Soft-Tissue Composition of the Columella and Potential Relevance in Rhinoplasty

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Background: The columella serves as the medial limb of the nasal tripod, with the medial crura functioning as the cartilaginous framework. Although soft-tissue of the columella may have both functional and aesthetic implications, it is a topic not often discussed in the rhinoplasty literature. The objective of this study was to evaluate soft-tissue histology of the columella and discuss findings that are pertinent to clinical rhinoplasty.

Methods: Ten fresh cadaver heads were obtained from The University of Texas Southwestern Willed Body Program. En bloc resections of the columella were harvested. Specimens were fixed in formalin and embedded in paraffin. Subsequently, specimens were sectioned serially and stained. Staining with hematoxylin and eosin was performed to evaluate collagen and fat composition. Van Gieson elastin stain was completed to assess for elastin fibers.

Results: Laterally, the columella was framed by stratified squamous epithelium, which transitioned to mucosa at the level of the membranous septum. An areolar tissue plane was found between the skin and adjacent medial crura. Much greater soft-tissue volume was present between the bilateral medial crura. Soft-tissue composition was found to be heterogenous, with varying distributions of tissue at different levels of the columella. Present in notable volume were fibroblasts, collagen fibers, elastin fibers, adipocytes, and neurovascular structures.

Conclusions: Columella soft-tissue is remarkable for the presence of fibroblasts, collagen and elastin fibers, muscle fibers, and adipocytes. These findings may have significant implications regarding surgical maneuvers influencing tip projection, effects of aging on the nose, and columellar aesthetics and function. (*Plast. Reconstr. Surg.* 134: 621, 2014.)

Comprehensive knowledge of the structures involved in nasal tip behavior is a crucial component of performing rhinoplasty. Although the tripod concept presents a simplified approach to understanding tip projection and rotation, greater complexity exists in actuality.[1] Although such sophistication is related mostly to the cartilaginous framework, there is notable contribution and influence from adjacent soft-tissue. Together, the cartilaginous framework and supporting soft-tissues create a construct responsible for ultimate tip conduct.

From the Department of Plastic Surgery, The University of Texas Southwestern Medical Center.
Received for publication May 9, 2013; accepted December 12, 2013.
Presented at the 18th Annual Meeting of the Rhinoplasty Society, in New York, New York, April 11, 2013.

DOI: 10.1097/PRS.0000000000000438

Support structures that suspend the nasal tip were originally elucidated by the anatomical dissections of Janeke and Wright.[2] Such structures included the fibrous connection between the upper and lower lateral cartilages, lateral crura complex, interdomal ligamentous sling, and attachment of the medial crura to the caudal septum. Knowledge of these structures proved invaluable, as they are now commonly modified to alter tip location.

Although consensus exists regarding actual components of tip support, the relative contribution of each structure is less clear. Clinical observation suggests that the medial tripod leg provides the greatest contribution. The medial tripod limb is composed of the columellar soft-tissue and encased medial crura cartilages. Ultimately, structural support of the medial crura and columella stems from the robust nature of underlying nasal

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

septum and spine. Soft-tissue of the columella is commonly present in ample volume and likely influences overall tip behavior.

Prior anatomical studies have revealed the importance of soft-tissue contribution to the lateral limbs of the nasal tripod.[3,4,5] However, a paucity of literature exists regarding histology of the columella and the composition of indwelling soft-tissue. Although this tissue may have both functional and aesthetic implications, it is a topic not often discussed in the rhinoplasty literature. Although anatomical dissections defining the gross columella structure exist in respectable volume, much less is known regarding histologic composition.[6] Greater understanding of this anatomy may lead to improved knowledge of tip support and behavior.[7] The purpose of this study was to provide insight into the histologic component of the columella and discuss potential clinical relevance.

MATERIALS AND METHODS

Ten fresh cadaver heads were obtained from The University of Texas Southwestern Willed Body Program. Each cadaver underwent en bloc removal of the nasal base. Excision was performed using 3.5× loupe magnification. The specimens were harvested as a composite resection, with sharp dissection used for soft-tissue and a 4-mm osteotome used for bone of the nasal base. Cadavers were all Caucasian and consisted of seven male and three female cadavers. The mean age of the cadavers was 72 years (range, 59 to 85 years).

Removed specimens were fixed in formalin for 24 hours and then embedded in paraffin. Subsequently, specimens were sectioned serially and then stained. Staining with hematoxylin and eosin was performed to evaluate collagen and fat composition. Van Gieson elastin stain was also completed to assess for the presence of elastin fibers. Slides were then studied by the lead author (M.R.L.) and a senior pathologist.

RESULTS

Laterally, the columella was framed by stratified squamous epithelium, which transitioned to mucosa at the level of the membranous septum. An areolar tissue plane was found between the skin and adjacent medial crura. Much greater soft-tissue volume was present between the bilateral medial crura. Soft-tissue composition was found to be heterogenous, with varying distributions of tissue at different levels of the columella. Present in notable volume were collagen fibers and fibroblasts, elastin fibers, adipocytes, and neurovascular structures.

Collagen Fibers and Fibroblasts

Collagen fibers and surrounding fibroblasts were identified throughout the columella. Sheets of collagen fibers were present at the abutments of (1) caudal septum and medial crura (Fig. 1), (2) caudal septum and nasal spine (Fig. 2), and (3) medial crura and nasal spine (Fig. 2). Furthermore, generalized distribution of collagen fibers existed along the entire length of the columella. Collagen fiber distribution was less organized between the bilateral medial crura compared with the aforementioned abutments.

Muscle Fibers

Muscle fibers constituted the majority of soft-tissue bulk between the medial crura cartilages (Fig. 3). Although this study precluded gross dissections that would have compromised the

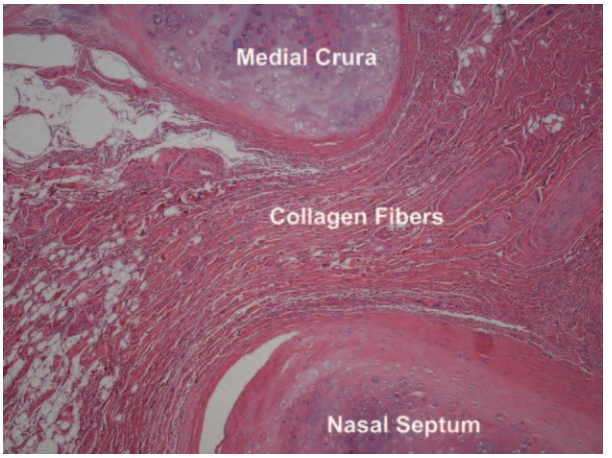

Fig. 1. Stain illustrating the layers of collagen fibers found at the junction of the caudal septum and medial crura (original magnification, ×40).

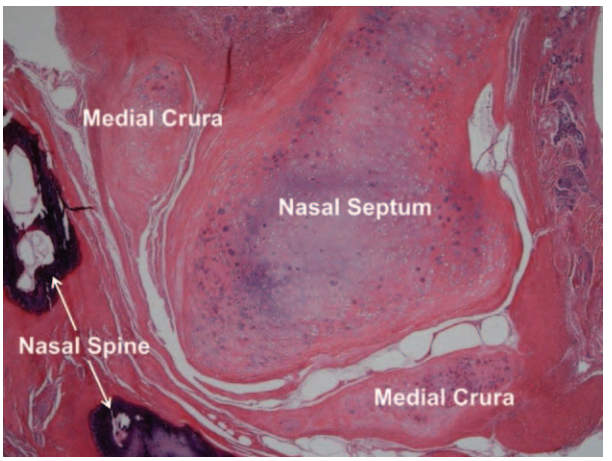

Fig. 2. Layers of collagen fibers separate the nasal septum from the abutting nasal spine and medial crura footplates (original magnification, ×40).

histologic results, prior studies would confirm these muscles as superficial orbicularis oculi and depressor septi nasi.[8,9] Muscle fibers portrayed an intimate relationship with perichondrium of the medial crura and septum.

Adipocytes

The presence of adipocytes in the columella was remarkable but location dependent. Most impressive was an assemblage of adipocytes creating a fat pad just anterior to the septum at the origin of the medial crura (Fig. 4). Generalized distributions of adipocytes were then consistently found throughout the columella interspersed between muscle and collagen fibers (Fig. 3). At the level of medial crura cartilage abutment to the septum and nasal spine, adipocytes were scant.

Elastin Fibers

The presence of elastin fibers was noted throughout the entire columella. Elastin fibers generally followed the distribution of collagen fibers. Found in ample quantity around the cartilaginous structures of the septum and medial crus, the fibers were organized into sheet-like structures (Fig. 5). In general, elastin fibers were plentiful in volume and extended between the medial crura to the level of the nasal spine (Fig. 6). Similar to collagen fiber distribution, this followed a less organized pattern of distribution.

DISCUSSION

Soft-tissue composition of the columella consists mostly of collagen fibers and fibroblasts,

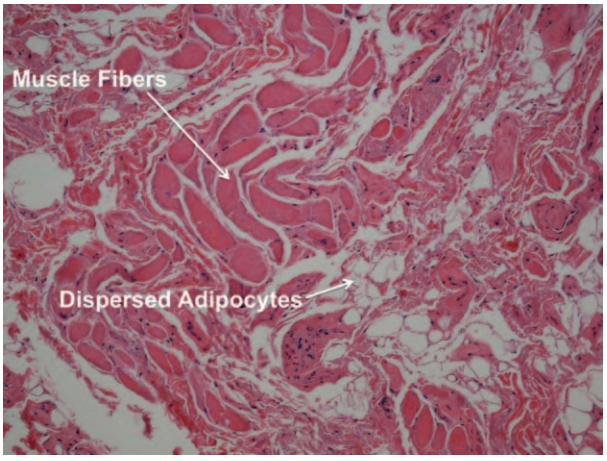

Fig. 3. Wide distribution of muscle fibers and adipocytes found in the region between the bilateral medial crura (original magnification, ×40).

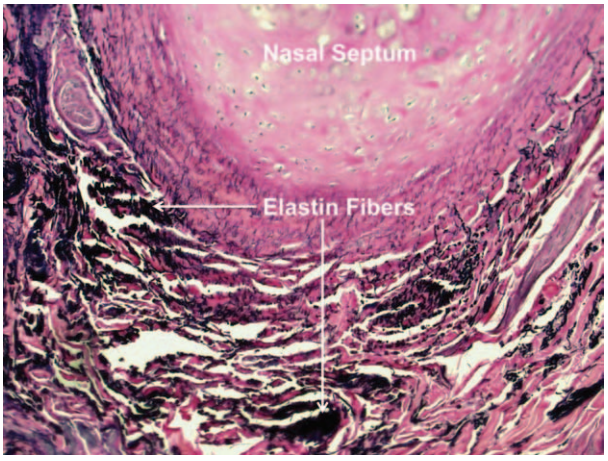

Fig. 5. Silver stain showing the layers of elastin fibers following the distribution of collagen fibers in proximity to the nasal septum (original magnification, ×40).

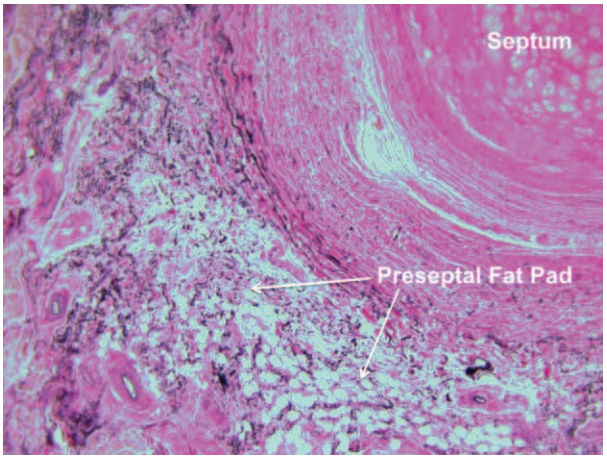

Fig. 4. Conglomerate of adipocytes forming preseptal fat pad between the anterior septum and superior medial crura (original magnification, ×40).

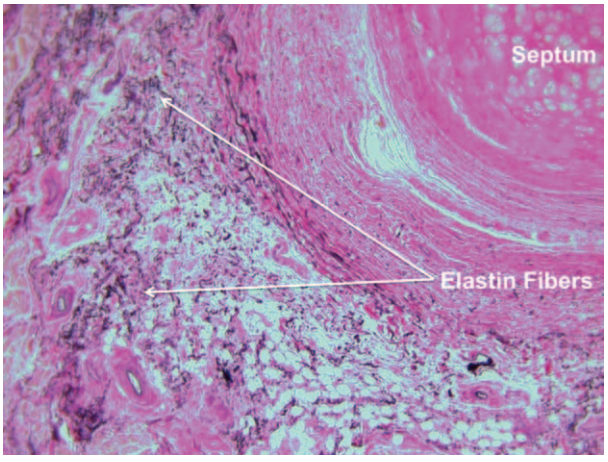

Fig. 6. Silver stain showing wide but less organized distribution of elastin fibers throughout the body of the columella (original magnification, ×40).

muscle fibers, elastin fibers, and adipocytes flanked bilaterally by medial crura cartilage. Although quantifying the influence of soft-tissue contribution to nasal tip support and behavior is difficult, it undoubtedly exists. The combined influences of cartilaginous structure and accompanying soft-tissue together determine nasal tip projection and position. Results of this study have elucidated the exact soft-tissue composition and arrangement that exist in the columella.

Recently, the relationship between medial crus position and tip projection has been studied.[10,11] Although cartilage morphology is likely the dominant influence on tip support, the significance of soft-tissue composition and distribution on cartilage morphology is largely unknown. Essential to determining the role of soft-tissue contribution is knowing the histologic composition and design. Obtaining such information allows for a more comprehensive approach to understanding nasal tip behavior. The findings of this study may provide not only improvements in surgical technique but also a basic science platform from which such technique is implemented. Ironically, this information has been long absent from the existing body of rhinoplasty literature.

It is important to note that this study focused on the Caucasian columella, and ethnic variations may exist. However, the findings of this study are congruent with the study performed by Han et al.[6] in the Asian nose. The composition and arrangement of soft-tissue was similar in all noses dissected in this study.

Influence on Shaping the Nasal Base

An important component of comprehensive rhinoplasty is correcting columellar deformity and modifying to the aesthetic ideal. Several authors have suggested techniques to accomplish such a task, although there remains debate on treatment of the indwelling soft-tissue.[12,13] The heterogenous composition of the columella may have consequence when determining the optimal technique to use. It stands to reason that the adipose tissue of the columella is compressible and easily displaced with simple suture approximation. Dissimilarly, muscle and collagen fibers likely provide more resistance during approximation, requiring resection before suture placement.

Maneuvers to Decrease Nasal Tip Projection

As is known from clinical study, violation of tip support structures results in decreased projection of the nasal tip. Examples of relevant maneuvers include (1) full transfixion incision separating the medial crura from the caudal septum, (2) resection of the medial crura, and (3) resection of the caudal septum. Improved understanding of what structures are being violated may help quantify the impact each maneuver has overall. A full transfixion incision separates the medial crura attachments to the caudal septum. The anatomical configuration is disrupted, followed by later scar formation. Possibly, scar formation prohibits the normal support structure created by the interaction of elastin and collagen fibers with the adjacent cartilage. Morphologically, cartilage position may be influenced by fiber composition or, inversely, fiber composition may be influenced by cartilage position. Aberrant medial crura position is associated with poor nasal tip support, thus underscoring the relevance of this matter.

The Aging Nose

Among the known effects of aging is a decrease in collagen and adipocyte production. At this time, insufficient data exist to establish a correlation between decreased tissue production and a loss of nasal support in the aging patient. However, it is logical that decreased volume of these soft-tissues may be partially responsible for the loss of nasal tip support seen in the aging patient. Furthermore, if elastin production in the nose were also decreased, it would likely contribute to loss of projection and nasal support. As patients age, the soft-tissue envelope often undergoes thinning, making the underlying cartilage more visible. It is plausible that the soft-tissue of the columella decreases in volume. Patients in this study had a mean age of 72 years and only the present milieu of the columella could be determined.

Aesthetics of the Columella

Frequently overlooked are the aesthetic ideals of the columella on the basal view. The columella creates the medial border of the nostril, thus making it relevant both aesthetically and functionally. Deformities arise when there is abundant or malpositioned medial crura, deviated caudal septum, or soft-tissue excess or deficiency.[12] Soft-tissue excess can distort the smooth, concave surface of the lateral columella known as the basal aesthetic lines.[13,14] Deficiency of soft-tissue fails to create the smooth, concave slope, often producing a long slender columella that deviates from the ideal columella. From the results of this study, it would stand to reason that fullness of the columella is likely the result of excessive fat and/or muscle fibers.

External Valve and Functional Implications

Fitting with untoward aesthetics from columellar deformities, there is also the potential for functional problems.[13] The nostril aperture can be narrowed by deviation or excess volume of the nasal base cartilage and soft-tissue deformity. Soft-tissue surplus may either primarily occlude the airway or secondarily displace the medial crura into the nostril. Knowledge of what soft-tissue exists in the columella and the histologic environment in which it exists may improve our understanding when treating this anatomy.[14,15]

CONCLUSIONS

The columella plays an important role both functionally and aesthetically. Although the cartilaginous and soft-tissue components have been studied grossly, the histology of this area is much less well known. Findings in this study were remarkable for the presence of fibroblasts, collagen fibers, elastin fibers, muscle fibers, and adipocytes. These findings may have significant implications regarding surgical maneuvers influencing tip projection, effects of aging on the nose, and columellar aesthetics and function.

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ACKNOWLEDGMENTS

The authors would like to thank Dennis Burns, M.D., from the Department of Pathology at The University of Texas Southwestern, Dallas, Texas, for gracious contribution to this study. They would also like to extend their gratitude to Katie Davis, Ph.D., and Imelda Delgado for invaluable contribution to this project.

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