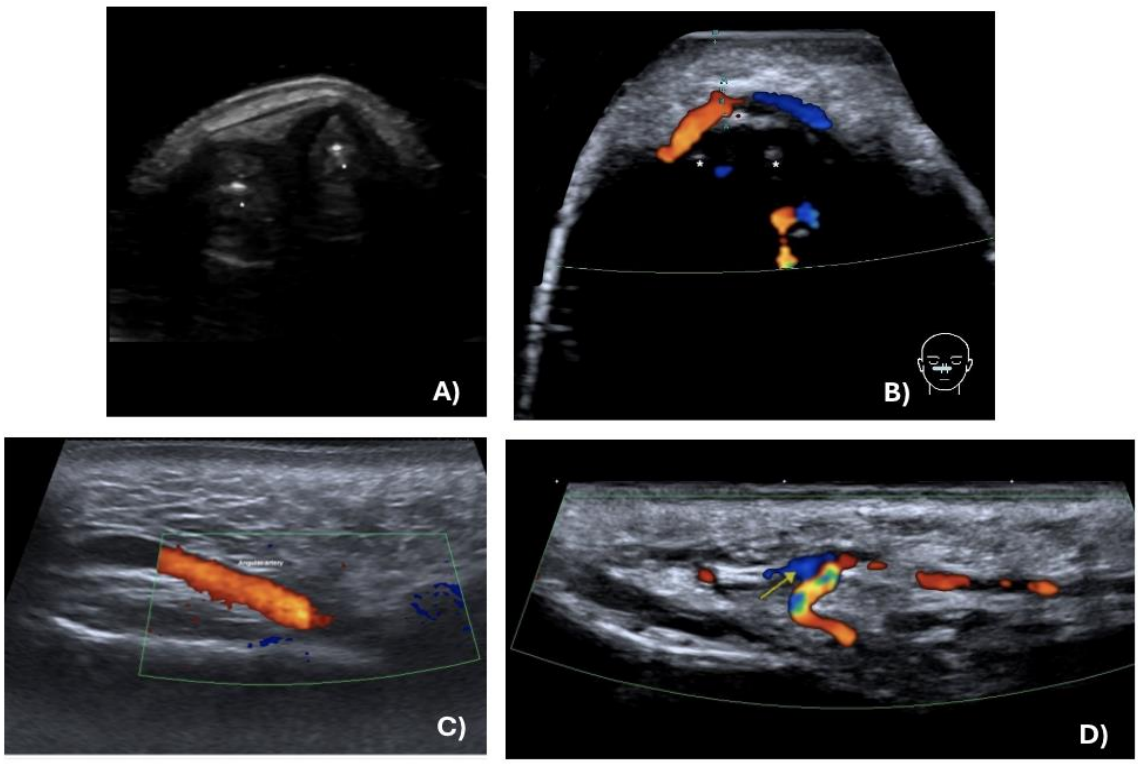

Figure 2: A) Axial image of the nasal dorsum, gray scale study, preoperative, shows asymmetry in morphology of the upper lateral nasal cartilages. B) Axial image of the postoperative nasal dorsum, color Doppler study, shows symmetry in the morphology of the upper lateral nasal cartilages (*asterisks). Delimited by calipers A+, vascular anastomosis of postoperative appearance is demonstrated in the nasal dorsum. Calipers B+ measure the depth of the same. C) Longitudinal image of the preoperative left nasolabial fold, color Doppler study, shows normal course of the Angular artery in the SMAS. D) Postoperative longitudinal image of the left nasolabial fold, color Doppler study, shows changes in the morphology of the artery, becoming tortuous and developing a vascular loop (arrow).

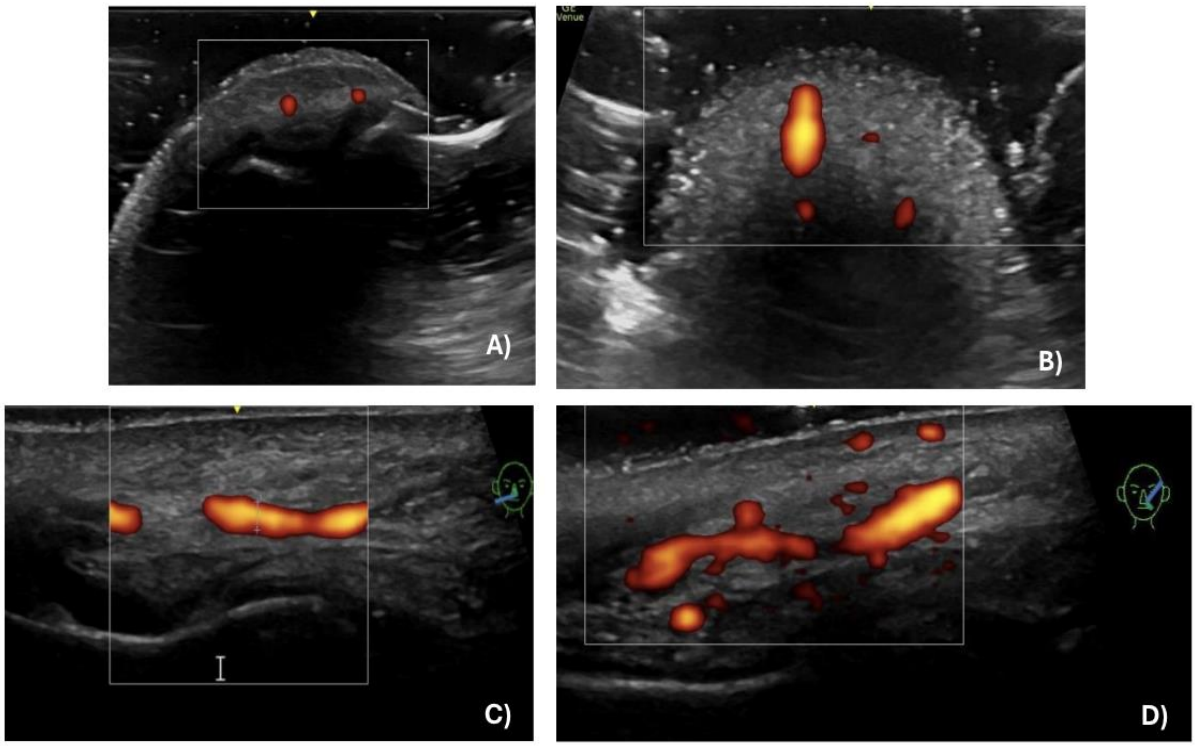

Figure 3: A) Preoperative nasal arteries. B) Postoperative nasal arteries have deepened, there is a new anastomotic artery in the midline. C) Preoperative left angular artery of normal caliber and course in SMAS. D) Preoperative left angular artery, its course remains normal in the SMAS, but there is an increase in perforators originating from it, and its course is slightly tortuous compared to the preoperative one.

5. DISCUSSION

This study described high-resolution ultrasound of the nasal vasculature, including angular, dorsal, lateral nasal, and columellar arteries. It is important as a facial plastic surgeon to know vascular anatomy and its variations. The importance of high-resolution Doppler ultrasound to avoid complications is discussed below. The arterial blood supply of the nose comes from three vessels mainly: lateral nasal artery, columellar artery, and the dorsal nasal artery. The facial artery divides into an upper labial artery and an angular artery near the corner of the mouth. A pair of columellar arteries branch off from the upper labial artery in the middle of the upper lip. [11]

The lateral nasal artery branches at the level of the alar crease and runs along the cephalic margin of the lateral crura. The angular artery (AA) terminal branch of the Facial Artery is so named beyond the nasal ala, after providing the lateral nasal branch, so the endpoint of this reference line in the superior nasal ala then goes towards the medial canthus to anastomoses with the dorsal nasal arterial system. The facial artery is approximately 3.2 mm lateral to the most lateral point of the nasal ala. [9.11]

Jung, in his studies, describes that the lateral nasal artery is the main blood supply of the nasal tip, followed by the dorsal nasal artery, and the variable contributions come from the columellar artery.[12]

The dorsal nasal artery is a continuation of the ophthalmic artery, whose origin is in the radix, the artery emerges from the orbit and perforates the orbital septum above the medial canthal ligament. [13] It runs deep to the orbicularis oculi muscle at the bottom and connects to the contralateral dorsal nasal artery at the origin of the procerus muscle. The dorsal nasal artery has direct connections to the angular artery, to the contralateral dorsal artery, to the superior and inferior medial palpebral arteries (both located deep in the orbicularis oculi muscle), and to the supratrochlear artery.[11,13]

Mitz 1973 confirmed that the major arteries run down or below the SMAS, dividing into perforating branches that run into the dermis to form the subdermal plexus (superficial anastomosis).[14] Toriumi et al. (1996) emphasized that the vascular system was located in the subcutaneous plane above the SMAS layer. [15] Saban in 2012, described an arterial polygonal system based on the findings of anatomical research and Doppler ultrasound, his study demonstrates the existence of an anastomotic system, which connects the external and internal carotid systems and the transfacial nasal system, which gives rise to the subdermal plexus16. Our study describes that the location of the angular artery was represented in 78 % SMAS/Superficial, SMAS/deep and Subdermal 11% (respectively).

Doppler ultrasound (DUS) is being promoted as a first-line imaging technique in aesthetic medicine. 1 In the last decade, an increasing number of articles have been published on fillers and the use of ultrasound; [1,2,17,18] The use of fillers remains one of the most performed non-surgical aesthetic procedures in the world. [8]

There are multiple uses of duplex high-resolution ultrasound in facial filler treatment that provides essential information that allows the injector to "blindly" visualize both the target tissue and vital structures under the skin.17,18 All fillers are visible with ultrasound. Fillers deposits can be identified based on their echogenicity and the artifacts generated in the tissues. [19,20] Determine the location, size of skin deposits and their presence in ectopic locations. [19,20,21]

No other currently available technology will provide all these parameters in a non-invasive way and, therefore, ultrasound represents a useful complementary tool for future research in this field. [1,18] The diagnosis of late complications such as chronic inflammation and granuloma, avoiding the need for biopsies and the likelihood of scarring,[19,21,22] also supports the management of complications. Ultrasound-guided injection can increase the likelihood of a hyaluronidase or steroid response, ensuring that treatment will be effective.[21.23]

Color Doppler ultrasound informs about the location of the main facial vessels, perform a vascular mapping, flow of the artery would detail probable arterial variations; [5] Adds new information, detailed in real time, and prevents unpredictable vascular damage during interventions. [5,24] In this study, angular, dorsal, columellar arteries, spectral curve, and peak systolic velocity were evaluated with this device.

With this knowledge, the provider can inject above or below the plane of a major vessel, which decreases the likelihood of vascular occlusion. Ultrasound can help effectively identify and dissolve an intravascular embolus, with hyaluronidase when a vascular occlusion is identified. [25] There are several studies that describe normal vascular variations. These variations make it difficult to detect so-called facial danger zones and require individual assessment. [5,26,27]

Recognition of normal facial vascular variations could also prevent catastrophic complications from cosmetic procedures, as a guide for surgical planning. [5.28]

Khorasanizadeh et al, in their article on color Doppler ultrasound noted large variations from person to person and even on two sides of the face in an individual. The angular artery was absent in 10 (11.62%) participants. [5] Our study describes that 11.12% of the patients had agenesis of the left angular and dorsal artery. Existing normal anatomical variations of the facial artery and its branches shown in previous studies need proper consideration and management during facial procedures. [5] These variations are most evident in the angular arteries and infraorbital branches of this artery according to previous studies. [5,29,30]

The history of previous surgeries should be checked because normal vasculature may change after surgery, trauma, and a history of previous fillers. [2,3,4,16] In particular, patients with prior open rhinoplasty in which the lateral, dorsal nasal, and columellar arteries may be altered comprise an alar margin that provides the main blood supply to the elevated flap in the external rhinoplasty approach. [15,16] Therefore, the tip of the nose is the one that is most at risk, care should be taken with filler injections, due to the changes that the Columellar Artery may present. [26,31] In our evaluation, changes were observed in angular, dorsal nasal, and columellar arteries. In 85.71% of cases, hypovascularity was described in the territory of dorsal nasal artery with almost undetectable flow in the nasal mid-third that restored flow to the nasal tip with a transverse vessel and prominent nasal angisomes. In addition, the depth of the dorsal artery increased in 4 (57.14%) patients, which reinforces what was previously described by the literature.

Nose filler augmentation should be approached with even more caution and less amount of filler in one session. [26,31] Incidental retinal artery occlusion occurs most frequently in glabella and nose treatment. [13,26,32,33]

To minimize intravascular injection of hyaluronic acid in nose augmentation, the filler should be placed along the midline of the radix, dorsum, supratip, tip, and nasal spine, in a preperichondrial or preperiosteal plane, which is relatively avascular. [16,26,31]

The literature recommends never injecting into the Nasal ala in any layer, as this is the location of the lateral nasal artery; always inject deep and superiorly into the alar crease for lateral injections. [26,27] Our study presented a case in which the angular artery changed from a subdermal to a supraperiosteal position on the right side in the postoperative control, which would increase the risk of a vascular complication.

If injections are performed intravascularly, the presence of many anastomoses may cause (1) a risk of anterograde arterial embolism, which in most cases does not cause necrosis of the skin due to blood supply from other vessels, and (2) a risk of retrograde arteriolar microembolism into the ophthalmic artery through the nasal artery, which can lead to temporary or permanent visual loss. [16,31,32,33,34]

Before filler injection in revisional rhinoplasties, it is important (especially in the nasal tip area) to evaluate the presence of certain structures. [16] First, the presence of any adhesion between the dermis and the bone or cartilage structure must be assessed. In a previous rhinoplasty, the SMAS layer may not have been spared, in which case the resulting scar tissue may have caused direct adhesion between the dermis and the deeper nasal structures.15,16 Second, the presence of cartilage grafts (i.e., shield graft or tip graft) should be assessed. In this area, the space between the

lower lateral cartilage and the dermis is thin; Grafts placed there to increase the projection of the tip compress the subdermal vessels. Filler injections in this area after the placement of tip grafts can be dangerous, causing skin necrosis, and more so after rhinoplasty with an open approach, as it interrupts the blood supply to the columellar arteries. [15,16,31]

When the blood supply to the nasal tip is compromised, filler injections performed in this area can further compress pre-existing vessels or new vessels due to postoperative neoangiogenesis. This can occur even if filler injections are performed correctly.[16,31]

6. CONCLUSION

Knowledge of vascular anatomy is crucial for performing surgical and non-surgical procedures; Knowing that there are normal variations from patient to patient and that they can increase after surgery, trauma or the use of fillers previously, it is here where high-resolution ultrasound plays an important role as a complementary tool which shows that it enhances interest within cosmetic medicine for diagnosis, therapeutic support in the detection of these situations in a non-invasive way, low cost, fast, real-time, safe thus avoiding complications that can be devastating for the patient. Thanks to this pilot study, although there are few patients, it creates a precedent for new research in the future. This study found variation in vascular anatomy after surgery, so it is recommended as an indication to perform vascular mapping with Doppler ultrasound in patients who will be filled with hyaluronic acid and have a history of rhinoplasty to reduce complications.

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