Nasal resistance

Its importance and measurement

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Authors

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Abstract

Nasal resistance is the resistance offered by the nasal cavity to inspired air. This resistance plays a vital role in preventing collapse of lung. It goes without saying a collapsed lung will hamper normal respiration. In adults nasal resistance constitutes about 2/3 of total airway resistance. Current respiratory physiologists consider this to be one of the functions of nose inaddition to olfaction and airconditioning. This article attempts to discuss the current trends and scenario of nasal resistance.

Nasal resistance

Introduction:

Nasal resistance[1]is defined as resistance offered to the air entry by the nasal cavity. This resistance is rather important as it prevents catastrophic collapse of lung. Nasal resistance also includes resistance provided by velopharynx. In normal individuals velopharyneal resistance to airflow is negligible. Partial obstruction at the level of velopharynx can increase nasal resistance exponentially.

Components of nasal resistance include:

Nasal vestibule: Has compliant walls with a tendency to collapse in response to negative pressure caused during inspiration. This collapse can reduce airflow within this segment of nose. This area should be considered as a flow limiting segment of the nose (Starling resistor). This area contributes to nasal resistance during inspiration. Studies reveal 30 liters/min is the limiting feature of this area.

Nasal valve: This is the narrowest portion of the whole nasal cavity. This area contributes to the maximum to the nasal airway resistance. Anatomically this area lies just anterior to the inferior turbinate. The dimensions of this area is governed by the size of the inferior turbinate and nasal septum. Inferior turbinate is an erectile tissue. Swelling of this structure has an important determining effect in the nasal resistance. Hence treatments aimed at reducing the size of inferior turbinate will have significant effect on nasal resistance when compared to that of nasal septal surgeries aimed at removing spurs. This area is located about 2 cms distal to the nasal passage, with an average cross sectional area of about 0.73 cm^2.

Turbinated nasal passages: Of nasal cavities can undergo increase / decrease in size because of their erectile nature contributing to nasal resistance immensely. Nasal decongestants play a role in reducing nasal resistance by reducing the size of turbinates.

The ala nasi muscle plays a vital role in determining nasal resistance [2]at the level of nasal vestibule. Contraction of ala nasi dilates nasal vestibule there by causing a decrease in the nasal vestibular component of nasal resistance. Paralysis of alae nasi as in the case of facial palsy causes inspiratory collapse of nasal vestibule [3]there by causing dynamic increase in the nasal resistance. Hypercapnia causes drastic reduction in the nasal resistance. This is brought about by increased activity of ala nasi [4]. Contraction of ala nasi muscle alters the shape of the vestibule in such a way there is a decrease in the overall air flow turbulence without causing any change in the effective cross sectional area. Active contraction of ala nasi muscle occurs during exercise also there by reducing nasal resistance.

Studies reveal that nasal resistance accounts roughly for about 50% of total airway resistance [5].

Reduction of nasal resistance component can cause tremendous improvement to the airflow into the lungs during periods of crisis.With regard to the nasal valve area, studies reveal that the anterior end of inferior turbinate can advance as much as 5 mm in response to histamine administration [6]. Bony portion of the nasal cavity located just behind the pyriform aperture plays very little role in nasal resistance.How is the nasal resistance controlled?In normal healthy subjects the nasal airway resistance is determined by the degree of engorgement of venous erectile tissue, as well as the accessory muscles of respiration which keep the nasal airway patent. The venous erectile tissue of nasal mucosa has dense adrenergic innervation which when stimulated cause intense vasoconstriction thereby decreasing the nasal airway resistance. Normally there is a continuous sympathetic vasoconstrictor tone to the nasal erectile tissue keeping the nasal airway resistance under check. Reduction in this sympathetic tone increases the nasal airway resistance. The parasympathetic tone in the nose controls nasal secretion, but has little role in nasal resistance.

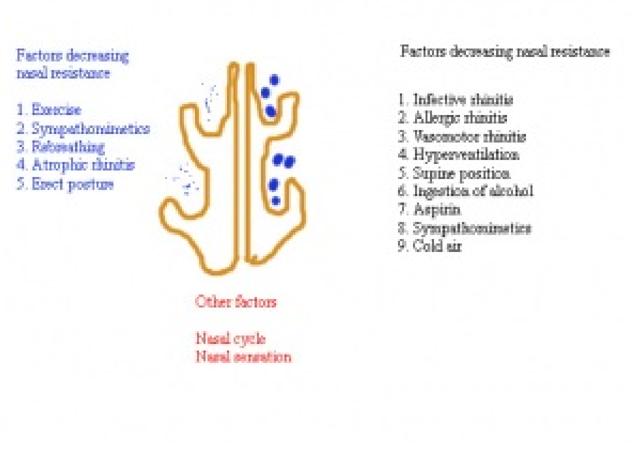

Diagram showing various factors determining nasal resistance

Nasal air flow receptors are present in the nasal vestibule, these receptors are supplied by infra orbital branch of trigeminal nerve. The sensation of nasal air flow is greatly enhanced by stimulation of these receptors. Menthol is one such stimulant. When balm containing menthol is applied outside the nasal cavity it stimulates these receptors increasing their sensation to nasal airway causing symptomatic improvement.Methods of measuring nasal airway resistance:History of measurement of nasal airway resistance: It was Zwaardemaker of Netherlands who first attempted to objectively measure nasal airway by using a cold mirror beneath the nasal cavity and comparing the size of resultant condensation. Glatzel replaced mirror used by Zwaardemaker with metal. These methods were considered to be physiologically perfect because nasal cavities were not deformed while these measurements were being made.1. Rhinomanometry [7]is used to assess the patency of the nose. There are two types of rhinomanometry, active and passive rhinomanometry. Active rhinomanometry involves the generation of nasal airflow and pressure with normal breathing. Passive rhinomanometry involves the generation of nasal airflow and pressure from an external source, such as fan or pump which drives air through the nose.Active rhinomanometry: can be divided into anterior and posterior methods according to the siting of the sensor tube. In active anterior rhinomanometry [8], the pressure sensing tube is taped to one nasal passage. This method measures resistance of one nasal cavity at a time and must be repeated on the other side. The total air flow through the nose is measured with the help of the sensor tube. In active posterior rhinomanometry, the pressure sensing tube is held within the mouth and it detects the post nasal pressure. Air flow through each nose can be measured by taping the opposite nose.Precautions taken while performing rhinomanometry:a. The use of face mask is desirable than a nasal cannula. The face mask should form a soft air tight seal and must not effect pull on the cheek.b. Calibration of the equipment must be performed regularly.c. Series of readings must be taken as a single reading is unreliable.2. Acoustic rhinometry: is performed by generating an acoustic pulse from a speaker which is transmitted along a tube into the nose [9]. The sound from the pulse wave is reflected back from inside the nose and is related to the cross sectional area of the nasal cavity, thus enabling an indirect measurement of cross sectional area of nasal cavity. The reflected sound is recorded by a microphone and calculations are made accordingly. It gives a precise estimation of the nasal cross sectional area. This study is considered to be accurate near the nasal valve area than in other areas of nasal cavity. Using acoustic rhinometry the distance between naris and anterior portion of inferior turbinate has been measured to be about 3.3 cms, and the average distance between naris and posterior portion of inferior turnbinate is 6.4 cms [10].3. Nasometry: During speech sound is transmitted through both the oral and nasal cavities. Nasal obstruction causes a reduction in the amount of sound transmitted through the nose. By measuring the nasal components of speech the patency of the nasal airway can be assessed. This is known as nasalance. It is the ratio of sound energy from the nasal and oral passages and can be measured by placing two microphones one over the nose and the other over the mouth. Infact the measure of nasalance has been proposed as a useful method of selecting children for adenoidectomy. It is also useful in measuring the nasal airway patency.

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