CHAPTER «MEDICAL SCIENCES»

CONTEMPORARY MANAGEMENT OF HYPERTROPHY OF THE INFERIOR NASAL TURBINATES

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Abstract. *Objectives*. Currently, chronic nasal obstruction due to hypertrophic rhinitis represents one of the most common problems in rhinology. Thus, it is important to mention that the etiology of the increase in size of the lower nasal turbinates can be varied and must be well specified, since the same aspect of the clinical picture can have a completely different substrate from a morphological point of view. In-depth knowledge of the changes in the structure of the turbinates are necessary and useful to form a correct diagnostic and therapeutic approach. The purpose of the given study was to perform a detailed analysis of the contemporary data of the specialized literature in order to determine the morphological conformation of the nasal mucosa in chronic hypertrophic rhinitis. *Materials and methods*. For the research, the articles available in the electronic resources, on various specialist platforms, with open access, were used. Subsequently, the articles with relevant topics for the subject were selected and analyzed depending on the common aspects necessary to carry out the study. *Results and discussions*. CHR represents an important medical management problem in recent years. These have led to an increase in efforts in terms of a better understanding of both the pathophysiological mechanisms involved in the appearance of this pathology, as well as the most appropriate diagnostic methods and the most reliable therapeutic means for an effective treatment of this conditions. *Conclusions*. Chronic hypertrophic rhinitis represents the increase in volume of the nasal mucosa and implicitly the nasal turbinates, with the reduction of the respiratory space. It affects both adults and

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children, but is more common after the age of 20. The causes that lead to the appearance of chronic hypertrophic rhinitis are not exactly known. Whatever the trigger, however, the result is the same – a hyperactivity at the level of the nerve endings, which is manifested by the enlargement of the nasal mucosa. The goal of treatment is to reduce the symptoms caused by the inflammation of the affected tissues and to increase the patient's quality of life.

1. Introduction

One of the major causes of chronic obstruction of the nasal fossa is the pathology of the inferior nasal turbinates. Although it is not a life-threatening pathology, nasal obstruction can influence the quality of life and cause complications in the ENT sphere. The most common non-infectious causes of hypertrophy of the mucous membrane of the inferior nasal turbinates and decreased airflow in the nasal cavity are perennial allergic rhinitis and nonallergic rhinitis. Untreated, these rhinitises can lead to chronic nasal obstruction secondary to venous sinus dilatation or fibrosis. In these cases, an effective therapy is surgery of the inferior nasal turbinate and, sometimes, of the middle nasal turbinate. The treatment of choice for hypertrophy of the inferior nasal turbinate is the pharmacological one, in many cases topical steroids, antihistamines and intranasal decongestants with good results. Patients who do not respond to medical treatment will undergo a surgical reduction treatment of the inferior nasal turbinates. Inferior turbinate hypertrophy – the result of nasal hyperreactivity – represents a considerable handicap for patients whose quality of life is drastically affected.

Epidemiological investigations carried out in the countries of the European Community show that between 10% and 20% of the population suffer from chronic obstruction of the respiratory tract, caused by hypertrophy of the inferior turbinates.

In the present work, we try to update the contemporary management of the hypertrophy of the inferior nasal turbinate, by analyzing the diagnostic algorithm and the selection criteria for surgical treatment from a theoretical and practical point of view.

2. General aspects of etiology and pathophysiology of chronic rhinitis

The nose represents the peripheral component of the respiratory system, due to adaptation to the environment in the process of evolution. In humans, the morphofunctional structure of the nose is subordinate to the achievement of breathing, which becomes the main nasal function. Therefore, the nose is constituted by the external part – the nasal pyramid and the internal part – the nasal fossae and their accessory cavities, framed in the thickness of the bones of the facial massif and the anterior floor of the base of the skull.

The nasal cavity is located above the oral cavity, and the nasal septum divides it into two nasal fossae. They communicate through the nostrils with the outside, and through the cones with the pharynx and implicitly with the larynx, forming the upper respiratory tract. The external wall of the nasal cavities presents the most complex and clinically important structure. It forms three turbinates and three meatus into which the paranasal sinuses and lacrimal canal open.

The lower nasal horn, being the most voluminous, has an independent structure, having a bony skeleton, covered by a mucosa provided with a cavernous venous system. An identical mucosa and cavernous system also covers the middle turbinate.

The middle nasal horn, a tributary of the ethmoid, is constituted by a thin bony plate. Sometimes an aberrant ethmoid cell (Concha bullosa) can develop in the mass of the middle turbinate.

The superior nasal turbinate, being formed by a thin bony blade of the ethmodium, and sometimes by a fold of the pituitary mucosa, is the smallest of the nasal turbinates and is visualized during posterior rhinoscopy.

Rhinitis is a pathology that includes many different subtypes and is mainly used to describe a pattern of nasal symptoms such as nasal congestion/obstruction, rhinorrhea, sneezing and pruritus that occur as a result of inflammation and/or dysfunction of the nasal mucosa [12, p. 485].

In the following, multiple classifications of rhinitis will be analyzed, in order to accurately establish the place of chronic hypertrophic rhinitis in the totality of the mentioned pathologies.

Depending on the evolution, rhinitis can be acute (infectious: viral or bacterial; allergic; traumatic; through foreign bodies) and chronic (infectious, allergic, structural (deviation of the nasal septum, nasal polyps, etc., other causes).

Chronic rhinitis represents a chronic inflammation of the nasal pituitary mucosa, representing morphofunctional changes of the nasal turbinates, with an evolution of more than 12 weeks.

According to the morphofunctional classification, chronic rhinitis is grouped into:

– Catarrhal rhinitis, which represents the catarrhal inflammation of the nasal mucosa;

– Hypertrophic rhinitis, which represents the hypertrophy of the nasal turbinates;

– Atrophic rhinitis, which is characterized by atrophy of the nasal mucosa simple localized, simple diffuse and ozena.

Chronic hypertrophic rhinitis is a common problem in childhood and adolescence and has a negative impact on physical as well as social and psychological well-being. The prevalence of chronic hypertrophic rhinitis in children (CHRC) is 20-55, and in the last 5 years this index is increasing. Epidemiological data on chronic hypertrophic rhinitis estimate that more than 200 million people worldwide suffer from it. In the pediatric population, they showed a prevalence of 16.1% at the age of 5 years and a prevalence of 42.3% at the age of 14 years [9, p. 1661]. The term "chronic, hypertrophic rhinitis" defines a state of congestion of the mucous membrane and underlying tissues of the nasal turbinate so that the lower nasal airways are considerably reduced, resulting in functional, constant nasal obstruction.

Although chronic hypertrophic rhinitis in children is a fairly common nosological pathology in children, its symptoms are often subtle and nonspecific, and this can lead to the diagnosis being ignored [10, p. 215]. Usually, the diagnosis of chronic hypertrophic rhinitis in children is based on symptoms that last more than three months and some abnormalities determined by endonasal examination or imaging examination. Patients with RCH often receive several types of drugs, decongestants, oral antibiotic treatments that can alter the clinical presentation, especially in the early stages of the disease. Chronic hypertrophic rhinitis manifests itself in two anatomoclinical forms: diffuse and lcoalized. The diffuse form has 2 phases: congestive and hyperplastic. Chronic diffuse hypertrophic rhinitis is characterized by diffuse hypertrophy of intranasal tissues with predominant localization in the nasal concha. In hypertrophic chronic diffuse rhinitis, hypertrophic (hyperplastic) processes develop slowly and reach first the lower and then the central part and the rest of the nasal mucosa. This process is most pronounced in the anterior and posterior ends of the inferior turbinate.

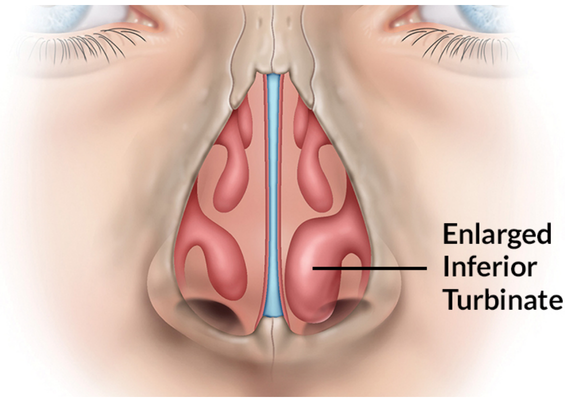

Figure 1. Hypertrophy of the nasal turbinates

In the pathogenesis of diffuse chronic hypertrophic rhinitis, an important role is played by factors such as chronic inflammation, impaired microcirculation, tissue oxygen insufficiency, distortion of metabolism, low local immunity and activation of saprophytic microorganisms.

The subjective symptoms do not fundamentally differ from those of chronic catarrhal rhinitis, however, the obstruction of the nasal passages by the hypertrophic structures of the nasal cavity determines the constancy of the difficulty or even the absence of nasal breathing. Patients complain of the ineffectiveness of nasal decongestants, dry mouth, snoring during sleep, persistent mucous or mucopurulent nasal discharge, the sensation of a foreign body in the nasopharynx, poor sleep, increased fatigue, decreased or absent smell, etc. Due to the compression, the lymphatic and venous vessels of the hypertrophic interstitial tissue are affected and the blood circulation of the lymphatic flow throughout the nasal cavity and in the forebrain, which leads to headaches, memory loss and mental performance. In the first phase of diffuse chronic hypertrophic rhinitis, patients often complain of intermittent deterioration of nasal breathing, typical of vasomotor rhinitis, and the difficulty or absence of nasal breathing becomes permanent.

The patient is constantly open-mouthed and closes it only when drawing attention to this "defect". During walking, running and other physical activity, the body can be supplied with oxygen only during oral breathing. The voice of patients is different nasalism; with this lesion, unlike the one with paralysis of the soft palate, called closed nasal (rhynalalia clausa), with paralysis of the soft palate – open nasal (rhynolalia operta).

Morphological aspects

The clinical course of diffuse chronic hypertrophic rhinitis is long, slowly progressive, which, without adequate treatment, can continue until old age.

According to the specialized literature available in the field, the following phases of the hypertrophic process are distinguished:

– The first phase – the so-called mild hypertrophy of the nasal mucosa, characterized by hyperemia and edema of the mucosa, moderate damage to the ciliary epithelium; in this phase, the muscle fibers of the venous plexuses of the lower nasal concha are not affected by the degenerative-sclerotic process and their vasomotor function is preserved [13, p. 657]; at this stage of the process, the effectiveness of nasal decorogestans is maintained; the lower ribs retain elasticity and flexibility during palpation [21, p. 15];

– Phase 2 is characterized by metaplasia of the ciliary epithelium, hypertrophy of the glandular apparatus, the initial phenomenon of degeneration of vascular muscle fibers, lymphocytic-histiocytic infiltration and thickening of the subepithelial layer; these phenomena lead to the compression of lymphatic vessels and blood, edema of the interstitial tissue, due to which the mucous membrane becomes pale or acquires a bluish-white color; at this stage, the effectiveness of vasoconstrictor agents is gradually reduced;

– Phase 3 in foreign literature is called "edematous", "mixed" or "polyoid hypertrophy", it is characterized by the phenomena of intervascular hypercollagenosis, diffuse infiltration of all elements of the mucous membrane, the walls of blood and lymphatic vessels and the glandular apparatus [8, p. 213]; These pathological changes are characterized by different degrees of severity, so the surface of the nasal concha can have a different appearance – smooth, uneven, polypodiform or a combination of these types of hypertrophy [3, p. 1145].

Also here, it is worth differentiating the notions of hypertrophy and hyperplasia, as hypertrophy represents the increase in size of the lower nasal turbinate due to the increase in cell size, and hyperplasia – an increase in the turbinate size based on the increase in the number of cells. Another important thing in the clinical picture of chronic hypertrophic rhinitis with direct transposition in the morphological aspect, is the uni- or bilateral damage, while the unilateral damage is more common in the deviation of the nasal septum, and the hypertrophy in this case occurs more on account of the bone tissue, than that of the nasal mucosa. Bilateral involvement, in turn, occurs in chronic allergic or non-allergic rhinitis (which also includes chronic hypertrophic rhinitis) and in this case cellular hyperplasia occurs, with edema and vascular congestion. In both cases, the lack of veridical hypertrophy of the mucosa of the inferior nasal turbinate should be noted.

In general, over the years, several theories have been proposed regarding the mechanism of the increase in volume of the inferior nasal turbinate. For example, the increase in size of the nasal turbinate has sometimes been attributed to the dilation of the submucous venous sinuses, due to a massive influx of blood – in this case it cannot be a matter of true hypertrophy of the inferior nasal turbinate.

Another idea was floated in 1997, about eosinophilic and mast cell infiltrates as causing turbinate dilatation, following a chronic inflammatory response. Saunders mentions the hyperplasia of bone cells in his works, in 1982, and Fairbanks and Kaliner, in 1998, discuss the combination of both mechanisms – mucous and bone.

This is why, the notion of hypertrophy, does not find its truthful explanation, since at the level of the inferior nasal turbinate, in chronic hypertrophic rhinitis, hyperplasia and not hypertrophy of goblet cells, squamous metaplasia with loss of cilia and intense fibrosis process are detected. Thus, the notion of hypertrophy should have been replaced by the notion of dilation or increase in volume of the inferior nasal turbinate.

In 2003, Berger G. studies the peculiarities of hypertrophied nasal turbinates in 16 specimens and performs a histological study (hematoxylin eosin staining). He points out that the mucosa on the medial side of the bone is thicker than the bone itself and the mucosa on the side. The epithelium is pseudostratified ciliated columnar type. Goblet cells are in a greater proportion on the side of the bone, as well as the number of mucus excretory glands. The lamina propria is thicker medially and extends toward the periosteum, consisting of connective tissue, few lymphocytes, seromucous glands, enlarged venous sinuses, and few arteries.

3. Contemporary diagnosis and management of chronic hypertrophic rhinitis

The diagnostic algorithm of patients with chronic hypertrophic kidney includes several stages and diagnostic methods.

Anamnesis. Anamnesis plays an important role in the diagnostic algorithm of patients, to establish the etiology of chronic rhinitis: allergic or non-allergic chronic rhinitis. The dominant symptom of patients with chronic rhinitis, regardless of its etiology, is chronic nasal obstruction. Depending on the etiology of chronic rhinitis, nasal obstruction is accompanied by anterior or posterior rhinorrhea, sneezing bursts, nasal, ocular or palatal itching, lacrimation, hyposmia-anosmia. The clinical picture can be completed by headache, blocked ear sensation, sleep disorders, fatigue, increased irritability, decreased ability to concentrate. Also, through the anamnesis, the onset of symptoms, the investigations and treatments performed by the patient up to the time of presentation to the consultation, the existence of dependence on nasal vasoconstrictor substances [14, p. 685] are established.

Heredo-collateral antecedents of allergy or atopic manifestations are important in the case of patients with allergic rhinitis.

ENT clinical examination. The clinical examination begins with the visual inspection, for which the patient's head must be tilted back to be able to assess the nasal base, which is an important aspect.

The inspection consists in the visual investigation of the structure of the nose, in order to obtain a first and superficial impression of the nose, but also of its respiratory function. During the clinical examination, it is important to analyze the nasal anatomy both at rest and during inspiration. With the help of a light source, the bone, cartilaginous and skin parts can be evaluated even better.

During the inspection, the following aspects are observed [1, p. 3441]:

– Mouth breathing, which can be caused by a nasal obstruction;

– Shape changes of the nose that may suggest intranasal abnormalities;

– Skin changes in the nasal vestibule, such as erythema and edema.

The inspection must show the degree of integrity, aspect, symmetry of the cervicofacial integuments, the presence of deformations, asymmetries, displacement from the median position (lateral positions, nose with hyperplasia, saddle nose, excavated or hypoplastic), the type of breathing (nasal or oral).

Palpation is a simple and appropriate action to analyze the pathology of the skin, tissues, bony and cartilaginous parts of the nose.

On palpation, bony discontinuities are detected and the facial region is palpated for painful points.

Previous rhinoscopy. Anterior rhinoscopy makes possible a quick but limited internal inspection of the anterior parts of the nasal cavity. Anterior rhinoscopy aims to examine the nasal passages and is performed with nasal speculums of various sizes. The mirror is held in the left hand in a full fist, so that the police is located on its joints, the index and middle fingers on the external side, and the ring and little fingers on the internal side of the handles, to be able to close and open them as wide as possible. The speculum is inserted into the nostrils with the valves closed and removed with the valves open. That technique is done in three positions of the head. To ensure them, the doctor places his right hand on the patient's crown and forehead, ensuring the movement of the head in different directions (flexion, extension, to the right or left).

The first position (low anterior rhinoscopy) – the patient's head slightly flexed, the floor of the nasal cavity in a horizontal direction. Rhinoscopy in this position ensures the examination of the turbinate and inferior meatus, the antero-inferior part of the nasal septum and the floor of the nasal fossae [2, p. 45].

The second position (oblique anterior rhinoscopy) – the extended head of the patient tilts back by 60 degrees, the nasal speculum is inserted obliquely upwards and backwards at an angle of 30 degrees to the floor of the nasal fossa. In this position, the head of the middle turbinate and the middle meatus are examined [15, p. 35].

The third position (high anterior rhinoscopy) – the patient's head in a hyperextension position in which the axis of the nasal speculum is directed towards the lower nasal meatus, thus ensuring the visibility of the upper portion of the nasal fossae.

Previous rhinoscopy highlights the cause of chronic nasal obstruction: hypertrophy of the lower nasal turbinates, deviation of the nasal septum, the presence of polypoid or tumoral formations at the level of the nasal fossae.

Nasal endoscopy. In the diagnosis of chronic hypertrophic rhinitis, special attention is paid to the endoscopic examination – the most informative method currently used in rhinology.

Compared to anterior and posterior rhinoscopy, nasal endoscopy offers the advantage of global evaluation of the endonasal cavity. Endoscopy offers the following advantages: a superior view and a more precise assessment of the lesions, perfect clarity thanks to the use of optical fibers, the possibility of video recording for teaching purposes or to re-evaluate the respective intervention, extensive and complete exploration of the lesion as a result of its suppleness and very high mobility of fiber optic systems and endoscopic instrumentation that can be flexible or rigid.

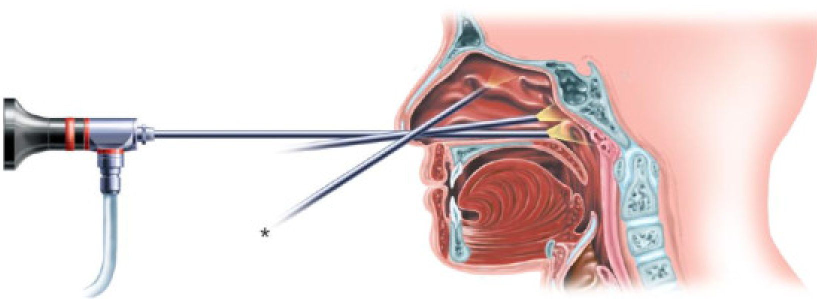

Figure 2. Nasal endoscopy

Thanks to the endoscopy, it is possible to correctly evaluate the septum, the entire nasal cavity and the nasopharynx, but also the middle meatus area, which is of clinical importance in rhinitis. The endoscopic examination complements the clinical examination and aims to highlight anatomical details and pathological changes, which cannot be detected during the clinical examination.

Nasal endoscopy produces a closer inspection of the involved areas than previous rhinoscopy by up to 85%. The method is appreciated as a practical, useful and well-tolerated method by patients of different ages.

Nasal endoscopy is performed with the help of a rigid endoscope or a flexible fiberscope, which is accurately inserted into the patient's nasal cavities, after prior application of a local anesthetic in the form of a spray and/or a vasoconstrictor (in case the patient has congestion of the nasal mucosa). The investigation is considered to be painless, but it may create minimal discomfort for the patient during the maneuvering of the endoscope by the otolaryngologist.

The nasal endoscope is an instrument in the form of a thin tube that can be rigid or flexible – fiberscope, with a diameter of about 4 mm, which is provided at the distal end with a video camera and lenses that allow obtaining detailed images of the anatomical structures entering the composition of the nose. The nasal endoscope is connected to a monitor that receives information from the video camera of the device and displays in real time the images obtained by the maneuvers performed by the doctor.

The information obtained through nasal endoscopy can specify the causes of upper respiratory obstruction represented by nasal turbinate hypertrophy, nasal polyps, tumor processes, adenoid vegetations or cavum tumor. Investigation can locate the seat of recurrent nosebleeds and confirm the diagnosis of rhinogenic headache caused by the presence of septal deviations contacting the lateronasal wall or hypertrophy of the middle nasal turbinate.

Nasal endoscopy is classified according to the medical equipment used, according to the following grouping:

– Rigid nasal endoscopy performed with the help of an endoscope in the form of a tube with a reduced diameter, equipped with an eyepiece; this method is used especially for exploring the nasal cavities and adjacent anatomical structures; the investigation allows the collection of biopsies from the level of polyps in order to establish the benign or malignant character of these formations, through additional examination in the department of pathological anatomy, obtaining hemostasis in the case of nasal epistaxis and the extraction of foreign bodies from the level of the nose;

– Nasal fiberoscopy allows visualization of the nasal cavities and the nasopharynx (the area behind the nose) with the help of a flexible fiberscope, which can avoid possible anatomical strictures of the nose that cannot be bypassed with the rigid endoscope [11, p. 215].

Rhinomanometry

New technologies allow the investigation of physiological processes in the nasal cavity, particularly nasal breathing, and the objectification of these changes in the pre- and post-operative period. In the current conditions, the assessment of the effectiveness of surgical treatment by different methods, including RMM, becomes an indispensable necessity.

RMM provides objective and quantitative information regarding nasal resistance. This is dependent on two parameters: differential pressure and flow rate. The differential pressure represents the pressure difference between the atmospheric pressure, measured in the mask at the level of the nasal vestibules, and the inspiratory and expiratory pressure at the level of the choans, expressed in Pa. The respiratory rate corresponds to the volume of air passing through the nasal passages and is measured in cm^3/s. The rhinomanometer allows the simultaneous measurement of these two mutually dependent parameters.

Passive and active RMM techniques are distinguished.

Passive rhinomanometry involves the introduction of a stream of air from the outside into the nasal cavity, with a certain known pressure, with the help of a pump and its elimination through the oral cavity. The pressure drop, the pressure difference is measured. This method has not entered routine practice in rhinology, its use being reserved for experimental research.

Posterior active RMM is the rhinomanometric method by which pressure is measured at the level of the choanae, with the help of a cannula inserted into the oral cavity, behind the palatine veil; the nasal airflow can be measured through both nasal cavities, simultaneously or separately for each cavity, by closing one of the cavities. Due to the presence of the cannula (probe) in the oral cavity, 30% of patients experience an involuntary lifting of the palatal veil or vomiting reflex, which is why the method has been abandoned in current practice [17, p. 59].

Anterior active RMM is the rhinomanometry method unanimously accepted and used by rhinologists, its performance technique and interpretation being standardized by the International Committee for Standardization of Rhinomanometry. In this method, the hermetic closure of a nasal cavity is performed, and the patient breathes through the free nasal cavity (inhale-exhale), using a face mask applied as tightly as possible.

Determining airflow – volume flow – is usually measured using a face mask, although there are rhinomanometers that use nasal probes. The pressure difference measured by the rhinomanometer is the air pressure difference at the level of the cones and the face mask. In fact, the rhinomanometer measures the airflow of each nasal cavity and the total airflow (the nose as a whole) at the level of both nasal cavities, at 75, 150 and 300 Pa [6, p. 159].

Depending on the value of nasal airflow resistance at a pressure of 150 Pa, nasal obstruction was classified as follows:

Table 1

Types of nasal obstruction

The type of nasal obstruction	Nasal airflow resistance values
Mild nasal obstruction	Between 0,41-0,68 Pa/ cm^3/s
Moderate nasal obstruction	Between 0,69-0,89 Pa/ cm^3/s
Severe nasal obstruction	Between 0,90-1,17 Pa/ cm^3/s

Source: Dinis P.B., Haider H., Gomes A. Rhinomanometry, sinus CT – scan and allergy testing in the diagnostic assessment of chronic nasal obstruction. Rhinology, 1997, 35, pp. 158–160.

According to the international standards established by the rhinological societies, the air resistance at the pressure of 75 Pa and 150 Pa is usually analyzed. In patients without nasal obstruction, the nasal resistance measured at a pressure of 150 Pa is between 0.15-0.39 Pa/cm^3/s, but the higher the value of the resistance of the airflow when passing through the nasal cavity, the more high degree of nasal obstruction.

Acoustic rhinometry. Acoustic rhinometry was proposed in 1989 by O. Hilberg et. al. for evaluating the geometry of the nasal cavities and is based on the principles of acoustic echolocation [16, p. 69]. The authors of the method developed a device, called an acoustic rhinometer, the operation of which consists in emitting acoustic signals, with a frequency between 150 and 10,000 Hz, which are propagated in the nasal passages through a plastic tube with a length of 580 mm and a diameter of 15 mm. At the distal end of the rhinometer tube is a removable nosepiece for connecting the tube to the patient's nostrils. The emitted acoustic signals are reflected by the walls of the nasal cavities, thanks to changes in acoustic impedance in response to changes in the transverse dimensions of the nasal cavity, and are directed back into the rhinometer tube, where they are picked up by a very sensitive microphone installed inside the tube. The recorded signals are processed by the computer and recorded on the monitor and/or on paper in the form of curves, which represent the cross-sectional area (AST) of the nasal fossae or the distance between the nasal septum and the nasal side wall.

Acoustic rhinometry is an informative, non-invasive and highly accurate method of nasal cavity investigation. Until now, this method has been applied in pediatric practice only in single cases, and the specialized literature in the country does not provide data on the role of this method in evaluating the preoperative state of the nasal cavities and the results of rhinosinus operations.

The small size of the nasal passages in children allows the application of sound with a higher frequency compared to adults, which significantly increases the accuracy of the method.

Acoustic rhinometry is performed according to an algorithm for calculating the area-distance function for measurements in the nasal cavity, which is based on the evaluation of the reflection of a directed acoustic signal – a sound wave with a frequency below 16 Hz [20, p. 15], generated by a acoustic source attached to a nasal piece with a known diameter; the recording of the incident and reflected acoustic signals is carried out with the help of a microphone, after which the data are processed by the computer. Acoustic rhinometry is independent of the patient's cooperation, but requires a rigorous technique related to the angle of incidence of the nasal probe; although it is easy to perform and has the advantage of continuously recording the geometric changes of the nasal cavities, it has the disadvantage that a marked obstruction of the anterior portion of the nasal cavity can lead to erroneous results regarding the nasal cavity itself.

Other diagnostic methods used (conventional radiography, Computed Tomography, MRI)

Contemporary diagnosis of chronic hypertrophic rhinitis includes other widely used methods, such as conventional radiography, computed tomography, nuclear magnetic resonance.

Conventional radiography is a method used in the diagnosis of rhinosinusal pathology, which aims to determine inflammatory changes in the paranasal sinuses and traumatic bone injuries. Thus, the radiographic examination of the nasosinusal region mainly aims at highlighting the following anatomical structures: craniofacial sinuses (frontal sinuses, anterior ethmoid cells, maxillary sinuses); craniobasal sinuses (sphenoid sinus, posterior ethmoid cells) and nasal bones.

Computed tomography (CT) allows the acquisition of high-precision images, in axial, coronal, but also sagittal sections, obtained through three-dimensional reconstructions, with the perfect visualization of bone structures, delimited cavities and their contents, with numerous applications in rhinosinusal pathology.

The CT scan uses X-rays absorbed differently by tissues, generating particularly detailed images; tissue contrast results from differences in electron density. The degree of attenuation of these rays is measured in Hounsfield units (HU). To create images, CT uses mathematical reconstruction algorithms. Bone or soft tissue algorithms can be used. Injection of iodinated contrast medium is necessary for indirect assessment of the vascularization of the space-replacing process, the accounts of the lesion and the extension of the pathological process.

Computed tomography is an indispensable examination before nasosinus endoscopy. In the preoperative visualization of a CT imaging examination, the rhinologist must highlight, along with the pathological process and the necessary endoscopic landmarks: the frontal recess and the agger nasi cell, the uncinate process and the ethmoid bulla, the middle and superior turbinate, the anterior ethmoid cells, the perforated blade of ethmoid and ethmoidal ceiling, lamina papyracea, posterior ethmoidal cells.

Nuclear magnetic resonance (NMR) is an imaging modality that uses, to create images, the response of biological tissues to the application of a dynamic magnetic field. It is a useful diagnostic method in taking stock of the extension of the pathological process in the soft parts, at the level of the orbits, the pterygomaxillary fossa and the dura mater. It is also the most appropriate technique for postoperative follow-up. The application of this method is limited by the relatively low accessibility and high cost.

4. Peculiarities of treatment of chronic hypertrophic rhinitis

Correct management of chronic hypertrophic rhinitis begins with identifying the cause that led to the hypertrophy of the nasal turbinates and treating that cause.

Respectively, the treatment of RCH must be carried out in accordance with the specifics of its etiology and includes: drug treatment and surgical treatment [5, p. 126].

Medicinal treatment represents the first line of approach to therapy in the pathology of nasal turbinate hypertrophy. Depending on the type, duration and severity of symptoms, medical treatment in RCH may include the following drug groups [19, p. 189]:

– Nasal decongestants – they can be used topically, but also orally;
– H1 antihistamines, which are used in patients with allergic rhinitis;
– Intranasal or oral corticosteroids;
– Chromones: sodium cromoglicate and nedocromil sodium;
– Anticholinergics: ipatropium bromide;
– Antileukotrienes;
– Specific immunotherapy with allergens, used in allergic rhinitis;
– Intramucosal injection of cortisone.

If the medical treatment was correctly and completely carried out, but in the end it is ineffective, or in case of its contraindication, surgical treatment is recommended.

An important decision factor in the surgical management of turbinate hypertrophy concerns the determination of the type of hypertrophy, which may be bony, mucosal, or a combination of the two types.

In daily practice, there are multiple surgical techniques for reducing the size of the nasal turbinates, the choice of one or another of them depending on various factors, such as:

– type of hypertrophy;
– experience and habit of the surgeon;
– the technical equipment of the clinic where the surgical intervention is performed;
– intervention costs.

The types of hypertrophy of the nasal turbinates are as follows:

In case of bony hypertrophy, total or submucous resection of the lower turbinate is used.

In case of hypertrophy of the nasal turbinate mucosa, several techniques are available [7, p. 208]:

– lateral fracture of the turbinal bone, single or multiple, with or without submucosal incision;

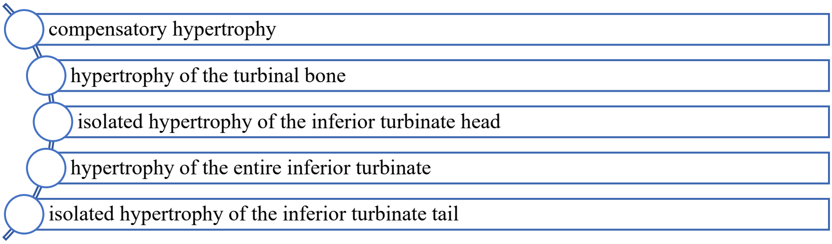

Figure 3. Types of hypertrophy of the nasal turbinates

– turbinectomy: partial, total, submucosal, anterior;

– coagulation techniques: electrocautery, submucosal diathermic coagulation, cryotherapy, radiofrequency coagulation, LASER vaporization.

With the exception of compensatory hypertrophy of the nasal turbinate, surgical treatment should be indicated only if medical treatment has had no subjective and objective success for 3 consecutive months.

In general, the surgical techniques used in the case of hypertrophy of the nasal turbinates are classified into two groups:

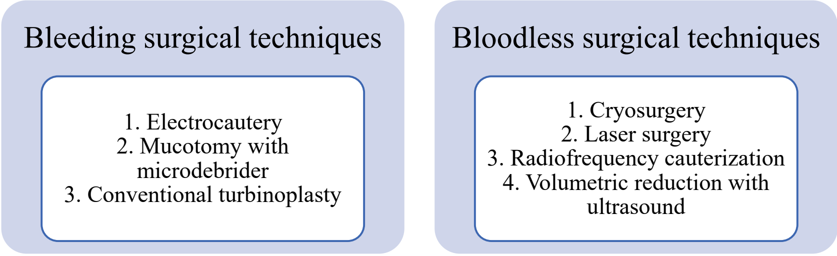

Figure 4. Typology of surgical techniques used in the case of RCH

According to another classification of surgical techniques used in the surgical treatment of RCH, there are surgical techniques with preserving the integrity of the mucosa of the inferior nasal turbinate and techniques without preserving it.

Also, the goal of surgical treatment must be to reduce symptoms and at the same time preserve nasal functions in their full functioning. The most important aspect to consider in the surgical treatment of the nasal turbinates

Table 2

Surgical techniques that preserve and destroy the mucosa of the nasal turbinate

Surgical techniques that do not preserve the mucosa of the turbinate	Surgical techniques that preserve the mucosa of the turbinate
Conventional Turbinectomy (Partial or Total) Electrocautery Laser surgery Cryosurgery	Conventional Turbinoplasty Mucotomy with microdebrider Radiofrequency cauterization Volumetric reduction with ultrasound Coblation Turbinoplasty

refers to the fact that a wider nasal cavity does not necessarily imply a better functioning of it. The goal of the surgical intervention involves reducing the patient's complaints, while preserving the function of the organ, and performing the optimal volumetric reduction while preserving the function. The respective surgical treatment must take into account, on the one hand, the effectiveness of the method in reducing respiratory obstruction, hypersecretion, sneezing, headaches and, on the other hand, the short- and long-term side effects.

Conventional turbinectomy. Turbinectomy involves the removal of all or part of the inferior turbinate and can be performed under direct visualization or with the aid of an endoscope. The degree of excision can be anywhere from limited to complete resection, depending on the degree of hypertrophy, and also includes the turbinate mucosa, erectile soft tissue, and bone. Usually, the inferior turbinate is resected using angled scissors along its insertion at the level of the lateral nasal wall. The disadvantage of the technique refers to the patients' nasal discomfort, headache, atrophic changes and the probability of postoperative bleeding. Thus, turbinectomy provides significant relief of nasal obstruction, but is associated with several complications, particularly severe pain, crusting, and bleeding. In this context, the "empty nose" syndrome also appears [4, p. 312], which appears as a late symptom, following its total turbinectomy. "Empty nose" syndrome is a disorder characterized by paradoxical nasal obstruction in the presence of a wide nasal cavity. The resulting crust and excessive dryness develop due to disruption of mucociliary clearance, rough mucosal edges, and exposed bone.

Laser surgery. The lasers that are usually used to reduce the inferior nasal turbinates are diode and CO_2 lasers. Other common types of laser are: argon laser, KTP laser (potassium titanyl phosphate), neodymium-yttrium aluminum garnet – Nd: YAG and aluminum-yttrium garnet Ho: YAG [18, p. 95]. The major differences between these types of laser appear depending on the wavelength of the emitted laser, the output power, whether the laser emission is applied in a pulsed or continuous wave.

The advantages of laser surgical treatment consist in the fact that in their case local anesthesia can be applied, there is a low bleeding tendency, but also because there is a higher acceptance by the patients. The disadvantages of laser surgery refer to the high recurrence rate of turbinate hypertrophy. In the same vein, it is proven that when it is used superficially, the laser energy leads, even if in a small proportion, to the damage of the mucous membrane surface with scars and disorders of the mucociliary clearance, which affects the respective function in the case of patients with the mentioned pathology.

Table 3

Characteristics of laser types used in the surgical treatment of RCH

Nr.	Laser type	The wavelength	Postoperative effects
1.	Argon Laser	488–514 nm	Very good effect on the venous plexus of the nasal mucosa, which results in an effective reduction of the corpus cavernosum with preservation of the surrounding tissue.
2.	CO_2 Laser	10 600 nm	Poor bleeding coagulation properties, precise cutting and shallow vaporization in continuous and pulsatile waves, high method efficiency
3.	Diode Laser	810–940 nm	Effective treatment of inferior turbinate hyperplasia and good hemostasis
4.	Neodymium: YAG laser	1 064 nm	Due to the interaction of the deep tissue, the superficial epithelial layers can be preserved and the development of postoperative nasal crusts is reduced compared to other types of laser
5.	Potassium-titanium-phosphate (KTP) laser	532 nm	Coagulative properties similar or identical to argon laser, it is absorbed by hemoglobin.
6.	Holmium laser: YAG laser	2 100 nm	Good coagulation capabilities, suitable for precise endonasal treatment with minimal carbonization, but good hemostasis

The diode laser is the perfect choice for volume reduction of the inferior nasal turbinates, as it ensures precise cutting and adequate hemostasis, being one of the most effective treatments for turbinate hyperplasia. The diode laser has a wavelength in the infrared spectrum of 805-980 nm, which is suitable for cutting soft tissue. The laser also provides a coagulation effect when set in low power pulse mode, which provides a precise cutting effect through the ability to vaporize mucosa, cartilage or bone continuously and with high energy. Next, the author developed a comparative analysis of the types of lasers used in the surgical treatment of RCH:

Electrocautery. That technique involves an application of electric current to cauterize the inferior nasal turbinate either on the mucosal or submucosal surface. When performed at the submucosal level, the volume of tissue destruction is difficult to measure, and there is a substantial risk of destroying more tissue due to the excessive temperatures generated due to the high level of power and voltage. The method consists in reducing the size of the inferior nasal turbinate by cauterization due to the elimination of some portions of the cavernous tissue after cauterization and by retraction of the rest of the tissue following the scarring process. The technique can be applied under local or general anesthesia, with direct endoscopic visualization and requires post-operative nasal packing.

Cryosurgery. Cryotherapy is a minimally invasive procedure that uses nitrous oxide or liquid nitrogen as a cooling agent and induces necrosis by freezing the turbinate. The technique works by inducing scarring and directly destroying the mucosa and submucosal erectile tissue. Overall short-term results are satisfactory, but usually the benefit is not long-lasting. The amount of reduction in the volume of the nasal turbinates is difficult to predict. Also, compared to other methods, in the long term the results are not satisfactory. After several practices, cryosurgery was later gradually abandoned due to the emergence and availability of new techniques that allow better and more efficient procedures to be performed.

Conventional Turbinoplasty. This surgery was designed to remove the non-functional obstructive part of the turbinate while preserving the functional medial mucosa, which plays a key role in warming and humidifying the air through the nasal passages. Performed endoscopically, inferior turbinoplasty has the advantage over other turbinate volume reduction procedures by preserving the mucosa long enough while removing adequate obstructing tissue for significant airway improvement. The other term used for this technique is "submucosa resection", in reference to the submucosal dissection procedure. There are two types of turbinoplasty: intraturbinoplasty and extraturbinoplasty. Intraturbinoplasty refers to the technique involving a tunneling inside the turbinate, which removes only the submucosal erectile tissue, leaving behind the bone of the inferior nasal turbinate. This procedure is intended for the treatment of inferior turbinate hypertrophy caused by erectile soft tissue. If the erectile soft tissue, but also the bone of the turbinates are removed, it is considered to be an extraturbinoplasty. Extraturbinoplasty is a modified turbinoplasty, which combines conservative sparing of the nasal mucosa together with the removal of obstructive soft tissue and part of the voluminous inferior turbinate bone. An intraturbinoplasty technique can be performed with microdebrider, coblation, radiofrequency, and ultrasound, while extraturbinoplasty can be performed by microinstrumentation, coblation, and microdebrider.

Mucotomy with microdebrider. Following its introduction into the specialty of otolaryngology, the microdebrider has made significant progress in endoscopic sinus surgery. It has become a widely accepted and useful tool for sinus surgery with the ability to continuously aspirate blood from the operative site, allowing a better surgical field of view and enabling precise tissue removal in a manner that preserves the nasal mucosa. Among the advantages of the technique are long-term effectiveness and preservation of mucosal function, but also the lower rate of postoperative complications, namely crust formation or synechiae formation.

Using the microdebrider blade, the entire lateral aspect of the inferior nasal turbinate mucosa and soft erectile tissue is removed in an anterior to posterior direction. Another advantage of the technique consists in the fact that, thanks to its blade, the technique allows action strictly at the place of application and shows a high degree of safety thanks to the protection of the cutting blade. The disadvantage of the technique is based on the higher cost and the mandatory need for tamponade of the nasal cavity post-operatively. At the same time, the technique is a beneficial alternative due to the advantage of reducing the hypertrophied and hyperplastic tissue of the turbinate under direct visualization, without bone damage and without thermal effect in depth. The technique is also practiced under local anesthesia.

Turbinoplasty by coblation. Coblation is a unique method of delivering radiofrequency energy to soft tissue. By using radio frequency in a bipolar mode with a conductive solution, such as saline, it energizes the ions in the saline to form a small plasma field. The decrease in thermal effect, consequently leads to less pain and faster recovery, for cases where the tissue is excised. Coblation induces reduction of the inferior nasal turbinate by vaporization and destruction of the soft erectile tissue. Volume reduction and tissue fibrosis are immediate and lasting. The coblation technique can be used in both intratubinoplasties and extraturbinoplasty. Basically, the soft tissue is melted physiologically, non-thermally, without affecting the integrity of the adjacent tissues. Unlike radiofrequency, where the current circulates throughout the body, in the case of the coblation technique, the electric current acts strictly locally. Advantages include mesh ablation of soft tissues, hemostasis by bipolar coagulation, fast and precise method with preservation of tissue integrity and reduced risk of complications, but also minimal pain and a quick recovery.

Radiofrequency cauterization. Radiofrequency turbinoplasty is a minimally invasive technique that reduces the volume of the inferior nasal turbinates in a precise and targeted manner. Radiofrequency is used to reduce tissue volume with minimal impact on adjacent tissues. Radiofrequency is applied as the main method in intraturbinoplasty. The surgical steps are similar to coblation, except that it does not require saline for its application. The use of radiofrequency involves energy from 60 to 90 degrees, which reduces excessive tissue damage. Among the advantages are the fact that the intervention does not require post-operative nasal tamponade, the intervention has a short duration and can be performed under local anesthesia, in an outpatient setting. Also, one of the main disadvantages of the present method refers to the persistence of increased rhinorrhea in the first 48 hours, and slight impairment of the quality of life. The intervention is carried out under endoscopic control, which also allows the approach of hard-to-access areas.

Volumetric reduction with ultrasound. Ultrasound technology for rhinological surgery is a relatively new technique. The technique is based on tissue destruction through the use of strong high frequencies (up to 50,000 Hz). Volumetric reduction with ultrasound is a minimally invasive, non-bleeding technique that aims to reduce the volume of hypertrophied nasal turbinate tissue. The method is applied under local anesthesia, in outpatient conditions.

5. Conclusions

Nasal obstruction syndrome due to hypertrophy of the inferior nasal turbinates is a very common pathology, with important repercussions on the quality of life of each patient. In front of a patient with nasal obstruction due to hypertrophy of the inferior nasal turbinates, it is necessary to objectively evaluate the respiratory function by rhinomanometry, acoustic rhinometry, etc.

The tissue volume reduction techniques of the inferior nasal turbinates are diverse and are divided into bleeding methods and non-bleeding methods, as a post-operative complication, and into techniques for preserving the nasal mucosa and destroying it.

Mucotomy with the shaver addresses the entire hypertrophied turbinate tissue and preferably the posterior third and the tail of the inferior nasal turbinates. For the hypertrophy of the lower nasal turbinates, different laser variants can be used, the indication of choice being in vasomotor rhinitis, using several laser vaporization surgical techniques.

Bipolar electrocautery is maintained as a viable method in the ablation of hypertrophied turbinate tissue, even if at present there are bloodless methods, more easily accepted by the patient.

The radiofrequency tissue destruction technique is a modern technique, with good functional results, being a viable alternative to laser or ultrasound techniques. Turbinoplasty is a surgical method performed under endoscopic control that addresses advanced chronic hypertrophic rhinitis in which there are hypertrophic and hyperplastic changes at the turbinate level.

All surgical techniques show a favorable functional result. According to the specialized literature, we can conclude that none of these can be considered the choice, the technique used being the most indicated for the existing pathology, as well as the one that is most easily accepted by the patient.

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