

ORIGINAL ARTICLE

Effect of resection of the posterior nasal nerve on functional and morphological changes in the inferior turbinate mucosa

KATSUHISA IKEDA, HIDENORI YOKOI, TATSUYA SAITO, KENJI KAWANO,
TORU YAO & MASAYUKI FURUKAWA

Department of Otorhinolaryngology, Juntendo University School of Medicine, Tokyo, Japan

Abstract

Conclusions. The underlying pathophysiological mechanisms of the posterior nasal nerve (PNN) resection involved the suppression of the secretagogue motor and the inhibition of neurogenic inflammation induced by parasympathetic and sensory denervation. **Objective.** The study was designed to clarify the underlying mechanisms of the resection of the PNN. **Patients and methods.** Ten patients with allergic rhinitis and non-allergic chronic rhinitis were enrolled in the study. Clinical symptoms were evaluated before and after administration of oxitropium bromide aerosol, and after the PNN resection. Biopsy specimens from the inferior turbinate mucosa obtained from five patients before and after resection of the PNN were examined. **Results.** The application of oxitropium bromide resulted in a significant reduction of both watery rhinorrhea and nasal obstruction, but not sneezing or postnasal drip. Resection of the PNN also significantly improved both rhinorrhea and nasal obstruction. Morphometric analysis of the density of the nasal gland showed a significant reduction, whereas no significant change was recognized in the density of the vessels. A significant reduction in the number of infiltrating neutrophils, eosinophils, and lymphocytes was recognized.

Keywords: *Posterior nasal nerve, oxitropium bromide, nasal acinar gland cell, vessel, neutrophil, eosinophil, lymphocyte*

Introduction

In an earlier study we reported the clinical effectiveness of the modified vidian neurectomy, resection of the posterior nasal nerve (PNN), with minimal side effects [1]. Although major symptomatic improvements were shown in watery rhinorrhea and sneezing, the pathophysiological mechanisms are still unknown.

In the present study, we aimed to carry out morphometric analysis of the nasal mucosa as well as anticholinergic effect to clarify the inhibition of hypersecretion of rhinorrhea and allergic inflammation. Resection of the PNN reflects the physiological **elimination of the parasympathetic innervation** to the inferior turbinate, which can be **mimicked by the topical administration of anticholinergic medication**. To evaluate resection of the PNN based on the clinical symptoms, clinical effectiveness of topical application of anticholinergic drug was compared with that of the PNN resection.

Patients and methods

Ten patients (seven males and three females; mean age 33 years, range 19–38) were enrolled in the study. They included five patients with perennial allergic rhinitis; two with seasonal allergic rhinitis with multiple pollen antigens such as Japanese cedar, and grass and weed pollen antigens; and three with vasomotor rhinitis. The clinical diagnosis was based on clinical history, clinical examination, amounts of serum IgE and specific IgE, numbers of serum eosinophils, and smear cytology. Oxitropium bromide aerosol was administered to the nasal cavity four times a day for 2 weeks. A visual analog scale (VAS) was used to evaluate clinical symptoms such as sneezing, rhinorrhea, nasal obstruction, and postnasal drip before and after medication. These patients underwent resection of PNN together with partial septoplasty at least 8 weeks after discontinuation of oxitropium bromide aerosol application, and the same questionnaire on clinical improvement was

given. The collected septal cartilaginous fragment was used to cover the resected surface of the PNN. No inferior turbinate surgery was performed. The patients with seasonal allergic rhinitis underwent surgery outside the allergy season.

Transnasal biopsy specimens (2–3 mm) from the inferior turbinate mucosa were obtained from five patients with perennial allergic rhinitis before and after resection of the PNN. Preoperative biopsy was carried out more than 8 weeks after cessation of oxitropium bromide aerosol application, which is thought to be long enough to wash out the drug from the tissue and eliminate the effect of the drug. Postoperative biopsy was performed 12–16 weeks after surgery. For morphometric analysis, each specimen was stained with the hematoxylin and eosin (H&E) and observed at $\times 200$ magnification. The nasal acinar gland cells and vessels in the five fields were counted. Inflammatory cells such as lympho-

cytes, eosinophils, and neutrophils in the five fields were also counted. VAS evaluated before and after the treatment with oxitropium bromide, and after resection of the PNN was compared by paired t test, and a p value <0.05 was regarded as statistically significant.

Results

Figure 1 shows the scatter plots for individual patients before and after medication and post-surgery. Two patients did not undergo the PNN operation due to the poor effect of administration of oxitropium bromide aerosol on the nasal symptoms. The application of oxitropium bromide resulted in a significant reduction of both watery rhinorrhea and nasal obstruction, but not sneezing or postnasal drip. Resection of the PNN also significantly improved both rhinorrhea and nasal

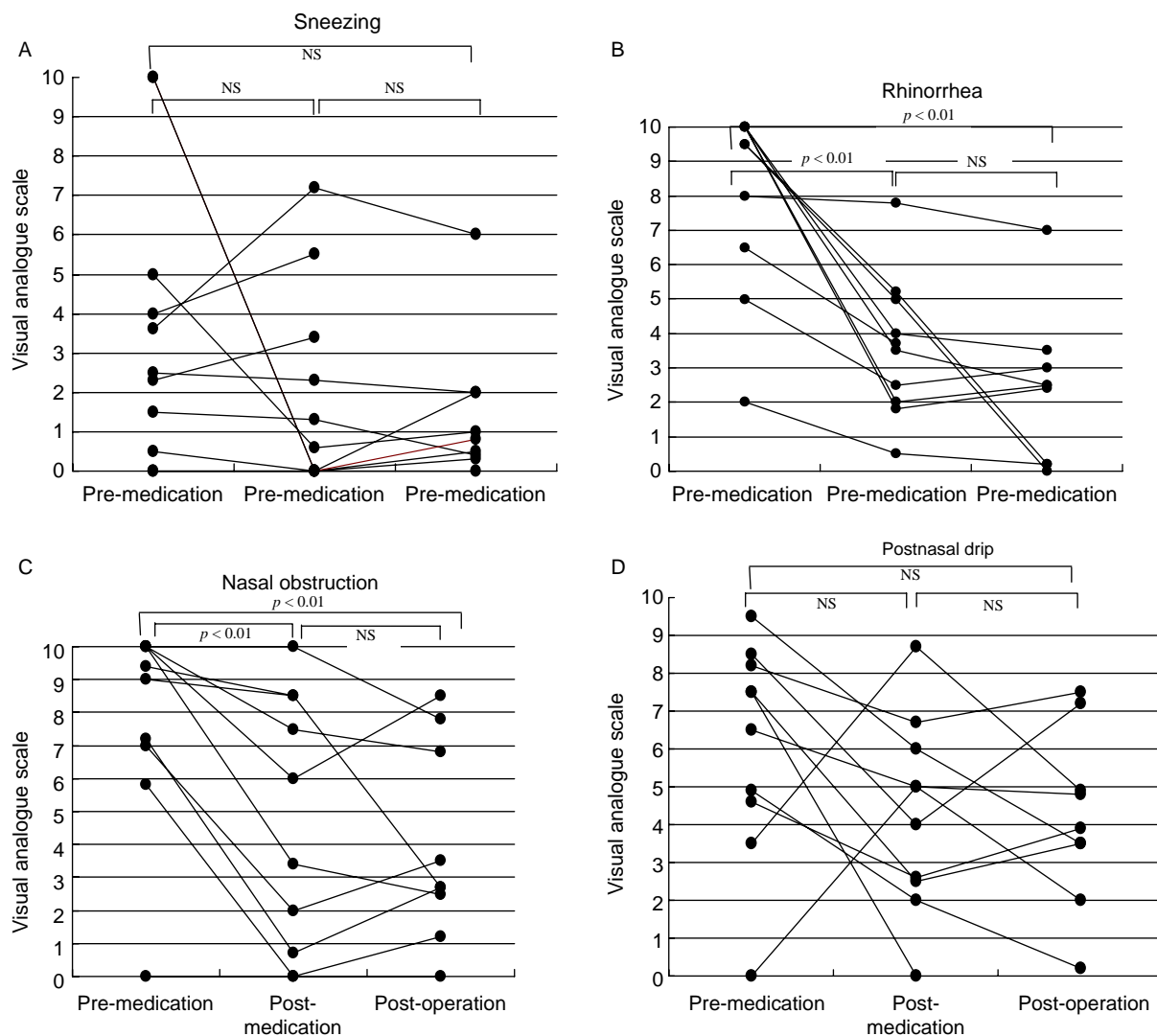


Figure 1. Scatter plots for individual patients before and after medication and after the posterior nasal nerve resection. (A) Sneezing, (B) rhinorrhea, (C) nasal obstruction, (D) postnasal drip.

obstruction. Furthermore, the effect of surgery on rhinorrhea resembled that of oxitropium bromide, suggesting that the pharmacological effect of resection of the PNN can be explained by inhibition of the parasympathetic nerve. Improvement of nasal obstruction may be mediated by a secondary effect of the decreased nasal secretion.

Next, morphological analysis of the inferior turbinate mucosa before and after resection of the PNN was performed (Figure 2). There was an apparent decrease in nasal gland acinar cells after surgery, but the vascular structure of the mucosa seemed to be unchanged. Morphometric analysis of the density of the nasal gland showed a significant reduction, whereas no significant change was recognized in the density of the vessels (Figure 3A, B). These findings suggest that resection of the PNN results in a decrease in nasal secretion but does not affect the congestion of the nasal mucosa. The infiltration of inflammatory cells in the nasal mucosa was also observed before and after operation. A significant reduction in the number of infiltrating neutrophils, eosinophils, and lymphocytes was recognized (Figure 3C, D, E).

Discussion

Our clinical experience revealed that the PNN resection improved watery rhinorrhea and sneezing [1], similar to vidian neurectomy [2,3]; however, the

underlying mechanisms had not yet been evaluated. The present study clearly demonstrated that the effect of an anticholinergic drug on nasal symptoms resembled that of PNN resection in patients with allergic rhinitis and idiopathic rhinitis, indicating that the pathophysiological mechanism for the PNN resection is related to parasympathetic neural systems.

Another series of experiments also demonstrated that the glandular acinar cells were significantly reduced after the PNN resection, which suggests degeneration or atrophy by parasympathetic denervation. The reduction in glandular cells may be explained by decreased secretion of the nerve growth factor [4] or epidermal growth factor [5] regulated by acetylcholine, a major neurotransmitter of parasympathetic systems. On the other hand, no change in vascular structures implies that the vascular proliferation cannot be regulated by neural interaction.

The third series of experiments aimed to examine the infiltration of inflammatory cells into the nasal mucosa. A significant reduction in the major components of inflammatory cells such as lymphocytes, eosinophils, and neutrophils was observed. In the present study, immunohistochemical staining of the cell marker of mast cells was not performed as the materials were formalin-fixed. However, dynamic changes of the other cells strongly suggest the reduction in mast cell infiltration. The reduction

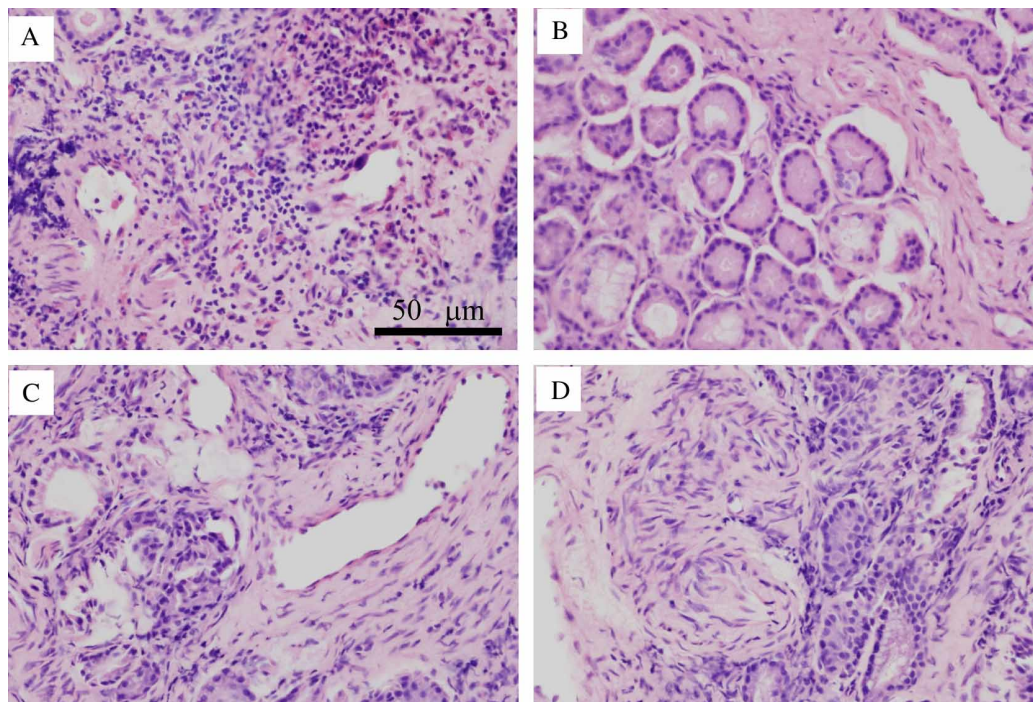


Figure 2. Histology of the inferior turbinate mucosa before and after the the posterior nasal nerve resection. Infiltration of inflammatory cells before surgery (A) is reduced after surgery (C). The extent of nasal gland cells before surgery (B) is also decreased after surgery (D), whereas the density of the vessels seems to be unchanged.

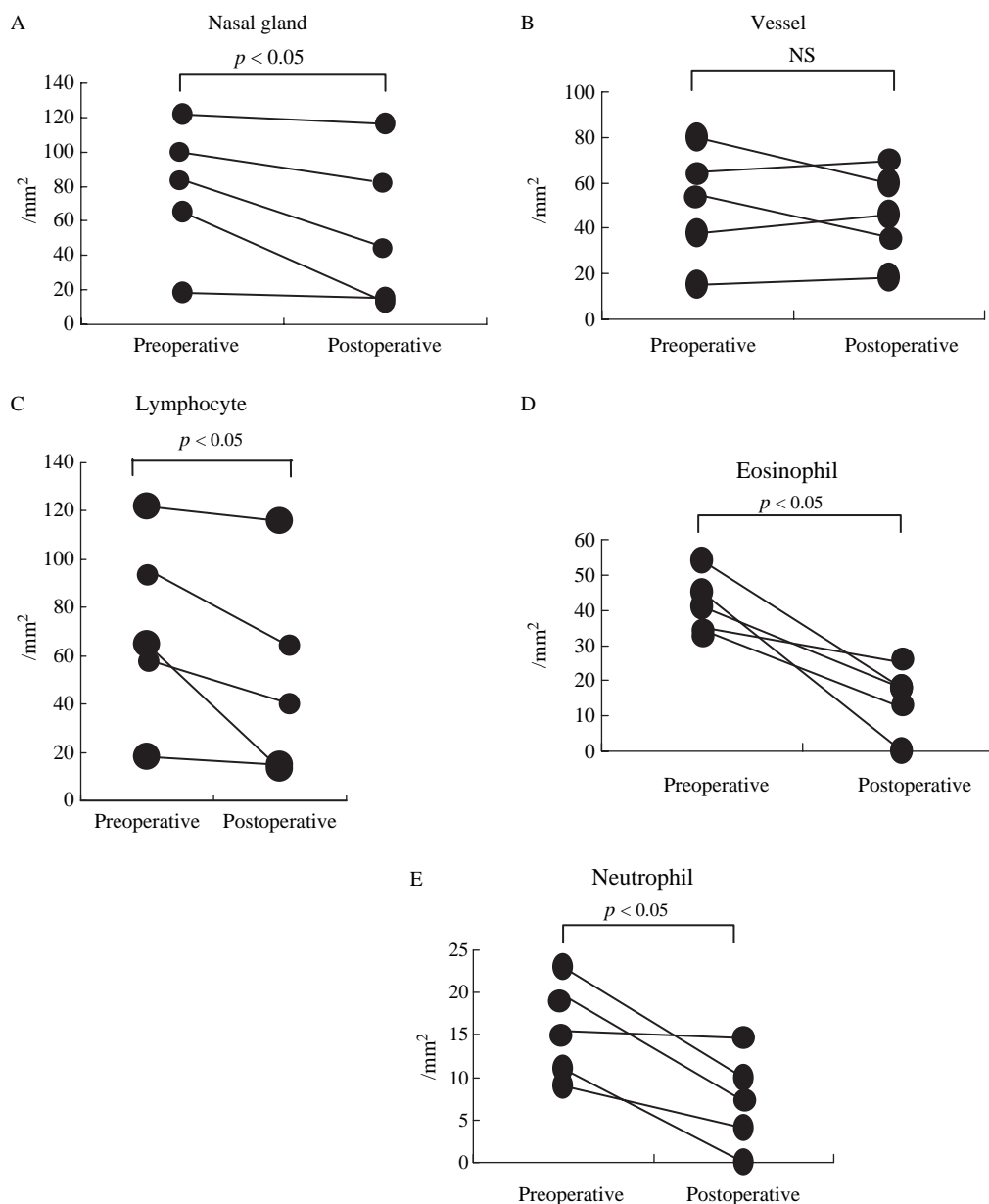


Figure 3. Morphometric analysis of the density of the nasal gland and the vessels, and the infiltration of inflammatory cells. A significant reduction of the density is observed in the nasal gland (A), but not in the vessels (B). There was significantly less infiltration by all the inflammatory cells, such as lymphocytes (C), eosinophils (D), and neutrophils (E), after surgery.

of inflammatory cells may be explained by inhibition of nerve activities via neurogenic inflammation [6–10]. In both allergic and idiopathic rhinitis, pathophysiologic features such as fluid secretion mediated by orothodromic reflex involving efferent nerve – predominantly parasympathetic – and release of neurotransmitters and neuropeptides from the sensory neurons via antidromic reflex is characterized by interaction of nerve activities with inflammatory cells [11].

Chronic inflammatory rhinitis is known to involve both antigenic and neurogenic factors [12]. A pivotal characteristic in the pathophysiologic concept of

inflammation would be mediated by the inhibition by denervation of parasympathetic and sensory nervous systems, leading to suppression of an influx of inflammatory cells [13,14]. The change in neuropeptide-containing sensory fibers after the PNN resection is also interesting, since the local release of neuropeptides is suggested to be increased during the allergy season [11,15,16].

In conclusion, the present study is the first to demonstrate that the underlying pathophysiological mechanisms of the PNN resection, a modification of vidian neurectomy, involved suppression of the secretagogue motor and the inhibition of neurogenic

inflammation induced by parasympathetic and sensory denervation.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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