REVIEW ARTICLE

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Nasal septum turbinate and its significance for a rhinoplasty surgeon

Małżowina przegrody nosa i jej znaczenie dla rynochirurga

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Literature Search
F – Funds Collection

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ABSTRACT: Nasal septal turbinate (NST) is a clearly visible structure located in the anterior part of nasal cavity on the nasal septum that limits the nasal valve laterally. It is often thought that the structure of NST and its function are poorly characterized and are rarely considered by rhinoplasty surgeons during planning and performing surgery. NST represents as a fusiform area of the erectile tissue, similar in structure and function to the nasal turbinate. The central part of NST contains cartilage of the nasal septum, but most of its three-dimensional volume consists of soft tissues: mucosa, erectile tissue, blood vessels and secretory glands. According to various researchers, the main function of NST is to ensure a change in the air flow towards the nasal turbinate and the ostiomeatal complex and humidification of the first portion of the air at the beginning of inspiration. Destruction of NST during septoplasty can lead to tissue drying and predispose to scabs and epistaxis. Preliminary treatment results suggest that NST is an important surgical target in rhinosurgery..

KEYWORDS: anterior septal tuberculum, impaired nasal patency, Kiesselbach's ridgenasal septal swell body, nasal septum elevation, nasal septum surgery, septal cavernous body, septal intumescence, septoplasty, tuberculum of Zuckerkandl

STRESZCZENIE: Małżowina przegrody nosowej (ang. *nasal septal turbinate*; NST) to struktura znajdująca się w przedniej części jamy nosowej, która ogranicza przyśrodkowo zastawkę nosową. Struktura NST i jej funkcja są słabo scharakteryzowane i rzadko uwzględniane przez rynochirurgów zarówno w trakcie planowania, jak i wykonywania operacji. NST to wrzecionowaty obszar tkanki z bogatymi naczyniami jamistymi, podobny do małżowin nosowych pod względem budowy i funkcji. Centralna część NST zawiera chrząstkę przegrody nosa, jednak większość jej trójwymiarowej objętości składa się z tkanek miękkich: błony śluzowej, tkanki erekcyjnej, naczyń krwionośnych i gruczołów wydzielniczych. Zdaniem różnych badaczy, główną funkcją NST jest zapewnienie zmiany kierunku przepływu strumienia powietrza w stronę małżowin nosowych i kompleksu ujściowo-przewodowego oraz nawilżanie pierwszej porcji strumienia powietrza wpływającego do nosa w trakcie wdechu. Zniszczenie NST podczas operacji przegrody nosa może doprowadzić do wysuszenia tkanek oraz predysponować do powstania strupów i krwawień z nosa. Wstępne wyniki leczenia sugerują, że NST stanowi ważny cel chirurgiczny w chirurgii nosa i dróg oddechowych.

SŁOWA KLUCZOWE: ciało erekcyjne przegrody nosa, mostek Kisselbacha, operacja przegrody nosa, septoplastyka, upośledzenie drożności nosa, wyniosłość przegrody nosa, wzgórek przegrody nosa, wzgórek Zuckerkandl'a

ABBREVIATIONS

NST – nasal septal turbinate
X-ray – radiological examination
CT– computer tomography
MRI – magnetic resonance imaging
DWI – diffusion-weighted imaging
PWI – perfusion-weighted imaging

INTRODUCTION

In most people the nasal septum has a thickening located in the anterosuperior segment. The first to describe this structure as a thickening of the mucosa in the anterior part of the nasal septum was Giovanni Battista Morgagni in 1706, followed by a similar observation made by Zuckerkandl in 1882. Thickening of the nasal septum is visible both during anterior rhinoscopy, endoscopic examination of the nasal cavity and imaging (X-ray, CT, MRI). The described thickening is located on the border of the cartilage of the quadrangular portion of the nasal septum at the junction with the perpendicular plate of the ethmoid bone bilaterally. The structure is located anteriorly to the ostiomeatal complex [1–3].

In 1900, Schiefferdecker, in the course of his histological studies, determined that this thickening has a vascular structure, very similar in structure to nasal turbinates, and introduced a new term nasal septal turbinate, or NST[4]. There are also other names

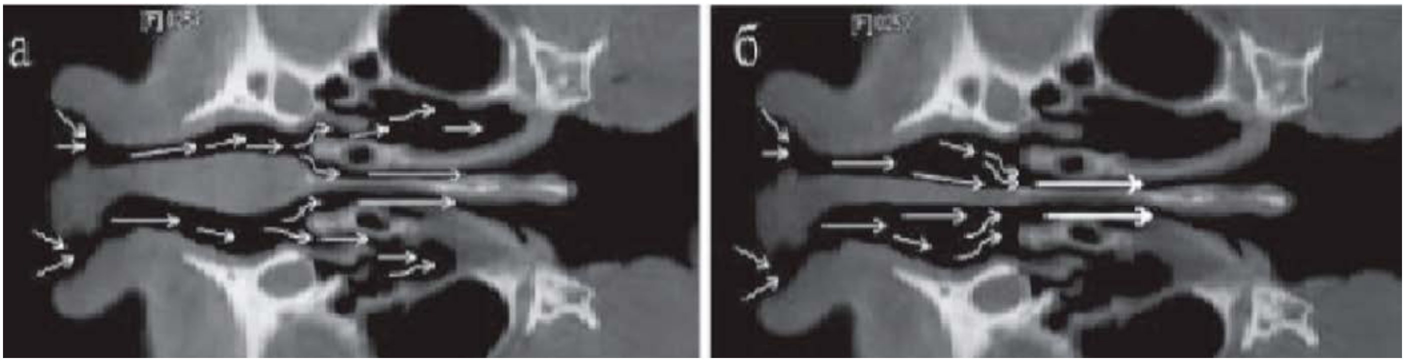

Fig. 1. The impact of nasal septum turbinate (A) or lack of it (B) on the direction of air flow in the nasal cavity according to Gariuk et al. [1].

of the described thickening of the nasal septum in the literature: nasal septal swell body, septal intumescence, anterior septal tuberculum, septal erectile body, tuberculum of Zuckerkandl and Kiesselbach's ridge [1, 4–9].

The air current that flows through the nasal cavity during inspiration, thanks to NST, changes its direction towards the anterior end of the middle turbinate, which in turn divides the air current into two parts (Fig. 1.). One portion of the air flows into the common nasal meatus and superior nasal meatus, while the other is directed under the middle turbinate into the ostiomeatal complex. The air current is divided in this way and has greater contact with the nasal mucosa in order to warm and humidify it. In the absence or development of this bulging of the nasal septum, most of the air flows through the common nasal meatus [1]. It is interesting that blood flows in the nasal cavity from back to front in the opposite direction to the air that flows into the nose. This mechanism allows for better heating of cold air. NST, similarly to other nasal turbinates, contains tissue with large cavernous bodies, from which blood outflows into veins that have an elongated muscular layer. The structure of those veins allows for bilateral blood flow but also for the deposition of blood in them, which results in their overload and swelling [5].

It is not excluded, that NST in mammals can be used to heat and direct air towards Jacobson's organ, and currently both these structures can be residual organs in humans.

The nose acts as an entrance to the respiratory tract and has many functions. It serves as an airflow channel, chemoreceptor, humidifier and air heater and as the first line of defense against respiratory infection. In humans and all mammals, the nose is divided into two anatomically separate channels (left and right), of which each has a separate blood supply and nerve endings. In this regard, the nose can be considered as two separate organs, which can sometimes quite independently.

The introduction of electrical pressure transducers, flow-through heads, rhinomanometry and acoustic rhinometry has significantly facilitated the performance of functional measurements in the nasal cavities. However, there is a lack of standardization as to the quantification of nasal breathing, especially taking into account the spontaneous changes in airflow associated with the nasal cycle [10]. The correlation between the degree of impaired nasal patency experienced by the patient and rhinoscopy is not always determined. This observation allows to presume that the cause of hyposmia in some cases may be a change in the path of airflow through the nasal cavity.

Consideration of the issue of nasal patency and assessment of factors affecting it should primarily include the nasal valve. The area of the nasal valve is not a single structure, but a complex three-dimensional formation consisting of several morphological elements. The region of the nasal valve is the site of maximum nasal resistance in the respiratory system. It is formed laterally by the caudal (distal) end of the lateral cartilage of the nose, the lateral branch of the greater alar cartilage and the anterior end of the inferior nasal concha. The medial restriction of the nasal valve is constituted by the nasal septum in its cartilaginous part. The concept of nasal valve was introduced by Minka in 1903 and was described in more detail in 1970 by Bridger [9, 11]. The discussed structure is also called internal nasal valve or ostium internum nasi [12]. The angle of the nasal valve in Caucasian people is 10–20°; in African-Americans and Asians this angle is significantly larger. For surgical purposes, the external nasal valve is also distinguished. Its lateral limitation is the lateral branch of the greater cartilage with the adipose tissue and skin of the ala of nose covering it, as well as the columella from the middle [9]. With age, both the elasticity of the skin and subcutaneous tissue as well as the structure of cartilaginous elements change, which may predispose to collapse of the lateral wall of the nasal vestibule and thus to narrowing of the nasal valve. In combination with the presence of NST, this may sometimes contribute to the development of severely impaired nasal breathing in the elderly [5].

THE INCIDENCE OF NASAL SEPTUM TURBINATE

In the available literature (PubMed, Scopus), data on the frequency of NST are similar. According to Petrovic et al. NST was found in 54% of respondents [13], in the study of Denlak et al. – in 66.4% [6] while according to Arslan et al. in 55.79% [14].

Muderris et al. analyzed a large group of patients with chronic sinusitis (n = 200), among whom NST was found in 122 (56.5%) patients. The group of patients with NST included 58.7% men and 41.3% women. In 8 (7.3%) patients with NST, the nasal septum was only found unilaterally [15].

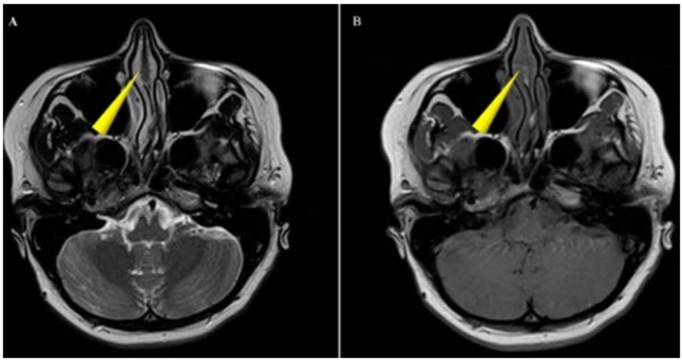

Fig. 2. Visualization of NST using imaging techniques A. diffusion-weighted imaging, or DWI and B. perfusion-weighted imaging, or PWI.

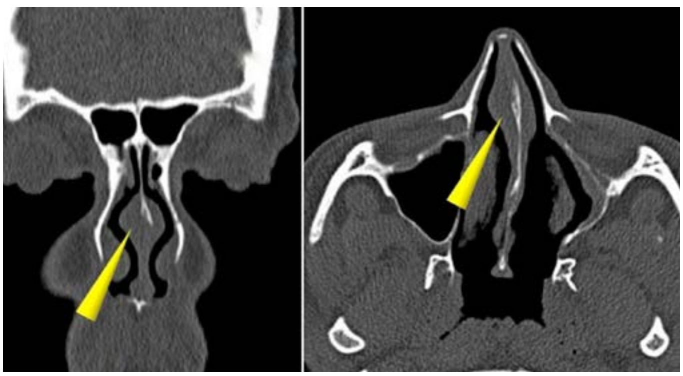

Fig. 3. Visualization of NST in cranial CT scan without contrast in frontal and axial projection.

MORPHOMETRIC STUDIES ON NASAL SEPTUM TURBINATE

Delank et al. conducted a morphometric study of NST on a human corpse. According to the authors, the dimensions of nasal septum turbinate were about 10.2 mm in the frontal plane and 6.2 mm in the sagittal plane. The presence of NST caused an increased thickening of the nasal septum from 4–5 mm to 12–13 mm. The distance from the nasal fundus to the lower edge of the NST was on average about 29 mm. The authors also noted an increase of 43% and 14% in the volume of air flow through the nose following the application of xylometazoline and saline solutions on the NST surface, respectively [6]. Costa et al. described NST as a spindle-shaped structure that was located anterior to the middle turbinate. The average width was 12.4 mm; height – 19.6 mm and length – 28.4 mm. The distance of NST from the nasal fundus was 24.8 mm, from the tip of the nose – 43.9 mm and from the anterior wall of the sphenoid sinus – 39.0 mm [2]. It was found that NST decreases with age correlates and the size of the inferior nasal turbinate [8]. Gelera et al. noted a tendency of increased NST in patients with a history of chronic allergic rhinosinusitis [16].

HISTOLOGICAL STRUCTURE OF THE NASAL SEPTUM TURBINATE

NST is a spindle-shaped area of the erectile tissue, similar in structure and function to nasal turbinates. The central part of NST contains septal nasal cartilage and bone, however, most of its three-dimensional volume consists of soft tissues: mucosa, tissue with rich cavernous vessels, blood vessels and secretory glands (serous and mucous). NST has been found to have a thicker mucosa and more abundant mucous glands and vascular plexuses compared to the mucosa of other nasal areas. Although the exact proportions of these elements varied in different studies, it was widely recognized that NST is a tissue characterized by rich cavernous vessels that regulates humidification and airflow, similarly to other nasal turbinates [2, 3, 7–9]. Wexler et al. performed histological examination of specimens from the inferior nasal concha, nasal septum and nasal septum turbinate taken from healthy people. The authors found mainly mucous glands in the NST region. Venous plexuses were clearly less present (10%) compared to the inferior nasal concha (50%).

Although the NST mucosa was thicker in patients with allergies than in patients without them, the incidence of glandular cells increased in NST in both allergic and non-allergic patients. There were no significant differences between allergic and non-allergic groups. More venous plexuses were found in the inferior concha than in NST. There were no differences in the occurrence of venous plexuses between allergic and non-allergic patients. NST is thicker in patients with allergies than in patients without them. However, NST is rich in glandular cells in both allergic and non-allergic patients. Therefore, any changes in this region may lead to changes in humidification, dysfunction and nasal obstruction [5]. NST is the thickest part of the nasal septum and at the same time the narrowest part of the nasal cavity, any increase in the volume of NST can cause nasal obstruction. Although NST was thicker in patients with allergies than in patients without allergies, there were no histopathological differences between the two groups in this study. The increase in NST dimensions as a result of both allergic and non-allergic inflammation is associated with infiltration of eosinophils and lymphocytes into the mucosa, which led to swelling, increased thickness of basal membrane, and increased space between cells in allergic patients. Appropriate treatment of allergies in patients with nasal obstruction can alleviate symptoms without surgery, especially in patients with nasal obstruction at the level of the nasal valve.

The study of the histological structure of NST on a human corpse was carried out by Sisman et al. Most specimens of NST mucosa and adjacent nasal septum areas exhibited typical respiratory epithelium containing columnar ciliated cells and goblet cells. The thickness of the mucosa and submucosa in NST as well as the average percentage of venous sinuses in this region were significantly higher compared to other nasal septum areas, but significantly lower compared to the middle and inferior nasal concha. The content of seromucous glands in the mucosa of the nasal turbinates and nasal septum was similar. However, the average percentage of glandular tissues in NST was higher than in other areas of the nasal cavity. The average share of vascular tissue was lower in the nasal septum and NST mucosa compared to the nasal turbinates, but the average share of capillary tissue was more abundant in the nasal septum and NST. The amount of connective tissue in the nasal mucosa and nasal turbinates was similar, while in NST it was lower than in other regions of the nasal cavity.

In a microscopic study, Costa et al. describe that the thickness of cartilage and bones forming the nasal septum in the NST region do not differ from the remaining portions of the nasal septum. However, they noted a much higher concentration of collagen fibers in the mucosa adjacent to NST. Unlike the results of Wexler et al. (2006), Costa et al. found higher venous sinus content in NST in their studies (37%) [5, 14].

The histopathological structure of NST differs from the middle and anterior nasal concha, which may indicate different functional properties of the two regions. Compared to the adjacent nasal septum, NST contains significantly more venous sinuses and glandular elements, suggesting the ability of NST to change nasal air flow and humidification of nasal air.

IMAGING EXAMINATION IN THE ASSESSMENT OF NASAL SEPTUM TURBINATE

Nasal septum turbinate is a structure that is very well visualized in the sagittal projection in faciocranial imaging. The bulging of the nasal septum in its anteroposterior segment may seem to be one of the variations of the deviation of nasal septum (Fig. 2.–3.).

Studies based on MRI and CT in the assessment of NST show its abundant vascular structure, which can change in size under the effect of vasoconstrictors (sympathomimetics, cold saline, antihistamines). The tendency of NST to shrink is lower compared to the inferior nasal concha, which is due to the smaller number of venous plexuses in those structures [7, 12]. However, given the relatively narrow section of the internal nasal valve, it can be expected that even small changes in NST size will have a significant impact on nasal flow.

Based on the analysis of morphometric data obtained in craniofacial CT of patients qualified for septoplasty, Gupta et al. suggest the advantage of external approach to NST similarly as in the case of open rhinoseptoplasty, which may lead to better postoperative results in the treatment of airway obstruction [18].

Our own surgical experience indicates that thickened cartilage and bone, up to 5 mm wide, are present in the anterior portion of the nasal septum. It seems logical that reducing the volume of these structures would lead to thinning of the septum and improve airflow, allowing to preserve the adherent mucosa. In the analysis of magnetic resonance imaging of the head, NST was easily identifiable in all cases and was consistently dorsally located in relation to the anterior end of the inferior nasal concha and anteriorly from the middle nasal turbinate. It was found that NST has a spindle-shape and narrows gently in the anterior portion, with the geometric center of NST situated near the junction of the septum cartilage with the perpendicular plate of the ethmoid bone.

Although NST was thicker in patients with allergies than in patients without allergies, there were no histopathological differences between the two groups in our study. Congestion and hyperplasia of the mucous glands, leading to edema, migration and infiltration of eosinophils and lymphocytes into the mucosa, increased thickness of the basal membrane and increased intercellular space could explain the greater thickness of NST in tomographic images of allergic patients [3].

THE ROLE OF THE NASAL SEPTUM TURBINATE IN PLANNING AND PERFORMING SURGICAL TREATMENT

Nasal septum turbinate affects the width of the internal nasal valve. NST is often thought to have little clinical significance and is rarely considered when planning surgical treatment.

In the study of Kim et al., they used a method of coblation of the NST area in patients with impaired nasal patency after previous ineffective pharmacological treatment with antihistamine drugs, steroids and sympathomimetics for several weeks. After the procedure, a decrease in NST volume and an improvement in nasal patency were noted. The authors paid special attention to avoiding damage to the septum cartilage and septal mucoperiosteum during NSB ablation. Clinical improvement was maintained in most patients throughout the entire follow-up period, although it was relatively short. Haight and Gardiner analyzed the results of reducing anterior nasal conchas using cryotherapy or electrocoagulation, with and without simultaneous reduction of NST. The researchers did not demonstrate a significant difference in improving nasal patency after intervention in the NST area [20].

According to a large review by Moss et al. in 2019, preliminary results of surgical treatment suggest that a reduction of NST may be one of the targets when planning surgical treatment of the nose and respiratory tracts [8].

The structure of NST may have important clinical significance since the glandular tissue contained therein is mainly responsible for moisturizing the air in the nasal cavity, and any damage to this region can lead to a feeling of dry nose after surgery. Therefore, any plan of reducing NST to improve nasal air flow should take into account the protective properties of the glandular tissue compacted in it. On the other hand, changes in venous structures, especially at the level of the nasal valve region, affect the amount of airflow through the nose both during inspiration and exhalation. The presence of an increased number of venous sinuses (an increase in the volume of NST) can affect the direction and method of airflow through the nose. A change in laminar/mixed to turbulent airflow may predispose to infection. An extensive NST may be the result of impaired nasal patency and may cause misinterpretation (false negative) of Cottle test [16].

According to various researchers, the main function of NST is to ensure a change in the air flow towards the nasal turbinate and the ostiomeatal complex. Therefore, the location of the glandular tissue in this region suggests that NST could be particularly well adapted to withstand the effects of drying of the nasal mucosa by the first portions of the air stream flowing into the nose during inspiration. The destruction of NST during nasal septum surgery could lead to tissue drying with possible crusting, tissue necrosis and nosebleeds.

References

1. Gariuk O.G., Merkulov A.I., Novak A.V., Nechiporenko A.S.: [The influence of the nasal septum tubercle on certain aerodynamic characteristics]. Vestn Otorinolaringol., 2014; (3): 45–47.
2. Costa D.J., Sanford T., Janney C., Cooper M., Sindwani R.: Radiographic and Anatomic Characterization of the Nasal Septal Swell Body. Arch Otolaryngol Neck Surg., 2010; 136(11): 1107.
3. Yigit O., Taskin U., Acioglu E., Sisman A.S., Erdem Huq G.: Histological Evaluation of the Nasal Swell Body in Allergic Patients. Turk Otolarengoloji Arsivi/ Turkish Arch Otolaryngol., 2013; 51(2): 41–44.
4. Yenigun A., Ozturan O., Buyukpinarbasili N.: Pneumatized septal turbinate. Auris Nasus Larynx., 2014; 41(3): 310–312.
5. Jones N.: The nose and paranasal sinuses physiology and anatomy. Adv Drug Deliv Rev., 2001; 51(1–3): 5–19.
6. Delank K.W., Keller R., Stoll W.: Morphological and Rhinological Aspects of the Intumescentia Septi Nasi Anterior. Laryngo-Rhino-Otologie., 1993; 72(5): 242–246.
7. Wexler D., Braverman I., Amar M.: Histology of the Nasal Septal Swell Body (Septal Turbinate). Otolaryngol Neck Surg., 2006; 134(4): 596–600.
8. Moss W.J., Faraji F., Jafari A., DeConde A.S.: A systematic review of the nasal septal turbinate: An overlooked surgical target. Am J Otolaryngol., 2019; S0196-0709(19)30071-7.
9. Bloching M.B.: Disorders of the nasal valve area. GMS Curr Top Otorhinolaryngol Head Neck Surg., 2007; 6: Doc07.
10. Eccles R.: Nasal Airflow in Health and Disease. Acta Otolaryngol., 2000; 120(5): 580–595.
11. Bridger G.P., Proctor D.F.: Maximum Nasal Inspiratory Flow and Nasal Resistance. Ann Otol Rhinol Laryngol., 1970; 79(3): 481–488.
12. Wexler D.B., Davidson T.M.: The nasal valve: A review of the anatomy, imaging, and physiology. Am J Rhinol., 2004; (18): 143–150.
13. Perovic D. A previously unobserved formation on the vomer and the true limit of the choanae. Z Anat Entwicklungsgesch., 1959; (121): 1–8.
14. Arslan M, Muderris T, Muderris S. Radiological study of the intumescentia septi nasi anterior. J Laryngol Otol., 2004; 118(3): 199–201.
15. Muderris S., Aykut M., Kaplan Y., Ungan M.: Tuberculum septi nasi anterior. KBB ve Baş Boyun Cerrahisi Derg., 1994; 2(3): 193–196.
16. E. Gelera J., Ojar D., Lim J.H., Wee J.H., Kim J.W. et al.: Radiographic Changes of the Nasal Septal Body Among Patients With Sinonasal Diseases. Clin Exp Otorhinolaryngol., 2017; 10(4): 338–343.
17. Şişman A.S., Acıoğlu E., Yiğit Ö., Akakın D., Cilingir Ö.T.: Nasal Septal Turbinate: Cadaveric Study. Am J Rhinol Allergy., 2014; 28(5): e173–177.
18. Gupta A., Brooks D., Stager S., Lindsey W.H.: Surgical Access to the Internal Nasal Valve. Arch Facial Plast Surg., 2003; 5(2): 155.
19. Kim S.J., Kim H.T., Park Y.H., Kim J.Y., Bae J.H.: Coblation nasal septal swell body reduction for treatment of nasal obstruction: a preliminary report. Eur Arch Oto-Rhino-Laryngology., 2016; 273(9): 2575–2578.
20. Haight J.S.J., Gardiner G.W.: Nasal cryosurgery and cautery: Should the septum be treated and is a diagnosis relevant? J Otolaryngol., 1989; 18(4): 144–150.

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