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Original Article

Histological insights into the nasal superficial musculoaponeurotic system implicating to oral and maxillofacial surgery — A preliminary study from cadavers

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Abstract *Background/purpose:* The superficial musculoaponeurotic system (SMAS) represents a pivotal component of midfacial soft tissue architecture, with significant implications for both aesthetic and reconstructive interventions. However, the histological characteristics of the nasal SMAS remain inadequately elucidated, particularly within Asian populations. This study aimed to characterize the histological features of the nasal SMAS in adult Vietnamese cadavers and to assess its potential relevance to oral and maxillofacial surgical procedures involving the midface.
Materials and methods: Histological analyses were performed on eight formalin-fixed nasal tissue specimens obtained from adult Vietnamese cadavers. Sections encompassing the skin to the periosteum overlying the nasal bone were subjected to hematoxylin-eosin and Trichrome

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staining. Microscopic evaluation focused on the SMAS architecture, as well as associated vascular, neural, and adipose structures, assessed across five anatomical landmarks: glabella (G), nasion (N), sellion (S), kyphion (K), and rhinion (R).
Results: A distinct SMAS layer was identified in all specimens, exhibiting two primary fibrous configurations: vertically oriented septa at G, N, and S, and parallel-running fibers at K and R. Vascular and neural elements were consistently observed superficial to the SMAS, with variable intralayer presence. The superficial fat layer demonstrated greater thickness at G and N, whereas the deep fat layer was predominantly noted at G.
Conclusion: This study provides novel histological insights into the nasal SMAS, contributing to a more precise anatomical framework pertinent to oral and maxillofacial surgical planning. Understanding these structural nuances may enhance surgical safety and optimize aesthetic and functional outcomes in midfacial procedures.

Introduction

The nose constitutes the anterior segment of the respiratory tract and exhibits a complex anatomical architecture. Centrally positioned on the face, it is the most prominent feature influencing facial contours and contributes significantly to both functional and aesthetic aspects of the craniofacial complex.[1] Beyond its physiological roles in respiration, phonation resonance, and olfaction, the nasal morphology profoundly affects facial harmony and ethnic identity, which has gained increasing attention in contemporary aesthetic and reconstructive practices.

The nasal soft tissues are relatively thinner than those of other facial regions but demonstrate a well-defined layered organization comprising five distinct strata: the skin, superficial fat layer, superficial musculoaponeurotic system (SMAS), deep fat layer, and the underlying perichondrium or periosteum.[2] The nasal SMAS, an anatomical extension of the facial SMAS, spans superiorly from the glabella and laterally toward the nasolabial fold. Initially described by Mitz and Peyronie in 1976 as the third soft tissue layer of the mid and lower face, the SMAS serves critical roles in facilitating nasal skin mobility, maintaining skin thickness, and supporting the vascular supply essential for soft tissue vitality.[3,4] Furthermore, it maintains intimate connections with the dermis, thereby contributing to dynamic facial expressions.[5]

The presence and detailed anatomical architecture of the nasal SMAS remain topics of ongoing debate, with some studies questioning its existence and others underscoring its surgical relevance, particularly in rhinoplasty and aesthetic nasal procedures.[5,6] However, its significance extends beyond aesthetic considerations, as precise knowledge of nasal soft tissue layers is crucial in oral and maxillofacial surgery. Procedures such as cleft lip and palate repair, orthognathic surgery, facial trauma reconstruction, and implant placement in the midfacial region often necessitate careful dissection and preservation of these anatomical structures to ensure functional integrity and aesthetic outcomes.

Despite its clinical importance, histological studies focused on the nasal SMAS in Asian populations remain scarce. In Vietnam, data detailing the microanatomy of the nasal soft tissues are particularly limited. Therefore, the present study aimed to characterize the histological features of the nasal SMAS layer in adult Vietnamese cadavers, including its fibrous architecture and the distribution of vascular, neural, and adipose elements across specific anatomical landmarks. Such findings are anticipated to enhance anatomical understanding relevant not only to aesthetic nasal surgery but also to the planning and execution of oral and maxillofacial surgical interventions, contributing to improved surgical precision, reduced complication rates, and optimized aesthetic and functional outcomes.

Materials and methods

Study design and sample collection

This cross-sectional study was conducted between May 2019 and January 2021 at the Department of Anatomy, Basic Sciences – Preclinical Medicine, Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Vietnam. Eight nasal tissue specimens, extending from the skin surface to the periosteum, were harvested from adult Vietnamese cadavers preserved in 10 % formalin. The cohort included four male and four female cadavers, with a mean age of 60.5 ± 18.2 years. Inclusion criteria encompassed cadavers aged over 18 years with intact nasal pyramids and no history of nasal surgery. Exclusion criteria were nasal deformities, tumors, anatomical abnormalities of the facial region, or evidence of prior partial or complete nasal dissection. Dissections were performed in the midfacial region using a scalpel. Anatomical boundaries for specimen excision were defined superiorly by a horizontal line through the medial ends of the eyebrows, laterally by the outer edges of the nasal bones and alar cartilage, and inferiorly by the lower border of the nasal alae and columella. All samples were fixed in 10 % formalin, and specific histological examination sites were marked with fine needles.

Histological analysis

Tissue samples underwent standard histological processing, sectioning, and staining with hematoxylin-eosin (HE) and

Trichrome stains at Children's Hospital No. 1, Ho Chi Minh City, Vietnam. Microscopic evaluations were performed using an Olympus BX53 light microscope at 4 × and 10 × magnifications. Morphological characteristics were systematically documented, and quantitative assessments were conducted using dedicated image analysis software. The analysis focused on the histological architecture of the nasal region across five anatomical landmarks: Glabella (G): the most prominent midline point on the forehead between the eyebrows. Nasion (N): the midpoint of the nasofrontal suture. Sellion (S): the deepest concavity of the nasal bone. Kyphion (K): the highest convex point of the nasal bone. Rhinion (R): the terminal point of the nasal bone at the junction of the bony and cartilaginous vaults. Evaluations included detailed assessments of the SMAS layer's fibrous structure, as well as the distribution of vascular, neural, and adipose components. Additionally, the study examined the morphological features of the superficial and deep fat layers at each anatomical landmark.

Data analysis

All collected data were entered and analyzed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequencies and percentages, were used to summarize the presence and characteristics of the SMAS layer, its fibrous architecture, and associated vascular and neural structures. The distribution and thickness of the superficial and deep fat layers were similarly analyzed by anatomical location.

Ethical considerations

This study was conducted in accordance with ethical standards and was approved by the Biomedical Research Ethics Committee of Pham Ngoc Thach University of Medicine (Decision No. 66/TĐHYKPNT-HDĐ, dated May 10, 2019).

Results

Layered structure of the nasal region

Histological examination consistently demonstrated a well-defined, five-layered architecture in all nasal specimens analyzed (8/8, 100 %). From superficial to deep, these layers comprised the epidermal and dermal skin components, the superficial fat layer, the SMAS, the deep fat layer, and the periosteum or perichondrium. This layered organization was observed uniformly across all anatomical landmarks investigated.

Histological characteristics of the SMAS layer

In all specimens, the SMAS was identifiable as a distinct fibro-fatty layer overlying the nasal musculature and showed continuity with the facial SMAS. The SMAS could be separated from the underlying muscle plane, appearing as a thin, well-delineated structure. Analysis of the fibrous architecture within the SMAS revealed two distinct histological patterns associated with specific anatomical regions. The first pattern consisted of vertically oriented collagenous septa connecting the dermis to the underlying SMAS, thereby subdividing the superficial fat into lobular compartments. This configuration was predominantly observed at the glabella (G), nasion (N), and sellion (S) regions, as illustrated in Fig. 1 (left). The second pattern exhibited parallel-running connective fibers arranged along the plane of the SMAS, accompanied by a thinner muscle layer and reduced superficial fat. This architectural type was evident at the kyphion (K) and rhinion (R) regions (Fig. 1, right). Vascular and neural structures were consistently present superficial to the SMAS at all examined points (100 %). However, their presence within the SMAS layer itself varied among anatomical landmarks, with intralayer vascular and neural elements identified in 25 % of specimens at G, N, and S; 33.3 % at K; and 37.5 % at R (Table 1). Figs. 2 and 3 provide representative histological images demonstrating neurovascular structures located above and within the SMAS layer, respectively.

Histological features of the superficial and deep fat layers

All examined nasal regions exhibited both a superficial and a deep fat layer. Notably, the superficial fat layer was relatively thicker at the glabella (G) and nasion (N) regions, whereas it appeared thinner at the sellion (S), kyphion (K), and rhinion (R) sites (Figs. 4 and 5). In contrast, the deep

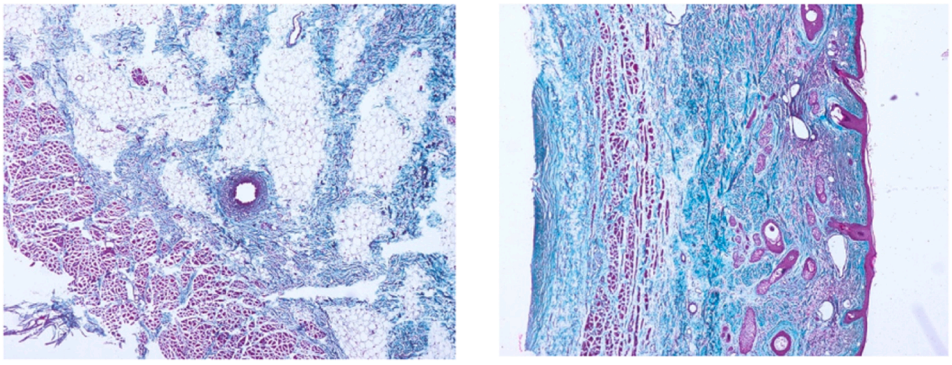

Figure 1 Histological appearance of the nasal SMAS layer demonstrating vertically oriented fibrous septa connecting to the dermis at point G (left), and parallel-running fibers situated above the underlying muscle layer at point R (right). SMAS, superficial musculoaponeurotic system. G, glabella. R, rhinion.

Table 1 Presence of vascular and neural structures relative to the SMAS at anatomical landmarks.

Feature	Point G (n = 8)	Point N (n = 8)	Point S (n = 8)	Point K (n = 3)	Point R (n = 8)
Above SMAS	100 %	100 %	100 %	100 %	100 %
Within SMAS	25 %	25 %	25 %	33.3 %	37.5 %

SMAS, superficial musculoaponeurotic system.

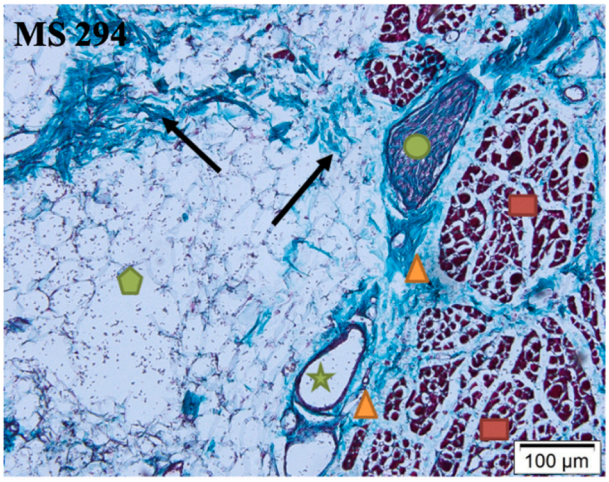

Figure 2 Vascular and neural structures located superficial to the SMAS layer. Blood vessels (star) and nerve fibers (circle) are identified above the SMAS (triangle), overlaying a thick muscle layer (rectangle). The superficial fat lobules (pentagon) are partitioned by vertically oriented fibrous septa (arrow). Staining: Trichrome, 10 × objective. SMAS, superficial musculoaponeurotic system.

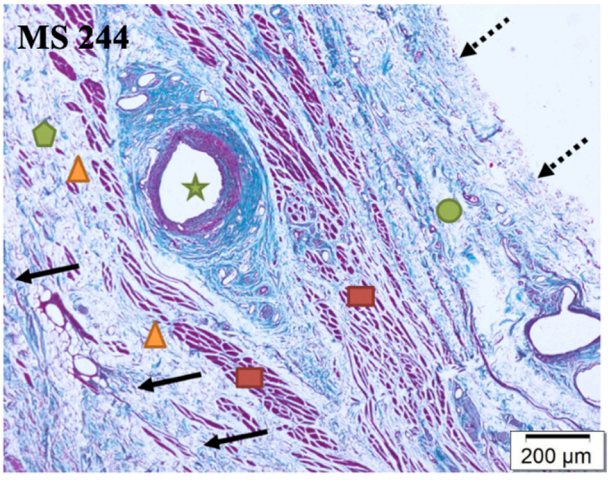

Figure 3 Vascular and neural elements situated within the SMAS layer. The SMAS (triangle), with a thin underlying muscle layer (rectangle), contains blood vessels (star). The superficial fat layer (pentagon) is associated with parallel-oriented fibroblasts (solid arrow), while the deep fat layer (circle) resides beneath the SMAS and above the periosteum (dashed arrow). Staining: Trichrome, 4 × objective. SMAS, superficial musculoaponeurotic system.

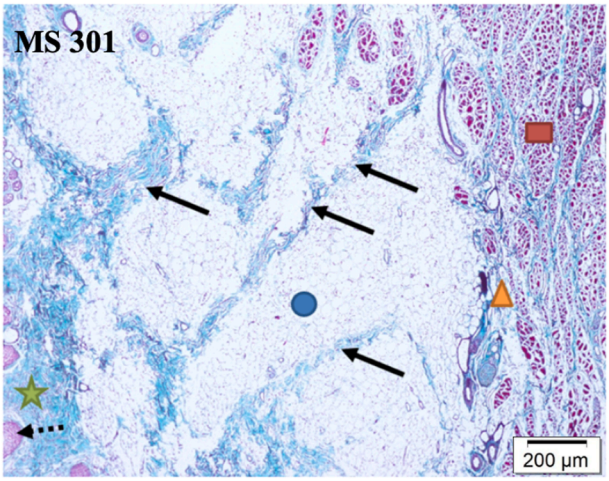

Figure 4 Histological features of the superficial fat layer at point N. A thick superficial fat layer (circle) is segmented into lobules by fibrous septa (arrow) extending from the SMAS (triangle) and the muscle layer (rectangle) toward the dermis (star), which contains sebaceous and sweat glands (dashed arrow). Staining: Trichrome, 4 × objective. SMAS, superficial musculoaponeurotic system. N, nasion.

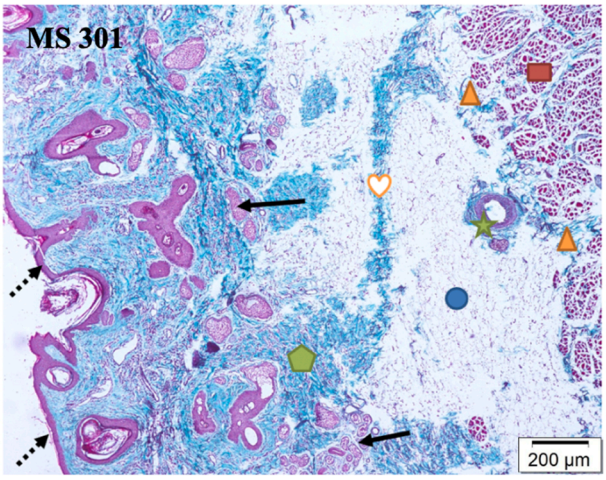

Figure 5 Histological features of the superficial fat layer at point S. The superficial fat layer (circle) appears thinner and is divided into lobules by fibrous septa (heart) extending from the SMAS (triangle) and the muscle layer (rectangle) toward the dermis (trapezoid), where sebaceous and sweat glands (arrow) are observed beneath the dermal layer (dashed arrow). Blood vessels and nerve fibers (star) are present superficial to the SMAS. Staining: Trichrome, 4 × objective. SMAS, superficial musculoaponeurotic system. S, sellion.

fat layer was most prominent at the glabella, where it formed a substantial adipose compartment beneath the SMAS. Along the nasal dorsum, encompassing the S, K, and R points, the deep fat layer was either markedly reduced or nearly absent. These anatomical variations in fat layer thickness and organization may hold significance for surgical interventions involving the midface and nasal regions, particularly in procedures requiring soft tissue

manipulation, contouring, or preservation of neurovascular structures in oral and maxillofacial surgery.

Discussion

The present study systematically examined the histological architecture of the nasal region in adult Vietnamese cadavers, confirming the presence of a consistent five-layered structure comprising the skin, superficial fat layer, SMAS, deep fat layer, and periosteum or perichondrium. These findings align with previous anatomical studies reporting similar stratification of the nasal soft tissues.[4,7–9]

A key observation in our investigation was the existence of two distinct connective fiber architectures within the SMAS layer. Vertically oriented fibrous septa were identified at the glabella, nasion, and sellion regions, where they interconnected the dermis and subdivided the superficial fat into lobules. In contrast, parallel-oriented fibrous arrangements predominated at the kyphion and rhinion, accompanied by a thinner superficial fat layer. These histological patterns corroborate prior reports describing regional variations in SMAS composition, reflecting the functional and dynamic demands of different nasal subunits.[5,10,11]

The consistent presence of vascular and neural elements superficial to the SMAS across all specimens, coupled with their variable occurrence within the SMAS layer itself, underscores the importance of precise anatomical knowledge for surgical interventions. Our data revealed intralayer neurovascular components in up to 37.5 % of cases at certain landmarks, highlighting potential risks during surgical dissection. Previous studies have similarly documented the complex and region-specific vascular network of the nasal region, reinforcing the necessity for meticulous surgical technique to prevent iatrogenic injury.[11,12] Based on these observations, we advocate for sub-SMAS dissection planes situated below the deep fat layer during nasal or midfacial procedures to mitigate the risk of vascular compromise, which could otherwise lead to scarring, contracture, or contour deformities.

With respect to adipose tissue distribution, our study confirmed that both superficial and deep fat layers are consistently present in the nasal region, albeit with notable variations in thickness across anatomical points. The glabella and nasion demonstrated relatively thick superficial fat compartments, while regions along the nasal dorsum exhibited thinner adipose layers. The deep fat layer was most pronounced at the glabella but nearly absent at more caudal points such as the sellion, kyphion, and rhinion. These regional differences in fat distribution are consistent with prior investigations and hold significant implications for surgical planning, particularly in procedures aiming for harmonious midfacial aesthetics and in reconstructive strategies following trauma or congenital deformities.[2,10]

The findings of this study extend beyond aesthetic rhinoplasty and bear relevance to oral and maxillofacial surgery. Procedures such as orthognathic surgery, cleft lip and palate repair, midfacial trauma reconstruction, and implant placement in the aesthetic zone frequently require precise dissection and preservation of nasal soft tissue structures to achieve optimal functional and aesthetic outcomes. Detailed understanding of the SMAS architecture, along with associated vascular and neural distributions, provides a critical anatomical framework to guide surgical approaches and minimize complications in these contexts.

Nevertheless, this study has several limitations. The relatively small sample size constraints the generalizability of our findings, and inter-individual anatomical variability could not be comprehensively addressed. Furthermore, ethnic differences in nasal anatomy suggest that these results may not be directly extrapolated to other populations. Future research should incorporate larger and ethnically diverse cohorts and explore correlations between SMAS morphology and clinical outcomes in various surgical interventions.

In conclusion, this study offers novel insights into the histological characteristics of the nasal SMAS in Vietnamese individuals, revealing distinct regional fiber architectures and variable neurovascular distributions. These anatomical details are essential for enhancing surgical safety and precision in both aesthetic and reconstructive procedures involving the nasal and midfacial regions. Integrating this knowledge into oral and maxillofacial surgical practice has the potential to reduce intraoperative risks and improve postoperative outcomes, underscoring the value of meticulous anatomical research in advancing clinical care.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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