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Compensatory hypertrophy of the contralateral inferior turbinate in patients with unilateral nasal septal deviation A computed tomography study

Kompensacyjny przerost małżowiny nosowej dolnej po stronie przeciwnej u pacjentów z jednostronnym skrzywieniem przegrody nosa. Badanie tomografii komputerowej

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
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G Funds Collection

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ABSTRACT:

Introduction: the compensatory hypertrophy of the inferior turbinate in patients with septal deviation to one of the nostrils is considered to protect the airways from the excess of air that could enter through the nostril and its potential negative effects such as dryness, alteration of air filtration, mucociliary flow, or lung involvement.

Materials and methods: A prospective, longitudinal, non-randomized study. Patients were divided in two groups: 10 consecutive patients, with nasal septal deviation and compensatory hypertrophy of the inferior turbinate in the contralateral nasal cavity (10 non-hypertrophied turbinates as control and 10 contralateral hypertrophied turbinates as study cases), and the second group with 5 patients without any nasal pathology (10 turbinates without any obvious pathology). In both groups CT scans of the nasal region were performed. A comparison of patients with nasal septal deviation with compensatory hypertrophy of the inferior turbinate in the contralateral nasal cavity and with non-pathological inferior turbinate was carried out.

Results: When analyzing the groups of patients with septal deviation, the contralateral hypertrophied turbinate and the non-hypertrophied turbinate side, we found a significant hypertrophy in the anterior portion of the inferior turbinate, at the level of the medial mucosa ($P = 0.002$) and bone ($P = 0.001$) in the group of patients with contralateral hypertrophied turbinate. However, when we compared the contralateral hypertrophic turbinate with the turbinate of patients without septal deviation, we found a significant difference in all volumes of the medial and lateral mucosa and the bone portion ($P = 0.001$, $P = 0.005$).

Conclusion: Surgical correction of the nasal septum and lateralization or reduction of the volume of the inferior turbinate (which may include the medial mucosa, head or part of the bone) is necessary in order to improve air passage into the nasal valve.

KEY WORDS: nose, turbinate, septal, deviation

STRESZCZENIE: **Wprowadzenie:** Uważa się, że kompensacyjny przerost małżowiny nosowej dolnej u pacjentów ze skrzywieniem przegrody jednego otworu nosowego pomaga w ochronie dróg oddechowych przed nadmierną ilością powietrza, która mogłaby dostać się do otworu nosowego, co mogłoby mieć takie negatywne skutki, jak suchość, zmiana filtracji powietrza, wydzielanie wydzieliny śluzowej lub zajęcie płuc.

Materiał i metody: Badanie prospektywne nierandomizowane. Pacjentów podzielono na dwie grupy: jedną grupę obejmującą 10 kolejnych pacjentów ze skrzywieniem przegrody i kompensacyjnym przerostem małżowiny nosowej dolnej w przewodzie nosowym po stronie przeciwnej (10 małżowin bez przerostu jako grupa kontrolna i 10 przerośniętych małżowin po stronie przeciwnej jako grupa ze zmianami patologicznymi) i drugą grupę, 5 pacjentów bez zmian w obrębie nosa (10 małżowin bez zmian patologicznych). W obu grupach przeprowadzono badanie tomografii komputerowej okolicy nosa. Porównano pacjentów z przerostem kompensacyjnym małżowiny nosowej dolnej w przewodzie nosowym po stronie przeciwnej i małżowiny bez zmian patologicznych.

Wyniki: Analiza grupy pacjentów ze skrzywieniem przegrody; porównanie hipertroficznych i prawidłowych małżowin wykazało w grupie pacjentów z przerostem małżowiny nosowej dolnej po stronie przeciwnej znaczny przerost małżowiny nosowej dolnej w odcinku przednim w obrębie błony śluzowej na ścianie przyśrodkowej (p: 0,002) oraz kości (p = 0,001). Jednakże kiedy porównaliśmy przerośnięte małżowiny nosowe dolne strony przeciwnej z małżowinami u pacjentów bez skrzywienia przegrody, stwierdziliśmy znaczącą różnicę we wszystkich wymiarach błony śluzowej powierzchni przyśrodkowej i bocznej, jak również kości (p = 0,001, p = 0,005).

Wniosek: W celu poprawy przepływu powietrza do zastawki nosowej konieczne jest przeprowadzenie chirurgicznej korekcji przegrody nosa oraz lateralizacja lub zmniejszenie rozmiarów małżowiny nosowej dolnej; która obejmować może błonę śluzową powierzchni przyśrodkowej, większość lub jedynie część kości.

SŁOWA KLUCZOWE: nos, małżowina, przegroda, skrzywienie

INTRODUCTION

The concept of compensatory hypertrophy of the inferior turbinate in patients with septal deviation to one of the nostrils is widely known [1]. This compensatory hypertrophy is considered to protect the airways from the excess of air that could enter through the nostril and its potential negative effects such as dryness, alteration of air filtration, mucociliary flow, or lung involvement [2].

Allergic rhinitis, vasomotor rhinitis, drugs, dust, cigarettes, pregnancy, sexual stimulation, etc. are conditions that have been associated with increased turbinate volume [3, 4]. However, deviated nasal septum is considered the most common cause of correctable nasal obstruction [5]. Moreover, in patients with unilateral deviation associated with compensatory turbinate hypertrophy, volumetric reduction is mandatory.

As regards nasal aerodynamics, the anterior portion of the nasal cavity is the area that generates the most of nasal resistance to the air flow [1] representing up to 2/3 of the upper airway resistance, produced by the anterior portion of the inferior turbinate in the region of the internal nasal valve [6]. The inferior turbinate reveals also vasoactive properties and is the most susceptible to increase its volume, leading to increased airway resistance and worsening of symptoms of nasal obstruction.

But what is the result of these inflammatory-hypertrophic phenomena? Cook *et al.* showed that persistent inflammation of the nasal mucosa leads to deposition of collagen and subsequent glandular hyperplasia, producing irreversible hypertrophy of the nasal mucosa [7]. Fairbanks and Kaliner claimed that it involves the bone as well as the mucosa and showed that the inferior turbinate becomes thicker and spongier and arches further medially into the airway. Moreover, the mucosa gets hypertrophied and creates a rich network of venous sinusoids, with increased expansibility. They suggested that these changes are not spontaneously reversible and should be corrected in conjunction with nasal septal surgery [8]. Otherwise, surgery may relieve the obstruction on one side of the nose but leave the other side obstructed, after an isolated relocation of the septum without correcting the hypertrophied turbinate. Other authors confirmed that concomitant surgery on the compensatory hypertrophic inferior turbinate during septoplasty is advisable [9-11].

For these reasons, the aim of our study was to determine the radiological characteristics of compensatory hypertrophy of the inferior turbinate in patients with unilateral septal deviation, in order to allow for appropriate and consistent surgical planning, and thus to provide more adequate treatment for each patient.

MATERIALS AND METHODS

A prospective, longitudinal, non-randomized study was performed. This study was approved by the ethics committee of our hospital and was conducted according to the principles of the Declaration of Helsinki.

All patients gave their informed consent prior to their inclusion in the study. Patients of both sexes, aged 18 years, who received an ENT consultation in a tertiary hospital with nasal obstruction symptoms, and patients without nasal pathology, considered as controls, were included. Later on those patients were divided into two groups: the first group of 10 consecutive patients, with nasal septal deviation and compensatory hypertrophy of the inferior turbinate in the contralateral nasal cavity (10 non-hypertrophied turbinates as controls and 10 contralateral hypertrophied turbinates as study cases), and the second group with 5 patients without any nasal pathology (10 turbinates without any obvious pathology). In both groups, CT scans of the nasal region were performed. In the pathological group, CT was conducted as a part of the study of the nasal pathology, whereas in the group of healthy patients, CT scan of the head and neck was carried out due to other pathologies.

As regards the radiological protocol, CT scans of paranasal sinuses were performed continuously, from anterior to posterior, with 3-mm slices in the coronal plane. The anteroposterior length of the hypertrophic and control turbinates was determined.

Patients enrolled in the pathological group had nasal septal deviation with compensatory hypertrophy of the inferior turbinate in the contralateral nasal cavity, no other nasal deformity, and had not undergone any previous intranasal surgery. In the control group, the inclusion criteria were: straight septum, normal nasal endoscopic evaluation and no nasal pathology or anatomical deformity. Patients were excluded if they had any upper respiratory tract infection or sinusitis within the previous three months, an abnormal CT with mucosal thickening, sinus opacification, air fluid level, an S-shaped deviation of the nasal septum or any previous intranasal surgery. Later on, measurements of the thickness of the medial mucosa, bone, and lateral mucosa were taken separately in the anterior, middle, and posterior portions of the inferior turbinate at a perpendicular plane to the mucosal surface, in both the hypertrophic inferior turbinate group and the two control groups, with an aid of a cursor on the screen of the CT scanner. All images were also evaluated for a disease.

The statistical analysis was performed using SPSS 20.0 for Windows (SPSS Inc. Illinois, USA). Quantitative and qualitative variables in the study were expressed as mean ± standard deviation. A comparison of the patients with nasal septal deviation with compensatory hypertrophy of the inferior turbinate in the contralateral nasal cavity and the non-pathological inferior turbinate was carried out using the *t*-test for paired data. A probability value (*P* value) of less than 0.05 was accepted as significant.

RESULTS

Fifteen patients were included in the study. The mean age of the sample was 49.6 years (± 15.22; Min: 25/Max: 70); 8 patients (53.3%) were male and 7 (46.6%) females. There were no statistical differences in epidemiological parameters in this study.

After comparing the size of the turbinates in the group of patients with septal deviation (contralateral hypertrophied turbinate vs turbinate control on the side of the deviation) and control group (no intranasal pathology) vs the group of patients with septal deviation (contralateral hypertrophied turbinate), we obtained the results shown in Tables I-VI.

When analyzing both groups of patients with septal deviation; the contralateral hypertrophied turbinate and the non-hypertrophied turbinate side, we found a significant hypertrophy in the anterior portion of the inferior turbinate, at the level of the medial mucosa (P = 0.002) and bone (P = 0.001) in the group of patients with contralateral hypertrophied turbinate. In the intermediate portion, only the medial mucosa hypertrophy was significant (P = 0.017) and in the posterior portion, only the bone hypertrophy was significant (P = 0.048).

However, when we compared the contralateral hypertrophic turbinate with the turbinates of patients without septal deviation, we found a statistically significant difference in all volumes (anterior, middle, and posterior portions) of the medial and lateral mucosa and the bone portion (P = 0.001, P = 0.005).

DISCUSSION

Before performing turbinate surgery, we should take into account a number of anatomical, histological, and physiological considerations described by Berger et al. [12] in the normal inferior turbinate. The medial mucosal layer is the thickest layer and responsible for obstruction of the nasal airflow. At that level we found less glandular tissue and in most cases this

Table 1. Anterior dimension of the inferior turbinate in the nasal septal deviation group.

	Total width	Medial mucosa	Bone	Lateral mucosa
Anterior non-hypertrofic turbinate	7.57 mm ± 2.23 mm	3.45 mm ± 1.05 mm	1.62 mm ± 0.51mm	2.5 mm ± 0.67 mm
Anterior hypertrofic turbinate	10.57 mm ± 2.18 mm	5.16 mm ± 0.80 mm	2.44 mm ± 0.48 mm	2.97 mm ± 0.90 mm
Statistical analysis		*P*: 0.002	*P*: 0.001	*P*: 0.189

Table 2. Median dimension of the inferior turbinate in the nasal septal deviation group.

	Total width	Medial mucosa	Bone	Lateral mucosa
Median non-hypertrophic turbinate	7.30 mm ± 2.43 mm	2.97 mm ± 0.92 mm	1.89 mm ± 0.61 mm	2.44 mm ± 0.90 mm
Median hypertrophic turbinate	9.6 mm ± 2.36 mm	4.15 mm ± 1.20 mm	2.25 mm ± 0.39 mm	3.20 mm ± 0.77 mm
Statistical analysis		*P*: 0.017	*P*: 0.063	*P*: 0.061

Table 3. Posterior dimension of the inferior turbinate in the nasal septal deviation group.

	Total width	Medial mucosa	Bone	Lateral mucosa
Posterior non-hypertrophic turbinate	7.75 mm ± 2.77 mm	3.74 mm ± 1.26 mm	1.60 mm ± 0.43 mm	2.41 mm ± 1.08 mm
Posterior hypertrophic turbinate	8.82 mm ± 3.11 mm	3.86 mm ± 1.61 mm	2.13 mm ± 0.62 mm	2.83 mm ± 0.88 mm
Statistical analysis		*P*: 0.800	*P*: 0.048	*P*: 0.238

Table 4. Anterior dimension of the inferior hypertrofic turbinate in the nasal septal deviation group vs non-pathological group.

	Total width	Medial mucosa	Bone	Lateral mucosa
Anterior non-hypertrophic turbinate	6.04 mm ± 1.78 mm	2.6 mm ± 0.8 mm	1.57 mm ± 0.37 mm	1.87 mm ± 0.61 mm
Anterior hypertrophic turbinate	10.57 mm ± 2.18 mm	5.16 mm ± 0.80 mm	2.44 mm ± 0.48 mm	2.97 mm ± 0.90 mm
Statistical analysis		*P*: 0.001	*P*: 0.001	*P*: 0.001

Table 5. Median dimension of the inferior hypertrophic turbinate in the nasal septal deviation group vs non-pathological group.

	Total width	Medial mucosa	Bone	Lateral mucosa
Median non-hypertrophic turbinate	5.52 mm ± 2.22 mm	2.04 mm ± 1.02 mm	1.50 mm ± 0.67 mm	1.98 mm ± 0.53 mm
Median hypertrophic turbinate	9.6 mm ± 2.36 mm	4.15 mm ± 1.20 mm	2.25 mm ± 0.39 mm	3.20 mm ± 0.77 mm
Statistical analysis		*P*: 0.001	*P*: 0.001	*P*: 0.001

Table 6. Posterior dimension of the inferior hypertrofic turbinate in the nasal septal deviation group vs non-pathological group.

	Total width	Medial mucosa	Bone	Lateral mucosa
Posterior non-hypertrophic turbinate	4.82 mm ± 3.11 mm	1.90 mm ± 0.60 mm	1.70 mm ± 0.58 mm	1.22 mm ± 0.27 mm
Posterior hypertrophic turbinate	8.82 mm ± 3.11 mm	3.86 mm ± 1.61 mm	2.13 mm ± 0.62 mm	2.83 mm ± 0.88 mm
Statistical analysis		*P*: 0.001	*P*: 0.005	*P*: 0.001

is the main target of surgical reduction. The inferior mucosal layer should also be a suitable target of reduction, because excision of an area that is rich in venous sinusoids might avoid excessive congestion and obstruction, whereas excision of an area consisting of fewer glandular elements does not increase the probability of nasal dryness. Additionally, excision of an area lacking major arteries decreases the risk of postoperative hemorrhage. Meanwhile, the lateral mucosal layer is relatively narrow and rich in glandular elements and therefore should be spared during surgery. It adds little to nasal obstruction but has an important role in humidifying the inspired air and maintaining the normal function of the mucociliary clearance system. Furthermore, retaining the mayor part of the bone is recommended because it contains all main arteries and a possible risk of bleeding is thus avoided.

Starting from this functional concept, the results of this study led us to determine that in cases of contralateral turbinate hypertrophy in patients with unilateral septal deviation, there would be a volume increase that includes the mucosa of the medial and lateral face, and the turbinate bone, which remains in a relationship to the results described previously by Egeli *et al.* [12] and is consistent with the results obtained by Berger *et al.* [2]. In our study we decided to include a control group of patients without nasoseptal pathology in order to determine the volume of mucosa and bone of a normal turbinate. That idea followed from our failure to find a significant correlation between the volume of mucosa and turbinate bone between patients with unilateral septal deviation and compensatory hypertrophy, as described by Egeli et al. [12], with the exception of the measurements of the anterior portion of the turbinates in the group of patients with septal pathology, where we found a significant difference.

The study performed by Berger et al.[2] included 19 patients with deviated nasal septum and compensatory hypertrophy of the inferior turbinate in the contralateral nasal cavity who underwent surgery for the correction of nasal obstruction. The patients' specimens were compared with those from the control group consisting of 10 inferior turbinates removed at autopsy. Measurements of the inferior turbinate on histological sections were carried out and included the width of the layers and morphometric calculations of the relative proportions of the soft tissue constituents. It was reported that conchal bone hypertrophy increased twofold and was mainly responsible for inferior turbinate hypertrophy. On the other hand, the medial and lateral mucosal hypertrophy contributed to a limited degree, and thus was less important. The findings supported the decision to excise the inferior turbinate bone at the time of septoplasty. Those findings were correlated with the findings of our study. However, because the measurements of Berger et al. [2] were conducted postmortem, their preservation was difficult and determination of hypertrophy of the medial and lateral mucosa was limited.

We also consider that the bone diameters in these patients increase the most proportionally, which is in relation to the histopathological results described by Berger *et al.* [2].

It has been recommended that successful management of nasal obstruction in such patients requires reduction of the inferior turbinates at the time of septal surgery [7-15]. In this way, Hilberg *et al.* [10] in a non-randomized trial of inferior turbinoplasty and septoplasty versus septoplasty alone found that two-thirds of patients who underwent contralateral turbinoplasty plus septoplasty reported satisfaction with the patency of the nasal cavity with turbinate hypertrophy, whereas none of the patients who underwent septoplasty alone reported satisfaction with the patency of their nasal cavity.

As regards the decision on what to carry out at the time of surgery, our findings are similar to those by Berger *et al.* [2] who argued that mucosal hypertrophy plays a second fiddle to bone expansion, and it should not be expected that nasal breathing improvement will occur shortly after septal surgery without turbinate reduction. Relocation of the septum will actually aggravate obstruction on the non-deviated side of the nose. Moreover, the tendency of the turbinate to adopt and fit into the new spatial conditions created after septoplasty is associated with bone resorption, a process that probably requires many months or even years [1]. Thus, based on the findings of Berger *et al.*, Egeli *et al.* and ours, we recommend that turbinate reduction must be performed at the time of septoplasty, and include, at least, the bone of the inferior turbinate.

Passali *et al.* [16] reported long-term results in 382 patients randomly assigned to receive electrocautery (62), cryotherapy (58), laser cautery (54), submucosal resection without lateral displacement (69), submucosal resection with lateral displacement (94), and turbinectomy (45). Objective test results of rhinomanometry, acoustic rhinometry, mucociliary transport time, and secretory immunoglobulin indicated that submucosal resection with lateral displacement of the inferior turbinate results in the greatest increases in airflow and nasal respiratory function with the lowest risk of long-term complications. In conclusion they pointed out that submucosal resection of the inferior turbinate was the most convenient technique among the surgical techniques available when the physiology of the nose is concerned.

However, our study had certain limitations. First, our sample was limited. Moreover, there is a turbinate asymmetry related to the nasal cycle that must always be taken into account. Besides, the radiological data obtained from this study have not been contrasted with in vivo or post-mortem specimens yet, so probably further studies must be carried out in the future to corroborate the veracity of these.

CONCLUSION

This study aimed to compare the dimensions of the inferior turbinate with compensatory hypertrophy in patients with unilateral septal deviation and the size of a normal inferior turbinate in patients without nasoseptal pathology by CT. Our results are consistent with hypertrophy of the medial and lateral mucosa, and bone surface of the inferior turbinate. For this reason, we consider it necessary in patients with a contralateral compensatory hypertrophic turbinate, to perform a surgical correction of the nasal septum and lateralization or reduction of the volume of the inferior turbinate, which may include the medial mucosa, head or part of the bone, in order to improve the air passage into the nasal valve.

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