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Cytology of nasal mucosa, olfactometry and rhinomanometry in patients after CO_2 laser mucotomy in inferior turbinate hypertrophy

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Abstract: To evaluate the cytology of nasal mucosa and sense of smell and nasal patency in patients underwent carbon dioxide laser turbinoplasty (CO_2 laser mucotomy) due to chronic nasal hypertrophy. 46 patients with inferior turbinate hypertrophy underwent complete laryngological examination, anterior rhinomanometry, olfactory measurements and cytology of nasal mucous which were performed before and 3 months after CO_2 laser mucotomy. Laser mucotomy was performed under local anesthesia. Cytograms revealed significant changes in cell proportion before and after the surgery. Goblet cells predominated in nasal smears before the laser mucotomy. An average percentage of eosinophils in evaluated cytograms before the surgery was 2.1%. Three months after laser mucotomy we observed decrease in goblet cells proportion (the mean range of goblet cells was 16.4%) in nasal cytology. We have also observed improvement in olfactory function, however only in 7 patients (20.6%). The mean value of total nasal airway resistance (NAR) before treatment was 0.98±0.24 Pa/cm^3/s at 75 Pa. Rhinomanometry after 3 months showed a reduction in mean total resistance from the pretreatment level to 0.77 Pa/cm^3/s. We believe that CO_2 laser mucotomy is an efficacious, minimally invasive and easy to use treatment of inferior turbinate hypertrophy which is performed under local anesthesia with little discomfort for the patient and does not require hospitalization.

Key words: hypertrophy of inferior turbinate, CO_2 laser mucotomy, olfactory, rhinomanometry, cytograms

Introduction

Chronic nasal obstruction is often caused by enlargement of the inferior nasal turbinate. It is commonly associated with anatomical and pathological conditions such as hypertrophic inferior turbinates, deviated septum and allergy [1]. Obstruction of the air flow due to mucosal swelling of the inferior turbinates may affect patients throughout the day as well as during sleep, contribute to headaches, olfactory disturbances and sleep disorders such as snoring and obstructive sleep apnea. Other symptoms are: sneezing and rhinorrhoea [1,2]. All these symptoms significantly disturb daily life of patients.

The inferior nasal turbinates play an important role in protecting the pharynx and larynx from the effect of direct insult of airflow and have influence on entire lung resistance.

Current treatments for chronic irreversible turbinate enlargement range from various medical treatments. Antihistamines, topical and systemic steroids and allergen avoidance are often used. However when these treatments fail, surgery is advised. Among surgical procedures intending to increase nasal airway passage there are inferior turbinate mucotomy, conchoantropexy, submucosal diathermy [3]. These procedures seem to be traumatic and too invasive. They may lead to different side effects such as crusting, bleeding, breathing difficulties, recurrent infections, nasal odor, pain, secondary atrophic rhinitis and empty-nose syndrome [4]. Therefore there is a need for less traumatic but effective surgery. It is important to use the minimally invasive, safe and effective method

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for volume reduction of hypertrophied turbinate. Instead of conventional surgery of the turbinates, laser vaporization can be used [5].

Although the histopathological soft tissue changes in inferior turbinates with prior laser treatment [6], there are no reports focusing on cytological evaluation of inferior turbinate mucosa and olfactory assessment before and after the surgery. In order to evaluate the usefulness of laser mucotomy it is important to establish the cell reaction and sense of smell before and after the treatment.

The aim of the study was to evaluate the cytology of nasal mucosa and sense of smell and nasal patency in patients underwent carbon dioxide laser turbinoplasty (CO_2 laser mucotomy) due to chronic nasal hypertrophy.

Material and methods

Patients. Forty six patients with inferior turbinate were included in this study. Disease was suspected on the basis of a history of chronic nasal obstruction in all patients with or without sneezing, olfactory disturbance and rhinorrhoea. All patients were evaluated by otolaryngological examination with nasal and nasopharyngeal endoscopy using a flexible fibereoptic endoscope. Prior to CO_2 laser mucotomy, all patients underwent CT of nasal sinuses and allergy tests were performed. All patients had been previously unsuccessfully pharmacologically treated. Patients with chronic sinusitis and a deviated septum were excluded from the study. In this study group there were twenty one men and twenty five women ranging in age from 22 to 58 years (mean age 43.7 years). All patients had anterior rhinomanometry, olfactometric measurements using the method by Cain *et al*. and cytology of inferior turbinate mucosa [7]. All above procedures were performed before and 3 months after the surgical procedure. The study was proved by the Ethic Committee of Medical University and each patient signed the agreement to participate in the study.

Rhinomanometry. The nasal patency to airflow was estimated by means of active anterior rhinomanometry (Rhinomanometry 300, Atmos 300, GmbH, Germany) using standard technique. The air flows were measured through each nostril at transnasal air pressure differences of 75, 150 and 300 Pascals (Pa). The Flow Sum (FS, cm^3/sec) and the total resistance (TR, Pa/cm^3/sec) were calculated by adding the values of air flows through right and left nostrils in the computer program.

CO_2 laser mucotomy. All patients underwent CO_2 laser mucotomy under local anesthesia (1% lidocaine) with a microslad attached to a Sharplan 15 watts. The patients were in supine position with the head elevated to 30°C. The procedure was performed by vaporizing the anterior 2-3 cm of each inferior turbinate. The average time of procedure was few minutes. No antibiotics or other medications were used following surgery.

The evaluation of olfactory function. The evaluation of olfactory function was obtained on the basis on two test: 1. identification test 2 threshold olfactory test. The identification test consisted of recognition of seven the most common scents, *e.g.* coffee, chocolate, baby powder, cinnamon, vinegar, cyclohexanon and camphor. The seven point scale was used: 1 – the identification of coffee and chocolate sent; 2 – the identification of baby powder; 3 – the identification of vanilla; 4 – the identification of camphor; 5 – the identification of cinnamon; 6 – the identification of cyclohexanon; 7 – the identification of vinegar. The result of the correct recognized scents was enlisted. Threshold test employed aqueous dilutions of n-butyl-alcohol (1-butanol) in 12 plastic bottles from the lowest to the highest concentration, *e.g.* from 0.002% to 4%. The patients placed the spout into the specified nostril, then squeezed and sniffed simultaneously. Testing began with the lowest concentration. Four correct choices in row led to complete the testing and determine the olfactory threshold. Eight point scale was used for the assessment: 0 – the threshold for 4% n-butyl-alcohol; 1 – the threshold for 1.5% n-butyl-alcohol; 2 – the threshold for 0.5% n-butyl-alcohol; 3 – the threshold for 0.2% n-butyl-alcohol; 4 – the threshold for 0.1% n-butyl-alcohol; 5 – the threshold for 0.002% n-butyl-alcohol; 6 – the threshold for 0.001% n-butyl-alcohol; 7 – the threshold for 0.0002% n-butyl-alcohol. Normosmia was determined in composite score between values of dilution: 6.0-7.0, mild hyposmia: 5.0-5.75, moderate hyposmia: 4.0-4.75, severe hyposmia: 2.0-3.75, and anosmia: 0.0-1.75. The improvement of the olfactory threshold was considered as the higher result in composite score in comparison to the preintervention value.

Nasal mucosa cytology. Nasal mucosa was taken from the surface of mucous membrane of inferior turbinate by scraping with a cytology brush. It was transmitted on the slide and then was placed in 96% alcohol. The slide were stained with hematoxylin and eosin. The following step was the microscopic evaluation of percentage of epithelial cells, *e.g.* columnar cells, goblet cells and squamous cells as well as migrating cells (neutrophils and eosinophils).

Ethical issues. The study has been approved by the Local Bioethics Committee of Medical University of Bialystok no. R-I-003/341/2004. All patient gave an informed consent on participation in the study.

Statistical analysis. Paired t-test was used to determine the significantly received variables and the value of $p<0.05$ was considered statistically significant.

Results

Most patients from the study group experienced subjective improvement of their symptoms. No immediate major complications observed. Only in one case we have observed crusting and one patient complained of small bleeding 1 month after procedure. The present report will focus on histological findings of nasal mucosa, olfactory measurements and rhinomanometric results.

Nasal patency was improved after 3 months in 38 our patients (82%), who complained of disorder of air flow. It was objectively measured by anterior rhinomanometry. Comparing the average resistance in nasal cavity before and after turbinoplasty we obtained significant reduction of nasal resistance. The mean value of total nasal airway resistance (NAR) before the treatment was 0.98±0.24 Pa/cm^3/s (ranged from 0.27 to 1.9 Pa/cm^3/s) at 75 Pa pressure point. Rhinomanometry after 3 months showed a reduction in mean total resistance from the pretreatment level to 0.77 Pa/cm^3/s. In 8 patients we didn't observed the reduction of NAR.

The quantitative cell distribution of the nasal swabs varied to some obtained before intervention. The pretreatment and follow-up results are shown in Fig. 1 –

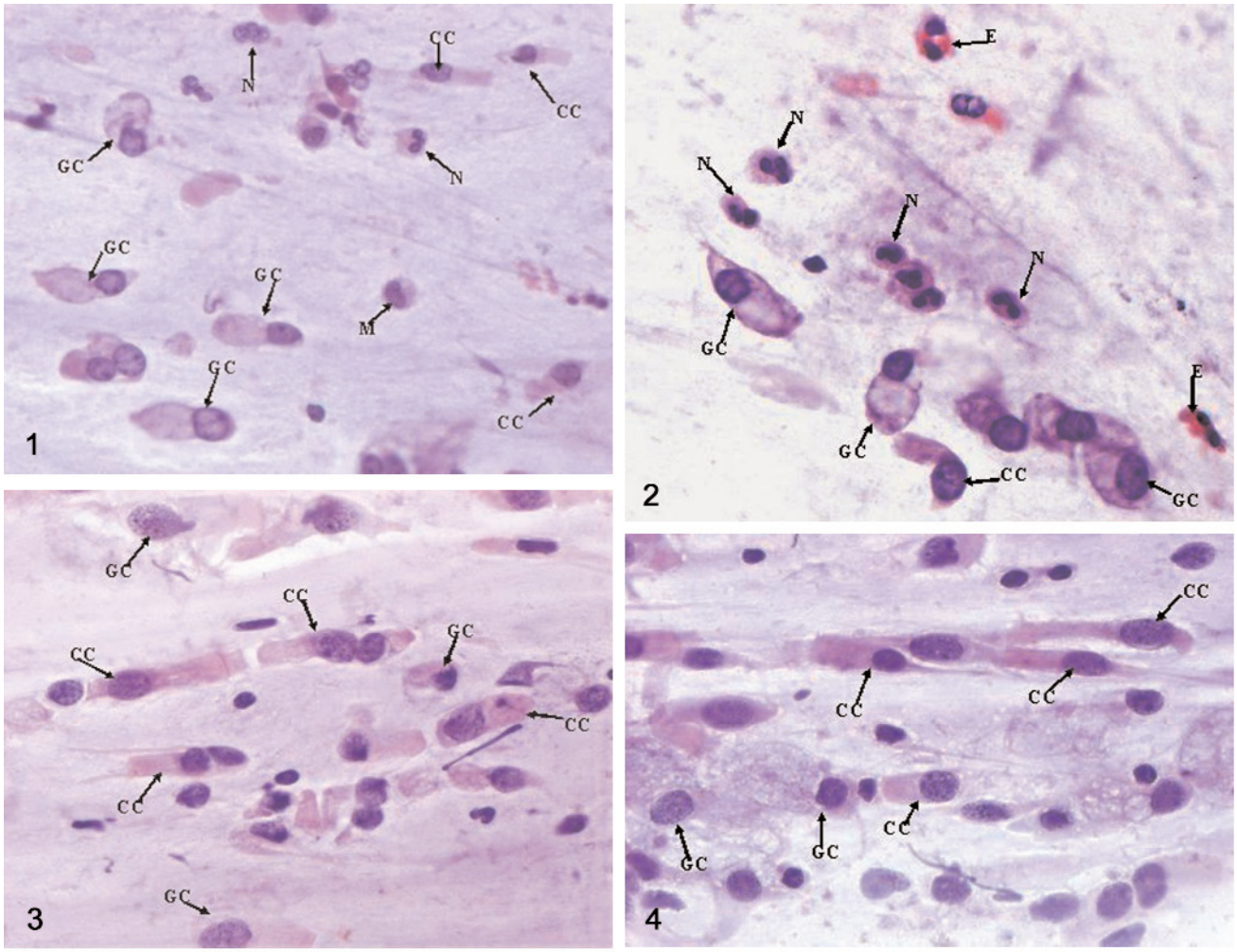

Fig. 1. The morphological picture of nasal mucous epithelial cells of patient before laser mucotomy. Numerous goblet cells (GC), neutrophilic granulocytes (N), monocytes (M) and columnar cells (CC) are visible (H+E, original magnification ×400). **Fig. 2.** Mucosal epithelial cells (mainly goblet cells (GC) and eosinophils (E) in the smear of patient before surgical procedure (H+E, original magnification ×400). **Fig. 3.** The smear of nasal mucous epithelial cells of patient after laser mucotomy. Some goblet cells (GC) and numerous columnar cells (CC) (H+E, original magnification ×400). **Fig. 4.** Mucosal epithelial cells (mainly columnar cells with cilia (CC) and singular goblet cells (GC) in the nasal of patients after the surgery (H+E, original magnification ×400).

4. The ratio between columnar and goblet cells deviated from the normal 1:5 in all patients before the treatment [8]. The percentage of goblet cells in nasal cytograms before the surgical intervention was significantly elevated (6% to 60% of all cells, the average was 46.7%). We determined 37% cytological pictures as secretory cytogram before the surgery (Fig. 1) [8]. The columnar cells had dense and irregular set of cilium changed before the laser mucotomy (Fig. 2). In most cases cytograms don't point out the allergic etiology both before and after mucotomy (very low proportion of eosinophils, average 2.1%). The ratio cylindrical/goblet cells changed after treatment significantly in 85% patients.

We observed significant decrease in goblet cells proportion in follow-up evaluation 3 months after laser mucotomy (the range of goblet cells was 3% to 28%, average 16.4%). The cylindric cells had regular, easy to recognize set of cilium after the surgery. The cylindric cells had regular, easy to recognize set of cilium after the surgery (Fig. 3, Fig. 4).

In 8 follow-up cytograms were noticed high percentage of neutrophils (30-65%).

The determination of percentage of cells in 4 microscopic assays was impossible because of insufficient amount of cells in mucus.

The olfactory assessment before the treatment according to composing score, normosmia was diagnosed in 12 patients (26%), mild and moderate hyposmia in 27 patients (59%), severe hyposmia in 5 patiens (11%), and anosmia in 2 patients (4%). The considerable change in sense of smell and lower olfactory threshold after intervention were observed in 7 cases (20.6%). In 1 case we observed the improvement of

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sense of smell (from anosmia before the surgery to severe hyposmia after the treatment). In one patient, who suffered from moderate hyposmia before the laser mucotomy, we obtained normosmia in our measurements. In 6 patients the improvement was noticed from severe and moderate hyposmia to mild hyposmia after laser mucotomy.

Discussion

Patients after conventional surgical turbinectomy usually emphasize the improvement in their nasal airway but may develop severe side effects, such as crusting and bleeding occasionally requiring blood transfusion. Various laser systems have been used for volume reduction of hypertrophied inferior nasal turbinate. Lippert and Werner evaluated the improvement in nasal patency and subjective symptoms in patients after CO_2 laser mucotomy. After one year 82.1% patients were satisfied with the admission procedure, after 2 years – 80.4% confirm satisfaction and after 5 years 77.1% of patients felt the improvement [9,10].

Some authors observed the adverse effects of this technique on mucociliary function, however it was effective in improving the nasal obstruction and subjective symptoms [11]. Nasal mucociliary function is an important defense mechanism that protects the respiratory system against some pathogenic factors. In our study the columnar cells had more regular set of cilium after surgery compared to smear before treatment.

Histopathological electron microscopy nasal mucosa analysis in patients with enlarged inferior turbinate reveal metaplasia of the nasal epithelium in the form of epithelial cell degeneration, loss of cilia and disruption of intercellular connections. The thickening of basilar membrane, edema, nasal mucus overproduction and inflammatory infiltration in lamina propria are also observed in the patients with chronic hypertrophic rhinitis [12,13]. Increased level of goblet cells may show the pathology and may be correlated with an nasal mucus overproduction [12]. Three months after laser mucotomy we observed the statistically decrease in goblet cells proportion. The ratio of cylindrical/goblet cells in our study changed significantly in 85% patients after the surgery. The use of laser mucotomy not only restore the nasal good breathing but also the cell proportion of nasal mucosa.

Based on nasal cytology we may diagnose chronic state of irritation and inflammation of the nasal mucosa. Glück *et al*. described chemical-induced rhinitis due to the exposure to diesel engine emission in nasal swabs with goblet cell hyperplasia, increased metaplastic and dysplastic epithelia and an increase in leukocytes [14].

The reduction of goblet cells and decrease in the number of glands were also observed as an effects of submucous diathermy of inferior turbinates in patients with chronic hypertrophic rhinitis [15]. However some authors, *e.g.* Gindros *et al*. based on the evaluation of nasal mucosa after submucosal monopolar diathermy, radiofrequency coblation and ultrasounds, have not confirmed the regeneration of cilia and restoration of normal structure of the epithelium [13].

The amount of evaporated mucosa and submucosa influences the volume reduction. Chronic rhinitis may impair the smell [16]. In patients with inferior turbinate hypertrophy the olfactory alteration seems to be caused by blockage of airflow to the olfactory receptors.

The modification of the intranasal volume may influence olfactory function [17,18]. The olfactory assessment before and after laser mucotomy did not show significant differences. The advantages of laser use in rhinology include good intraoperative visibility, high precision tissue removal and less tissue trauma resulting.

Short operation time, good postoperative results, and minor side effects compared to other surgical methods provide an excellent clinical response of the patients. In our study we didn't observed serious complications after laser method of turbinate volume reduction.

Conclusion

CO_2 laser mucotomy is an efficacious, minimally invasive and easy to use treatment of inferior turbinate hypertrophy, which can be performed under local anesthesia, with little discomfort for the patient and does not require hospitalization. It is an effective treatment for nasal obstruction and to restore more physiological cell proportion of nasal mucous.

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