RESEARCH ARTICLE

Comparative Study of Nasal MCC in Post-FESS and Healthy Individuals Using Saccharin Test

Ramya Subramanian[1], Vivek Narayan[2], Gowri Shankar[3]

Received on: 19 June 2023; *Accepted on:* 07 February 2025; *Published on:* 20 February 2025

Abstract

Aims and objective: To demonstrate the ciliary function in postendoscopic sinus surgery patients clinically and compare with that of normal individuals using Saccharin test.

Materials and methods: It is a comparative study between the mucociliary clearance (MCC) of healthy individuals and post-endoscopic sinus surgery individuals. The study group people who fit in the inclusion and exclusion criteria are divided into two groups A and B. Group A candidates are healthy adult individuals while group B candidates are post-surgical patients. With the help of 0-degree nasal endoscope a crystal of Saccharin is placed on the floor of the left nasal cavity at the level of the anterior end of the inferior turbinate. The time taken for the perception of the taste of the Saccharin is noted and results are analyzed.

Results: Endoscopic sinus surgery has not reduced the mucociliary clearance mechanism in our study group patients as the time taken by the group B candidates for perception of the taste of Saccharin matches with that of the group A candidates.

Keywords: Endoscopic sinus surgery, Mucociliary clearance, Saccharin test, Sinusitis.

Clinical Rhinology (2024): 10.5005/jp-journals-10013-1410

Introduction

Mucociliary function is one of the major defense mechanisms of the nose and paranasal sinuses. The best air conditioner in nature is the mucociliary system, which shields the upper and lower airways. The four primary cell types that make up the columnar epithelium are basal cells (20%), goblet cells (20%), and ciliated and non-ciliated columnar cells (80%). There are between 50 and 200 cilia in each ciliated cell, and each cilium is made up of a 9-plus-2 microtubular structure joined by dynein arms. Mucociliary transport happens at a rate of 1 cm/minute, and the average ciliary beat frequency is between 700 and 800 beats per minute.

Aims and Objective

This prospective study was to demonstrate the mucociliary activity after functional endoscopic sinus surgery and compare it with normal individuals.

Inclusion criteria include age above 15–50 years, both male and female and candidates with normal taste sensation, people who underwent functional endoscopic sinus surgery (FESS), non-smokers, no h/o of upper respiratory tract infection at present and people who gave consent for study.

Exclusion criteria include age less than 10 years and more than 60 years, candidates with loss of taste and smell sensation, candidates having diabetes mellitus, systemic hypertension, cystic fibrosis, cilia dysfunction, with a history of aspirin sensitivity, asthma, and patients unwilling for study.

Materials and Methods

Study design: A Prospective Study

Study duration: 6 months.

Study Participants:

In group A, 40 healthy volunteers (25 male,15 female) were included.

[1–3]Department of ENT and Head and Neck Surgery, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India

Corresponding Author: Gowri Shankar, Department of ENT and Head and Neck Surgery, Government Stanley Medical College and Hospital, Chennai, Tamil Nadu, India, Phone: +91 9789980453, e-mail: Gowrishankarmurari@rediffmail.com

How to cite this article: Subramanian R, Narayan V, Shankar G. Comparative Study of Nasal MCC in Post-FESS and Healthy Individuals Using Saccharin Test. Clin Rhinol 2024;15(2):54–57.

Source of support: Nil

Conflict of interest: None

In group B candidates who underwent functional endoscopic sinus surgery were selected and divided into three groups B1, B2, and B3.

About 30 post-FEES patients were in the immediate post-op period (2 weeks), 20 post-FESS patients were in the Intermediate post-op period (1 month) and 20 post-FESS patients were in the long-term post-op period (3 months).

All the patients included in the study were subjected to history taking and clinical examination and informed consent was also obtained for the study. The nasal cavity was cleaned from debris and discharge.

Procedure

Position: Slightly neck extended with flexion maintained in the horizontal plane. Nostril choice: Nonobstructed nostril preferred.

Instrument for the placement of Saccharin: Surgical pincers used.

Saccharin was placed at 1 cm behind the anterior end of the inferior nasal turbinate.

The candidates were advised not to cough, sneeze, blow, or scratch the nose, but to breathe normally and swallow normally,

© The Author(s). 2024 Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.

every 30 seconds or regularly. On perceiving a sweet taste candidate was instructed to raise the finger and the time was noted. Time was measured with a stopwatch.

Functional Endoscopic Sinus Surgery (FESS)

It is a minimally invasive procedure done in a complex anatomical area. It improves sinus airflow and makes topical medication accessible by using nasal endoscopes to widen the paranasal sinuses.

Functional endoscopic sinus surgery is an effective technique for patients with both chronic rhinosinusitis with polyposis and without polyposis cases when medical management has failed. Good preoperative planning, surgical technique, and postoperative follow-up have been demonstrated to produce optimal outcomes.

Usually indicated to treat chronic rhinosinusitis that do not respond to drugs, benign and malignant conditions of paranasal sinus, and decompression of optic nerve, pituitary, and *trans*-nasal *trans*-sphenoidal surgery.

A well-experienced surgical team performed FESS for all 70 patients. Postoperatively antibiotics were given. The day after surgery, saline nasal douching was started and continued for 3 weeks.

Saccharin test is easy to perform, as it is easily obtained and non-toxic. we used Food Safety and Standards Authority of India (FSSAI)-approved non-nutritive sweetener saccharin crystals. Saccharin technique plays an important role in diagnostic and prognostic roles in ciliary motility disorders.

Results

All times were rounded off to the nearest minute.

Group A: Healthy individuals' mean clearance time as 12 (ranging from 10 to 18).

Group B1: Immediate postoperative (at 2 weeks) mean clearance time as 36 (ranging from 32 to 40).

Group B2: Intermediate postoperative (at 1 month) mean clearance time as 28 (ranging from 22 to 30).

Group B3: Long-term postoperative (at 3 months) clearance time as 18 (ranging from 12 to 22).

Group A: 40 Healthy individuals.

Group B1: 30 postoperative patients after 2 weeks.

Group B2: 20 postoperative patients after 1 month. Group B3: 20 postoperative patients after 3 months.

Saccharin Test Results

Mean clearance time (in minutes) for group A: 12.

Group B1: 36.

Group B2: 28.

Group B3: 18.

A Chi-square test was applied to the data to ascertain if there was a significant difference between the mean clearance of healthy and post-functional endoscopic sinus surgery patients.

$$\text{Overall mean: } \frac{40 \times 12 + 30 \times 36 + 20 \times 28 + 20 \times 18}{110} = 22.54$$

Chi-square value (2 degree of freedom) 0.1% (99.9%) = 13.82.

According to the Chi-square table for a two-sided test, the statistic value is greater than the tabled value. Hence, this shows that the test is significant and the mucociliary clearance is improved in post-functional endoscopic sinus surgery cases.

In immediate postoperative cases, ciliary clearance was prolonged and after 3 months, the ciliary clearance time was near normal.

Discussion

The recurrent infections of the nose of these patients lead to edema and obstruction of the sinus openings, thus lowering intraluminal oxygen tension and encouraging the growth of anaerobic organisms. Exotoxins are released which then lead to further mucociliary impairment, thus setting up a further vicious cycle within the sinus. The aim of functional endoscopic sinus surgery is to re-establish normal drainage and ventilation of sinuses through the natural ostia.

In 1974, Andersen et al.[1] reported a method for performing a Saccharin test in relation to the nasal mucosa. Briefly, when a Saccharin granule is adhered to the nasal mucosa, it dissolves within 1 minute. The molecules are then transported as a result of the mucociliary function to the nasopharynx, where the sweet taste is recognized by the experimental subject. The time interval between the introduction of the Saccharin granule and the sensation of sweetness is measured and called the Saccharin time.

According to Hafner et al.,[2] when the Saccharin test was performed by attaching a Saccharin granule to the anterior end of the inferior turbinate, a reduction in Saccharin time was observed following functional endoscopic sinus surgery.

In their study of the Saccharin test, Elwany et al.[3] found that the detection of many cilia on the sinus mucosa coincided with a reduction in the Saccharin test time.

Gelardi et al.[4] conducted a study in patients, after 4 weeks in the group rinsing with saline after functional endoscopic sinus surgery. There was an increase in Saccharin test time that could be the result of the acute surgical trauma.

Functional endoscopic sinus surgery is minimally invasive surgery that opens up all sinus air cells and the sinus ostia using an endoscope.[5]

In another study that investigated the ciliary beat frequency and Saccharin test in patients with extensive chronic rhinosinusitis, an improvement of Saccharin test was noted 7 months after sinus surgery in those without recurrent disease.

Shusterman demonstrated a difference in nasal mucociliary function between (self- reported) allergic rhinitis and non-rhinitis.[6] Aroor et al. observed that the patient's symptoms and the nasal mucociliary clearance (MCC) time were improved after surgery.[7,8]

Pandya and Tiwari Saccharin test used to detect nasal MCC in healthy individuals and diseased. Nasal MCC was prolonged in diseased. The Saccharin transit time involves procedural details that vary from study to study.[9]

Passali et al., used pure Saccharin powder at 3% concentration added to vegetable charcoal powder for measuring nasal MCC time.[10]

According to one study, any polyps and edematous mucosa found in the maxillary sinus should be removed by using curved cutting forceps to remove only the surface mucosa. The bone wall is kept hidden throughout these operations.[11] According to certain research, patients with chronic rhinosinusitis may benefit

from a steroid agent nebulizer and chemotherapy with macrolide antibiotics.[12] Techniques for calculating the transit durations of technetium 99m and Saccharin in the nasal cavity are among the methods that have been documented for assessing mucociliary function.[13,14] In a nutshell, a Saccharin granule on the nasal mucosa dissolves in a minute. The mucociliary function subsequently transports the molecules to the nasopharynx.[15] Furthermore, King examined the ciliary activity in rabbits' maxillary sinuses and verified that it was directed toward the ostium in the middle meatus.[16]

In this investigation, we looked into the post-FESS mucociliary function by performing a Saccharin test. The results showed MCC time was longer in immediate postoperative cases. In addition, we performed the test in 1 month and 3 months post-FESS cases. In this study, patients with chronic sinusitis who underwent FESS had their mucociliary function examined using the technique of Saccharin time.

In our study, Saccharin test time was increased in immediate post-surgical cases compared with the normal individual and Saccharin test time improved to near normal in long-term postoperative cases.

Elements Affecting MCC

Age

As people age, the respiratory system changes, most likely as a result of a rise in cilia structural abnormalities.

Smoking

Acute exposure to cigarette smoke leads to an increase in the ciliary beat frequency by the action of inflammatory mediators. Therefore, in addition to the chronic condition, smoking reduces ciliary function.

Physical Activity

Everyday existence exercise is a stressful stimulus that can cause both short-term reactions and long-term changes. The first is linked to elevated adrenergic mediator levels, which in turn enhance the frequency of ciliary beats.

The way MCC functions is also impacted by the chemicals that are consumed. While extended exposure to alcohol inhibits the β-agonist activation of kinase protein activity and ciliary beating, short-term exposure is known to rapidly stimulate the cilia.

Medication

Salbutamol increased mucociliary clearance, whereas sodium chloride decreased it and xylometazoline had no discernible effect. In their evaluation of the effects of regular clinical pharmaceutical usage on MCC, Houtmeyers et al. found that benzodiazepines (anxiolytics and tranquilizers), aspirin, anticholinergics (tertiary ammonium compounds), and anesthetics all depress the mucociliary system. However, the MCC is improved by cholinergic drugs, methylxanthines (theophylline, aminophylline), sodium cromoglycate (antiasthmatic), antibiotics (such penicillin, cephalosporin, and sulfonamide), surfactant, hypertonic saline solution, and water aerosol (Fig. 1, Table 1).

Conclusion

Functional endoscopic sinus surgery which is reserved for patients with failed medical management, requires preservation of healthy nasal cavity mucosa as much as possible so that the ciliary function is preserved.

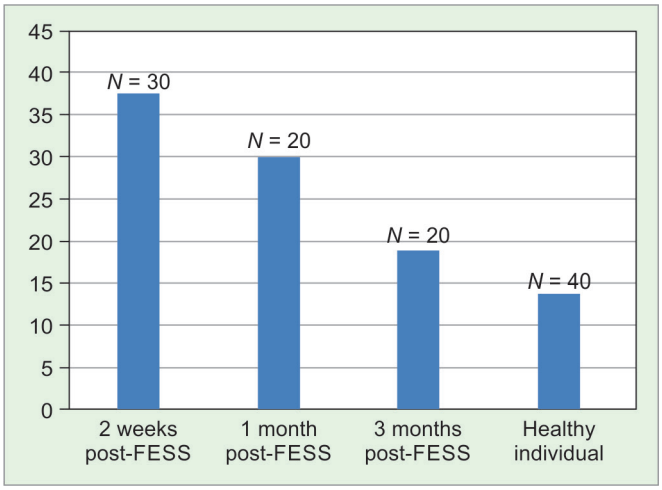

Fig. 1: Saccharin clearance time

Table 1: Saccharin test results

Source	*A*	*B1*	*B2*	*B3*
Observed clearance time	12	36	28	18
Anticipated clearance time	22.5	22.5	22.5	22.5
$(O-E)^2$	111.1	181.2	29.8	20.6

In this study, on analysis of ciliary function during the postoperative period of endoscopic sinus surgery, the mucociliary function was improved to near normal levels in the long-term period following a brief fall of mucociliary function in the immediate postoperative period.

However, further continuation of such research and application of advanced technologies like electron microscopic analysis may give additional data which are very much required for the assessment of mucociliary function at the level of osteomeatal complex. This will give much more precise data.

References

1. Andersen I, Camner P, Jensen PL, et al. A comparison of nasal and tracheobronchial clearance. Arch Environ Health 1974;29(5):290–293. PMID: 4472935.
2. Hafner B, Davris S, Reichelmann H, et al. Endonasal sinus surgery improves mucociliary transport in severe chronic sinusitis. Am J Rhinol 1997;11(4):271–274. DOI: 10.2500/105065897781446612.
3. Elwany S, Hisham M, Gamaee R. The effect of endoscopic sinus surgery on mucociliary clearance in patients with chronic sinusitis. Eur Arch Otorhinolaryngol 1998;225:511– 514. DOI: 10.1007/s004050050109.
4. Gelardi M, Guglielmi AV, De Candia N, et al. Effect of sodium hyaluronate on mucociliary clearance after functional endoscopic sinus surgery. Eur Ann Allergy Clin Immunol 2013;45(3):103–108. PMID: 23862400.
5. Pradhan B, Thapa N. Functional endoscopic sinus surgery (FESS). JNMA J Nepal Med Assoc. 2006;45(164):337–341. PMID: 17676068.
6. Shusterman D. A simplified technique for evaluating nasal muco-ciliary clearance via saccharin transit time. Int Forum Allergy Rhinol 2020;10(4):572–574. DOI: 10.1002/alr.22528.
7. Aroor R, Sunu Ali Z, Gangadhara Somayaji KS. Do Nasal Surgeries Affect Muco-ciliary Clearance? Indian J Oto laryngol Head Neck Surg 2017;69(1):24–28. DOI: 10.1007/s12070-016-1016-y.
8. Pandya VK, Tiwari RS. Nasal muco-ciliary clearance in health and disease. Indian J Otolaryngol Head Neck Surg. 2006;58(4):332–334. DOI: 10.1007/BF03049581.

9. Proctor DF, Andersen I. Nasal muco-ciliary function in normal man. Rhinology 1976;14:11–17. PMID: 1273411.
10. Passali D, Bellussi L, Bianchini Ciampoli M, et al. Experiences in the determination of nasal mucociliary transport time. Acta Otolaryngol 1984;97:319–323. DOI: 10.3109/00016488409130995.
11. Moriyama H, Yanagi K, Ohtori N, et al. Healing process of sinus mucosa after endoscopic sinus surgery. Am J Rhinol 1996;10:61–66. DOI: 10.2500/105065896781795067.
12. Moriyama H, Yanagi K, Ohtori N, et al. Evaluation of endoscopic sinus surgery for chronic sinusitis: Post-operative erythromycin therapy. Rhinology 1995;33(3):166–170. PMID: 8560171.
13. Sakakura Y. Nasal mucociliary clearance under various conditions. Acta Otolaryngol (Stochh) 1983;96:167–173. DOI: 10.3109/00016488309132888.
14. Burgersdijk FJA, De Groot JCMJ, Graamans K, et al. Testing ciliary activity in patients with chronic and recurrent infections of the upper airways: Experiences in 68 cases. Laryngoscope 1986;96:1029–1033. PMID: 3528726.
15. Sakakura Y, Ukai K, Yamagiwa M, et al. Nasal mucociliary function in man. J Otolaryngol Jpn 1980;83:1592–1598. PMID: 6973014.
16. King E. A clinical study of the functioning of the maxillary sinus mucosa. Ann Oto/ Laryngol 1935;44:480–482. DOI: 10.1177/0003489435044002.