The Fusion Sling—Revisiting the Nasal Tip Suspensory Anatomy

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KEYWORDS

• Rhinoplasty • Pitanguy ligament • Fusion sling • Preservation rhinoplasty

KEY POINTS

- "Pitanguy's ligament" description may be a surgical artifact—the Pitanguy's flap.
- The central and lateral olfactory processes merge to create the Fusion Sling.
- The embryologic Fusion Sling of the nose creates different compartments separated from each other by connective tissues.
- The Fusion Sling flap may be used in rhinoplasty reconstructions to achieve better, long-lasting results with reduced need for grafting and, consequently, less use of cartilage.

Video content accompanies this article at http://www.facialplastic.theclinics.com.

INTRODUCTION

Nasal tip's support mechanisms have been a topic of debate and refinement for several decades. Through the years, there has been a—mostly—general consensus on the supporting mechanisms of the nasal tip. Authors like Janeke and Wright,[1] as well as Tardy and colleagues[2] have described a series of ligaments/connections that have led to the acceptance of the "tripod concept"[3] as an accurate description of how the tip position is maintained. The 5 main structures depicted by

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Facial Plast Surg Clin N Am 33 (2025) 143–157
https://doi.org/10.1016/j.fsc.2025.02.001
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Abbreviations	
3D	three-dimensional
ANS	anterior nasal spine
ASA	anterior septal angle
H&E	Hematoxylin and Eosin
LLC	lower lateral cartilage
SEG	septal extension graft
SMAS	superficial musculoaponeurotic
SOON	superficial orbicularis oris nasalis
STE	soft tissue envelope
TIG	tongue-in-groove
ULC	upper lateral cartilage
VVG	Verhoeff-Van Gieson

these authors were (1) the intrinsic strength of the lower lateral cartilages (LLCs); (2) the scroll ligament; (3) the junction between the footplate of the LLC and the septum; (4) the lateral sesamoid ligament; and (5) the interdomal sling. Tardy and colleagues[2] labeled the 3 first structures as the major tip support, and the latter 2 as minor. Other structures like the dermocartilaginous ligament described by Pitanguy and colleagues[4–6] have also been implied to influence in tip support.[7]

Several of these "ligaments" have been redefined and/or dismissed in consequent dissections. Daniel and Palhazi[8] did not find any fibrous attachments between the medial crura footplate and the caudal septum nor any lateral sesamoid ligament, arising questions regarding their existence and/or their role in tip support. The scroll and the dermocartilaginous or "Pitanguy" ligaments have also been redefined in recent years. Saban and colleagues[9,10] described the nasal superficial musculoaponeurotic system (SMAS) as a unique continuous layer consisting of the procerus, transverse nasalis, and compressor minor muscles up to the level of the internal nasal valve. From that point on, it divides into a superficial and deep layer, each with a medial and lateral expansion. The deep medial expansion of the nasal SMAS would correspond with the previously described Pitanguy ligament. The deep lateral expansion consists of vertical fibers with a fatty component that go from the skin to the internal nasal valve, at the level of the scroll ligament. Therefore, a new "Scroll Ligament Complex" has been proposed, in which this structure has 2 components: a horizontal one (as described in earlier dissections) and a vertical component (as recently described).[8,9]

After the anatomic descriptions of these structures made by Anderson,[3] Janeke and Wright,[1] and Tardy and colleagues,[2] the redefinitions made by Saban and colleagues,[10] the surgical applications recommended by Çakir and colleagues,[7] and the more recent anatomic portrayals illustrated by Daniel and Palhazi,[8] these concepts and support mechanisms have been very well integrated into the general rhinoplasty knowledge.

Embryologic studies suggest that nasal anatomy is defined by a complex sequence of invagination and fusion of the "placodes," or olfactory processes. In the work "*Evo-Devo: The Origin of the Nose, Anterior Skull Base, and Midface*" by Roger Jankowski,[11] an extensive embryologic discussion on how the nose originates is presented. It states that "*phylogenetic considerations suggest that, in human development, fusion of the medial olfactory processes and formation of the intermaxillary process might give rise to the septolateral cartilages, whereas the lateral olfactory processes would give rise to the alar cartilages. (…) the medial olfactory processes of the olfactory pits (moves) from their lateral position to fuse on the midline continues along the midline between the two deepening olfactory sacs with the complete invagination of the medial olfactory process to form the septolateral unit, which as a consequence would bring the lateral olfactory processes to meet caudally of the septolateral cartilage and form the alar cartilages*" (**Fig. 1**).

Through this merging process, fusion of the lateral olfactory processes toward the midline forms a connective structure that interconnects the cephalic border of the LLCs and functions as a sling. This structure will be referred to in this work as "the *Fusion Sling*" (**Fig. 2**). This sling acts as a continuous suspensory mechanism that stabilizes the nasal tip through a network of connective tissue fibers, extending from the pyriform aperture to the footplates of the medial crura, following the cephalic border of the LLCs. It thereby constitutes an intercompartmental support structure.

At the level of this fusion area, we will focus on describing the connections between these

Fig. 1. Embryologic origin of the nose: blue—the fronto-nasal process, green—the maxillary process, red—the medial nasal process (olfactory placode), yellow—the lateral nasal process (olfactory placode), and black—the Fusion Sling.

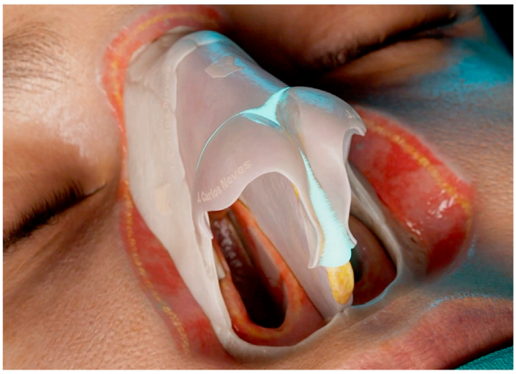

Fig. 2. The Fusion Sling: The cephalic border of the LLC, where vertical and horizontal connections are established as a sling during embryologic fusion.

different structures. There are vertical connective tissue densifications between the upper lateral cartilages (ULCs) and the LLC that separate the nasal mid-third from the nasal lower third.

They continue along the cephalic borders of the intermediate and medial crura, extending to the footplates. These densifications are perpendicular to the surface of the LLC and will be referred to as “vertical densifications” in the text. Furthermore, we will describe the horizontal connections of the LLC with neighboring structures. These connections are parallel to the LLCs surface and constitute a continuation of the LLCs and ULCs perichondrium’s—corresponds to the layer 5 of the superficial soft tissue envelope (STE).

We propose that the described Fusion Sling divides the nose in different compartments through its trajectory. At the level of the fusion area, between the upper lateral cartilages (ULC) and the LLC, it separates the mid-third of the nose from the lower third. In the tip-columella complex, it encompasses 3 distinct compartments: the supratip, the intercrural, and the membranous septum compartments.

The purpose of this study is to redefine the concept of nasal tip stability by describing the anatomy of the Fusion Sling and the tip compartments. This article will present an anatomic and histologic analysis of the Fusion Sling, its implications for rhinoplasty, and its role in maintaining nasal tip stability. The findings have significant implications for surgical techniques aimed at preserving and manipulating nasal tip support in rhinoplasty procedures.

MATERIAL AND METHODS

Study Design

This study utilized a combination of surgical dissections, cadaveric studies, and histologic analysis to define the anatomy of the nasal tip, focusing on the Fusion Sling and anatomic compartments. Over a period of 4 years, systematic dissections were performed during 537 primary rhinoplasty surgeries. The aim was to map the consistency of the suspensory structures and to identify the compartments created by the Fusion Sling within the nasal tip.

Complementary cadaveric studies were conducted on 23 fresh specimens. Of these, 7 cadaveric noses were injected with colored acrylic ink to delineate specific compartments at the tip midline. Three key areas were selected for ink injection: the space between the medial crura, the supratip region, and the membranous septum. Each of these areas was dissected separately to preserve and define the compartmental boundaries, allowing for precise mapping the nasal tip compartments and the connective denser structures.

Histologic studies were performed in 7 specimens with 2 objectives: (1) to describe and classify the tissues using Hematoxylin and Eosin (H&E) and Verhoeff-Van Gieson (VVG) staining method and (2) to identify and delineate the compartments at the tip region by injecting with Nankin—Chinese ink. Only preliminary results from this histologic study will be evaluated, as we are analyzing more specimens with the ultimate goal of histologically mapping the nasal tip. Even though we present our initial results here, they align with the anatomic dissections previously described.

Cadaveric Injection Studies

Prior to dissection, 3 key areas were injected with different colored inks:

1. Membranous Septum Compartment: The medial crura were pulled forward to expose the membranous septum. The ink was injected through the mucosa, immediately in front of the caudal border of the septum, until tension was felt.
2. Inter-medial Crura Compartment: The ink was injected through the skin at the midpoint of the columella between the 2 medial crural borders until tension was felt.
3. Supratip Compartment: Injection in the midline, immediately above the domal area, in the supratip region. The ink was injected through the skin until tension was felt.

Histologic Studies

Histologic studies were performed using 2 strategies:

1. Coronal and axial cuts of the nasal structure were analyzed with H&E and VVG staining method.

2. With the nose intact, the specimens were injected with Nankin—Chinese ink into the intercrural, membranous septum, and supratip compartments to enhance visualization of the compartment boundaries. The ink was introduced into the compartments following the technique previously described.

Surgical Technique

Surgical dissections followed a standardized protocol to systematically expose and define the layers of the nasal tip:

1. Medial Crura Dissection: Dissection commenced at the caudal border of the medial crura, proceeding in a subareolar plane toward the domal region. The plane was then extended onto the corresponding outer surface of the lateral crura. At the cephalic border of the medial crura, connective tissue densifications linking the medial crura to their contralateral counterparts were identified. This structure, representing an important stabilizing feature, was meticulously preserved, maintaining its attachment to each crura throughout the dissection process.
2. SMAS and Muscular Attachments: The SMAS over the lateral crura and domal areas was identified as a dense fat-connective tissue structure, interspersed with muscle fibers. Key muscles, including the compressor minor and the dilator naris, were marked by increased resistance to dissection, indicating firm attachment points to the perichondrium.
3. Scroll and Supratip Dissection: At the scroll and supratip regions, vertical connective tissue densifications, oriented perpendicularly to the surface of the lateral crus, were observed. These vertical densifications interrupt the continuity between the tip and the mid-third compartments and serve to establish their anatomic boundaries, effectively demarcating these distinct regions. The perichondrium, recognized as the fifth layer of the STE at the cartilage framework, was preferentially preserved throughout the dissection. In the scroll area and in the supratip region, which links the 2 cephalic borders of the lateral crura over the WASA segment (the segment located between the caudal border of the ULC, the W, and the anterior septal angle, ASA) down to the level of the para-septal sesamoid cartilages, a perichondrium-like structure was identified and preserved, when elevating the scroll and tip vertical densification.
5. Compartmental Analysis: The supratip, intercrural, and membranous septum compartments were consistently identified during dissection. Saline injections were utilized intraoperatively to confirm the compartmental integrity, effectively demonstrating the distinct separation of these spaces.
6. After dissecting and elevating the vertical densifications, scroll and supratip, the midline perichondrium-like Fusion Sling was meticulously preserved. At the midline, it was elevated starting at the W region in a caudal progression with the surgeon placed at the head of the patient (**Fig. 3**). This dissection elevates the Fusion Sling till the level of the footplates, exposing the deeper anatomy, the membranous septum, and the septal caudal border. At this point, a *Fusion Sling Flap* (**Fig. 4**A) was produced to be used for tip stabilization.
7. Intercrural Sling Opening: In cases where transecting the Fusion Sling Flap was necessary, particularly to access the anterior nasal spine (ANS) region, it was carefully performed in the midline. This approach preserved both hemi-Fusion Sling Flaps (**Fig. 4**B) connected to the cephalic border of the correspondent LLCs, thereby maintaining the stabilizing characteristics of the structure. By preserving these connections, after tip reconstruction, the Fusion Sling continued to provide support to the nasal framework.

RESULTS

Cadaveric Findings

The dissections consistently revealed 3 distinct and independent compartments within the nasal tip complex: the intercrural compartment, the supratip compartment, and the membranous septum compartment. After injecting the acrylic ink, each compartment was delineated by well-defined connective tissue structures, with no intermingling between them (**Fig. 5**).

NASAL COMPARTMENTS DESCRIPTION

1. Intercrural Compartment: The dispersion of ink revealed an independent space, distinct from the surrounding supratip and membranous septum compartments. It extends from the infratip area to the ANS. It is bounded superficially by the subcutaneous and dermis layers, and deeply by the intercrural Fusion Sling. This compartment encompasses the area occupied by the *superficial orbicularis oris nasalis* (SOON). The muscle fibers insert into the subcutaneous infratip region but do not extend cephalically beyond the tip (Video 1). They are cephalically limited by supratip vertical densifications, which end at the subcutaneous layer as well.

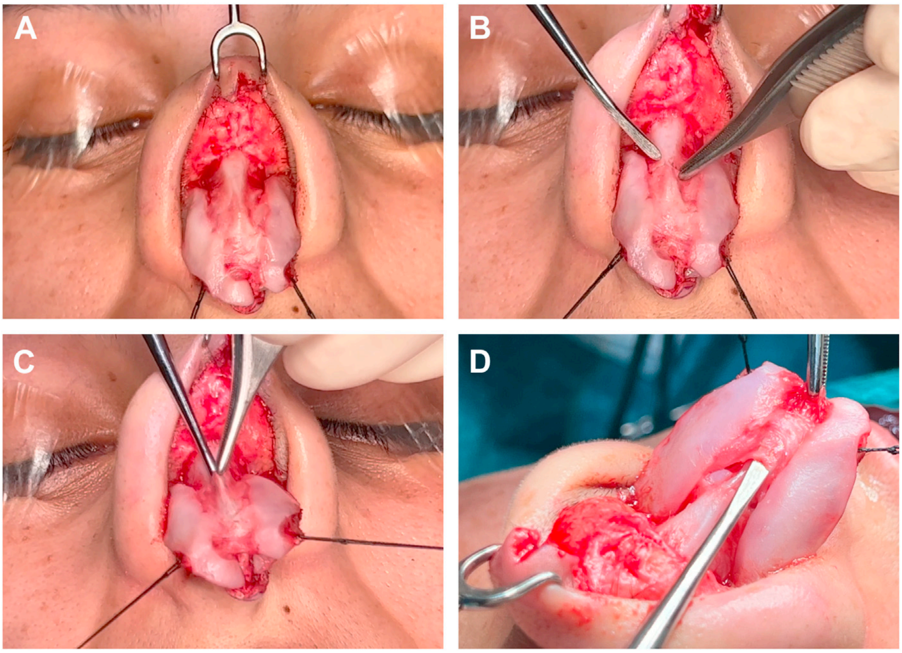

Fig. 3. (*A*) The Fusion Sling connecting the ULC and LLC; (*B*) incising the perichondrium at the W region; (*C*) elevating the perichondrium-like Fusion Sling; (*D*) the inter-LLC Fusion Sling.

2. Membranous Septum Compartment: The membranous septum region was identified as an independent compartment, with clearly defined boundaries established by a connective tissue layer. It encloses the caudal septum within approximately 2 mm and is bordered caudally by the intercrural Fusion Sling and the cephalic borders of the medial crura. Anteriorly, at the level of the ANS, the compartment is limited by the perichondrium-like Fusion Sling, which separates it from the supratip compartment. Posteriorly, the membranous septum compartment does not extend beyond the ANS (see **Fig. 5**).
3. Supratip Compartment: At the supratip area, a more complex anatomic structure is identified, where a distinct supratip compartment can be delineated. The scroll vertical densification extends toward the midline and bifurcates into 2 distinct arms: one is a denser transverse arm that converges with the contralateral densification over the WASA segment, while the other is an oblique arm that follows the cephalic border of the LLC to the infradomal region, merging at the midline. This configuration at the midline forms an architectural structure resembling the “keel of a boat” (**Fig. 6**). The 3 arms described create a geometric figure similar to a truncated triangular pyramid—a *triangular pyramid frustrum*, bounded cephalically by the transverse supratip densification, laterally by the 2 oblique arms, posteriorly by the perichondrium-like

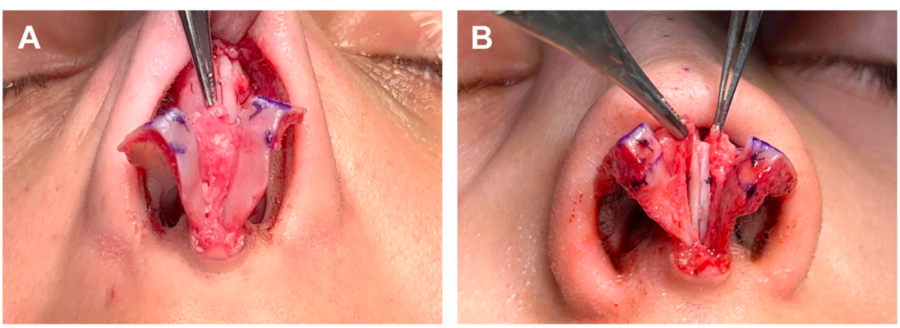

Fig. 4. *A*) Fusion Sling flap; (*B*) Hemi-Sling flaps, right and left. The Fusion Sling is split at the midline, maintaining its attachments along the entire length of the cephalic border of the LLC in both hemi-flaps.

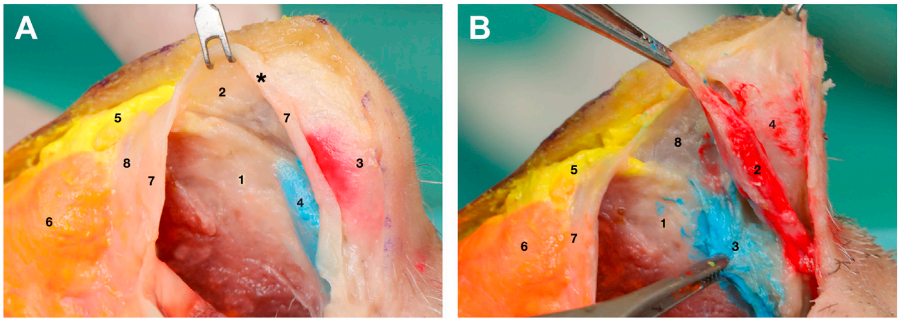

Fig. 5. (*A*) Different colors of ink were injected into separate compartments before dissection. 1—nasal septum; 2—perichondrium-like Fusion Sling; 3—intercrural compartment; 4—membranous septum compartment; 5—supratip compartment; 6—transversalis muscle; 7—LLC lateral crus (partial); 8—horizontal scroll. (*B*) After opening the compartments: 1—nasal septum; 2—SOON; 3—membranous septum compartment; 4—left medial crura 5—supratip compartment; 6—transversalis muscle; 7—LLC lateral crus (partial); 8—perichondrium-like Fusion Sling.

Fusion Sling, and anteriorly by the subcutaneous tissues (Videos 1 and 2).

These anatomic boundaries encapsulate a distinct supratip compartment where injected ink remains localized (**Fig. 7**). Importantly, neither the supratip densification nor the supratip compartment demonstrates any connection with the membranous septum compartment. The "keel of the boat" runs cephalically parallel to the fibers of the SOON, with each structure mutually defining the other's boundaries, and this configuration continues into the interdomal densification, by changing its fibers orientation.

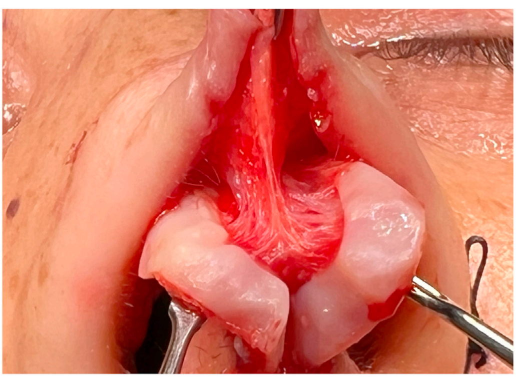

Fig. 6. The supratip vertical densification. The "keel of a boat" represents the caudal limit of the triangular pyramid frustum shape of the supratip vertical densification. Note that the fibers extend to the cephalic border of the LLC. As they transition from the supratip to the intercrural space, their orientation shifts from vertical to oblique and then horizontal, yet they remain consistently perpendicular to the surface of the LLC. When dissecting, interrupting the continuity of this structure at the level of the intermediate crura creates an artifact that is often misinterpreted as an individual intercrural ligament. The basal limit of the supratip vertical densification is the perichondrium-like Fusion Sling, while its roof is formed by the subcutaneous layer.

Histologic Findings

Upon analyzing the results with H&E and the VVG staining method, no distinct ligaments were observed as histologic units. Ligaments, in this context, are better defined by the connections they establish rather than as isolated histologic entities. At the level of the vertical and intercrural densifications, a fibroadipose tissue is identified (**Fig. 8**). The supratip compartment is richer in fat cells (**Fig. 9**).

The continuity of the perichondrium between the ULC and the LLC in the scroll area manifests as a perichondrium-like tissue (**Fig. 10**), and not a ligament, that extends over the WASA segment connecting the cephalic borders of both LLCs at the level of the paraseptal sesamoid cartilages (**Fig. 11**), which are located caudal and lateral to the ASA.

This tissue is in the same layer as the perichondrium and periosteum and serves as the deep limit of the STE, forming its fifth layer. It lies beneath the areolar layer, which functions as the gliding plane for the soft tissues. This structure corresponds to the horizontal perichondrium-like Fusion Sling.

In specimens where Nankin (Chinese ink) was injected, the compartments were well-defined. The membranous septum compartment was clearly delineated below the ASA Fusion Sling, encompassing the caudal margin of the septum by approximately 2 mm. This compartment is bounded caudally by intercrural Fusion Sling and extends posteriorly to the ANS (**Fig. 12**). An additional structure was identified anterior to the intercrural densification, originating from the ANS

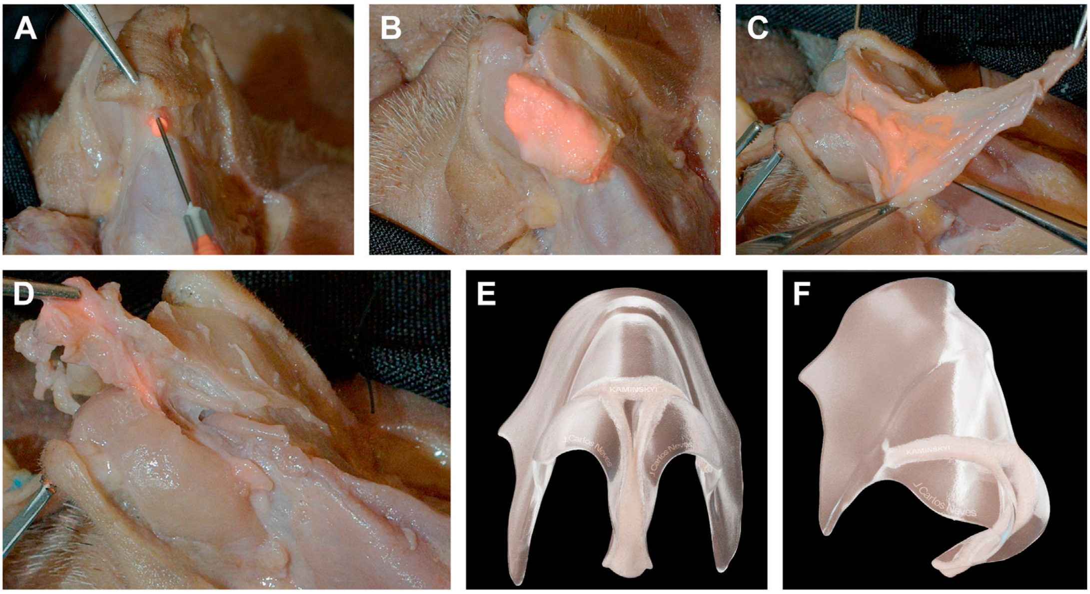

Fig. 7. The supratip compartment. (*A*) The supratip compartment was injected with acrylic ink, from cephalic to caudal, after removing the scroll vertical densifications. (*B*) The supratip vertical densifications were removed, exposing the boundaries of the compartment. Note that it extends to the W region, with the transverse arm of the supratip vertical compartment serving as its cephalic limit; (*C*) after removing the ink, it left an impression of its triangular shape on the horizontal Fusion Sling (over the WASA region). At this stage, the LLC and ULC perichondrium were elevated along with the perichondrium-like Fusion Sling; (*D*) after elevating the perichondrium-Fusion Sling envelope, no ink was observed in the membranous compartment, confirming the absence of a connection between the 2 compartments, which are separated by the Fusion Sling; (*E*) the periosteum-perichondrium-Fusion Sling envelope, the triangular base of the supratip compartment can be observed; (*F*) lateral perspective of the periosteum-perichondrium-Fusion Sling envelope.

region and extending to the subcutaneous tissue at the infra-lobule, corresponding to the SOON.

Surgical Findings

By dissecting in the subareolar plane over the medial surface of the medial crura, we successfully protected the SOON compartment, preserving the intercrural densification, which remained attached to the cephalic border of the medial crura. This dense connective tissue structure corresponds to the intercrural ligament described in the literature.[2] In all dissections performed, it extends continuously along the cephalic border of the LLC toward

Fig. 8. VVG staining method. 1—interdomal fibroadipose tissue, at the level of the macroscopic vertical densification; 2—medial crus; 3—lateral crus; 4—dermis; 5—SMAS; 6—areolar layer (subareolar dissection plane is what was used during surgery).

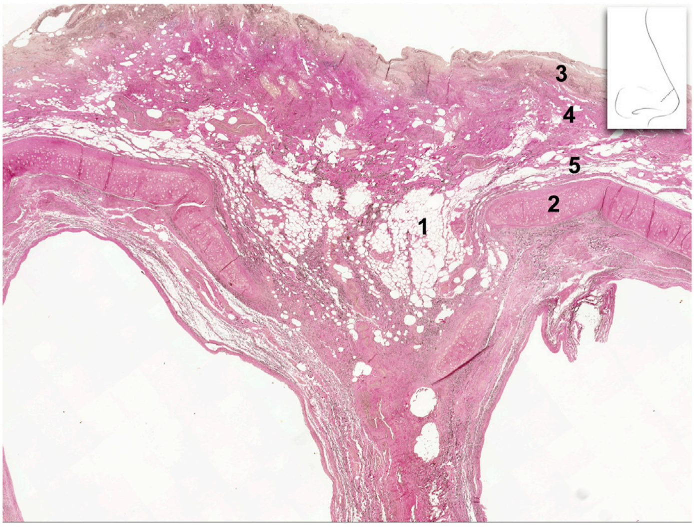

Fig. 9. VVG staining method. 1—supratip compartment with adipose tissue; 2—lateral crus; 3—dermis; 4—SMAS; 5—areolar layer (subareolar dissection plane is what was used during surgery).

the lateral crus distal end, forming the cephalic boundary of the lower third nasal compartment. It consistently appears as a perpendicular unit to the cephalic surface of the LLC, notably at the scroll area (vertical scroll densification), supratip area (supratip vertical densification), and intercrural area (intercrural densification).

Injecting saline into the membranous septum compartment caused it to enlarge without any observable effect on the intercrural region or the supratip area. This finding supports the notion that there is no direct connection between the membranous septum compartment and the supratip region. Only when the anterior limit of the membranous septum compartment—defined by the perichondrium-like Fusion Sling—was incised, did the saline flow from the membranous space into the supratip region, confirming their separation under normal conditions (Video 2).

When injecting saline into the supratip compartment, the *triangular pyramid frustum* was clearly identifiable with well-defined boundaries, showing no connection or continuity with neighboring compartments or structures. The SOON is identified, along with its insertions in the infratip subcutaneous tissues, located caudal to the keel-like structure formed by the supratip densifications (see **Fig. 6**). The scroll and supratip densifications, originating at the cephalic border of the LLC from the perichondrium-like Fusion Sling, were elevated along with the rest of the soft tissue layers, preserving layer 5 (the perichondrium and perichondrium-like Fusion Sling). The continuity of this layer from the ULCs to the LLCs represents

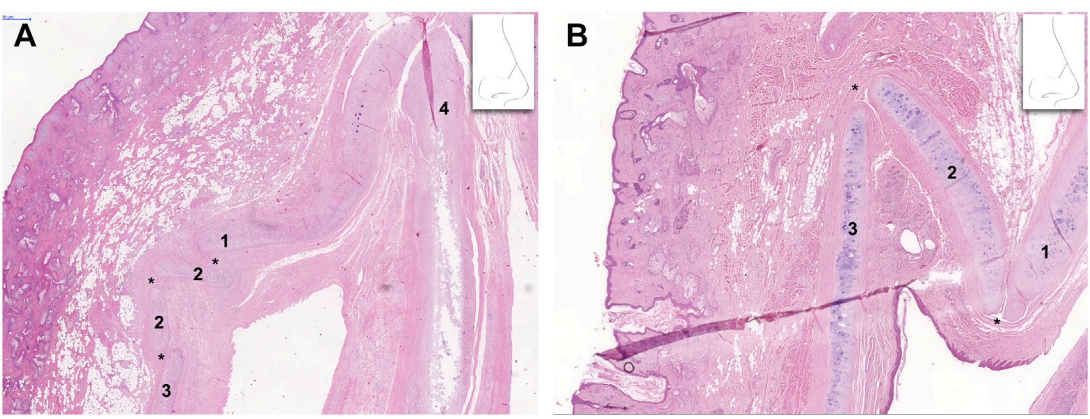

Fig. 10. (*A* and *B*) H&E staining method. The horizontal scroll Fusion Sling appears as an extension of the perichondrium, connecting the ULC, sesamoid cartilages, and LLC. 1—ULC; 2—sesamoid cartilage; 3—LLC; 4—quadrangular cartilage; *—horizontal scroll Fusion Sling.

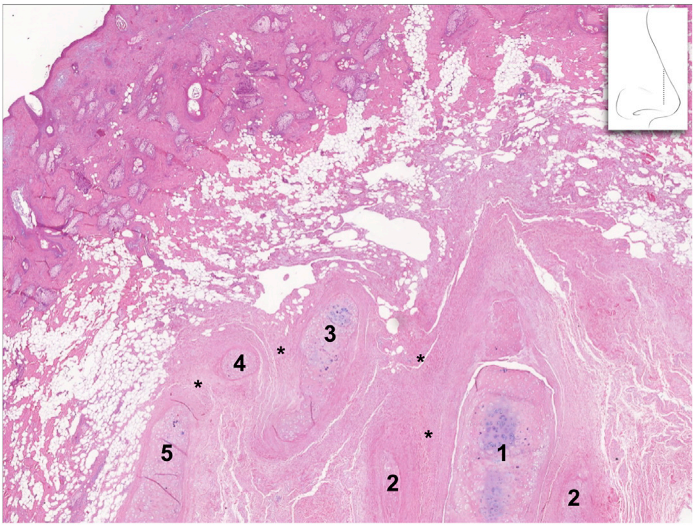

Fig. 11. H&E staining method. The horizontal perichondrium-like Fusion Sling appears as an extension of the perichondrium, connecting the quadrangular cartilage with the paraseptal cartilages, ULC, sesamoid cartilages, and LLC. 1—quadrangular cartilage; 2—paraseptal cartilage; 3—ULC; 4—sesamoid cartilage; 5—LLC; *—horizontal perichondrium-like Fusion Sling.

a strong support to the LLCs and is, in fact, the only connection they have to the rest of the nasal framework. By elevating the vertical soft tissue densifications, intrinsic stability—particularly in the domal region between the LLCs—is compromised. However, it is the disruption of layer 5 that plays the most significant role in spatial alterations of these structures.

ANATOMICAL MODEL

Analyzing the embryologic development of the nose has guided the conceptual elaboration of an anatomic model for the nasal tip midline, with a particular focus on the cephalic border connection of the LLC. This cephalic border is the only component in contact with the rest of the nose, establishing the cephalic boundaries of the tip compartment.

The Fusion Sling

The LLC connects to the corresponding ULC and the contralateral LLC through a three-dimensional (3D) soft tissue sling formed during the embryologic fusion process of the lateral placodes, which give rise to the LLC—termed the Fusion Sling (see **Fig. 2**).

The Fusion Sling forms a curved Y-shaped structure, originating from both pyriform apertures, merging at the supratip region, and continuing to the footplates.

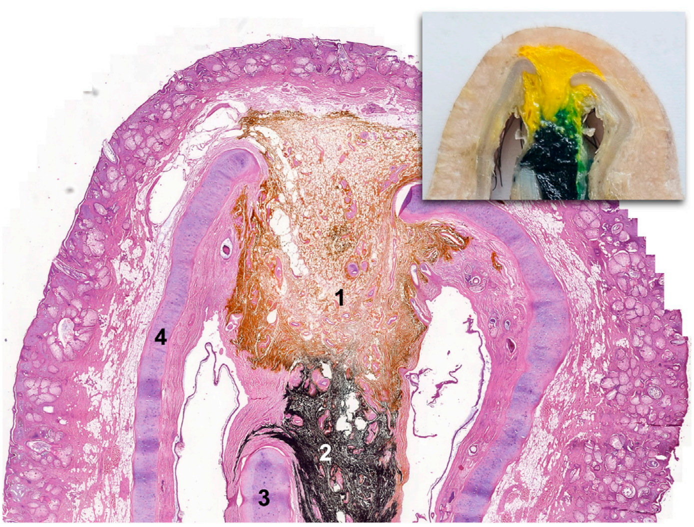

Fig. 12. H&E staining method with Nankin ink, yellow at the supratip compartment (1) and dark green at the membranous septum compartment (2). 3—quadrangular cartilage; 4—LLC.

Components of the fusion sling

Connective tissue densifications perpendicular to the lower lateral cartilage At the scroll area, it defines the vertical scroll densification (*as per Saban*), which is looser and richer in fat cells.

At the supratip area, occupying the entire WASA segment, it defines the supratip densifications, which are stronger and richer in connective tissue (*as per Saban*).

In the columella, it forms the intercrural densifications, constituting the central leg of the Y.

This component, located in the scroll and supratip areas, functions as a wall separating the nasal lower third compartment from the nasal mid-third compartment, a result of the opposition of 2 embryologic structures.

In the midline, both slings merge at the columella, forming the intercrural densification. While it remains perpendicular to the LLC surface, the 3D orientation change redirects the densification toward the opposing medial crura. At this level, the densification forms part of the deep limit of the STE (**Fig. 13**).

Horizontal perichondrium-like structure connecting the upper lateral cartilages and lower lateral cartilages perichondrium This structure extends from the pyriform aperture to the tip area, reaching the level of the para-septal sesamoid cartilages. It covers the entire WASA region as a sheet.

Beyond this point, and until the footplate, no perichondrium-like tissue is identified. Instead, a connective tissue sheet connects the cephalic borders of both medial crura, as evidenced by compartmental ink studies.

This horizontal component corresponds to the deep layer of the STE (Layer 5), which is the same as the perichondrium and periosteum.

At the scroll area, it is underlined by the nasal mucosa. In the supratip midline, it covers the septum and caudally, down to the footplates, it defines the caudal boundary of the membranous septum compartment. This compartment is an anatomic structure located deeper than the STE.

In the WASA region, the horizontal Fusion Sling forms a wide sheet that connects: the caudal-medial borders of both ULCs; the central aspects of the cephalic borders of both lateral crura; the cephalic borders of the domes and intermediate crura; it includes the para-septal sesamoid cartilages and sits over the WASA segment of the septum. This configuration separates the gliding supratip compartment from the gliding membranous septum compartment.

At the scroll and supratip areas, the perpendicular densifications originate from the horizontal perichondrium-like Fusion Sling (Layer 5), extending vertically to the subcutaneous layer. This creates a wall that separates the tip lower third compartment from the nasal mid-third compartment. In the scroll area, this structure consists of fatty fibrotic tissue, which becomes more fibrotic in the supratip area. Upon reaching the supratip region, the scroll densification branches into 2 arms: a transverse arm, connecting with the contralateral sling over the WASA segment; an oblique arm, running along the cephalic-medial border of the lateral crura and merging at the interdomal region to form a keel-like structure.

At the supratip, the densification, with its 2 oblique arms on each side and the transverse arm cephalically, forms a triangular pyramid approximately 15 mm in length, over the WASA segment. Within this structure lies the supratip compartment, which resembles a truncated pyramid with the following boundaries: posterior, the perichondrium-like Fusion Sling; anterior: the dermis; cephalic: the transverse arm of the supratip densification; latero-caudal: the 2 oblique arms of the supratip densification.

The oblique arms of the supratip densification gradually align horizontally, connecting the 2 medial crura forming the intercrural densification and extending to the footplates. The intercrural

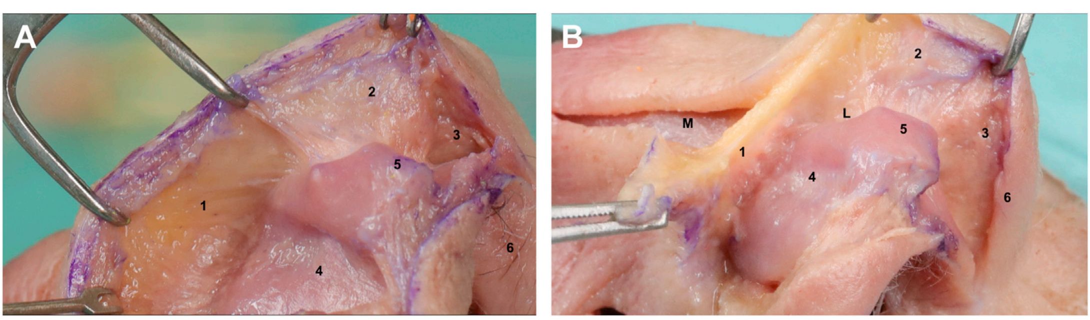

Fig. 13. (*A*, *B*) Vertical densifications. (1) Vertical scroll densification; (2) supratip vertical densification; (3) SOON; (4) lateral crus; (5) domus; (6) columella; L, lower third compartment; M, mid-third compartment.

densifications also originate at the cephalic border of the LLC and become denser in the infra-tip region.

Cephalic to the intercrural Fusion Sling lies the membranous septum gliding pad. This structure is not part of the STE, as it is located deep to Layer 5. It is separated from the supratip compartment by the perichondrium-like Fusion Sling at the WASA region.

Caudal to the intercrural densification, the SOON is well-defined, extending from the ANS region to the subcutaneous tissues of the infratip region, caudal to the keel-like interdomal densification.

Cephalic to the transverse arm of the supratip densification lies the nasal mid-third compartment. Within this mid-third compartment, the midline aponeurosis—formed by the fusion of both transverse muscles—can be found and is independent of the supratip vertical densifications (**Fig. 14** and Video 3).

CORRESPONDENCE TO PREVIOUSLY DESCRIBED ANATOMY

- Vertical scroll ligament—scroll vertical densification of the Fusion Sling
- Horizontal scroll ligament—scroll perichondrium-like Fusion Sling
- Converse Suspensory Ligament—WASA perichondrium-like Fusion Sling
- Intercrural Ligament—intercrural densification of the Fusion Sling
- Pitanguy Ligament
  - Dorsal extension of the Pitanguy Ligament—transverse muscles midline aponeurosis (SMAS)
  - Supratip component of the Pitanguy Ligament—supratip vertical densification of the Fusion Sling
  - Superficial Pitanguy Ligament—supratip vertical densification, followed caudally by the SOON (SMAS)
  - Deep Pitanguy Ligament—supratip vertical densification, supposedly continued with the membranous septum compartment, which is a deep anatomic structure, and not SMAS, and has no continuity with the supratip area.

FUSION SLING AND SURGICAL APPROACH

Over the past 4 years, the Fusion Sling has been the primary method for stabilizing the nasal tip position in the majority of the primary rhinoplasties of the main author (J.C.N.). The components used to create the Fusion Sling Flap, which stabilizes the tip via a hook suspension method over the WASA

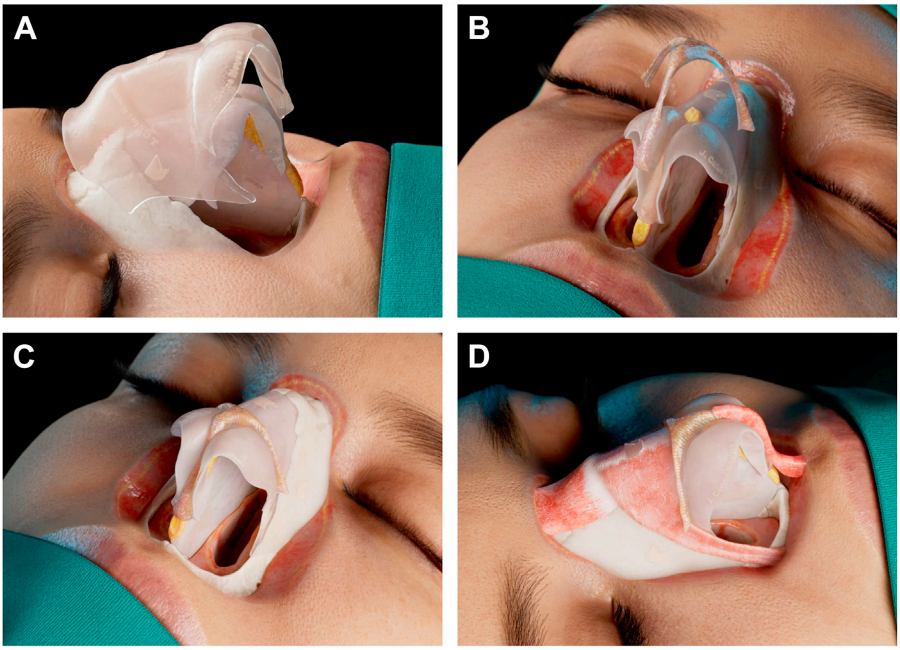

Fig. 14. Anatomic model: (*A*) The periosteum, perichondrium, and horizontal perichondrium-like Fusion Sling envelope, layer 5. (*B*) The supratip compartment and the membranous septum compartment (highlighted in yellow). (*C*) The scroll, supratip, and intercrural densification unit. (*D*) The midline muscles and aponeurosis, including the SOON, transverse muscles, and procerus muscles.

segment, include the WASA perichondrium-like Sling and the intercrural connective tissue and densification sling. Although the main focus of this article is not the surgical approach, a summary of its application is provided later.

As the Fusion Sling is embryologically attached to the cephalic border of the medial crura, this connection is preserved to maintain the tip in an ideal position. The nondistensible Fusion Sling, which secures the medial crura, is anchored over the WASA segment, functioning as a hook. Importantly, it is the Fusion Sling itself—not a suture passing over the WASA segment—that acts as the hook. Sutures subjected to continuous tension at the tip can risk tearing the cartilage. Similarly, sutures placed around septal extension grafts (SEGs) or the medial crura are prone to tearing, potentially leading to tip position relapses with these methods.

As previously described, the Fusion Sling is elevated starting from the W point and extending to the footplate region, ensuring the stability of the LLC cephalic borders is preserved.

There are 2 options for securing the Fusion Sling over the WASA segment:

1. Intact Fusion Sling:

If the Fusion Sling remains intact, it is brought over the WASA segment like a "blanket" and sutured into position in a hook fashion, allowing for adjustments in tip projection and rotation.

2. Splitting the Fusion Sling:

If the Fusion Sling is split at the midline, with each half remaining attached to its respective LLC, it can be reconstructed over the WASA segment by uniting the 2-halves to create a hook. Typically, the process involves: marking 5 mm from the new dome; passing a needle tangentially through one-half of the Fusion Sling at the cephalic border of the medial crura, creating a loop around the WASA segment to elevate the sling; capturing the other half of the Fusion Sling and tightening the suture to unite both halves at the midline over the WASA segment. This forms a supportive structure referred to as the *Fusion Sling Hook Suspension* (Video 4).

Importantly, the Fusion Sling tissue itself—not the suture material—provides the hook-like support over the WASA segment. This minimizes the risk of septal cartilage tearing caused by repeated tension from sutures. The *Fusion Sling Hook Suspension* plays a crucial role in defining nasal tip projection and length. Its nondistensible nature and embryologic connection to the medial crura ensure excellent tip stability without risking cartilage damage.

While anchoring at a single point prevents sliding, it does not prevent rotation. As tip rotation may vary under different perspectives, additional stability is routinely achieved with a footplate tongue-in-groove (TIG) suture. This technique utilizes the natural positioning of the footplates around the septum. Both the Fusion Sling Hook Suspension and the Footplate TIG sutures are performed using 5-0 Nylon or Prolene.

If a SEG is used, the Fusion Sling can be sutured around its cephalic aspect. For optimal effectiveness, the SEG must be sculpted at its cephalic end to accommodate the volume of the Fusion Sling hook appropriately. By employing the Fusion Sling Hook Suspension concept, tension on the SEG is significantly reduced, as the supportive characteristics of the Fusion Sling stabilize the cephalic border of the medial crura.

In this approach, the SEG primarily serves to define the midline, enhance tip esthetics, and provide additional support for projection and rotation. However, it experiences less long-term stress from factors such as facial expressions, gravity, and aging, ensuring greater durability and more reliable outcomes over time.

DISCUSSION

The description of the nasal tip midline and its anatomy has been one of the most challenging aspects of nasal anatomy and rhinoplasty. Pitanguy described a dermato-cartilaginous ligament,[5] which he suggested pulls the tip to a more ptotic position. According to his description, interrupting this ligament at the level of the infratip region would result in tip rotation. Yves Saban, in his studies of the nasal SMAS,[10] described vertical and horizontal scroll ligaments and identified a superficial and a deep SMAS structure at the nasal tip level. This SMAS would be related to the superficial Pitanguy ligament (located in the intermedial crural space), and a deep SMAS structure, the deep Pitanguy ligament (found in the membranous space). These were separated by the intercrural ligament, and both are thought to be originated in the supratip region. This anatomic concept has also been elaborated by P. Palhazy and R. Daniel.[8] Baris Çakir[7] utilized the Pitanguy ligament to develop a surgical approach in tip-preservation rhinoplasty, leveraging it to support tip positioning. Additionally, the concepts of preserving or reconstructing the vertical scroll have been considered essential for defining the supra-alar crease.

In our study, we did not identify a defined or distinguishable ligamentous structure when analyzing the midline anatomy and histology. Instead, we observed a variety of histologic tissues, including muscle, fat, perichondrium-like tissue, and connective tissue. These findings suggest that the so-called

"Pitanguy Ligament" may exist only as a surgical concept—an artifact produced during dissection—rather than as a true anatomic or histologic structure. Based on this, we propose considering it as a flap—"*Pitanguy's Flap*"—instead of referring to it as a ligament.

Our conclusion aligns with the findings of Popko and colleagues[12] who, upon histologic examination, also reported was the absence of identifiable nasal ligaments. This study considered the existence of a periosteum-perichondrium membrane (see **Fig. 7**), which, in cartilage transitions, we identified as the perichondrium-like *Fusion Sling*. This envelope membrane corresponds to Layer 5, the deepest layer of the STE.

Even though no ligament was identified in histologic analysis, macroscopic dissection revealed tissue densifications along the cephalic border of the LLCs throughout their entire length. These densifications correspond to areas of embryologic fusion and define the cephalic boundary of the nasal lower third compartment, separated from the nasal mid-third compartment. These densifications are consistently oriented perpendicular to the surface of the LLC and are observed in the scroll area, supratip area, and intercrural region. All arise from the cephalic border of the LLC and are consistently positioned above the horizontal Fusion Sling (see **Figs. 13** and **14**).

The horizontal supratip Fusion Sling, a perichondrium-like structure, spans the entire WASA segment to the medial crura, delineating the caudal boundary of the membranous septum compartment—an anatomic structure located deeper than the STE system (see **Figs. 5**, **12**, **14**, and **15**). This finding is incompatible with the existence of a deep Pitanguy Ligament, described as extending from the supratip area to the membranous septum space, as it would require perforating the Fusion Sling at the supratip level. Analysis of the supratip and membranous compartments using ink injections, both macroscopically and microscopically, confirms that these compartments are independent and distinctly separated by the Fusion Sling, with no ligamentous structure, such as the deep Pitanguy Ligament, present in this region. The membranous septum compartment, encapsulating the caudal septum and delimited anteriorly and caudally by the Fusion Sling, functions as a gliding mechanism for the columella and tip. This is facilitated by the loose connective tissues within the compartment, which act to absorb movements of the nasal tip and columella. Due to the nature of these tissues, when the membranous septum TIG maneuver exclusively targets them, its effectiveness diminishes over time. These tissues are prone to tearing and disruption under the constant mechanical load exerted by the nasal tip, ultimately compromising the long-term stability of the maneuver.

This study is inspired by and rooted in the embryologic movements of the nasal placodes, which fuse the cephalic border of the LLC to the surrounding structures. This connective sling comprises various structures and layers. Many authors have described these structures from different anatomic perspectives and with diverse applications in surgery. Some of these perspectives appear contradictory. For example, the tip midline dermatocartilaginous ligament described by Pitanguy[5] is said to contribute to tip ptosis, with cutting it proposed as a method to achieve tip rotation. Conversely, Çakir[7] described the preservation of the Pitanguy ligament as a strategy to support the tip position and prevent ptosis. This raises a pertinent question: why do surgeons hold such differing perspectives? The authors believe the answer lies in their varying interpretations of this fascinating anatomy.

The SMAS at the columella level is defined by the SOON, which acts as the true tip depressor, inserting into the subcutaneous tissues of the infratip region. By interrupting this muscle, the depressing forces it generates can be eliminated, thereby contributing to a more stable, projected, and rotated nasal tip.

The Fusion Sling Flap, which is embryologically attached to the LLC and is a nondistensible structure, is preserved to be used in the Fusion Sling Hook Suspension technique. This method provides tip support and serves as an effective tool to stabilize tip projection and rotation.

From the pyriform aperture to the supratip area (the WASA segment), we observe the perpendicular densifications described by Yves Saban[9,10] as an extension of the SMAS, known as the vertical scroll. These structures separate the nasal mid-third compartment from the lower third compartments, connecting the subcutaneous tissues to the lateral perichondrium-like Fusion Sling, also referred to as the horizontal scroll. The preservation or reconstruction of these scroll and supratip densifications plays a crucial role in defining the transition from the tip to the nasal dorsum, enhancing the definition of the supratip and supra-alar crease.

Another relevant aspect of the intercrural Fusion Sling at the footplate level is its role as a tip position stabilizer. By connecting the footplates around the septum, the sling embraces the caudal border of the septum when the footplates are positioned parallel to the septum, each on its respective side. When the tip is stressed downward, the natural movement of the footplates is posterior and

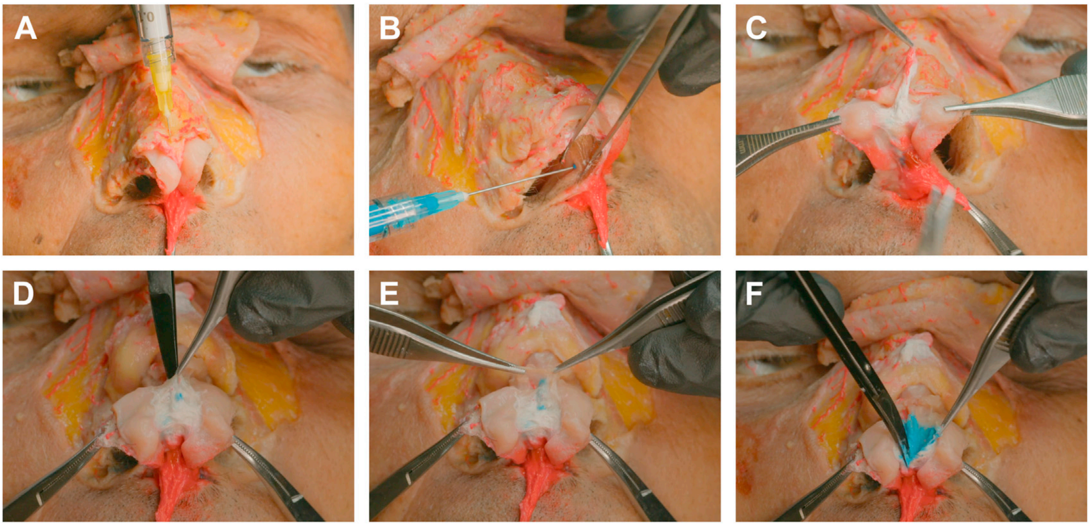

Fig. 15. Supratip and membranous septum compartments: (*A*) white ink was injected into the supratip compartment. (*B*) Blue ink was injected into the membranous septum compartment. (*C*) Elevating the supratip vertical densifications, exposing the supratip compartment. (*D*) Elevating the Fusion Sling flap.

cephalic. During this motion, the Fusion Sling is pressed against the caudal border of the septum, effectively blocking further movement of the footplates. This mechanism may explain why there appears to be a ligament between the nasal septum and the footplates,[1,2] though no such ligament is identified during dissection.[8] Instead of a ligament, the stabilization is achieved through a Fusion Sling belt mechanism that restricts footplate movement.

By gaining a deeper understanding of this anatomy and integrating the various "ligaments" and structures described over the past decades into a more comprehensive perspective, we can better explain the observations made by different authors in relation to their surgical strategies.

The goal of this article is not necessarily to introduce new designations for already known and described structures but rather to organize these structures as a continuum, grounded in their embryology and histology. This approach allows us to identify certain inconsistencies in existing anatomic models, which we believe can be clarified through this study.

SUMMARY

The study of the embryology and histology of the nasal tip was the main purpose of this research, with a focus on improving the understanding of the anatomic model.

The identification of the Fusion Sling as a distinct suspensory structure redefines conventional theories of nasal tip support. By providing a stable framework for both the medial and lateral compartments, it introduces new opportunities for rhinoplasty procedures that prioritize the preservation and enhancement of nasal tip stability.

Future studies will aim to further explore the histologic characterization of this structure and its role in nasal pathologies, paving the way for more effective and predictable surgical outcomes.

CLINICS CARE POINTS

- The "Fusion Sling Concept" in rhinoplasty provides an extra level of support for tip reconstruction and stability.
- The implementation of this concept in tip reconstruction allows for less grafting and less use of cartilage.

DISCLOSURE

None of the authors have conflicts of interest and this study required no external funding.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.fsc.2025.02.001.

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