“IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS”

By

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Tamil Nadu Dr. M. G. R. Medical University, Chennai, Tamil Nadu

In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

YOGA

Under the Guidance of

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Date: **Dr. R.N.RANI**

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LIST OF ABBREVATIONS USED

NPIF	NASAL PEAK INSPIRATORY FLOW
NPIFR	NASAL PEAK INSPIRATORY FLOW METER
CBT	CILIARY BEAT FREQUENCY
MCT	MUCOCILIARY CLEARANCE TIME
NI	NASAL IRRIGATION
URTIs	UPPER RESPIRATORY TRACT INFECTIONS
RSDI	RHINOSINUSITIS DISABILITY INDEX
ASL	AIRWAY SURFACE LIQUID
MALT	MUCOSA ASSOCIATED LYMPHATIC TISSUE
IG	IMMUNOGLOBULINS
OH	HYDROXYL
MCC	MUCOCILIARY CLEARANCE
NO	NITRIC OXIDE
T2Rs	BITTER TASTE RECEPTORS
IL	INTERLEUKIN

ABSTRACT

Background: The use of nasal saline is deeply rooted in history. It has been practiced for thousands of years as part of Hatha Yoga, where it is called Jala Neti. Yogis use nasal cleansing, as well as cleansing of other areas, to attain a higher state of meditation, but practitioners also note advantages related to bodily health. On the physical level irrigation of the nasal mucosa removes accumulated mucus from the nostrils, associated passages and sinuses, allowing air to flow without obstruction.

Methods: Sixty healthy volunteers of age group between 18-25yrs will participate in the study. After obtaining informed consent, the selected individuals would be subjected to two practices of Jala neti. After the practice , the individuals are made to perform Jala neti(nasal irrigation) under the supervision of yoga Experts. After obtaining informed consent the nasal peak inspiratory flow is measured using nasal peak inspiratory flow meter. The collection of first data is before the practice, Second data is taken immediately after the procedure.

Results: The study group showed improved Nasal Inspiratory Flow Rate Immediately after the Practice of Jala Neti Procedure.

Interpretation and Conclusion: Regular practice of Jala neti maintains healthy secretory and drainage mechanisms of the entire ear, nose and throat area. This helps to ward off colds and coughs, allergic rhinitis, hay fever, catarrh, and tonsillitis

Key Words: Jala Neti, Nasal peak Inspiratory flow, Saline nasal irrigation.

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1.0 INTRODUCTION

The nose and upper airway play a sentinel role in the respiratory tract, making an individual alert to the qualities of the inspired atmosphere. The upper airway also clears contaminants from the inspired airstream and physically conditions inspired air before entering into the lower respiratory tract. By these anatomical and functional considerations, the nose may be the initial—or even prime—target of air pollutants.

Healthy people's respiratory tracts are protected from airborne contagion and debris by a mucociliary layer that lines the sinonasal cavity. This layer consists of columnar, ciliated epithelial cells and goblet cells bathed in mucus. Foreign particles are trapped in the sticky layer of mucus, and ciliary action propels the entire mucous layer out of the sinuses toward the nasopharynx. When this transport mechanism fails, rhinosinusitis occurs, usually in response to a virus, bacterium, irritant, or allergen.(1)

Nasal hygiene has been shown to relieve congestion, reduce the viscosity of mucus and keep nasal cavity clean and moist. Nasal breathing is the only physiological type of breathing in humans, and is considered mandatory, although substituting mouth breathing is compatible with life.

The mucociliary layer, which covers the nostrils, actively participates in respiratory homeostasis through ciliary function, mucus secretion and the release of inflammatory mediators.

The maintenance of integrity of the respiratory mucosa is essential for the airways to fulfill their role; this can justify the use of external media, such as sprays, lavage and irrigation of the nasal cavity to promote or facilitate nasal hygiene. The use of saline solutions seems to facilitate the transport of mucus, particles, irritants and microorganisms toward nasopharynx, probably by direct physical action and by increasing ciliary beating, which is reduced during inflammatory processes.(2)

Yoga is one of the ancient sciences prevalent from time immemorial. The system of yoga on one hand is a theoretical study and on the other, it is a practical step for self-realization. 'Yoga Shastra', the science of Yoga has to be studied systematically to realize the hidden truth in this great ancient science. Maharshi Patañjali defines yoga as 'yogah cittavrtti nirodhah'.

He explains about the distractions of the mind and the development of disease (vyādhi), their symptoms and methods to overcome from them. Classical yogic texts like Hathapradīpika, Gheranda Samhita and Śiva Samhita describe different yogic techniques to overcome various disorders of

body and mind. We can systematically adopt these therepeutical values in the prevention, curing and management of the diseases. Healing the health problems using the techniques of yoga is called ‘Yoga Therapy(3)

Yoga has the potentiality to prevent and cure the diseases of both body and mind. One does not know what unknown diseases are in store for him in future.

Therefore, the refinement in health should be such that one should feel the slightest change in his body. This is possible by the proper adaptation of yogic principles.

Poor lifestyle, too much of competition, excessive hurry-worry, wrong kind of eating and sleeping habits, mental and social conflicts lead to the health problems. Apart from the functional unity of different parts of the body, yoga believes in the close relationship between the body and the mind. Mental factors effect the functioning of different parts of the body and vice versa. Holistic approach of yoga has the potentiality to heal the diseases completely. *Patañjali* says “*yogāngānusthānadaśuddhiksaye jñānadīptirāvivekakhyāteh*” (2^{nd} chapter, 28^{th} sūtra).(4)

It emphasizes that by following different parts of the yoga, the impurities of both body and mind can be destroyed. Sinusitis is an inflammatory disorder. Therefore, naturally, there will be impurities in the sinuses. These impurities can be removed by proper yogic techniques.(5)

1.1 Kriyā

Kriyās are the wonderful techniques of Hathayoga, which help to eliminate the excess fat and phlegm and thereby purifying the body. “medah ślesmādhikah pūrvam satkarmāni samācaret” says the Hathapradīpikā.(2) Kriyas help to reduce the excess kapha in the body in case of sinusitis. Simultaneously, they improve immune system of the body to fight against the allergens and climate changes.

Excess production of “ślesma” and impurities inhaled through breathing will be transformed to the air-filled cavities, the sinuses. Excess mucous and impurities cause the inflammation of sinuses, which will lead to the symptoms such as headache, nasal congestion, heaviness of the head, etc., This infected “ślesma” can be removed by the practice of kriyas. Classical texts explain that neti and kapālabhāti are the important kriyās which are beneficial to maintain healthy sinuses.

Svātmārāma in Hathapradīpikā says,

“kapālaśodhanīcaiva divyadrstipradāyinī |
jātrurdhvajātarogaugham netirāsu nihanti ca |”(2nd Chapter, 31st śloka)

“kapālabhātirvikhyātā kaphadosaviśosanī||” (2nd Chapter, 36th śloka)

Gheranda Samhita (6) says that vaso-dhauti kriya and neti kriya help to cure the disorders of phlegm.

It also explains the techniques of three types of bhālabhāti kriyā to cure the disorders of phlegm.

The jalaneti kriyā, using saline water, helps to remove the infected ślesma from the nasal sinuses. The ślesma slowly drain from the sinuses due to the process of osmosis. Practice of kapālabhāti after jalaneti kriya, expels the stagnated phlegm and dries up the nasal sinuses by increasing the mucosal temperature. Thus, this practice also increases the resistance of the nasal mucosa against the allergens and microorganisms.

Sūtraneti is one of the powerful cleansing techniques of hathayoga which clears the nasal passages and hardens the nasal mucosa to resist against the infective particles. Therefore, sūtraneti effectively works as a preventive and curative practice of yoga against the “kapha” disorders like sinusitis.

Dhauti kriya may be practiced in chronic sinusitis conditions. This practice removes excess “kapha” from the digestive tract starting from mouth to stomach. Reduction in “kapha” from the body naturally helps to reduce the sinusitis condition. Similarly, dhauti kriya stimulates the digestive power which in turn helps to relieve the aggravated “kapha” from the body.

Other kriyas such as Vahnisāra and nauli also increase the pitta which increases the digestive capacity and indirectly decreases the aggravated kapha from the body.

2.0 AIMS AND OBJECTIVES

2.1 AIM:

The aim of this study was to evaluate the **IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS**.

2.2 OBJECTIVES OF THE STUDY:

To evaluate the effects of Immediate effect of Jala neti on Nasal Peak inspiratory Flow.

Primary variables are

- Nasal Peak Inspiratory Flow Rate (NPIF)

3.0 REVIEW OF LITERATURE

One of the most important Yoga practices for the prevention and management of sinusitis is the Neti Kriya that is one of the Shat Karmas of Hatha Yoga. All the diseases occurring in the head and neck can be dealt with neti . Neti is the practice of cleaning the nasopharyngeal tract with liquids or thread. Types of Neti include Jala Neti (nasal irrigation with lukewarm saline water) and Sutra Neti (nasal cleaning with a thread or catheter. Others are Dugdha Neti (with milk), Ghrta Neti(with ghee). (7)

3.1 JALA NETI

The use of nasal saline is deeply rooted in history. It has been practiced for thousands of years as part of Hatha Yoga, where it is called Jala Neti(8). Yogis use nasal cleansing, as well as cleansing of other areas, to attain a higher state of meditation, but practitioners also note advantages related to bodily health.

FIGURE.1 JALA NETI

Nasal cleansing has also been advocated in western medicine for over 100 years. In 1895 the British Medical Journal declared the nose “one of the dirtiest organs of the body loaded with all sorts of nastiness” and recommended regular cleansing(9).

Wingrave(10) in 1902 described various methods and solutions for nasal douching. Proetz(11) published hisbook “The Displacement Method of Sinus Diagnosis and Treatment” in 1931, describing isotonic saline irrigation of the nose and sinus cavities. In 1953, sphenoid sinus irrigation in the otolaryngologist’s office was recommended for protracted headaches(12). Maxillary antral irrigation(13) was done for thousands of patients in physician offices. Even race horses have been treated with nebulized saline for persistent sinonasal secretions(14).

In 1958 Myerson(15) described the technique of maxillary sinus irrigation via the middle meatus as a standard office procedure and an improvement on the often-performedinferior meatus puncture. The same year, the canine fossa puncture for saline maxillary lavage was described(17). Until recently, most sinus lavage in western medicine was a procedure performed in the physician’s office, rather than something done regularly by an individual for the maintenance of their own sinonasal health.

3.2NASAL ANATOMY

The nose is the organ of smell, and serves in breathing and airway function. The nasal cavity lies between the base of the brain (skull base) and above the oral cavity and palate below.

3.2.1 EMBROYOLOGY

During the 6th week of embryological development, ectodermal thickened parts of the frontobasal prominence invaginate resulting in two symmetrical nasal placodes. Nasal pits divide the placodes (*Fovea nasalis*) into medial and lateral nasal processes (17). This deepens, becoming the nasal sac – an ectodermally lined cavity, which is divided into two halves by the primary septum.

Between weeks 6 and 7, a membrane separates the oral cavity from the primitive choanae. This resolves due to immigration of mesenchymal cells. The mesenchymal septum (secondary septum) grows caudally, merging with the palate and enlarging the embryonic structures of the nose. In weeks 7 and 8, first cartilaginous cells are identified, including parts of the turbinates. Starting in the 3rd month, mucosal lining migrates into the lateral nasal wall priming the development of the paranasal sinuses. By cell differentiation and maturation of the respiratory mucosa, detection of glands is possible after the 4th month of intrauterine development.

During the 5th month of fetal development, ossification of the nose starts, including the previously cartilaginous areas of the turbinates. Influenced by various transcriptional factors, including Sox (18), cells differentiate further into the various cell types included in respiratory mucosa.

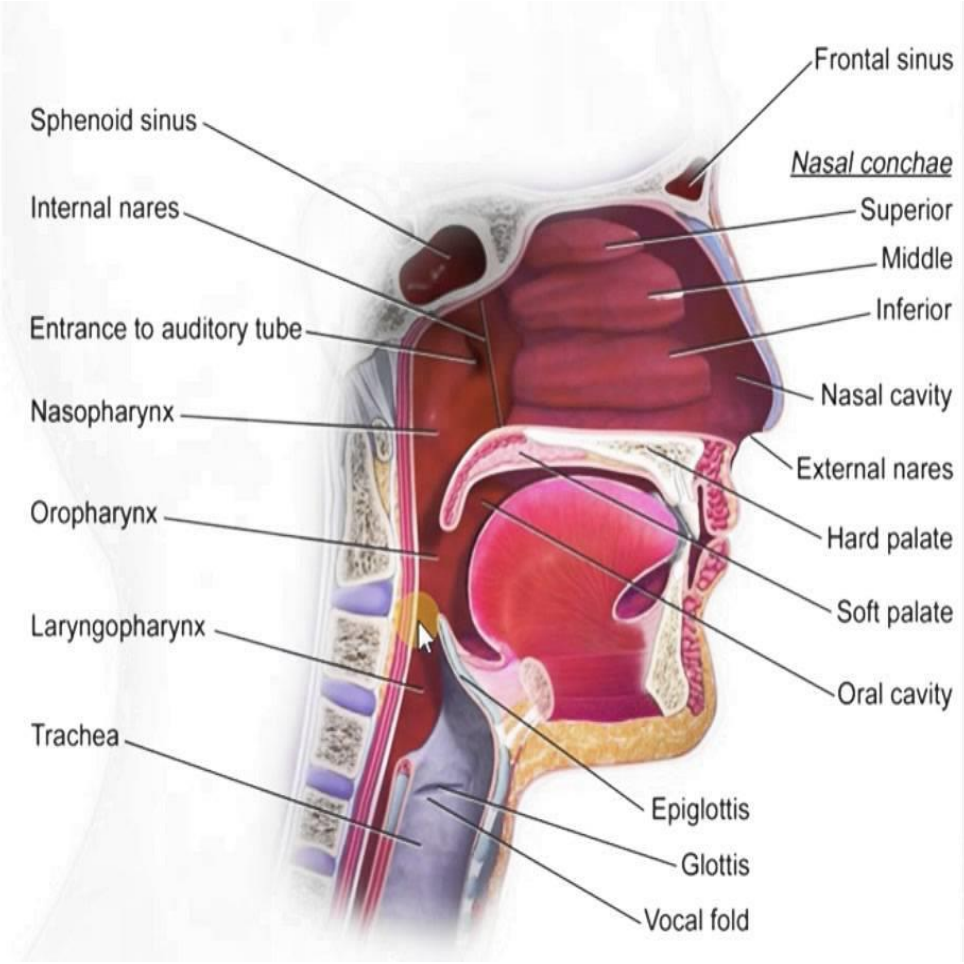


FIGURE 2: ANATOMY OF UPPER RESPIRATORY TRACT

The nasal cavity is surrounded by paired, air-filled chambers on each side, and these lie towards the sides and above the nose (the "paranasal sinuses"). These paired sinuses are the maxillary (lying in the cheek bones), frontal (lying between the eyebrows), ethmoid (between the eyes) and the sphenoid sinuses (between the center of the skull base and the nose).

Smell is perceived through part of the roof of the nasal cavity (olfactory cleft) that is just next to the part of the brain responsible for smell (olfactory bulb and fossa). This bony partition in this area ("cribriform" bone) is pierced by numerous nerves ("Olfactory" nerves) on each side.
These nerves supply the top parts of the nasal septum, middle and inferior turbinates and carry smell sensations to the brain. In the nasal cavity, physical obstruction and injury, or inflammation to the olfactory cleft by tumors, polyps etc. can affect smell.

The nasal cavity is divided by a vertical partition (the "nasal septum") into a right and left side. The nasal septum is made up of cartilage (quadrangular cartilage) towards the front of the nose, and bone towards the back. Parts of four different bones make up the bony septum: the perpendicular plate of the ethmoid bone, vomer, and the nasal crest of the maxilla and palatine bones.

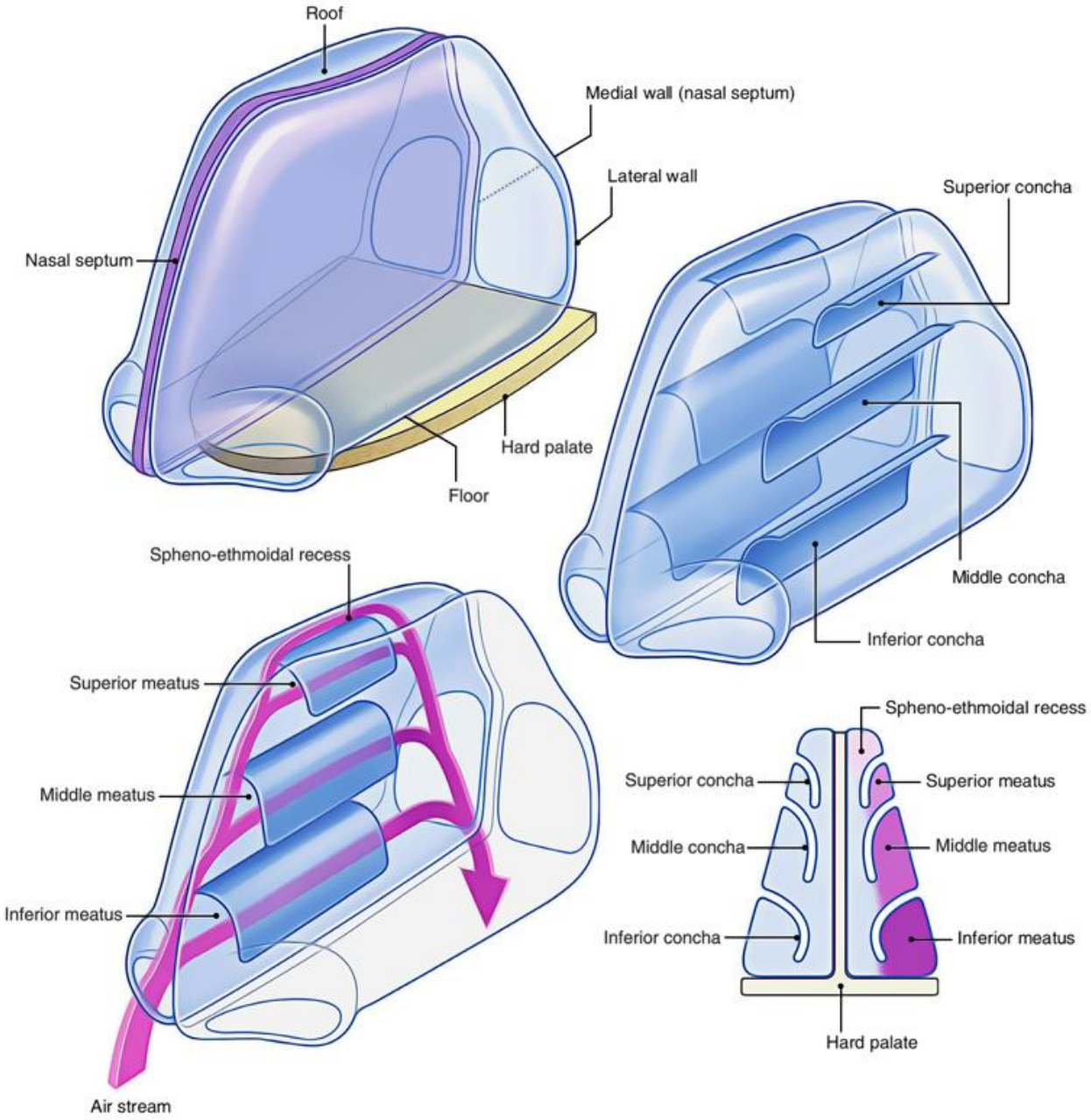


FIGURE 3.NASAL CAVITY

The nasal septum is often not located in the midline, but pushed over to the right or left side in various parts. This shift is referred to as a “deviated nasal septum”.

These deflections usually occur where the various parts of the nasal septum join together, due to overgrowth of one or more components. Sometimes, trauma to the nose can also create deflections and fractures.

When this deviation is large or severe it can result in narrowing of one or both sides of the nasal cavity. In the front, the left and right sides of the nasal cavities form the right and left nares. Towards the back, these nasal passageways terminate into the right and left “choana” and open into a common chamber called the “nasopharynx”.

The nasopharynx is the upper part of the throat (pharynx), which lies below the skull base and opens into the oropharynx, the part of the throat that lies behind the mouth. When we breathe in, air travels through the nostril, through the right and left nasal passages, through the choana into the nasopharynx, then the oropharynx, and then through the voice box (larynx) into the lungs.

The nasopharynx contains a collection of lymphoid tissue towards the midline, called the adenoids. Into each side of the nasopharynx open the eustachian tubes.

The eustachian tubes connect the nasopharynx to the middle ear (the part of the ear cavity behind the ear drums).

The eustachian tubes help air to pass from the ear to the nasopharynx and vice versa and thus help fill the middle ear with air and equalize air pressure with the atmosphere. This function is very important for hearing normally. When the adenoids are enlarged or infected, eustachian tube, and thus ear function can be affected, leading to problems with fluid in the ear, or ear pain and pressure. Enlarged adenoids can also block the choana and affect breathing through the nasal passageways, leading to mouth-breathing and snoring.

The nasal cavity is bounded in by bony sidewalls (lateral nasal walls). Attached to these sidewalls are three structures called turbinates. The turbinates are fingerlike projections made up of a bony core and outer soft tissue. They are covered with a lining (mucosa) which is continuous with the lining of the rest of the nasal cavity.

The turbinates serve to increase the mucosal surface area of the nasal cavity, and also direct smooth nasal airflow towards the lungs.

Between each turbinate and nasal sidewall lies a space termed a meatus. These spaces are named according to the turbinate above them.

The bottom most turbinate, the “inferior” turbinate serves the most important role in the air-conditioning action of the nose. This capacity of the inferior turbinate comes from soft tissue below the lining.

This tissue is extremely rich in blood vessels and glands, and helps the nasal air-conditioning function. The inferior turbinate is the largest of the three paired turbinates, and runs along the entire length of the lateral nasal wall, adjacent to the nasal floor.

Sometimes, the inferior turbinate can get enlarged due to allergy or irritation, and can cause nasal blockage and a runny nose. The tear duct (nasolacrimal duct), which drains tears from the eye, drains beneath the inferior turbinate into the inferior meatus.

The middle turbinate lies above the inferior turbinate and is a very important structure with a complex, boomerang shape. The front part of the middle turbinate is vertical, attaching to the skull base. The back of the middle turbinate is horizontal, and attaches to the nasal sidewall just above the inferior turbinate. The middle part of the middle turbinate is oblique, connecting the vertical and horizontal parts, and is thus connected both the skull base in the front and the nasal sidewall in the back.

The frontal sinus and anterior ethmoid sinus cells drain beneath the middle turbinate into the middle meatus.

The superior turbinate is the smallest of the turbinates. It resides just above

and behind the middle turbinate. The sphenoid sinus and posterior ethmoid sinus cells drain into an area between the nasal septum and superior turbinate called the sphenoethmoid recess.

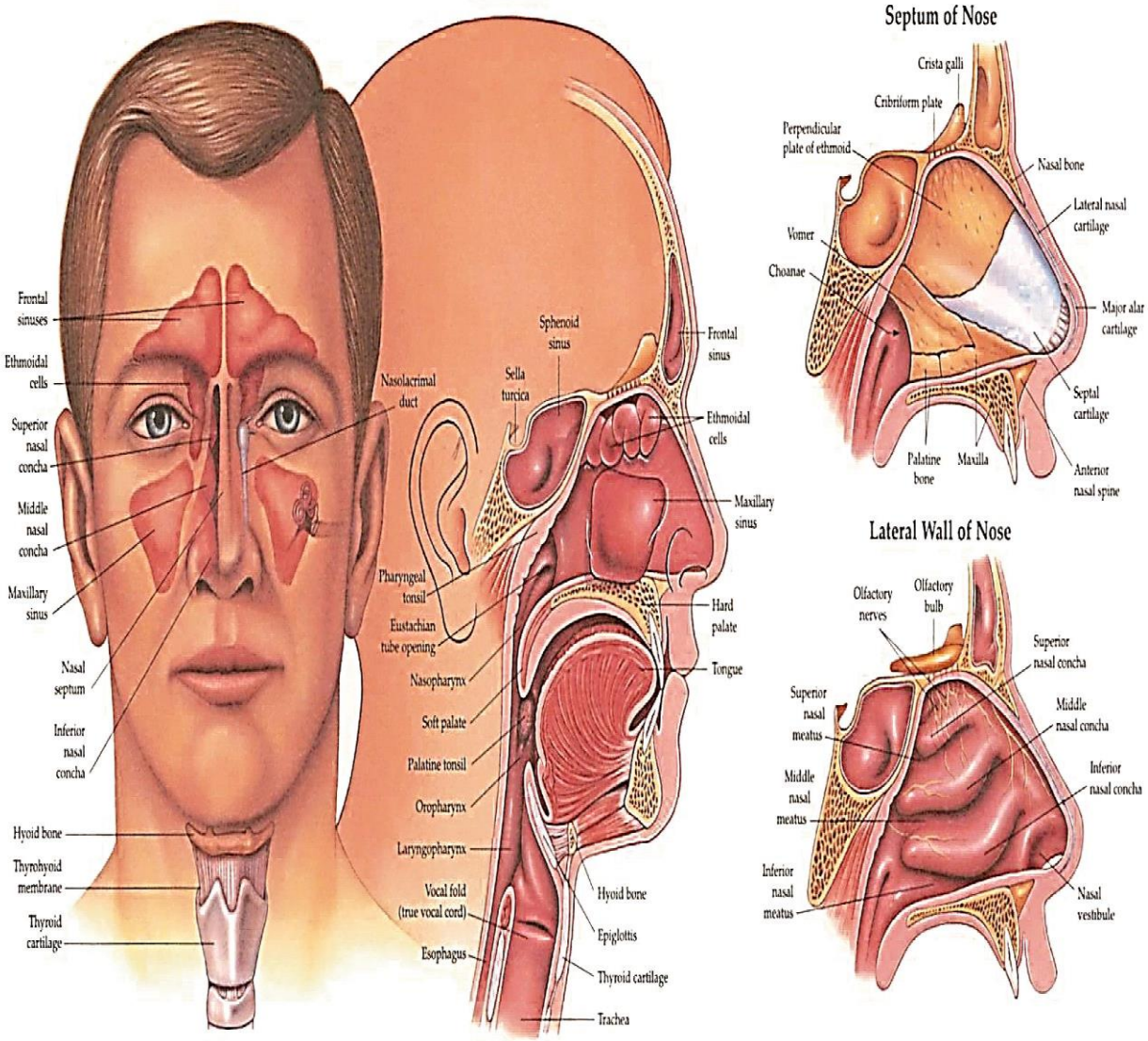


FIGURE 4 : ANATOMY OF SINUSUS

3.2.2 BLOOD SUPPLY

The nasal cavity has a very rich blood supply arising from both the **Internal and external carotid arteries**. A confluence of these blood vessels supplying the nasal septum in the front ("Kiesselbach plexus" in the "Little's area") is a common source of nasal bleeding (epistaxis). This area can often be cauterized in the office to stop nasal bleeding.

The anterior and posterior ethmoid arteries, both branches of the internal carotid artery system supply the upper nasal septum and nasal sidewalls. The superior labial branch of the facial artery supplies the front part of the nose. The sphenopalatine artery, a branch of the external carotid system supplies most of the back of the nasal cavity. It enters the nasal cavity through an opening located along the nasal sidewall called the sphenopalatine foramen.

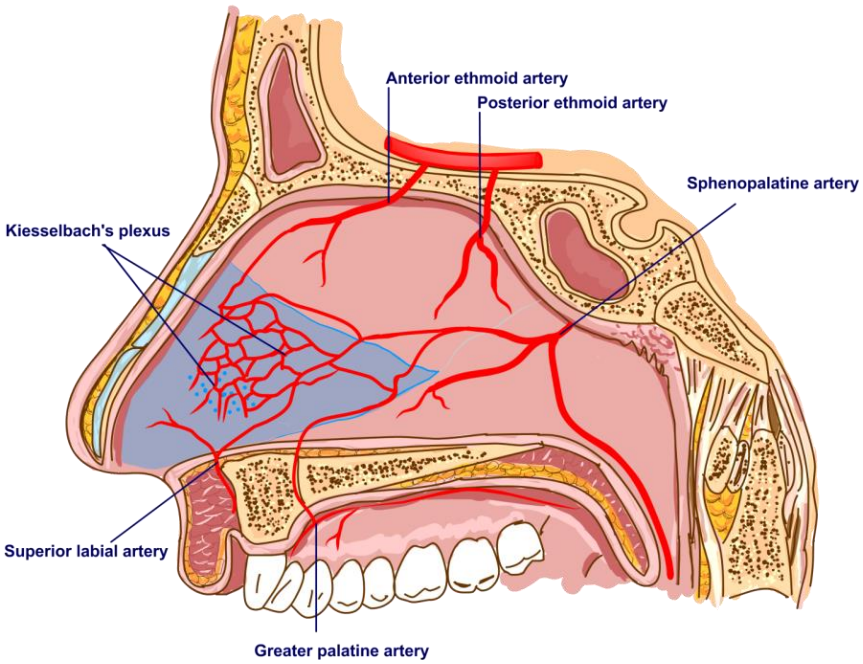


FIGURE 5. BLOOD SUPPLY TO NASAL CAVITY

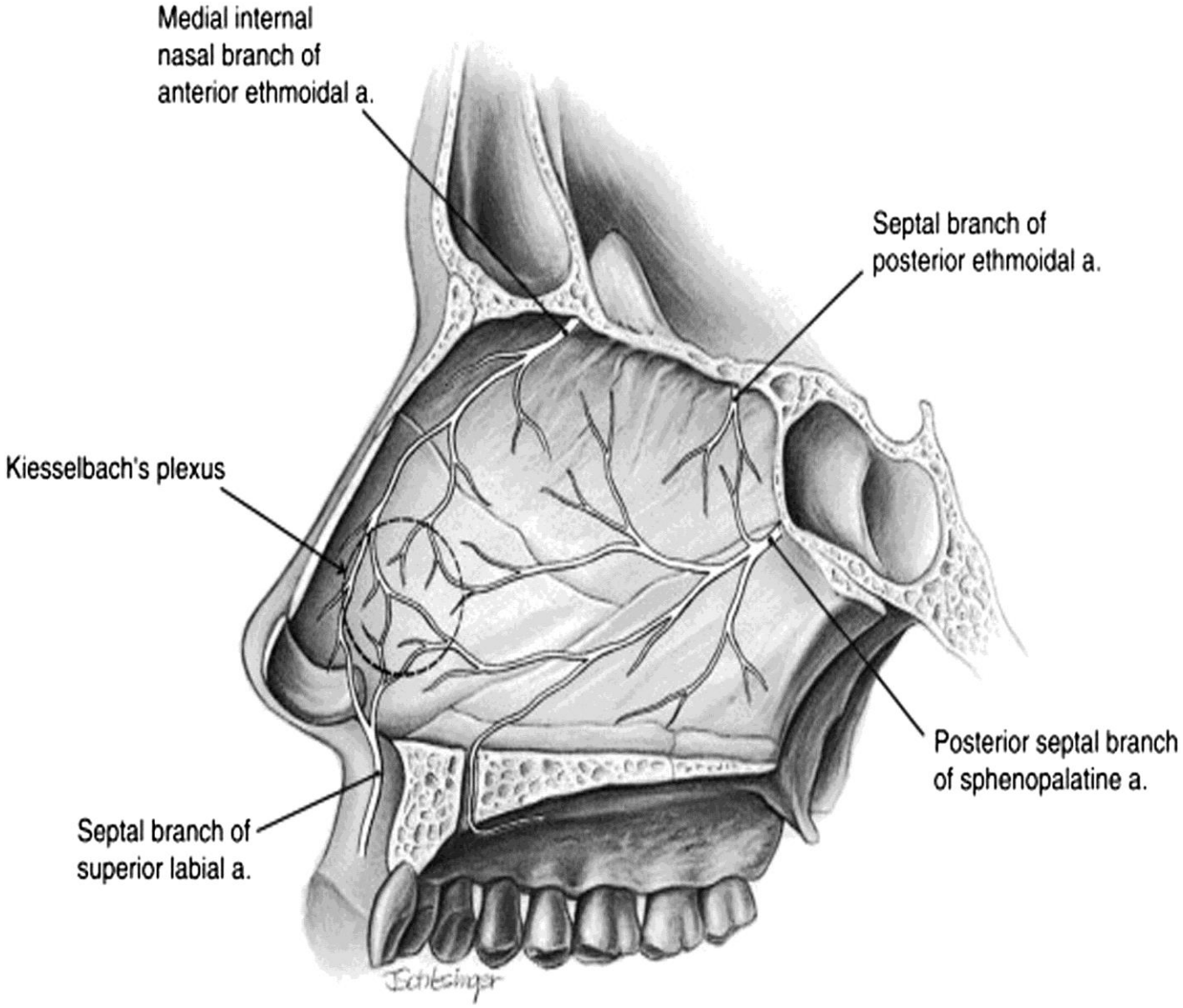


FIGURE 6 : NERVE SUPPLY TO NASAL CAVITY

When nasal bleeding is more from the back part (posterior epistaxis), this artery is often the culprit. When recurrent posterior epistaxis becomes a problem, the sphenopalatine artery may need to be tied or embolized.

In addition to this larger vasculature, there is a confluence of the small vessels that supply the front portion of the nasal septum that is termed Kiesselbach's plexus. This lattice of veins is a common source of nasal bleeding (epistaxis) due to trauma and dry air exposure, and may require medical attention in many cases.

3.2.3 NERVE SUPPLY

Sensation to the nose is provided to the nasal cavity primarily via branches of the trigeminal nerve. The ophthalmic division (V1) of the trigeminal nerve gives off the anterior and posterior ethmoidal nerves, which supply sensation to the top half of the nasal cavity and septum. The maxillary division (V2) of the trigeminal nerve exits the skull base via an opening called the foramen rotundum and ultimately divides into several smaller branches. The largest of these branches is the sphenopalatine nerve, which travels with the corresponding artery and supplies sensation to the lateral nasal wall and septum. Sensations of the nasal cavity can be disrupted by injury to the mid-face and palate due to trauma, tumors or surgery, resulting in numbness.

The nose is also richly supplied by special nerves from the autonomic

nervous system. The autonomic nervous system controls many involuntary functions in the body (blood pressure, heart rate, breathing) via "sympathetic" and "parasympathetic" nerve fibers. In the nose, the autonomic nerves control the air-conditioning action, nasal resistance, mucus secretion and the function of the cilia and mucus blanket. Nasal secretions and mucus gland production are controlled by "parasympathetic" innervation, which is carried to the nasal cavity via the greater superficial petrosal nerve.

This nerve ultimately becomes the vidian nerve, which sends parasympathetic nerve fibers along with branches of the sphenopalatine nerve Blood flow to the nasal cavity and nasal mucosa is controlled largely by sympathetic innervation, fibers of which also travel along with the sphenopalatine nerve. Changes in sympathetic stimulation result in a rhythmic swelling of nasal blood vessels and a corresponding increase in nasal airway resistance (nasal cycle).

The autonomic nerve systems can often be imbalanced during old age or due to allergies, inflammation, infection or medications. Normal nasal function can be disrupted, leading to nasal congestion and increased nasal secretions.(19)

3.2.4 LYMPHATIC DRIANAGE

Superficial and deep lymphatic vessels (15–200 μm) can be demonstrated in respiratory mucosa, which lead in the middle nasal meatus to the natural

ostium of the maxillary sinus. Their density decreases from top to bottom of the middle nasal meatus; their number is higher in the paranasal sinuses than the nose. Several connections are visible between lymphatic vessels and the vascular supply (20). More lymphatic vessels begin at the nasal floor and the turbinates and converge in the medal inferior area of the turbinates. From this area, lymphatic vessels pass retropharyngeally and to the parapharyngeal space, reaching lymph nodes of both anatomic areas (21).

3.3 NASAL PHYSIOLOGY

3.3.1RESPIRATION

The nose is a natural pathway for breathing. During respiration the nose acts as an air conditioning unit by performing humidification, heat transfer, and filtration. The nasal mucosa can help adjust the humidity and temperature of the air before it reaches the lungs. The large surface area of the nasal mucosa helps regulate the temperature and humidity of inspired air. The nasal cycle is a rhythmic cycle of growth of venous sinusoids that alters between the left and right nasal passages.

The activation of sympathetic nerve fibers (part of the autonomic, i.e. automatic, nervous system) controls blood flow to the nasal cavity and nasal mucosa. Alternating the volume of blood between the left and right nasal passages varies between individuals but on average occurs every 4 hours.

Nasal secretions and mucus production is controlled by parasympathetic autonomic innervation and is also cyclical with increased secretion on the

side with the greatest airflow. This diurnal nasal cycle is normal, but can be a source nasal obstruction for some patients that may require evaluation.

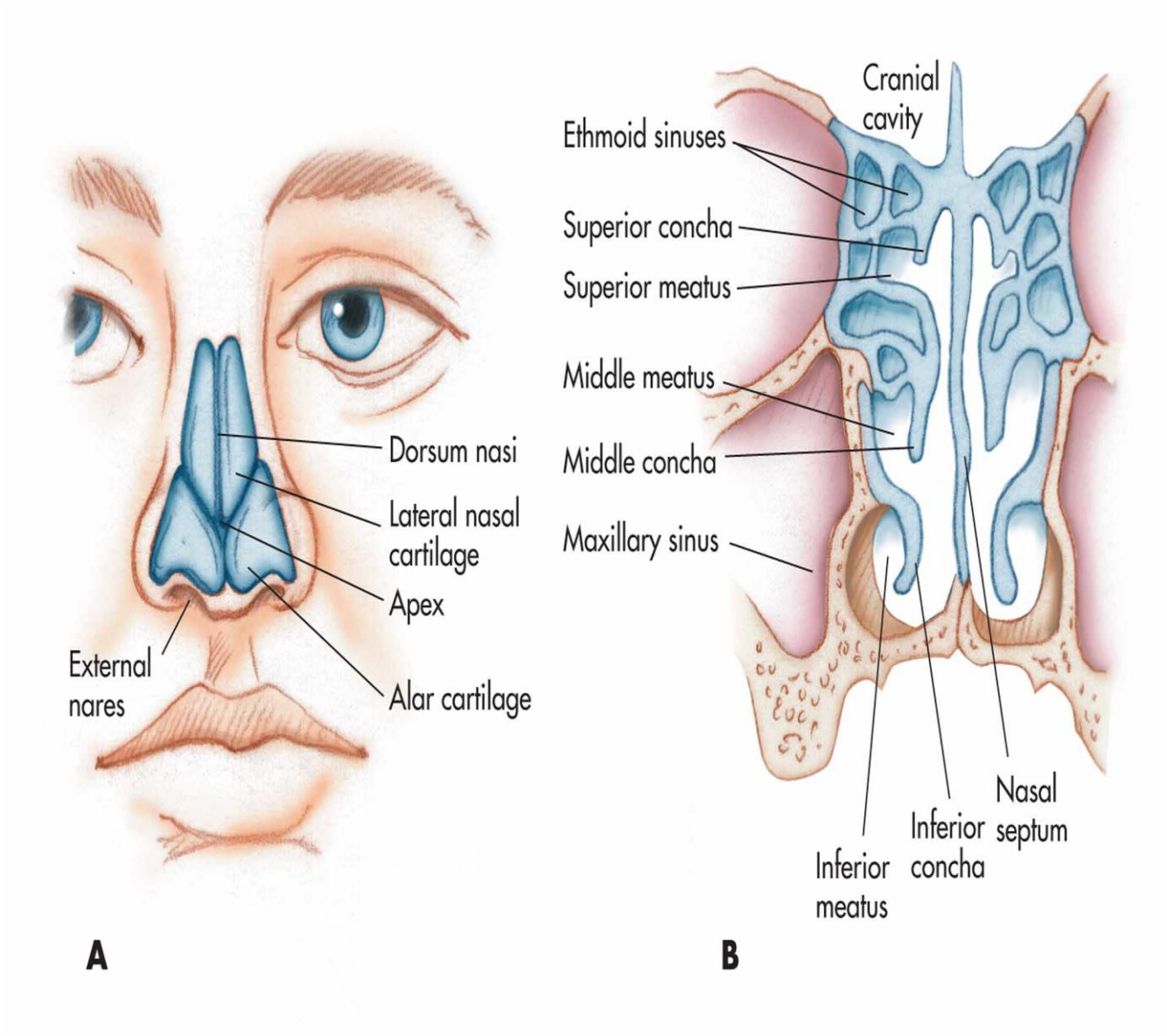


FIGURE 7 : ANATOMY OF INTRNAL NOSE

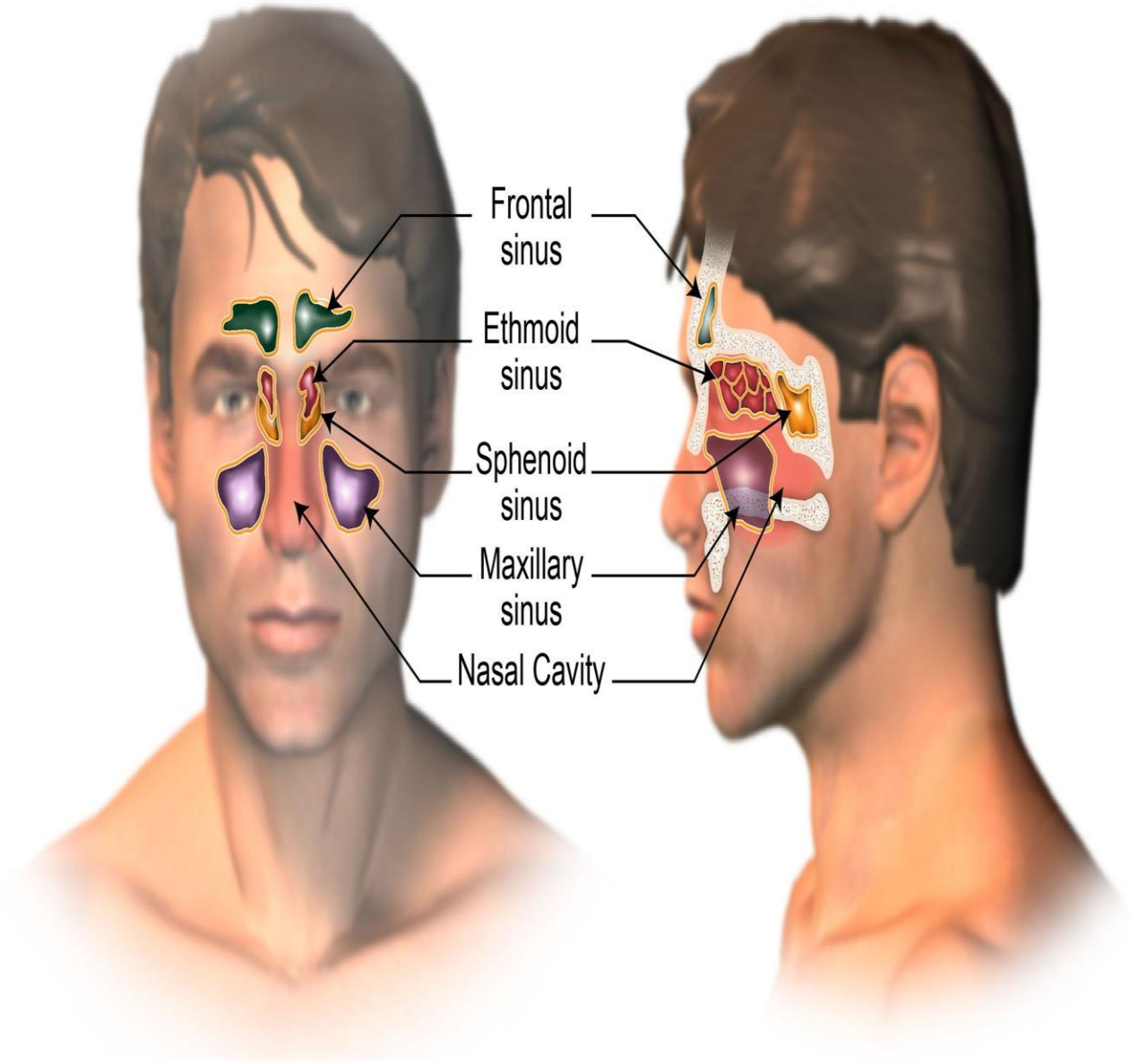


FIGURE 8 : LOCATION OF SINUSUS

3.3.2 VOCAL RESONANCE

The nose is thought to be a resonating chamber for certain consonants in speech during exhalation. This is evident during phonation (making the sound) of M, N, and NG, as sound passes upwards through the nasopharynx and is emitted through the nose. Many nasal conditions causing obstruction of the nose affect the quality of the voice.

OLFACTION

Our ability to smell stems from specialized olfactory neuroepithelium found high in the nasal cavity. Impaired olfaction is commonly observed in patients with sinonasal disease with a prevalence reported up to 30-60% of this patient population and is a criterion used for the diagnosis of chronic rhinosinusitis.

Olfactory dysfunction in rhinosinusitis is likely due to many different reasons, stemming from both physical obstruction and an inflammatory component that damages the olfactory neuroepithelium.

FILTRATION OF THE AIRWAY

As we breathe, the nose is constantly exposed to inhaled debris and microbes (viruses, bacteria, and fungus). The respiratory system has developed several lines of defense to combat this continuous assault. Larger particles are trapped by the nasal vibrissae (hairs at the front of the nose). Smaller particles are trapped in the mucus, considered to be one of the initial defenses of the airway.

Mucus is designed to trap inhaled particles (including microbes) that are subsequently cleared from the airways. Nasal secretions also contain enzymes, anti-microbial mediators, and immune cells, which kill unwanted bacteria and viruses.

The vast majority of mucus is propelled into the throat where it is swallowed and destroyed by the products of the stomach. Mucus containing pathogens and debris can also be coughed up or sneezed out.

3.3.3 CILIA

The mechanism by which mucus is propelled to the throat involves the rhythmic beating of very small cellular projections, known as cilia (which look like hair), which line the airways (Figure 4).

In order for the mucus produced in the sinuses to reach the throat, the cilia throughout the sinonasal cavity are “programmed” to beat in a very specific direction. Each sinus has an ostium (opening) that the cilia carry the mucus towards and through into defined anatomical areas within the sinonasal cavity .

The middle meatus is located lateral to the middle turbinate and accepts drainage from the frontal, maxillary, and the anterior ethmoid sinuses. Posteriorly, the superior meatus is below the superior turbinate, which accepts drainage from the posterior ethmoid sinuses.

The drainage continues medially into the sphenoethmoidal recess, which also accepts drainage from the sphenoid sinus and ends up in the nasopharynx or the upper part of the throat and subsequently swallowed.

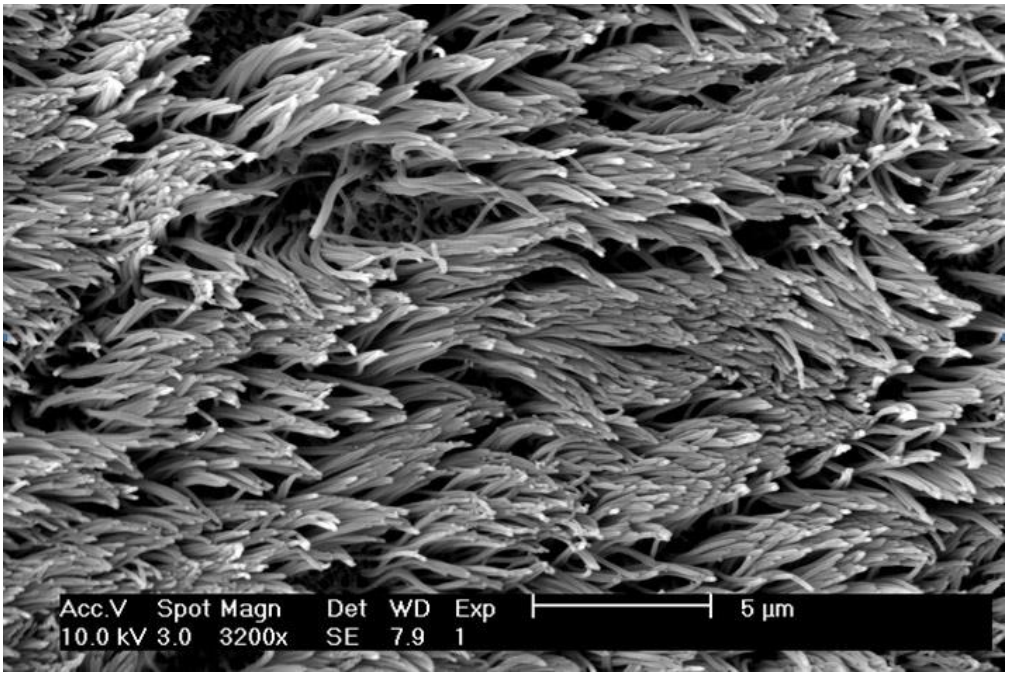
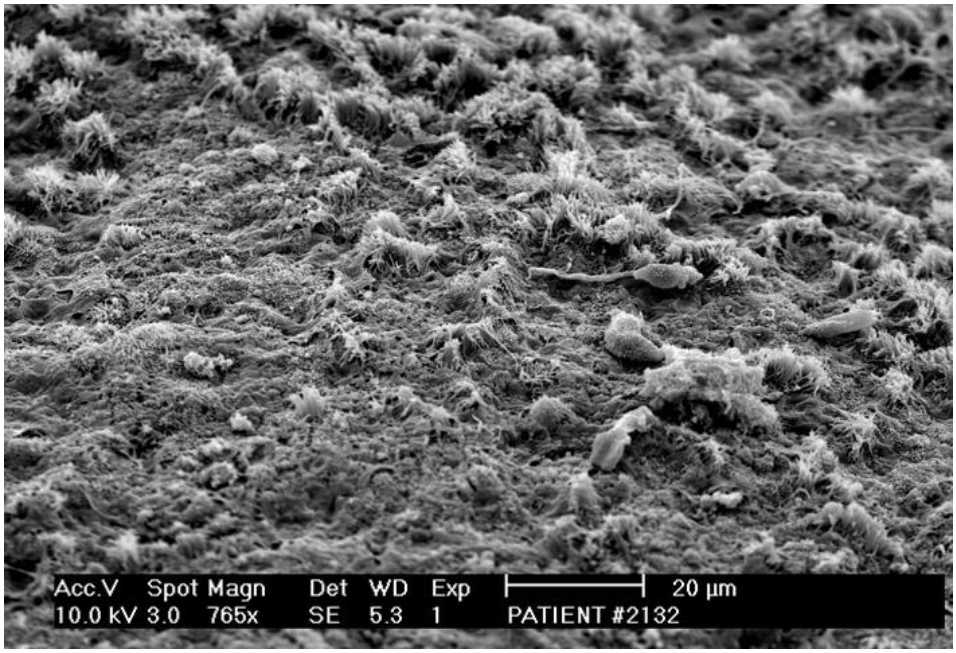


Figure 9: Representation of cilia in the upper respiratory system.

Cilia continuously beat to drive the debris-laden mucus from the airways. Ciliated cells have multiple sensors that allow the cell to respond to locally produced mediators and/or certain cues, such as changes in mucus thickness and mucus loads to make their cilia increase the speed at which they beat. By increasing the speed at which they beat, the cilia can generate more force and thus continue to clear the heavier mucus, or clear normal mucus at a faster rate.

Conversely, when mucociliary clearance is inhibited or slowed there may be an increased incidence of rhinosinusitis, as seen in patients with cystic fibrosis

While the ciliated cells respond to environmental cues, environmental insults can also affect cilia function in a detrimental manner. Many microbes that attack the airways produce toxins that rapidly alter cilia movement. Paralyzing the cilia stops the movement of mucus and optimizes the conditions for infection. Infection perpetuates a local inflammatory response and it is becoming clear that even the inflammatory molecules our bodies produce to fight infection also have detrimental effects on cilia function thereby worsening the insult and further hindering mucus clearance. The combination of microbes and inflammation over a relatively short period can lead to loss of cilia (Figure 5).



(fig 10)combination of microbes and inflammation over a relatively short period can lead to loss

The upper respiratory system needs a mechanism by which it can detect and initiate an appropriate response to microbes.

Bitter taste receptors (T2Rs), identified in the cilia of sinonasal epithelial cells, are an emerging receptor class that may be contributing to this mechanism via recognition and removal of microbes. For example activation of one specific T2R, T2R38, by molecules secreted by gram-negative (a particular type of) bacteria, stimulates the ciliated cells to produce nitric oxide, which in turn increases mucociliary clearance and directly diffuses into the mucus where it kills bacteria. Furthermore, genetic variability of T2R38 may explain why certain individuals are more susceptible to developing gram-negative infections and inflammation. Additional T2Rs are expressed throughout the respiratory epithelium but the role of these T2Rs have yet to be identified.

This combination of microbial and inflammatory products is often found in the upper airway of patients with chronic rhinosinusitis. The good news is that if the microbes can be removed and the inflammation controlled, the cilia can regrow and resume proper movement of mucus.(22)

3.4 ANATOMICAL AND HISTOLOGIC STRUCTURES OF RESPIRATORY MUCOSA

Dorsally to the vestibulum nasi, which is lined with squamous epithelium, lies the nasal cavity. This is coated with 120 cm^2 of pseudostratified columnar ciliated epithelium. The respiratory mucosa shows a thickness of 0.3–5 mm. Three (rarely four) turbinates protrude into the nasal cavity showing the thickest respiratory mucosa on their medial surface. In respiratory mucosa, several **specific cell types** can be identified. All cells are attached on the basal membrane. *Basal cells* lie on the membrane and show non-contact with the epithelial surface. Their specific morphologic features are desmosomes for cell adhesion.

Columnar cells represent up to 70% of the epithelium and have 300–400 microvilli on their surface. The general principle of microvilli is the increase in surface area to retain moisture and to prevent drying of the surface (23). Another 20–50% of epithelial cells are ciliated cell possessing 200–300 cilia on their surface, which are the morphological substrate of the mucociliary clearance. *Cilia* are 5 to 10 µm long and 250 nm thick and sheated in a plasma membrane. Within cilia, nine double tubules are arranged around two sheated central tubules. An inner sheath surrounds the central tubules. Outer pairs of microtubules (A and B-tubules) are connected to each other by nexin bridges and dynein arms and to the central pair by radial spokes.

Bending of the cilia occurs as an ATP-consuming mechanism, called “sliding filament mechanism”. Existence of non-motile cilia is discussed in cells without central double tubules acting as sensory antenna. Cilia are covered by a 10–15 µm thick layer of mucus, filling also the spaces between cilia (24).

In respiratory mucosa, goblet cells and seromucous glands in the adjacent connective tissue are typically found. *Goblet cells* represent 5–15% of cells in the respiratory mucosa and produce secretions for the endonasal mucus together with the submucosal glands. Next to their form, existence of microvilli and a small opening, called stoma, are their characteristics. They differentiate out of non-ciliated cells (25).In connective tissue, 20–80 *anterior serous glands* with 2–20 mm long ducts opening into small crypts are visible. Their importance is unclear (26)About 90,000 *seromucous glands* possess ducts lined by cubical epithelium and are organised in two layers. Moreover, 20–50 intraepithelial mucous glands are detected around a central lumen. Their contribution to mucus production is regarded as small.

At the anterior septum, epithelium is underlined by a 1.5 mm thick tissue of convoluted vessels, called Locus Kieselbachii. In addition, venous plexus are seen in the area of the inferior turbinate and the nasal septum, acting as swell bodies during the nasal cycle.

Dimensional orientation for healthy respiratory mucosa in a biopsy indicate a subepithelial capillary network with a diameter of 0.025 mm, below a 1.6–10 µm thick basal membrane covered with a epithelium showing 40–100 µm

height. Ciliated cells have a height of 15–20 µm and a width of 15 µm. Human cilia are about 6 µm long and 0.3 µm thick. Microvilli are 0.5–4 µm long and about 0.1 µm thick. These reference data are limited due to a high degree of variation depending on the endonasal localisation of cells.

As migrating cells, more T- than B-lymphocytes are detectable in subepithelial healthy tissue. The ratio of T-helper to regulatory T-cells (T-suppressor cells) is subepithelial 3:1 and in deeper layers 2:1 (27).Natural killer cells are rare. 50% of IL-5-positive cells and 100% of IL-6 positive cells are mast cells (28).

3.5 PHYSIOLOGY OF RESPIRATORY MUCOSA

Every day about 12,000 litre airflow is passing through the adult nose (29) and being hydrated (cf. article of Lindemann and Keck) and filtered. The nose is of extreme importance to protect the distal airways from deterious influence of gas, aerosol and pathogens. The nose and paranasal sinuses also act as area of voice resonance and produce nitric oxide (NO) for regulation of lower airways. Finally, the nose acts as chemosensoric organ responsible for smelling.

CLEANING FUNCTION

The nasal passage filters 95% of particles with a diameter of more than 15 µm out of inspired air (29).The cleaning function for pollen and dust of

smaller dimensions is severely diminished but not abolished (30).Liquids inhaled as aerosol will be eliminated from the upper airway if inspirited through the nose to 95% (mouth: 50%). Dosage of inhaled gas measured in the pulmonary alveoli will be diminished from 6–10% during mouth breathing to 0.9% during nasal breathing (31).

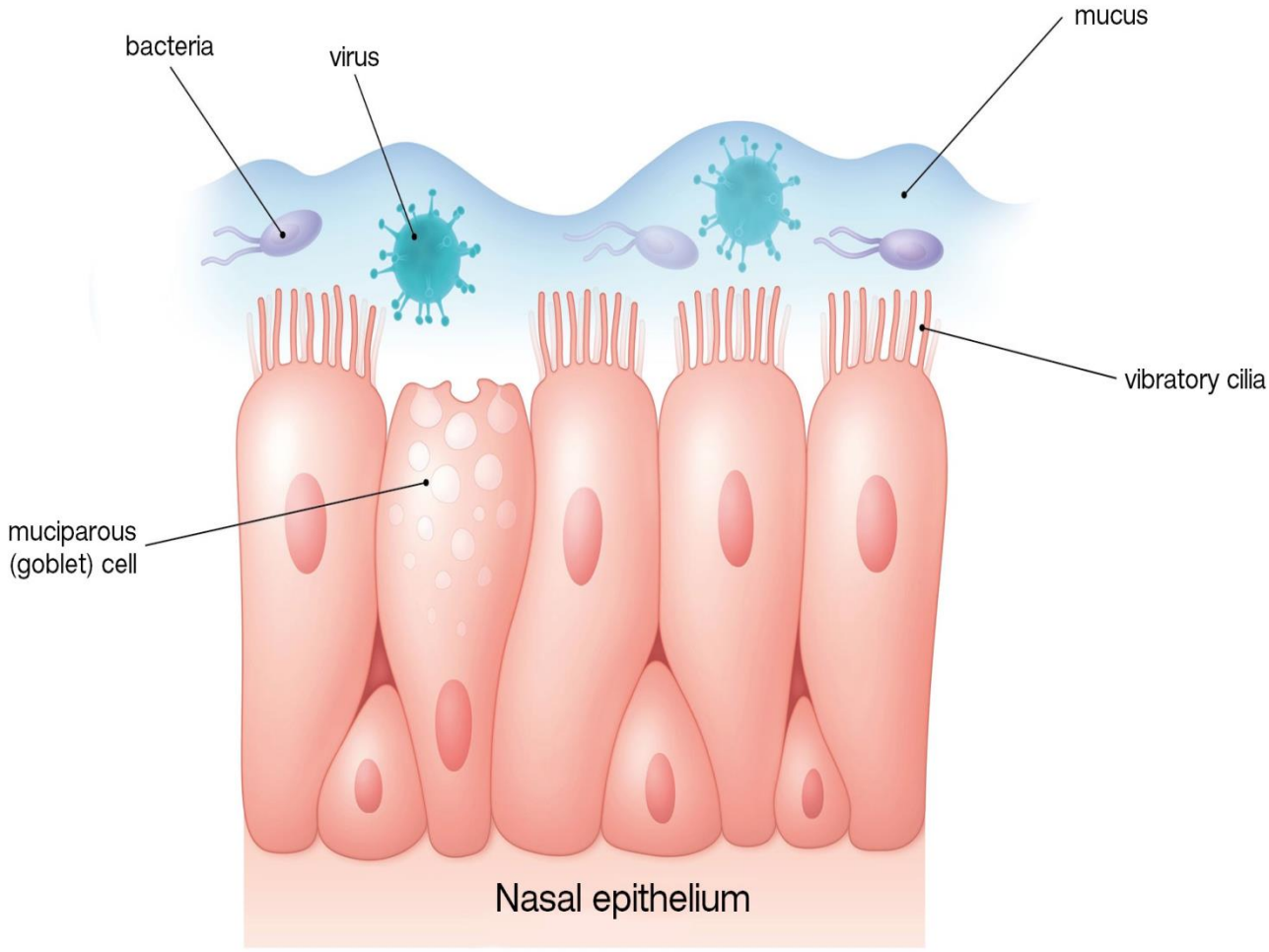


FIGURE 11 : NASAL EPITHELIUM

SNEEZE REFLEX

Sneezing aims for elimination of particles from the nose. This reflex is most complexly coordinated affecting also the solitary nucleus (32).Typically, sneezing will be provoked by foreign bodies in the anterior parts of the nose, which stimulate H1-receptors of trigeminal C-fibres (33).After inspiration (34) ceases to allow glottic closure, sudden contraction of abdominal and breast muscles happens. After glottal opening, liquid drops or foreign bodies are tossed from the nose at velocities of 50 m/s (35).This type of reflex can be triggered by light called photic sneeze reflex.

NASOLACRIMAL REFLEX

Nasolacrimal reflex results after chemical or mechanical stimulation of the nasal respiratory mucosa in increased lacrimal secretion. Afferent, C-fibre nociceptive neurons run together with the trigeminal nerve to the superior salivary nucleus, continuing via the geniculate ganglion, the large superficial petrosal nerve and through the pterygoid canal to the sphenopalatine ganglion. Cholinergic fibres reach together with the maxillary nerve the lacrimal gland [29]. Stimulation of one side leads also to a physiological, weaker reaction contralaterally [28] (36).

Unspecific defense mechanism

Static and dynamic mechanisms (structure of the epithelium, configuration of endonasal airflow) and regulated physical and chemical mechanisms (structure and content of nasal mucus, mucociliary clearance, nasal cycle,

plasma extravasation by NO [37]) assist in immune defense. Epithelial cells have a key position as a physical barrier and are the mainly responsible cells for maintaining the mucociliary transport. Respiratory mucosa of the nose is characterised by a high enzymatic activity, especially of the cytochrome P450 system (38) NO, produced mainly by the mucosa of the sinuses and released at the surface, is discussed to have bactericidal effects in the airway (39).

MUCOCILIARY CLEARANCE (MCC)

Mucociliary clearance is defined as cleaning of upper and lower airway by interaction of nasal mucus (about 200 g or 2 litre/day produced by the respiratory mucosa) (40)and ciliary beating. Number, structure and coordinated stroke of the cilia are as important as the biochemical, physical and chemical properties of the mucus. Nasal mucus has a weak, flexible, three-dimensional network formed from linear, hydrated mucin molecules. This is enhanced by disulfide bonds and secondary chemical connections between ions (41).

To prevent infections, mucus is slightly acid with a physiological pH-value of 5.5–6.5 and has a small capacity as chemical buffer. Via hydroxyl- (OH-) groups and oligosaccharide chains, negatively charged groups, the highly hydrated form of nasal mucus and the embedded network of linear and flexible glycoproteins, nasal mucus may form unspecific secondary connections, e.g. with pathogens or drugs. Viscoelasticity, adhesive and cohesive properties of nasal mucus are mainly determined by the

glycoprotein compound (41).They comprise a protein backbone covalently bound to oligosaccharide chains at a molecular mass of about 200 Kilodalton (kDa) and are responsible for the negative electric charge of the nasal mucus.

Optimal mucociliary clearance is achieved at 37° Celsius and 100% relative humidity (absolute: 44 mg/dm^3). Nasal Mucus is about 10–15 µm thick (42)and has two layers: the lower, 6 µm thick liquid layer (also called: periciliary liquid) is covered by the more viscous gel phase. The gel phase is structured by embedded mucin. Height of the liquid layers has tremendous effect of the efficiency of the ciliary stroke (43).Nasal mucus contains 90% water and glycoproteins as well as ions (cf. Table 1 (Tab. 1)).

It is produced by submucosal, seromucous glands, goblet cells, transsudation of blood plasma, mucosal tissue fluid and tear fluid. Due to transsudate, most proteins detectable in serum may also be demonstrated in nasal secretions. In cases of local inflammation, the amount of transudate and their respective proteins will increase.

Electrolyte	Concentration
sodium	128 to 150 mmol
potassium	17 to 41 mmol
calcium	4 mmol
magnesium	5 mmol
chloride	139 mmol

Table 1**Concentration of ions in the nasal mucus**

Due to the coordinated, metachronous ciliary stroke the mucus layer will be moved at a velocity of 2–25 mm/min (44)In detail, control of the ciliary beat frequency is unknown.

However, ciliary beat frequency will increase if cells are exposed to NO or a mechanical, calcium-mediated stimulus (45)whereas IL-13 will decrease the frequency(46). In addition, intensive physical activity will decrease mucociliary clearance (47).

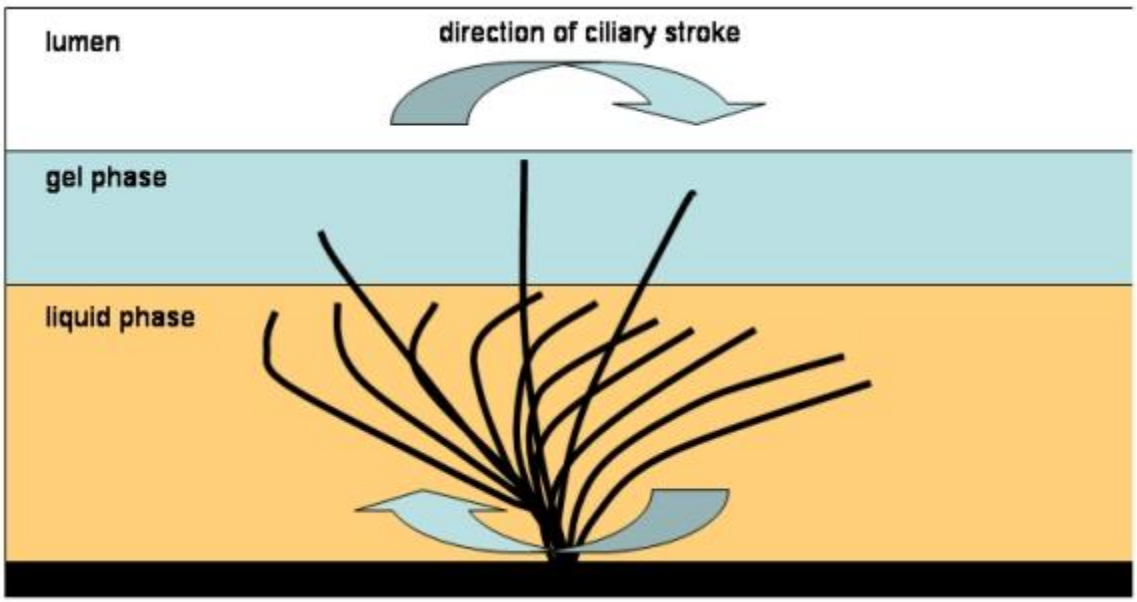


Figure 12 : **Schematic drawing of the ciliary stroke in nasal mucus**

Particles bound to the mucus layer will be transported towards the pharynx passing the hiatus semilunaris. A second stream runs from the sphenoid sinus to the posterior ethmoid towards the choanae. Within a paranasal sinus, mucociliary clearance will always be orientated towards the primary natural

opening(48), while accessory ostia are bypassed by the mucociliary clearance.

Next to water and electrolytes, immune globulin (Ig) G and A can be detected in high concentrations in nasal mucus.

Secretoric Ig-A (up to 80% Ig-A1; among others against Coxsackie viruses and polio virus) is an obligatory ingredient and may provide up to 50% of the total protein of nasal secretions (49).It is secreted into the tissue from plasma cells located near the basal membrane of the glands to bind and neutralise the antigen.

Due to this effect, Ig-A is discussed as an important factor in pathogenic microbiological colonisation of respiratory mucosa. Ig-G is synthesised in nasal submucosa and secreted after muscarinergic stimulation or exposition to histamine (50).In physiology, Ig-M is not detectable, while Ig-E levels are below serum concentration. Moreover, lipids (e.g. surfactant [0.8%] and carboanhydrase [1%]) may be detected.

Application of sodium-chloride leads to increase of ciliary beat frequency (51)and thereby improvement of mucociliary clearance. According to a Cochrane review (52) salt concentration is of minor importance. On the other

hand – depending on the pathophysiology – hypertonic solutions in chronic rhinosinusitis and isotonic salty solutions in acute sinusitis may be beneficial (53).

HUMORAL MECHANISMS

Unspecific substances for immune defense are localised in the epithelium and in nasal secretions. These include lysozyme (attacks peptidoglykans in the cell wall of gram positive bacteria), lactoferrin (inhibits bacterial growth) (54) and oligosaccharides (bind bacteria) (55) .

Furthermore, neutrophil granulocytes produce proteases and hydrolases to destroy the cell membrane of bacteria and viruses. The 20 proteins of the complement system are detectable in blood and in tissue. They destroy foreign structures and marker pathogens for phagocytosis. The kinin-kallikrein system activates an inflammatory response after viral invasion by vasodilatation. Intracellular interferon impedes viral replication and inhibits ongoing viral infection.

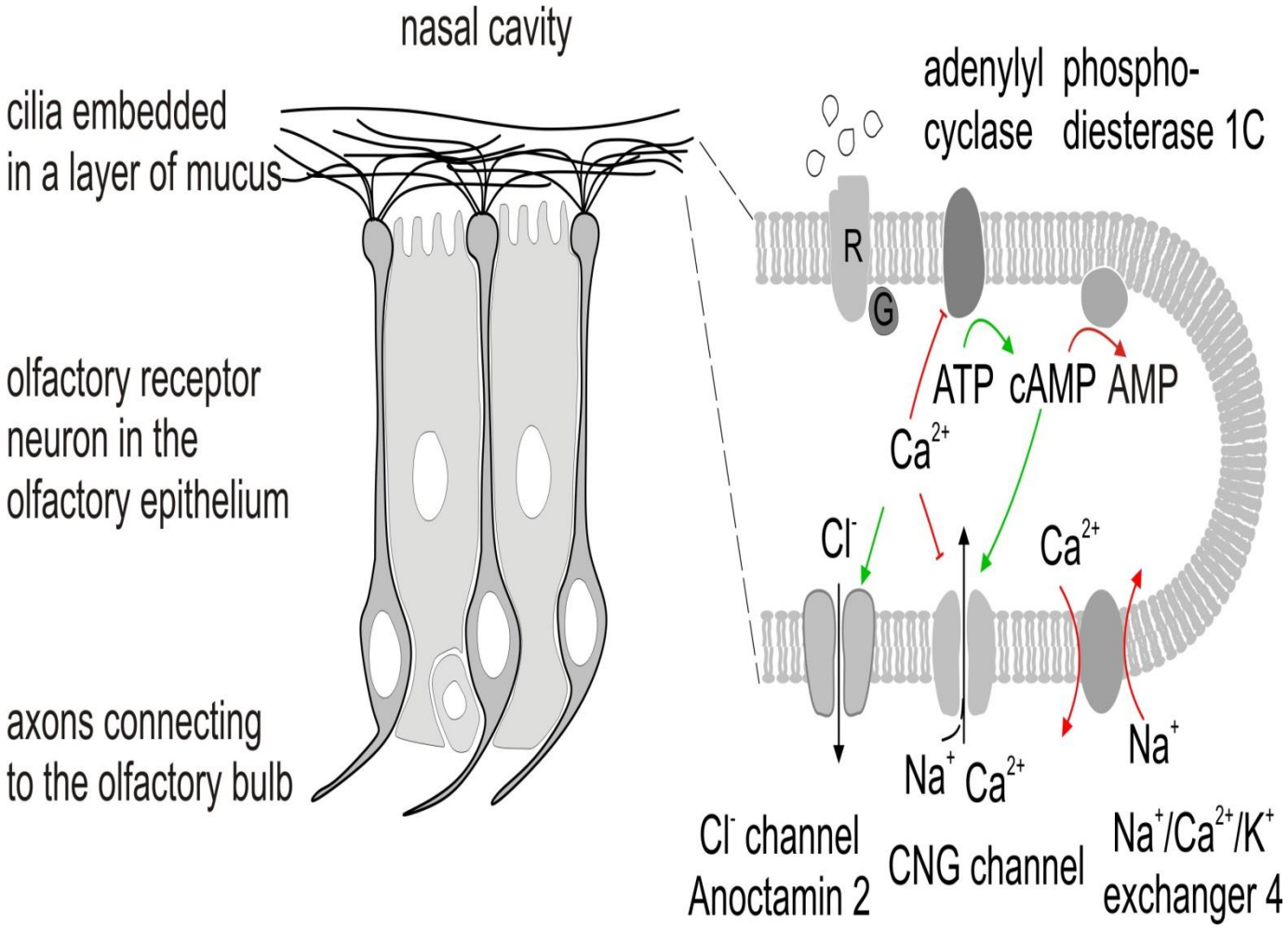


FIGURE 13 : BIOCHEMICAL MECHANISM IN NASAL CAVITY

CELLULAR MECHANISMS

Neutrophil granulocytes, monocytes and macrophages are cellular components of the host defense using phagocytosis in the subepithelial tissue of the nose and sinuses. Immigrated natural killer cells destroy infected cells. Under physiologic conditions, importance of cellular mechanisms is subordinated to unspecific components of immune defense. In case of

pathogen invasion, multiple immunocompetent cells immigrate, and increase the importance of cellular defense. The specific immune system in nasal respiratory mucosa is part of the lymphatic system (*mucosa-associated lymphatic tissue;* MALT).

NASAL CYCLE

Nasal cycle is defined as spontaneous and reciprocal change of nasal congestion without change of the total nasal airflow. It was first described by R. Kayser in 1895 (56) According to literature, nasal cycle can be detected in 70–90% of humans (57),(58).

The nasal cycle is regulated by the hypothalamus (60) with efferents running along the vidian nerve and showing an asymmetrical activity in controls (61) Changes of volume in the erectile tissue of the septum, the inferior and middle turbinates and even in the paranasal sinuses can be demonstrated (62).

The working and resting phase can be easily distinguished. During the working phase the nasal passage is characterised by an increased hydraulic diameter, passage of nasal airflow and turbulence, while resistance is decreased.

During resting phase resistance is raised, while hydraulic diameter, transnasal airflow and turbulence are diminished (63). Mucociliary clearance is enhanced by factor 2.5 in a working phase in comparison to the contralateral resting phase (64) Resting phase allows gathering of mucosal moisture (64), Mucosal cleaning and regeneration as well as improved host defense are

discussed as advantageous during the evolution, eventually leading to the development of the nasal cycle (65).

3.6 JALA NETI

Jala neti exert a profound physiological effect on the body, mind and personality. On the physical level irrigation of the nasal mucosa removes accumulated mucus from the nostrils, associated passages and sinuses, allowing air to flow without obstruction.

The membrane lining the nostrils secretes a protective film of sticky mucus. Tiny hair like cilia promote the movement of this mucus, along with the pollutants, dust etc.., which adhere to its surface. The nasal membrane is highly innervated by nerve fibres and is perhaps the most sensitive area of the whole body.

Regular practice of neti maintains healthy secretory and drainage mechanisms of the entire ear, nose and throat area. This helps to ward off colds and coughs, allergic rhinitis, hay fever, catarrh, and tonsillitis.

It also gives resistance to various diseases of the ears, eyes and throat such as myopia, tension head ache due to eye strain, certain cases of deafness such as glu ear and middle ear infections, inflammations if the adenoids,as well as inhibiting the formatipn of nasal polyps(66).

PRECAUTION

To complete the purification of the nose, strongly expel the breath a further 3-5 times through each nostril while holding the other nostril shut (as when blowing your nose). It is important that the mouth remains open during this process to prevent water getting into the ears.

FIGURE 14 : PRACTICE OF JALA NET

BENEFITS

- Neti removes all the dirt and bacteria filled mucus from the nasal cavity
- Helps to drain sinus cavity which helps to reprogramme the bodys natural mechanism against nasal infections
- Thinning remaining mucus so that sinuses and ostia don't clog[67,68]
- Decreasing swelling of the nasal mucosa[67,69]
- Removing histamine, leukotrienes, and other inflammatory substances[67, 70]
- Increasing frequency that cilia beat to remove mucus, crusts and debris
- It has coling and soothing effect on the brain by drawing out excessive heat and therefore beneficial for headaches and mental tension
- Has a positive influence on all sense organs in the head. Strengthens vision and relieves tired eyes (e.g. after working long hours at the computer
- Neti can also cure or at least ease hay fever and pollen allergies.(71)

3.6.1 EFFECT OF JALA NETI(NASAL SALINE IRRIGATION) ON RESPIRATORY MUCOSA

CILIARY BEAT FREQUENCY

Nasal epithelial cell culture can be used to examine ciliary beat frequency (CBF) in response to various agents. Cells are bathed in a test solution and CBF monitored to assess whether the solution affects ciliary function. Isotonic saline causes either slowing or no effect on CBF *in vitro*. Hypertonic (3%, 7%) saline rapidly causes reversible ciliostasis with stronger (14%) solutions causing irreversible ciliostasis. Hypotonic solutions (0.06% and 0.12%) have no effect on CBF(72).

WATER ABSORPTION

Jepsen (73) used tissue culture to look at various common topical nasal preparations and their effects on sodium and chloride transport across nasal epithelium. Ipratroprium and azelastine both perturbed the integrity of the epithelia. Saline and fluticasone caused increased sodium absorption and therefore increased water uptake into the cells. Saline also increased chloride uptake.

MUCOCILIARY CLEARANCE TIME

Mucociliary clearance time (MCT) is a general measure of sinonasal health and can be measured in various ways *in vivo*. Saccharin granules can be

placed on the tip of the inferior turbinate and the time measured until the subject detects

a sweet taste.

Talbot(74) measured saccharin clearance time in 21 healthy adults before and after atomized isotonic or 3% saline was introduced into the nose. He found isotonic saline sped clearance time by 2%, while the hypertonic solution sped clearance by 17% 10-20 minutes after treatment

Daviskas(75) found speeding of pulmonary mucociliary clearance time in both asthmatic and healthy subjects after inhalation of 14% saline, with the effect lasting 15-20 minutes.

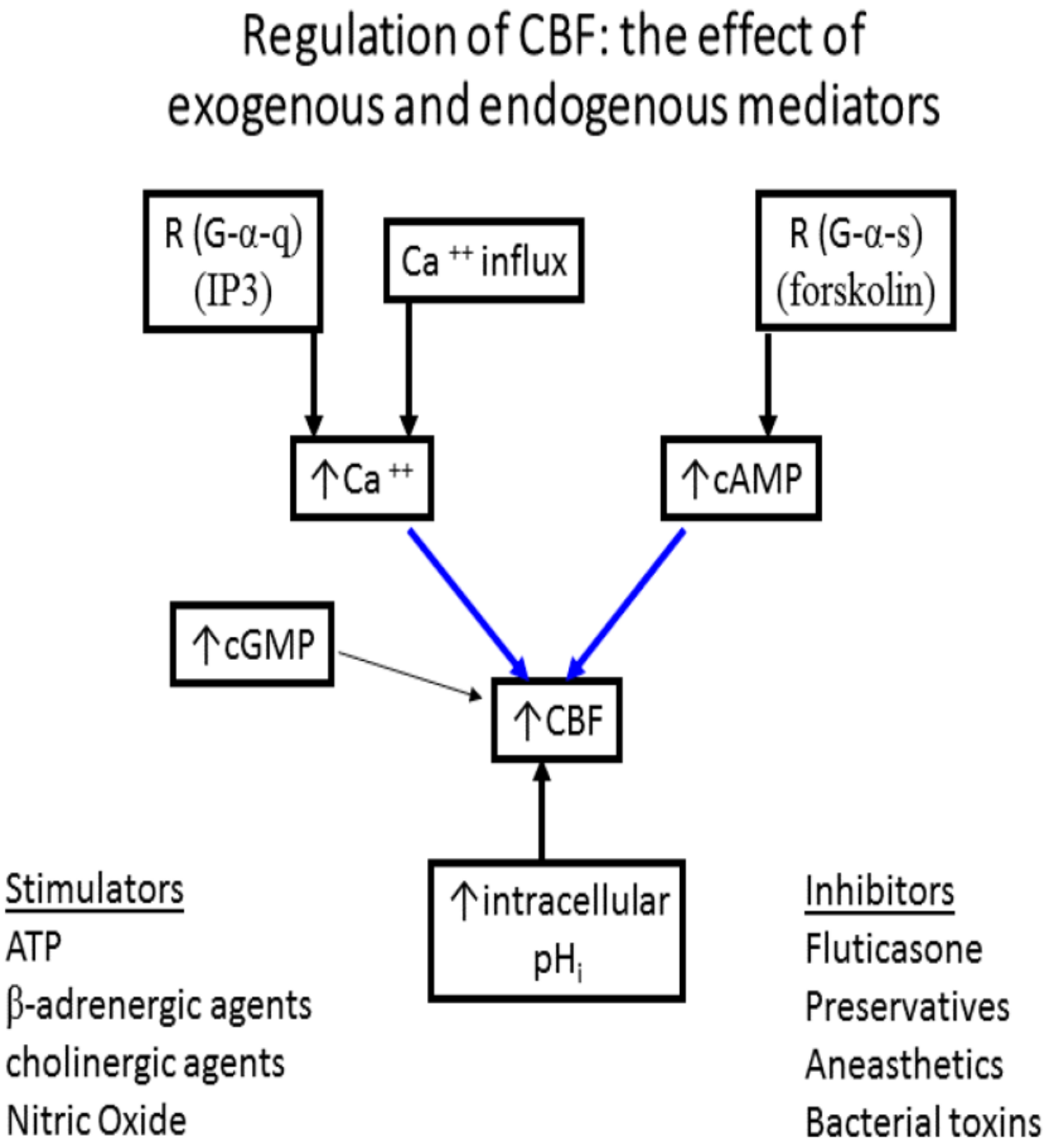


FIGURE 15 : REGULATION OF CILIARY BEAT FREQUENCY

INFLAMMATORY MEDIATORS

Inflammatory mediators cause extravasation of plasma proteins into the airway lumen .This normal defense mechanism may be exaggerated in people with airway disease.

Histamine is one mediator that causes plasma exudation. Methacholine, on the other hand, causes direct mucus secretion into the airway lumen.

In 16 healthy subjects mucus secretion and plasma exudation into the nasal airway was measured after lavage with isotonic saline, 3% saline and 5% saline(76). Both hypertonic solutions caused mucus secretion, and potentiated the plasma exudation of histamine and the mucus secretion ofmethacholine. Hypertonic-saline-induced increase in mucus secretion may reflect sensory nerve irritation by the solution with substance P release.

AIRWAY SURFACE LIQUID

Sood (77) found that acutely increasing airway surface liquid volumes does speed mucociliary clearance in normal subjects. He studied 16 volunteers treated with the sodium blocker amiloride and various concentrations of aerosolized saline, following clearance with a gamma scan every 10 minutes for 2 hours and again after 24 hours. Mucociliary clearance was equivalent in hypotonic (0.12%) and isotonic saline, and much faster with hypertonic (7%) saline. Most of the effect was apparent in the first 20 minutes.

CHRONIC SINO NASAL DISEASES

Rabago(78) prospectively followed 69 adults with chronic sinonasal symptoms over 6 months. The use of daily 2% saline irrigation with a SinuCleanse™ neti pot was compared to a control group who received no specific intervention. In the irrigation group, there was improved score on the RhinoSinusitis Disability Index (RSDI), decreased symptom severity, and less antibiotic and nasal steroid spray use compared with controls.

In a follow up study of the same individuals(79), 54 subjects continued to participate for 12 additional months RSDI and symptoms improve even further. On average, participants use nasal irrigation 2.4 times weekly, with one-third using it regularly and the others only when symptomatic. Side effects are infrequent and minor, and satisfaction with this form of therapy is high.

Shoseyov(80) treated children with chronic sinonasal symptoms with isotonic versus 3.5% saline, using nose drops three times daily over 4 weeks. After an initial 3-day complaint of more burning in the hypertonic group, this group improved in cough,

post-nasal drainage, and radiographic score compared to the isotonic saline group, which only improved in post-nasal drainage.

Of 150 adults with chronic sinusitis who used daily hypertonic (2-3%) saline nasal irrigation with a SinuCleanse™ neti pot or a bulb syringe for 14 days,

over 70% improved Rhino Sinusitis Outcomes Measure-31 symptom scores and 1/3 decreased use of other sinus medications(81).

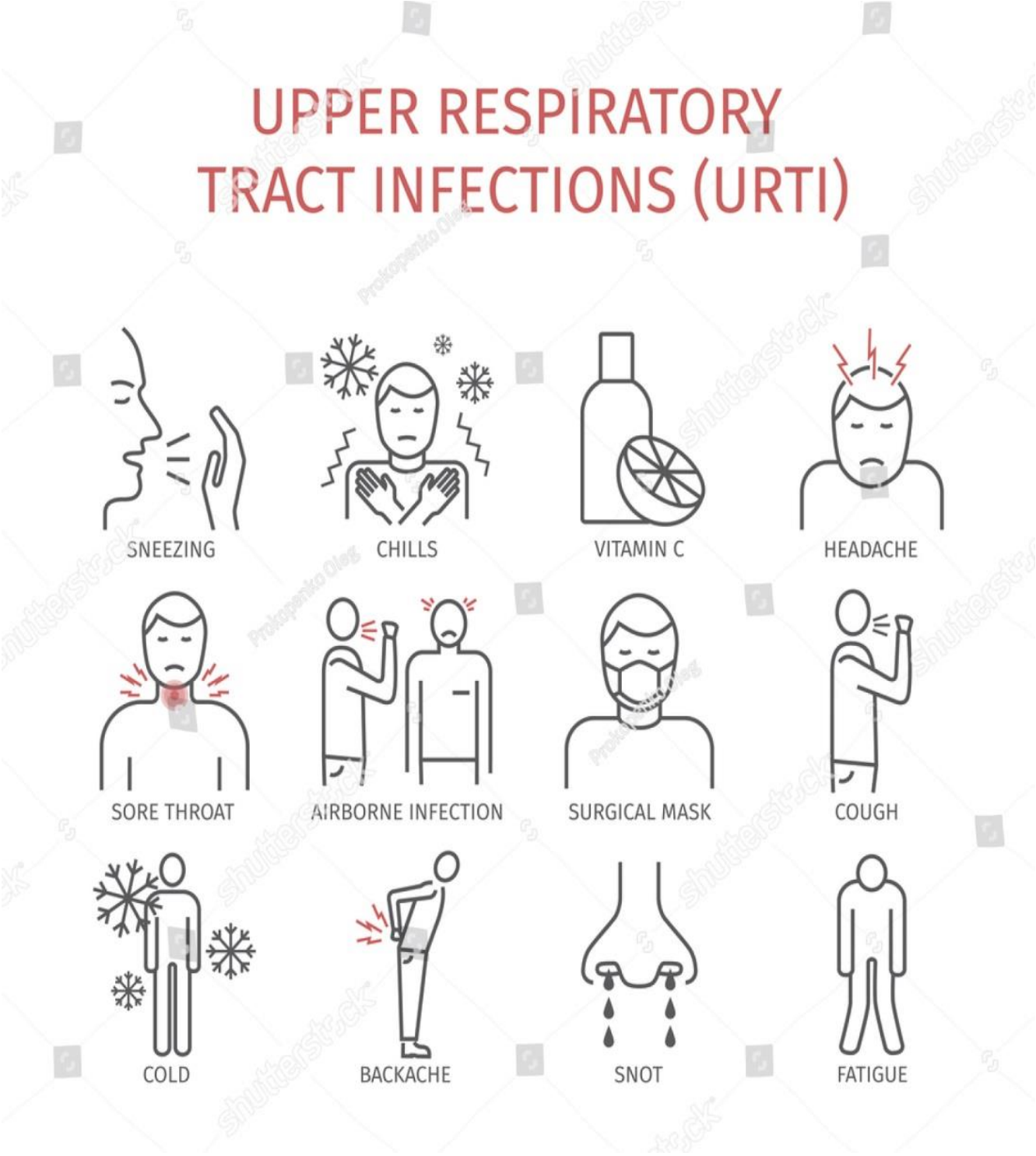


FIGURE 16 : COMMON SYMPTOMS OF UPPER RESPIRATORY TRACT INFECTIONS

3.7 MECHANISM OF ACTION OF JALA NETI (NASAL IRRIGATION)

The exact mechanisms by which NI works are not known. However, most of the experts think that it is primarily a mechanical intervention leading to direct cleaning of the nasal mucosa, independent of the composition of the solution used for nasal washing (82).

The mucus lining the nasal cavity may be softened and dislodged. Moreover, inflammatory mediators—such as prostaglandins and leukotrienes—and antigens responsible for allergic reactions can be removed favoring resolution of URTIs and AR (83,84,85) . However, some data seem to indicate that the composition of the solution can influence some aspects of the NI action. Although the impact of the salt concentration on mucociliary clearance through a modification of ciliary beating frequency is not defined because data collected in vitro and in vivo have been contradictory, it has been demonstrated that the composition and activity of nasal secretions are related to the tonicity of the solution (86).

The activity of NI seems further increased by the addition to the solution containing ions different from Na^+ and Cl^- because they can exert a relatively positive effect on epithelial cell integrity and function. Magnesium (Mg) promotes cell repair and limits inflammation by reducing the eicosanoid metabolism both at the level of the liberation of arachidonic acid and by direct inhibition of the 5-lipoxygenase enzyme (86).

3.8 COMPOSITION OF SOLUTIONS COMMONLY USED IN NASAL IRRIGATION

Isotonic saline (0.9%) and hypertonic saline (1.5% to 3%) are the most common commercial preparations used for NI. Both are acidic, with pH values varying from 4.5 to 7. Solutions with NaCl concentrations higher than 3% are not recommended, although the emergence of adverse events due to hypertonicity—such as sensations of pain, blockage, and rhinorrhea—have been demonstrated to be dose-dependent and occur only when the NaCl concentration is ≥5.4% (87).

Solutions for NI can also be prepared at home according to the suggestions of several authors and institutions. In general, boiled water mixed with table or canning salt is used.

3.9 MEANS OF NASAL IRRIGATION

Several methods, including the one based on the old neti pot simply filled with lukewarm water, can be theoretically used to perform NI (89).

To maximize the efficacy, large-volume (no less than 100 mL) low-pressure irrigation is preferable to low-volume high-pressure irrigation (90).

3.10 TOLEREBILITY AND SAFETY OF NASAL IRRIGATION.

Adults generally have minimal side effects from NI. Transient adverse reactions, such as nasal irritation, nasal discomfort, otalgia, or pooling of saline in paranasal sinuses with subsequent drainage, have been described They are more common (10–20% of the cases) when very high volume devices are used. However, because they are mild in most of the cases, compliance is high (91).

Attention should be paid to the temperature of the solution because solutions that are either too cold or too hot can cause problems of tolerance.

The problem of sterility of the solutions and devices has been debated. Solutions are at risk of contamination when large volumes of solution based on distilled water, bottled water, or boiled water are prepared at home, maintained in containers and used each time when NI is needed by withdrawing the required amount of liquid. Devices can be contaminated when they are continuously used without adequate cleaning (92).

3.11 NASAL PEAK INSPIRATORY FLOW METER(NIPF)

NIPF is inexpensive, easily applied, fast, portable, simple to measure, does not depend on computers to analyze the data and has good reproducibility. Both rhinometry as well as the NIPF are accurate to detect nasal obstructive changes, with 0. 77 vs. 0. 66 of sensitivity, respectively. The methods' specificity is 0. 8 with a diagnostic accuracy around 0. 75. The cutting value for the peak flow measured by the NIPF, according to some authors, is less than 120 l/min.(93).

Acoustic rhinometry, rhinomanometry and Inspiratory Peak Nasal Flow (IPNF) are used in order to objectively assess nasal patency. These are expensive not very practical tests, except for IPNF, which is a fast, simple and low cost method. The objective of the study is To assess IPNF in healthy individuals complaining of nose obstruction caused by allergic rhinitis(93).

FIGURE 17. NASAL INSPIRATORY PEAK FLOW METER

Changes in PNIF seen after FESS correlate well with improvements in subjective QOL. As an investigation that is convenient and inexpensive, the PNIF meter can be successfully utilised as an objective assessment tool in functional endoscopic sinus surgery.(94)

PNIF is an inexpensive, fast, portable and simple technique, which does not depend on computers to analyse the data. It has a good reproducibility (95,96)) with a correlation coeffi- cient up to 92% (97). Furthermore, PNIF, measuring nasal flow, gives a direct measure of nasal obstruction (98). Presented by Youlten in 1980, PNIF is a modification of the Wright peak flow meter (99) and consists of a face mask which the patient applies over the nose (without touching it) with the mouth closed.

The patient must be encouraged to inhale as hard and fast as he can through the mask keeping the mouth closed starting from the end of a full expiration [residual volume method]. Three satisfactory maximal inspirations are usually obtained and the highest of these results is taken as the PNIF (100).

PNIF should be measured standing because PNIF measures, as PEF measurements, are higher when standing than sitting PNIF especially in females (101). PNIF increases with practice, particularly after the first attempt, so it is important to allow the patient a few tries before taking the three measurements(101).

(FIGURE 18) PATIENT WITH NPIF METER

4.0 METHODOLOGY

The methodological process involved in the following study is described in detail in this chapter.

4.1 STUDY DESIGN:

The study employs Pre and Post Interventional study. This particular study is tailed majorly towards evaluating the Immediate effect of Jala neti on Nasal Peak Inspiratory flow rate on healthy volunteers.

4.2. ETHICAL CONSIDERATIONS

4.2.1 Ethical clearance

Ethical clearance was sought from the Institutional Ethics Committee prior to the start of the study and the approval for the same was granted.

4.2.2 Written informed consent

Subjects who fulfilled inclusion criteria were apprised about the purpose of the study and their rights as research subjects. Informed consent form was administered in English.

As all the subjects understood spoke English, there was no requirement of translating the signed informed consent form into native language i.e.,

Tamil. Adequate time was given to each patient to go through the information sheet and their queries were answered.

Their right to withdraw anytime from the study and the need for willingness to participate voluntarily in the study was explained. All the subjects expressed their willingness to participate in the study by giving a signed informed consent.(A sample information sheet and consent form is enclosed as Annexure 1.

4.3 SUBJECTS:

The study subjects, comprised of 60 healthy volunteers of age group between 18 -25yrs will participate in the study. The subjects will be referred by outpatient department of Government Yoga and Naturopathy Medical College Hospital, Chennai.

After obtaining informed consent, the selected individuals would be subjected to two practices of Jala neti. After the practice , the individuals are made to perform Jala neti

(nasal irrigation) under the supervision of yoga Experts. After obtaining informed consent the nasal peak inspiratory flow is measured using nasal peak inspiratory flow meter. The collection of first data is before the practice, Second data is taken immediately after the procedure.

4.4 SUBJECT SELECTION:

Taking the subjects who are satisfying the following inclusion & exclusion criteria

4.4.1 Inclusion Criteria

- Age group: 18 to 25 years
- Both sexes
- People who are ready to give their consent

4.4.2 Exclusion Criteria

Participants will be excluded if they have

- Systemic issue or Chronic illness
- Active athletes
- Under medication
- Regular practice of yoga for the past 3 months
- Recently hospitalized
- Pregnant and lactating women
- Sports person

4.5 Sample Size

60 healthy volunteers of age group between 18 -25yrs will participate in the study. The subjects will be recruited from the Out – patient department of Government Yoga and Naturopathy Medical College Hospital, Chennai

4.6 Withdrawal Criteria:

All subjects are free to withdraw from participation in the study at any time, for any reason, specified or unspecified, and without prejudice to further yogic practices. Subjects who are withdrawn from the study will not be replaced

4.7 Methodology:

A single group pre-post study design will be adopted in this study. Sixty healthy volunteers of age group between 18-25yrs will participate in the study. The subjects will be recruited from the Out-patient department of Government Yoga Medical College Hospital, Chennai.

After obtaining informed consent, the selected individuals would be subjected to two practices of Jala neti. After the practice , the individuals are made to perform Jala neti(nasal irrigation) under the supervision of yoga Experts. After obtaining informed consent the nasal peak inspiratory flow is measured using nasal peak inspiratory flow meter. The collection of first data is before the practice, Second data is taken immediately after the procedure

4.8 Procedure for Jala neti

4.8.1 Stage I: Washing the nostril

- The neti pot is filled with the prepared salt water.
- The individual is made to Stand squarely, legs apart, with the body weight evenly distributed between the feet, and lean forward.
- The individual is made to Close the eyes for a minute or so and relax the whole body.
- And the head is tilted to one side and slightly back.
- They are advised to breathe through the mouth. By Gently inserting the nozzle into the uppermost nostril. There should be no force involved.
- The nozzle is made to press firmly against the side of the nostril so that no water leakage occurs.
- The neti pot is tilted in such a way that water runs into the nostril and not down the face.
- The body position is adjusted to enable the water to pass out through the other nostril. When half the water has passed through the nostrils, the nozzle is removed from the nostril, centre the head and let the water run out of the nose.
- Any mucus from the nose is removed by blowing gently.

- The head is tilted to the opposite side and the process is repeated , by placing the nozzle of the lota in the other nostril. After completing this process the nostrils must be thoroughly dried.

Stage 2: Drying the nostrils

- The individual is made to Stand erect. Closing the right nostril with the right thumb and breathe in and out through the left nostril 5 to 10 times in quick succession, emphasizing exhalation as in kapalbhati pranayama.
- Repeat through the right nostril, with the left nostril closed. Perform once more through both nostrils.
- They are advised to Bend forward from the waist so that the trunk is horizontal. Repeating the same process as described above but tilt the head to the right, closing the right nostril. Repeated again, tilting the head to the left and closing the left nostril. Finally, repeat again with the head centred, breathing through both nostrils.

4.9 Time period for data collection:

1. Base line (before): PNIF values are recorded before the practice.

2. Post Data : PNIF is recorded immediately after the practice.

4.10 DATA EXTRACTION

4.10.1 Nasal Peak Inspiratory Flow Rate.

PNIFR measurements were performed with a Youlten Peak flow meter which is similar to a mini-Wright flow meter. Peak Nasal Inspiratory Flow Rate expressed in L/min is defined as the maximal instantaneous airflow achieved during forced inspiration through the nose. Asking the patient to take a deep, quick forced inspiration after having expired normally, performs the test. The amount of air left in the lungs after a tidal breath out is the Functional Residual Volume (FRV).

Then the patient is instructed to inspire deeply through the nose, so that the Total Lung Capacity (TLC) is achieved. Total Lung Capacity (TLC) is the total volume of gas contained in the lungs at the end of a maximal inspiration. The apparatus function was demonstrated and each subject was instructed how to inhale forcefully.. The Youlten Peak flow meter is a rather inexpensive portable device which is easy to use and which should be available, in clinical practice, to all physicians.

The mean average values are collected from three pre and post recordings.

4.11 Statistical Analysis:

Paired t test or one way ANOVA followed with post hoc test was performed to find the variation of mean using R statistical software.

FIGURE 19: PRACTICE OF JALA NETI

FIGURE 20 : ASSESMENT OF PEAK NASAL INSPIRATORY FLOW RATE

5.0 RESULTS

5.1 Introduction

The following chapter represents the overall results of the current study that determines the effectiveness of Jala neti practice on peak nasal inspiratory flow rate, which were further subjected to statistical analysis.

5.2 Statistical analysis

The results for the following studies were statistically determined for PNIFR and the results were graphically plotted by R-statistical software. The following data for each subsets were expressed Mean± SD.

JALA NETI ON NASAL PEAK INSPIRATORY FLOW RATE

Table: 2 Comparison of Peak Nasal Inspiratory Flow Rate before and after jala neti practice

Variable	Yoga group		P value
	Pre	Post	
PNIF L/min	84.56±13.25	110.85±12.56	0.001

The Resultant table Impacts that the immediate effect of Jala neti on Peak Nasal inspiratory flow Before the practice (84.56 ±13.25) was improved to (110.85±12.56). And was statistically significant with Pvalue (0.001)

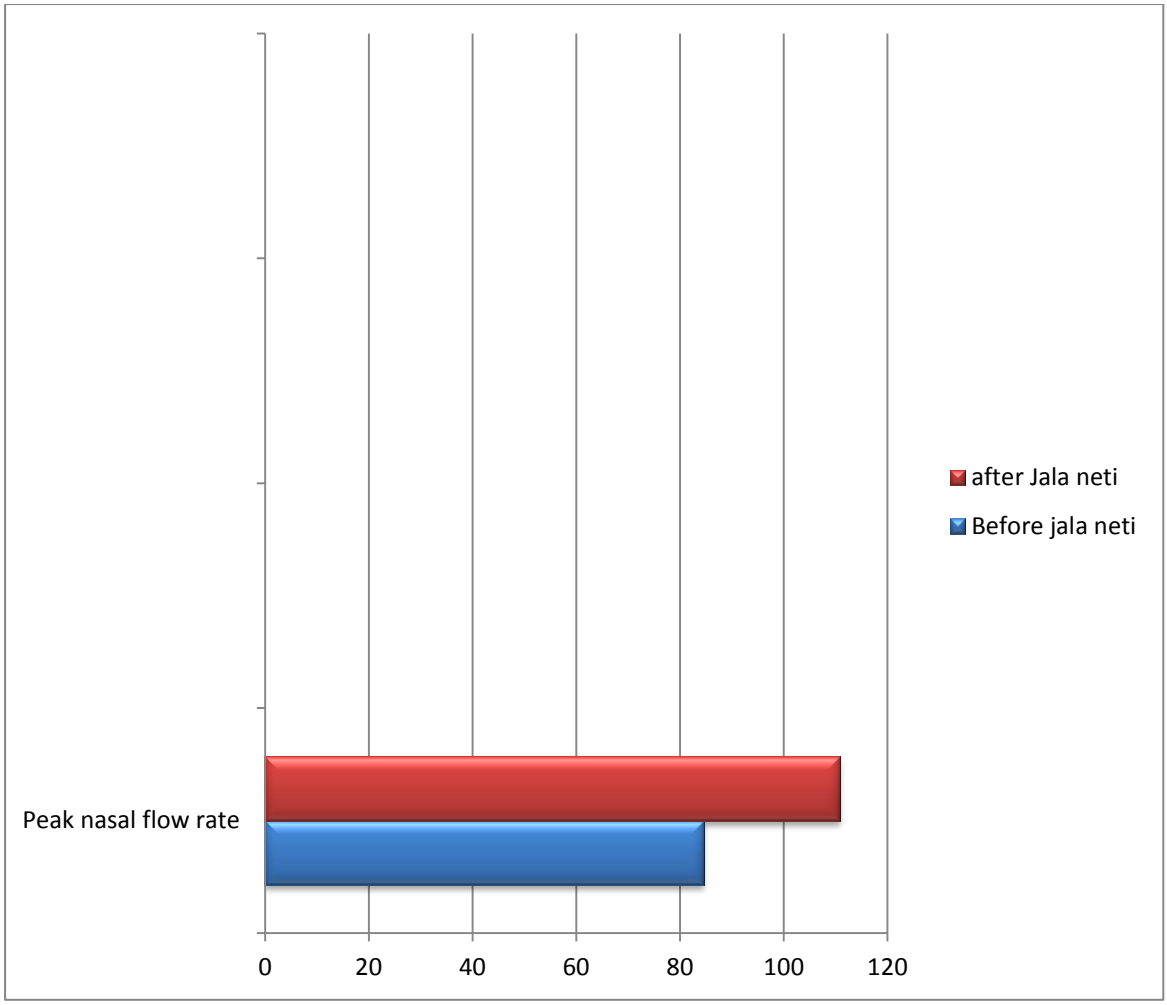


FIGURE 21 ;GRAPHICAL REPRESENTATION OF JALA NETI ON PNIFR(L/MIN)

The above Figure provides a graphical illustration, representing the overall changes observed in the PNIFR, before and after the completion of intervention.

Table: 3 Comparison of Peak Nasal Inspiratory Flow Rate before and after jala neti practice among the male participants

Variable	Yoga group		P value
	Pre	Post	
PNIF L/min	86.45±12.82	124.25±10.96	0.02

The Resultant table Impacts that the immediate effect of Jala neti on Peak Nasal inspiratory flow among the male participants Before the practice (86.45 ±12.82) was improved to (124.25±10.96). And was statistically significant with p value(0.02).

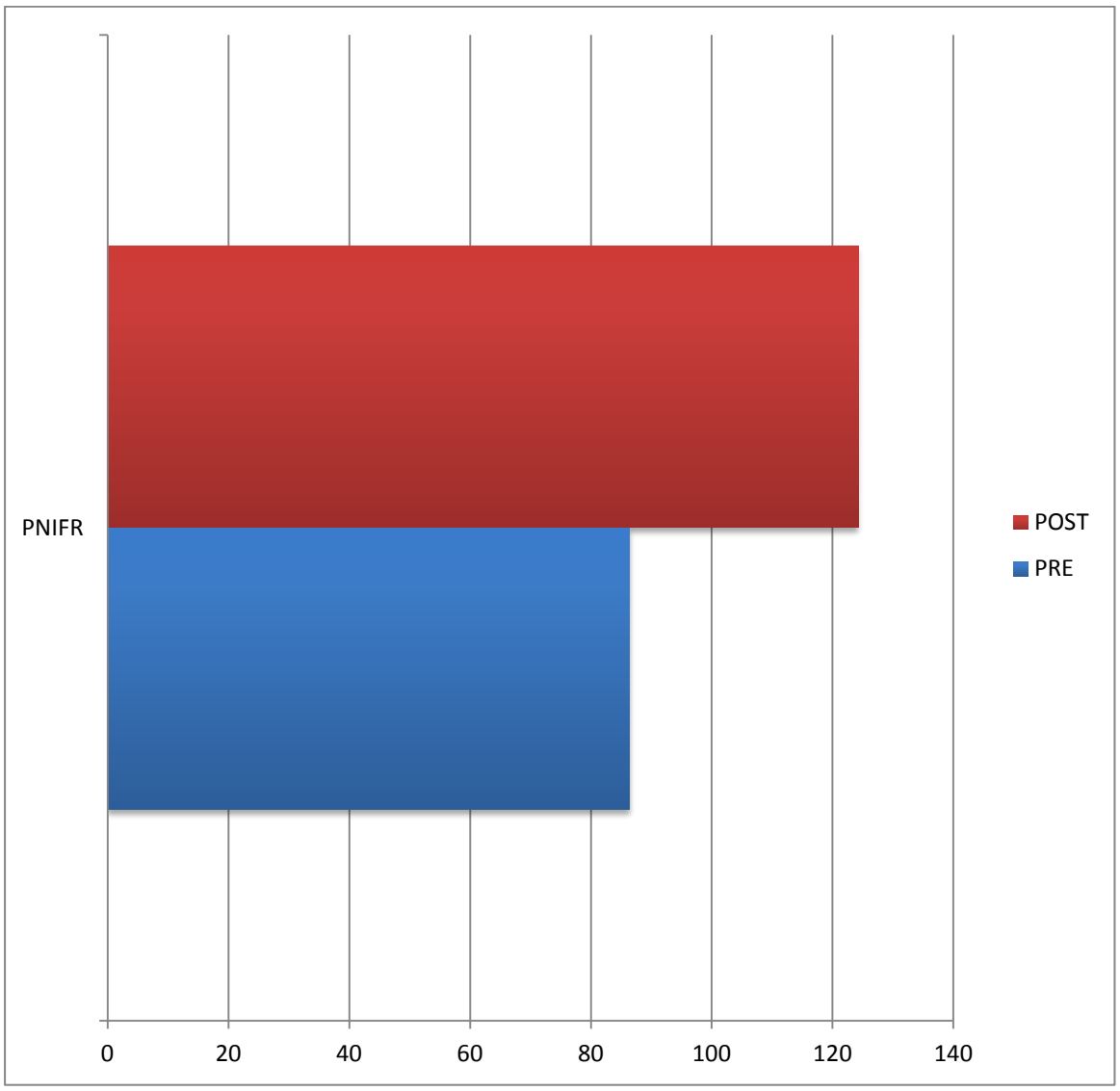


FIGURE 22 ;GRAPHICAL REPRESENTATION OF JALA NETI ON PNIFR(L/MIN) AMONG MALE PARTICIPANTS

The above Figure provides a graphical illustration, representing the overall changes observed in the PNIFR ,among male participants before and after the completion of intervention.

Table: 4 Comparison of Peak Nasal Inspiratory Flow Rate before and after jala neti practice among the Female participants

Variable	Yoga group		P value
	Pre	Post	
PNIF L/min	78.32±14.52	98.65±12.78	0.04

The Resultant table Impacts that the immediate effect of Jala neti on Peak Nasal inspiratory flow among the female participants Before the practice was(78.32±14.52) improved to (98.65±12.78). And was statistically significant with pvalue (0.04).

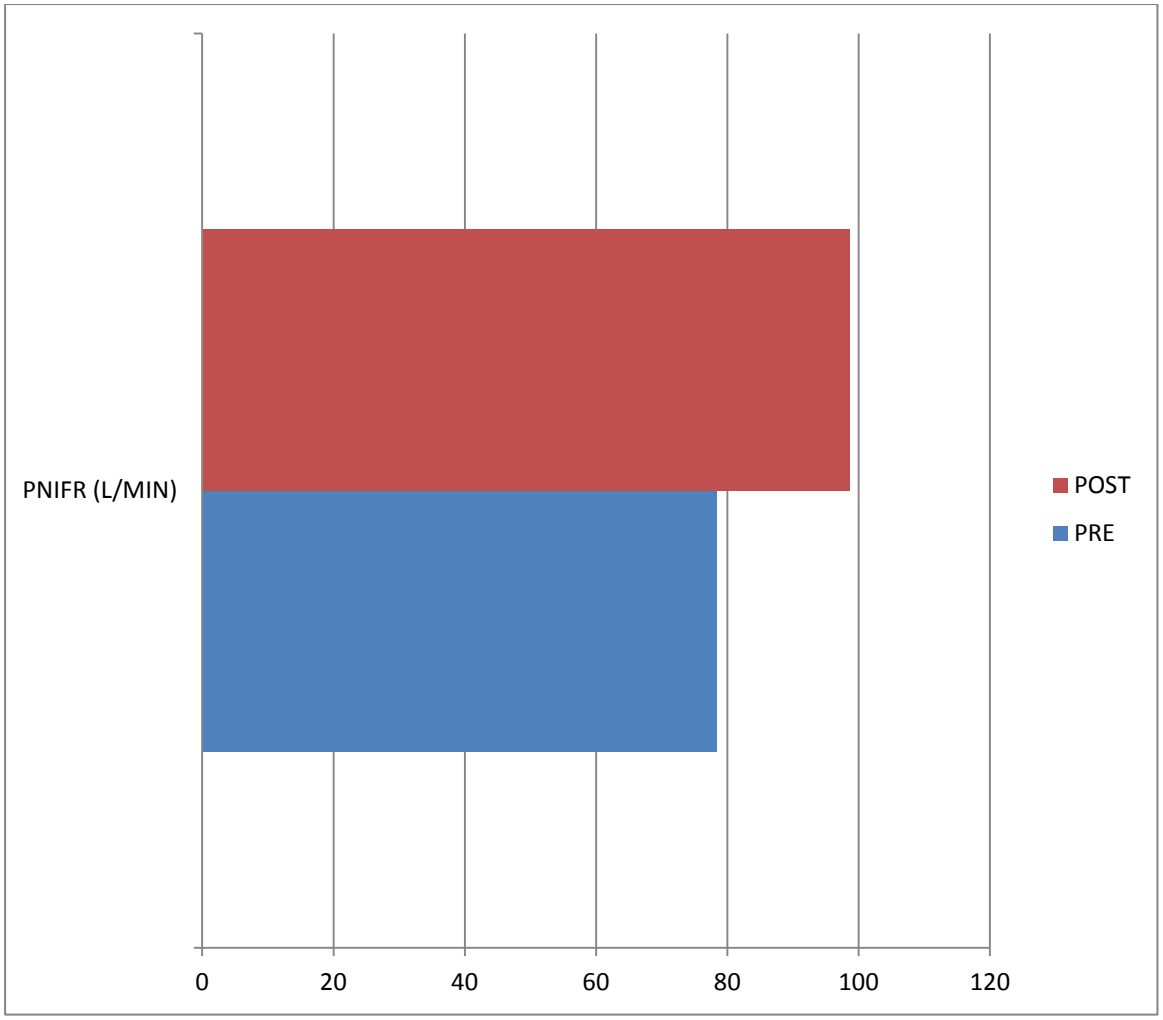


FIGURE 23;GRAPHICAL REPRESENTATION OF JALA NETI ON PNIFR(L/MIN) AMONG FEMALE PARTICIPANTS.

The above Figure provides a graphical illustration, representing the overall changes observed in the PNIFR ,among Female participants before and after the completion of intervention.

6.0 Discussion

As the nose is in direct contact with the external environment, it is exposed to the many Microorganisms and pollutants present in the atmosphere. Due to the increase in environmental pollution and the busy lifestyles of today, rhinitis is a common disease in the present era.

Improper management of this stage leads to sinusitis, which may later lead to chronic sinusitis. More than 120 million Indians suffer from at least one episode of sinusitis each year and, according to the American Academy of Otolaryngology and Head and Neck Surgery, more than 37 million Americans suffer from at least one episode of sinusitis each year . Jala Neti is one among six purificatory measures to be utilised by yoga practioner for inner and outer purification.

Neti includes number of operations affecting nose, which relates cleaning of healthly nasal passage and related function. Neti is a pre-requisite for cleaning up respiratory passage for the proper practice of pranayama.
Jala neti exert a profound physiological effect on the body, mind and personality. On the physical level irrigation of the nasal mucosa removes accumulated mucus from the nostrils, associated passages and sinuses, allowing air to flow without obstruction.

In modern medical science, a wide range of antibiotics and decongestants are available for the treatment of sinusitis.But these drugs can help only in the initial stage. FESS (functional endoscopic sinus surgery), Caldwell-Luc operation, Howarth's operation, etc., are the chief operative procedures to drain the sinus in advanced stages but many complications are associated with these surgical procedures, including bleeding, oro-antral fistula, infraorbital anaesthesia, neuralgia, and paraesthesia.

The modern treatment modalities for rinosinusitis are also expensive and high chances of reoccurrence , the indegenious technique of net seems to be appropriate, simple and cost effective for the patients of rinosinusitis. This paper attempts to focus on the scientific basis of Jala Neti that may help in the prevention and management of sino nasal diseases.

7.0 CONCLUSIONS

The present study confirms that by practicing “JALA NETI” alone could improve the overall hygiene of Nasal cavity and its function. Nasal hygiene has been shown to relieve congestion, reduce the viscosity of mucus and keep nasal cavity clean and moist. Nasal breathing is the only physiological type of breathing in humans, and is considered mandatory, although substituting mouth breathing is compatible with life.

The use of nasal saline is deeply rooted in history. It has been practiced for thousands of years as part of Hatha Yoga, where it is called Jala Neti. Yogis use nasal cleansing, as well as cleansing of other areas, to attain a higher state of meditation, but practitioners also note advantages related to bodily health.

NIPF is inexpensive, easily applied, fast, portable, simple to measure, does not depend on computers to analyze the data and has good reproducibility. Both rhinometry as well as the NIPF are accurate to detect nasal obstructive changes.

Through assessing these parameters among the study participants/subjects showed significant changes, thus exhibiting the effectiveness of practicing Jala neti kriya.

LIMITATIONS:

- The current study was a pilot study comprising only of minimal number of subjects.

- The outcome variable used in the study, cannot be inferred, or taken as an overall mean, since the age and gender related factors could vary.

- Randomization was not done.

RECOMMENDATIONS:

The same study can be conducted on a larger population with suitable study design and some objective kind of outcome variables could be included to validate the current results.

8.0 Summary

The study's objective was to determine the impact of Jala neti kriya in improving Peak Nasal Inspiratory flow and Nasal functioning. The causes for major respiratory infections are due to Poor lifestyle, environmental pollution, too much of competition, excessive hurry-worry, wrong kind of eating and sleeping habits, mental and social conflicts lead to the health problems. Mental factors affect the functioning of different parts of the body and vice versa.

Many literature studies has witnessed the efficacy of practicing Jala neti to assist in normal functioning of Upper Respiratory tract . The following study was intended majorly towards determining that the regular practice of Jala Neti could facilitate in improving the PNIF and respiratory function.

The study subjects, comprised of 60 healthy volunteers of age group between 18 -25yrs will participate in the study. The subjects will be referred by outpatient department of Government Yoga and Naturopathy Medical College Hospital, Chennai. After obtaining informed consent, the selected individuals would be subjected to two practices of Jala neti. After the practice , the individuals are made to perform Jala neti(nasal irrigation) under the supervision of yoga Experts.

After obtaining informed consent the nasal peak inspiratory flow is measured using nasal peak inspiratory flow meter. The collection of first data is before the practice, Second data is taken immediately after the procedur

The Results Impacts that the immediate effect of Jala neti on Peak Nasal inspiratory flow Before the practice (84.56 ±13.25) was improved to (110.85±12.56). And was statistically significant with Pvalue (0.001). Also that the immediate effect of Jala neti on Peak Nasal inspiratory flow among the male participants Before the practice (86.45 ±12.82) was improved to (124.25±10.96). And was statistically significant with p value(0.02). Also the immediate effect of Jala neti on Peak Nasal inspiratory flow among the female participants Before the practice was(78.32±14.52) improved to (98.65±12.78). And was statistically significant with pvalue (0.04).

Variable	Yoga group		P value
	Pre	Post	
PNIF L/min	84.56±13.25	110.85±12.56	0.001

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INFORMATION SHEET

- We are conducting a study on **IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS"** the Government yoga and naturopathy medical college & hospital, Chennai and for that, your participation may be valuable to us.

- The purpose of this study is to evaluate the effectiveness of Jala neti on peak inspiratory flow rate

- The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

- Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

- The results of the special study may be intimated to you at the end of the study period.

Signature of Investigator Signature of Participant

Date:

INFORMED CONSENT FORM

Title of the study : "IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS"

Name of the Participant :

Name of the Principal Investigator : Dr. R.N.Rani

Name of the Institution : Government Yoga & Naturopathy Medical College & Hospital, Chennai – 600 106

Documentation of the informed consent

I _____ have read the information in this form (or it has been read to me). I was free to ask any questions and they have been answered. I am over 18 years of age and, exercising my free power of choice, hereby give my consent to be included as a participant in **IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS"**

1. I have read and understood this consent form and the information provided to me.

2. I have had the consent document explained to me.

3. I have been explained about the nature of the study.

4. I have been explained about my rights and responsibilities by the investigator.

5. I have been informed the investigator of all the treatments I am taking or have taken in the past _____ months including any native (alternative) treatment.

6. I have been advised about the risks associated with my participation in this study.

7. I agree to cooperate with the investigator and I will inform him/her immediately if I suffer unusual symptoms.

8. I have not participated in any research study within the past _____month(s).

9. I am aware of the fact that I can opt out of the study at any time without having to give any reason and this will not affect my future treatment in this hospital.

10. I am also aware that the investigator may terminate my participation in the study at any time, for any reason, without my consent.

12. I hereby give permission to the investigators to release the information obtained from me as result of participation in this study to the sponsors, regulatory authorities, Govt. agencies, and IEC. I understand that they are publicly presented.

13. I have understood that my identity will be kept confidential if my data are publicly presented.

14. I have had my questions answered to my satisfaction.

15. I have decided to be in the research study.

I am aware that if I have any question during this study, I should contact the investigator. By signing this consent form I attest that the information given in this document has been clearly explained to me and understood by me, I will be given a copy of this consent document.

For adult participants:

Name and signature / thumb impression of the participant (or legal representative if participant incompetent)

Name _____ Signature_____

Date_____

Name and Signature of impartial witness (required for illiterate patients):

Name _____ Signature_____

Date_____

Address and contact number of the impartial witness:

Name and Signature of the investigator or his representative obtaining consent:

Name _____ Signature_____

Date_____

INFORMATION TO PARTICIPANTS

Investigator: Dr.R.N.Rani

Name of Participant:

Title: IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS"

You are invited to take part in this research/ study /procedures. The information in this document is meant to help you decide whether to take part. Please feel free to ask if you have any queries or concerns.

You are being asked to participate in this study being conducted in Government Yoga and Naturopathy Medical College, Chennai.

What is the Purpose of the Research?

The purpose of the research to evaluate IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS"

The Study Design

Observational study

Study Procedures

Sixty healthy volunteers of age group Sixty healthy volunteers of age group between 18-25yrs will participate in the study. The subjects will be recruited from the Out-patient department of Government Yoga Medical College Hospital, Chennai.

After obtaining informed consent, the selected individuals would be subjected to two practices of Jala neti. After the practice , the individuals are made to perform Jala neti(nasal irrigation) under the supervision of yoga Experts. After obtaining informed consent the nasal peak inspiratory flow is measured using nasal peak inspiratory flow meter. The collection of first data is before the practice, Second data is taken immediately after the procedure.

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Possible Risks to you - Nil

Possible Benefits to you-Nasal hygiene will improve.

Possible benefits to other people

The result of the research may provide benefits to the society in terms of improving the nasal hygiene.

Confidentiality of the information obtained from you

You have the right to confidentiality regarding the privacy of your medical information (personal details, results of physical examinations, investigations, and your medical history). By signing this document, you will be allowing the research team investigators, other study personnel, sponsors, IEC and any person or agency required by law like the Drug Controller General of India to view your data, if required.

The information from this study, if published in scientific journals or presented at scientific meetings, will not reveal your identity.

How will your decision to not participate in the study affect you?

Your decisions to not to participate in this research study will not affect your medical care or your relationship with investigator or the institution. Your doctor will still take care of you and you will not lose any benefits to which you are entitled.

Can you decide to stop participating in the study once you start?

The participation in this research is purely voluntary and you have the right to withdraw from this study at any time during course of the study without giving any reasons.

However, it is advisable that you talk to the research team prior to stopping the treatment.

REMARKS OF THE GUIDE

This work undertaken / to be done by **Dr. R.N.RANI** titled **"IMMEDIATE EFFECT OF JALA NETI(NASAL IRRIGATION) ON NASAL PEAK INSPIRATORY FLOW ON HEALTHY VOLUNTEERS"**at Government Yoga and Naturopathy Medical College Hospital, will be under my supervision and I ensure that the candidate will abide by the rules of the Institutional Ethics Committee.

Dr. S. T. Venkateswaran,

HOD -Department of Yoga,

Government Yoga and Naturopathy

Medical College & Hospital,

Chennai – 106

Date: