BENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X.
Online ISSN 2357-0016

Original article

Microscopic Changes of Nasal Mucosa in Atrophic Rhinitis (Ozena) Before and After Nasal Closing Operation

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Received:
Accepted:

Abstract:

Background: Assess the return of nasal mucosa to the respiratory type epithelium after nasal closing procedure to assess its impact on nasal anatomy and physiology. **Patients and methods:** This prospective randomized study was conducted in the Otorhinolaryngology and Histopathology Department of Benha University Hospital over a three-year period, from 2019 to 2022. The study cohort consisted of 36 cases of primary Atrophic Rhinitis, following approval from the research ethics committee, approved under the code number RC1-1-2025, and after obtaining informed consent from the patients. **Results:** Total number of 36, patients, with male percentage 10 (27.7%) and female percentage 26 (72.3%). Rural: urban residence ratio 3.2 :1 and the main histopathological pictures in patients preoperative, postoperative and 6 months postoperative seen in the study are shown in table 4. **Conclusion:** After the nasal obstruction of patients with atrophic rhinitis, the affected pseudostratified columnar epithelium of the atrophic nose advances to metaplasia. Transforming into stratified squamous epithelium with or without slight keratinization. Submucosal fibrosis escalates alongside glandular structures in addition to vasodilation. These alterations may account for the relief of symptoms like crusting, infections, and unpleasant smells. Nonetheless, even with symptom relief, the nasal mucosa does not revert to its normal state.
Keyword: Atrophic rhinitis; Ozena; Respiratory epithelium.

Introduction

Atrophic rhinitis is a crippling, long-term nasal condition. It can be secondary (Empty nose syndrome) or main (Ozena). Their etiology is the only distinction between the two groups. It was believed that the abrupt onset, slow progression, and unclear cause were characteristics of primary atrophic rhinitis. While secondary atrophic rhinosinusitis is identified following surgeries, granulomas, or radiation therapy, primary atrophic rhinosinusitis results in a progressive loss of the nasal mucosa and underlying bone in the turbinates. Usually, the turbinates bones and submucosal tissues are not impacted until the disease is advanced. Secondary atrophic rhinosinusitis is often linked to atopy [(1)].

Several characteristics were assumed to be shared by both kinds, including nasal crusting, expanded nasal cavities, mucosal atrophy, and paradoxical nasal congestion. Histopathologic findings in patients with atrophic rhinosinusitis revealed the followings histopathological findings, Degeneration of serous and mucinous glands, reduction in cilia and goblet cells, presence of non-specific inflammatory cell infiltration, and obliterative endarteritis [(2)].

Radiological assessments of individuals with atrophic rhinitis reveal several key observations: thickening of the mucosa in the paranasal sinuses, diminished clarity of the osteomeatal complex due to the degradation of the ethmoid bulla and uncinate process, underdevelopment of the maxillary sinus, expansion of the nasal cavities accompanied by damage to the lateral nasal wall, and bony erosion of the inferior and middle turbinates [(3)].

Austen Young first described atrophic rhinitis in 1967, and Young's technique is a surgical treatment for the condition. The surgical technique uses mucocutaneous flaps to close the nasal cavity that has been harmed by atrophic rhinitis. Both the skin and mucosal layers of the flaps are sutured together. A revision operation is performed and the nasal cavity is reopened after the nasal cavity has been closed for six months and examined to see if the crusts have disappeared. This treatment is predicated on the idea that the nasal passage being closed gives the body time to repair [(4)].

The outcome in the first patient who underwent Young's procedure for atrophic rhinitis faced social isolation due to a strong stench. Both nostrils were originally blocked and eventually reopened. Despite having no sense of smell and impaired taste (unable to taste spices/herbs), the patient has not experienced any issues since then [(5)].

The Modified Young's operation is a relatively unknown procedure in rhinology. It aims to enhance nasal cavity and airflow abnormalities. During the procedure, septoplasty is performed. This guarantees that the nasal septum moves to the left side while also reducing the airway diameter of the left nasal cavity. Right turbinate radiofrequency reduction .The left nasal cavity's airway resistance is enhanced by a modified version of Young's procedure [(6)].

We aimed in this study to assess the return of nasal mucosa to the respiratory type epithelium after nasal closing operation to assess its impact on nasal anatomy and physiology.

Patients and methods:

This prospective cohort study (2022–2025) was conducted in the Otorhinolaryngology and Histopathology Departments of Benha University Hospital, following approval by the Research Ethics Committee (RC1-1-2025). Thirty-six patients with primary atrophic rhinitis were enrolled after providing written informed consent

Inclusion criteria:

1. Patients with primary atrophic rhinitis with symptoms of at least 6 months
2. No prior nasal or paranasal surgery performed.

Exclusion criteria

1. Patients did not have any systemic

disease such as diabetes, nasal granulomas…etc.

2. The patients are free from any nasal tumors, irradiation therapy and trauma for the nasal area.

All participants underwent:

- Full clinical examination.
- CT scan for the nose and paranasal sinuses.
- Biopsy samples were collected from the nasal cavity, specifically from the undersurface of the middle third of the inferior turbinate, utilizing a 0° rigid nasal endoscope.

Sections were prepared through standard paraffin processing, followed by staining with Hematoxylin and Eosin. These sections were then analyzed under a light microscope to identify any histopathological alterations. Nasal closure is done by circular incision at the lower edge of the lower lateral nasal crus laterally and superiorly. Mucocutaneous junction of the septum medially and the floor of the vestibule inferiorly. Dissection is done from behind forward. The edge of the flap is sutured at the middle taking 2 stitches by 3 zero proline. After 10–12 months, recanalization was performed via; Y-shaped incision at the closed skin. Three flaps are stitched to the vestibule laterally and superiorly and the caudal septal ends medially, another biopsy was taken from the reopened nostril. Post recanalization follow up was done for 6 months postoperative and a third biopsy was taken**.**

Statistical analysis:

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 28 (IBM, Armonk, New York, United States). The Z-score measures how far a data point is from the mean, with positive values indicating above-average measurements and negative values indicating below-average measurements. A Z-score closer to zero suggests the measurement is near the mean. In this study, 95% confidence intervals were used, reflecting the range within which the true mean is expected to lie, based on the central limit theorem. Hypothesis testing relied on Z-values and p-values, where *$p > 0.05$ indicated no statistically significant differences between groups.*

Figure (1): shows radiological findings for atrophic rhinitis patients.

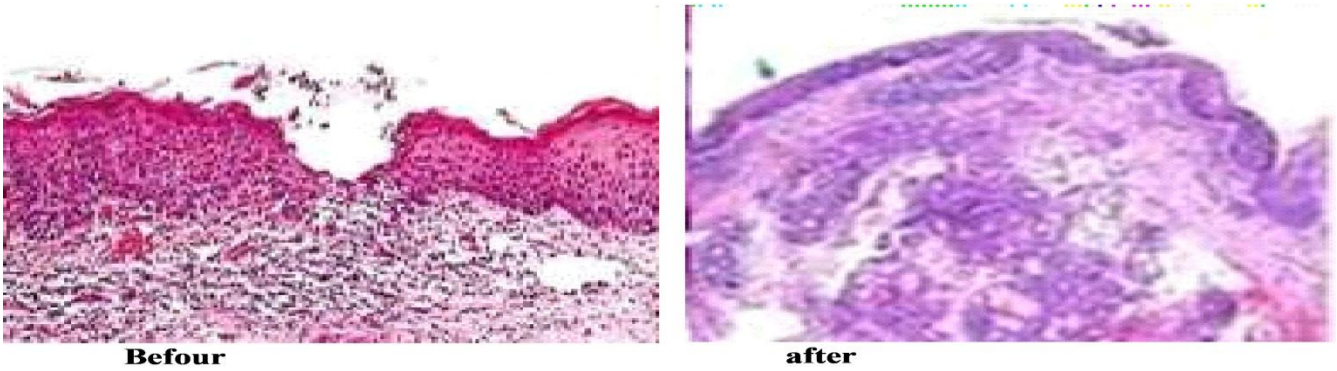

Figure (2) shows examples of atrophic rhinitis mucosa Before nasal closing operation and After nasal closing operation

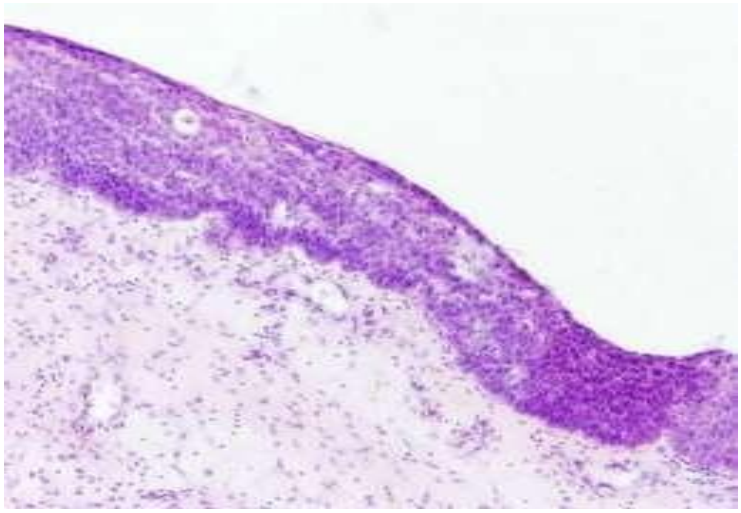

Figure (3) shows examples of postoperative squamous metaplasia

Result:

Table (1): Shows age distribution for 36 patients.

Mean age	Maximum incidence	Range of age
22years old	Between 18 and 35 years old	11 to 45years old

The table displays the age distribution of 36 patients, with a mean age of 22 years, most cases occurring between 18–35 years, and an age range of 11–45 years. **Table 1**

Table (2): shows gender distribution for patients

Number of patients	Male percentage	Female percentage
36	10 (27.7%)	26 72.2)

The table shows the gender distribution of 36 patients, with 27.7% males (10 patients) and 72.2% females (26 patients). **Table, 2 and figure 1**

Table (3) shows socioeconomic class distribution for patients.

Number of patients	Rural to urban ratio	socioeconomic class percentage	
36	3.2: 1	Low 25 (69.6%)	Medium 11(30.5%)

Table (4) shows the main histopathological pictures in patients preoperatively, postoperatively and 6 months postoperatively seen in the study.

Histopathologic al picture	Number of cases and (%) preoperatively	Number of cases and (%) postoperatively	Number of cases and (%) 6 months postoperatively
Partial squamous metaplasia	17 (47.2 %)	12 (33.33%)	7 (19.4%)
Total squamous metaplasia	-	18 (50.0%)	21 (58.3%)
Denuded epithelium	19 (52.7 %)	6 (16.6%)	-
Total squamous Metaplasia with keratinization	-	-	8 (22.2%)
Basement membrane			
Thickened	23 (63.8%)	-	20 (55.5%)
Ill-defined	13 (36.1%)	22 (61.1%)	11 (30.5%)
Normal	-	14 (38.8%)	05 (13.8%)
Tunica propria			
Granulation tissue	14 (38.8%)	13 (36.1%)	-
Chronic inflammatory cellular infiltrate	15 (43.33%)	17 (47.2%)	-
Fibrosis	7 (16.66%)	02 (5.5%)	26 (72.2%)
Granulation tissue with fibrosis	-	04 (6.6%)	05 (13.8%)
Chronic inflammatory Cellular infiltration with fibrosis	-	-	05 (13.8%)
Mucous glands			
Absence of glands	12 (33.33%)	-	14 (38.8%)
Reduction in size and Number of glands	18 (50.0%)	26 (72.2%)	20 (55.5%)
Normal glands	6 (16.66%)-	10 (27.7%)	2 (5.55%)
Blood Vessels			
Reduced vascularity	16 (44.4%)	24 (66.6%)	10(27.7(%)
Endarteritis	13 (36.1%)	3 (8.3%)	1 (2.7%)
Periarteritis	07 19.4%)	3 (8.3%)	03 (8.3%)
Dilated blood vessels	-	6 (16.66%)	22 (61.1%)

The mean duration of symptoms was 3 years (range from 2 years to 11 years). The most frequently encountered symptoms included bilaterally were nasal crusting, fetor nasal obstruction anosmia and epistaxis.

Common findings observed during rhinoscopy included malodorous crusting, varying levels of atrophy in the nasal mucosa and turbinates, as well as enlarged

nasal cavities. The primary imaging characteristics identified in the study consisted of enlarged nasal cavities, atrophy of the nasal turbinates along with their mucosal covering, and underdeveloped maxillary sinuses. **Table, 3 and figure 2**

The table highlights histopathological changes in patients preoperatively, postoperatively, and 6 months postoperatively. Key findings include a reduction in partial squamous metaplasia (47.2% to 19.4%), an increase in total squamous metaplasia (50% to 58.3%), and significant fibrosis development (72.2% at 6 months). Vascular changes, such as reduced vascularity and dilated blood vessels, were also observed. **Table, 4 and figure 3**

Discussion

The nasal mucosa comprises three layers, starting with the basal membrane epithelium, which acts as a barrier between it and the tunica propria, or stroma. The epithelial layer of the nasal cavity consists of ciliated pseudostratified columnar epithelium, which includes goblet cells connected by desmosomes. The stroma is divided into three sublayers: the superficial lymphoid layer, followed by a glandular layer containing seromucinous glands, and a venous pseudo cavernous layer that is closely associated with the periosteum and perichondrium. Atrophic rhinitis impacts all layers of the nasal mucosa, presenting with varying degrees of severity. The alterations range from minor changes in the pseudostratified columnar epithelium to metaplasia, where the respiratory epithelium transforms into stratified squamous epithelium with keratinization and a reduction in goblet cell numbers. When present, the basement membrane appears to be thin. Changes within the stroma include serous and mucinous glands that appear normal, alongside the infiltration of inflammatory cells in the lymphoid area just beneath the epithelial layer. Furthermore, observations noted periarteritis and endarteritis affecting terminal arterioles, inflammatory cell infiltration, and hypertrophy of the basement membrane [(7)].

Starting with a squamous epithelium in the vestibule, the nasal mucosa gradually changes to a pseudostratified columnar epithelium with many ciliated cells at the rear. According to Garcia et al., the ciliary action on the posterior lining mucosa caused the water and airflow in the front part to be more significant than in the rear. As a result, mucus evaporation occurs in cases of atrophic rhinitis when air and water flow increase in the rear part of the nasal canal. It is believed that the drying effect of airflow causes the respiratory mucosa to metaplasia to the squamous form. The weakening of the underlying bone is also explained by the capillary endothelial layer of Atrophic Rhinitis tissue that had more cytoplasm than normal and showed a strong reactivity with alkaline phosphatase [(8)].

Prior studies have examined the histological changes, as described by Sampson et al., who reported that 89% of patients had squamous metaplasia and 67% and 33% of patients, respectively, had type I and type II vascular involvement. Despite the presence of squamous metaplasia, this first report shows no connection between atrophic rhinitis and precancerous nasal cavity lesions. It also confirms the presence of two different types of vascular alterations in the disease, which helps determine the best course of treatment. Vascularity was divided into two categories: type 1, which responds to estrogen therapy, and type 2, which does not [(9)].

Light microscopy examination of the primary atrophic epithelium demonstrated the presence of characteristic nonkeratinized stratified squamous epithelium, which transitions into keratinized squamous epithelium featuring a delicate keratin layer on the

surface, according to another study examining light and electron microscopy of the nasal mucosa. Between the epithelial cells were well-formed desmosomes. There were no submucosal glands seen in the lamina propria. Its electron microscopy revealed that the epithelium's stratification was improved. In some regions of the growing epithelium, sloughing of the surface cells was seen. It was shown that neutrophils (mostly) and lymphocytes (to a lesser amount) infiltrated the epithelium. In these cases, no many multilamellar bodies (MLBs) were seen. The basement membrane was found to include more collagenous fibers **(10).**

By comparing the microscopic findings in Table 4, we may determine that the nasal mucosa undergoes squamous metaplasia following nasal closure, with a decrease in inflammatory cells and an increase in tunica propria fibrosis. However, both the mucous glands and the basement membrane have partially returned to nearly normal. When it comes to blood vessels, vascularity decreases in conjunction with blood vessel infection, although dilated blood vessels rise **(11).**

Reviewing the relevant literature, this is the initial study addressing the alterations in the nasal mucosa of atrophic rhinitis following the obstruction of the nasal passage. Squamous metaplasia is regarded as a compensatory alteration because squamous epithelium demonstrates greater resistance to damage compared to other epithelial varieties.

Conclusion

After the nasal obstruction of patients with atrophic rhinitis, the affected pseudostratified columnar epithelium of the atrophic nose advances to metaplasia. Transforming into stratified squamous epithelium with or without slight keratinization. Submucosal fibrosis escalates alongside glandular structures in addition to vasodilation. These alterations may account for the relief of symptoms like crusting, infections, and unpleasant smells. Nonetheless, even with symptom relief, the nasal mucosa does not revert to its normal state.

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To cite this article: Ahmed M. El-Hewity, Hany A Riad. Microscopic Changes of Nasal Mucosa in Atrophic Rhinitis (Ozena) Before and After Nasal Closing Operation. BMFJ XXX, DOI: 10.21608/bmfj.2025.369868.2349.