Measuring Nasal Obstruction

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KEYWORDS

• Nasal obstruction • Nasal airway • Rhinomanometry • Nasal resistance • Nasal function

KEY POINTS

- The nose/nasal airway is a complex structure with intricate 3-dimensional anatomy; portions of the structure are composed of skin that has no supporting cartilage or bone.
- The nose functions as a heat and moisture exchanger. The nose also acts as a filter for particles.
- The measurement of nasal obstruction (NAO) can be broken into 3 tools for measurement: patient-derived measurements, physician-observed measurements, and objective measurements.
- The concept of a nasal valve has been key to our understanding of NAO.
- The field of evaluation and surgical treatment for NAO has grown tremendously in the past 4 to 5 decades and will likely continue to grow.

THE NOSE IS A COMPLEX STRUCTURE

The nose and the nasal airway is a highly complex structure with intricate 3-dimensional anatomy resulting in one of the few areas of the body where portions of the structure are composed of skin that has no supporting cartilage or bone. Despite this incomplete substructure, it functions in respiration and filtration in a highly advanced way. This presents difficulty for both patients and clinicians in determining where within the nasal airway perceived obstruction lies.

Nasal obstruction (NAO) is a common complaint in primary care and otolaryngologists' offices. Evaluation of NAO goes back just as far as the published record. The study of obstruction is the study of flow and resistance. The complex intranasal anatomy contains areas of substantial variability in flow (**Fig. 1**). The first published studies on these were using molds of the upper airway and smoke trails in the early 1950s. These studies demonstrated rapid air flow through the areas of the inferior and middle meatus.[1] Further studies in the 1980s, 1990s, and today, using more advanced modeling techniques, demonstrated similar findings.[2,3] However, we are no closer today to finding the single answer to the cause of NAO than we were decades ago.

FUNCTION AND PHYSIOLOGY

Humans are unique among hominids with increased nasal projection, anterior nasal convexity, expansion of the nasal bone breadth, exaggerated nasal angles, prominence of the anterior nasal spine, and substantial cartilage framework at the nasal tip.[4] These traits began with the *Homo erectus* and continued in our lineage. All of these adaptations are felt to increase the ability of the nose to warm and moisturize the inspired air. These changes afforded the nose the ability to pull increased volumes through a more limited space and increase the contact with mucosa. This evolution is thought to be brought on by migration of early humans to more arid climates.[4] This migration may be the underlying drive towards improving NAO as *Homo erectus* strived to have the air he breathed remain as moist, warm, and pure as it had been in tropical climates.

Studies supporting this hypothesis were hard to generate and were based much on earlier research

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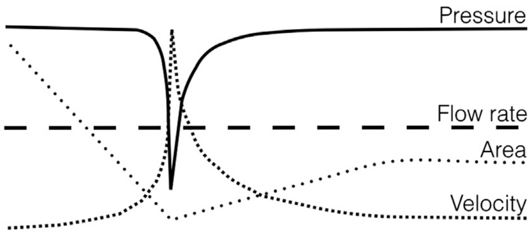

Fig. 1. Bernoulli effect. Pressure varies inversely with velocity for a constant flow rate. Thus, as the area decreases, velocity increases and pressure drops significantly.

of the nasal physiology. Heat and moisture exchange was determined experimentally through evaluation of patients with and without tracheotomies. The nasal physiology is complex, but data from these studies demonstrate air presented to the nostrils at 20°C attains 32°C at the back of the nasopharynx and changes from 45% relative humidity to 98%. The same temperature air only reaches 30°C and 80% humidity if inspired orally.[5] Thus, the ability of the nasal mucosa to moisten air would be key in a more arid climate to prevent dehydration.

Heat and moisture exchanges represents only a small portion of the physiologic purpose for the nose and nasal cavity. The nose also acts as a filter for particles. The earliest studies began in the 1950s and continue currently to evaluate the filtration function of the nose. Through multiple study methods, particles larger than approximately 25 to 30 microns are deposited at near 100% within the nasal cavity.[6–8] This filtration and subsequent chemoreception is sensed in both the olfactory cleft and portions of the anterior nasal cavity.

The loss of thermoreception and chemoreception may represent some of the feelings of NAO when a patient's airway is made overly patent by turbinate surgery. Thermoreceptor TRPM8 function has been implicated in the sensation of NAO with loss of adequate thermal change in the mucosa of the nose resulting in feelings of NAO. The turbinates create nonlaminar flow resulting in the warming of the air by contact with mucosal surfaces. This presents cooling to TRPM8, which is postulated as one of the mechanisms of sensation of nasal patency.[9]

NASAL OBSTRUCTION POORLY CHARACTERIZED

Some of the earliest attempts to measure NAO began with attempts to establish the diagnosis. Early surgeons struggled in patients with persistent symptoms of NAO, but an absence of definitive pathologic findings. The Cottle maneuver was developed by Heinberg and Kern in the 1970s and named for Dr M.H. Cottle to evaluate patients with NAO.[10] The maneuver is performed by pulling the cheek laterally and is positive when this improves the patient's sensation of nasal airflow.

The Cottle maneuver is a well-known and highly sensitive test with poor specificity. As such, multiple revisions of the technique have been performed to improve specificity with some encouraging results. The use of a small item (ear curette or cotton swab) to support the lateral nasal wall during inspiration was shown to correlate significantly with postoperative results from placement of spreader grafts to improve the nasal airflow.[11]

In our practice, we perform what we call the passive Cottle maneuver. With this maneuver, the examiner's fingers are placed on each side of the nasal sidewall on the skin of the medial maxillary buttress. The examiners fingers are used to simply 'tense' the skin of the lateral nasal wall rather than expand the nasal airway. The patient is then asked to breathe in. If the patient gets relief from this maneuver, it is likely they have dynamic lateral wall insufficiency and would benefit from strengthening the lateral nasal wall.

MEASURING NASAL OBSTRUCTION

The measurement of NAO can be broken into 3 different tools for measurement: patient-derived measurements, physician-observed measurements, and objective measurements. The first is highly important, but a well-known, inexact form of measurement. The second is key in establishing a diagnosis and, although intrarater recognition of findings is fairly consistent, interrater assessment can be variable and is not necessarily correlated with patient symptoms. The third can be very standardized, but also does not necessarily correlate with patient symptoms or patient findings on examination.

PATIENT-DERIVED MEASUREMENTS

Multiple patient reported outcome measures have been used previously for evaluating the symptoms of NAO. Before the current century, no single test was validated, widely accepted, and used. Visual analog scales (VAS) were some of the first to be used. These scales represent patients' overall perception of a problem or group of problems placed on a linear scale from absent to severe. Although this is a useful gauge to determine problem severity, based on its intrarater and interrater variability, its usefulness as a standalone measure is minimal.[12]