Coclia Nasal Function

7. What is the Cottle sign?

Medline
The Cottle maneuver is a classic technique used to diagnose an internal nasal valve disorder. While the patient inspires quietly, the cheek is pulled laterally, thus simulating widening the cross-sectional area of the internal nasal valve. If the patient notes an appreciable improvement in breathing with this maneuver, the Cottle sign is positive. This generally has been interpreted as an indication for spreader graft placement to improve the internal valve angle and nasal function. A false-positive Cottle sign sometimes may be observed in patients with alar collapse, with a false-negative result occasionally observed in patients with scarring in the valve region.

8. Nasal valves—where are they and how does one assess dysfunction?

Cummings:

Internal Valve

The nasal valve area is the functional unit that “includes the distal end of the upper lateral cartilage, the head of the inferior turbinate, the caudal septum, and the remainder of the tissues surrounding the piriform aperture” (floor of the nose, lateral fibrofatty tissue, and frontal process of the maxilla). This is the “flow-limiting segment” with the “Mink” valve as its distal orifice. Other designations for the valve area are “valve region,” minimal cross-sectional area (mCSA), and cross-sectional area 2 (CSA2). In the rest of this chapter, we use the term valve region to refer to this anatomic unit in order to avoid confusion of the term “area” with the measurement of a cross-section. The valve region is the anterior part of the nose where the minimal cross-sectional area occurs. Bridger and Proctor, using rhinomanometry and a plastic catheter passed along the floor of the nose, found that instead of a solitary highest resistance point, the resistance was spread across the valve region and that beyond that only a little additional resistance was noted. Using a similar method, Haight and Cole found that the greatest resistance drop occurred at the anterior end of the inferior turbinate in the first few millimeters of the bony cavum. They demonstrated that the site of greatest resistance was in the same location even after decongestion. Extending this study to a larger group of subjects, Hirschberg and associates found that before decongestion, the most restrictive portion of the nose (78% of the resistance) was in the first 4cm, with 56% of the resistance in the first 2cm. After decongestion the greatest resistance (88%) was in the first 2cm. This finding demonstrated that the anterior tip of the inferior turbinate is the site of most resistance in the nasal airway for some patients before but not after decongestion.

The valve region is bounded by compliant and mobile as well as rigid components, giving the region a dynamic character. Any change in dimension can alter the cross-sectional area and thus affect airway resistance exponentially. Therefore, the
effect of changes in the valve region is greater than elsewhere in the nose. This fact reinforces the importance of not distorting the anterior nasal structures during performance of an objective test. This region of the nose has been noted to account for half of the airflow resistance of the entire respiratory tract. It is the most common site of pathology causing significant obstruction.

The endoscope has the advantage of visualizing parts of the nasal airway, such as polyps and other pathology, that may not be seen with a headlight and speculum. The endoscopes may also be used for visualizing the area of the internal valve without any potential speculum effect. Endoscopes, however, have the disadvantage of a two-dimensional “fish-eye” view that may not give a clear assessment of relative adjacencies of structures that may contribute to obstruction. These observations are the examiner's subjective assessments of anatomic factors that might affect the patient's nasal breathing. There have been attempts to “objectify” nasal endoscopy digitally by recording the endoscopic examination and measuring photographs. These measurements are influenced by lighting, equipment, positioning, and so on.

Maneuvers performed as part of the examination can help elucidate the nature of a nasal obstruction. One simple test is to occlude one side of the patient's nose at a time and ask the patient to compare the nasal breathing through the two sides. It is very important that the examiner then looks to see whether his/her visual assessment of the airway matches the patient's subjective impression. To assess the effect of the nasal valve, the patient's cheek can be drawn back (as in the presence of Cottle's sign) to see whether a significant decrease in obstruction occurs. Alternatively, the patient can be asked how much improvement in breathing is noted when the valve area is held open with a nasal speculum, with one of the commercially available adhesive plastic strips or dilators, or with a wax curette. These tests are easy to perform and are noninvasive; however, they require subjective appraisal by the patient and clinician and thus are not easily quantified objectively.

External Nasal Valve

The external nasal valve is described as the region caudal to the internal valve bounded superolaterally by the caudal edge of the upper lateral cartilage, laterally by the nasal alar and bony piriform aperture of the maxilla, and medially by the septum and columella. The ligamentous attachment of the lateral crus to the bony maxilla provides support for the lateral border area. The primary muscles responsible for maintaining the patency of the nasal valve include the nasal and dilator naris muscles.
External nasal valve obstruction

External nasal valve collapse is due to collapse of the nostril margin at the opening of the nose (alar collapse) with moderate-to-deep inspiration through the nose. This phenomenon is usually observed in patients with narrow slitlike nostrils, a projecting nasal tip, and thin alar sidewalls.

The cause of external valve collapse may be surgical, congenital (eg, hypoplasia, paradoxical lateral crura), or posttraumatic in nature. This article focuses on only postrhinoplasty-related external valvular collapse. Constantian and Clardy reviewed 160 patients treated for external nasal valve incompetence. Surgical reconstruction was performed with septal cartilage or with composite conchal cartilage-skin grafts. Using
rhinomanometry, Constantian and Clardy found that correction of external valvular incompetence increased total nasal airflow during quiet ventilation by more than 2-fold over preoperative values. Thus, the external nasal valve may play a crucial role as the cause of nasal airway obstruction in some patients.

Static dysfunction includes tip ptosis and cicatricial stenosis, described as follows:

- Tip ptosis
  - The etiology of tip ptosis can be divided into either structural deficiencies in the cartilaginous or ligamentous support of the tip or excess soft tissue bulk that creates a mass effect at the tip.
  - Structural ptosis can result from rhinoplasty as a consequence of weakened support from the medial crura or columella. Furthermore, performing rhinoplasty through the delivery approach and dividing the cephalic margin of the lower lateral cartilage from the caudal margin of the upper lateral cartilage disrupts one of the major tip support mechanisms and may cause caudal slippage of the lateral crura, which results in structural ptosis.
  - Ptosis from soft tissue bulk is usually idiopathic in nature and is the consequence of thick redundant skin and subcutaneous tissue in the tip and supratip regions. Ptosis may also be the consequence of conditions such as rhinophyma.

- Cicatricial stenosis
  - Cicatricial stenosis is a less common cause of significant external nasal valve dysfunction and may be secondary to iatrogenic injury from poorly placed marginal incisions or may be a result of an inhalation injury.
  - Scar tissue may narrow the valve area through the formation of hypertrophic webs; however, more often, wound contracture causes a cicatricial narrowing.
  - Sheen conservatively estimated that 75-85% of postrhinoplasty patients have some reduction of the nasal vestibule.

Dynamic dysfunction includes (1) flaccid collapse of the lower lateral cartilage after the overresection of cartilage during tip-modeling procedures and (2) nasal musculature deficiency, described as follows:

- Flaccid collapse of lower lateral cartilage after overresection of cartilage during tip-modeling procedures
  - The cutaneous and skeletal supports of the lower lateral cartilages comprise the structural support of the external nasal valves.
  - Overzealous resection of the cephalic margin of the lower lateral cartilages can lead to flaccid collapse of the cartilaginous framework of the lateral nasal wall. Because of this lack of support, the pressure differential across the nasal valve during inspiration can cause the lateral nasal wall to collapse.

- Nasal musculature deficiency
The nasal musculature normally acts to pull the lateral nasal wall outward to prevent medial collapse during inspiration.

The importance of functional nasal musculature can be inferred from the nasal obstruction that occurs in patients with facial nerve paralysis.

Nasal muscular deficiency can be secondary to aging or can be due to rhinoplasty surgical damage such as devascularization, partial denervation, or fibrosis.

9. Discuss objective measures of nasal obstruction.

**Nasal Airflow and Transnasal Pressure**

Airflow through the nose occurs because there is a difference in pressure across the nasal airway, with the airflow occurring from an area of higher pressure to an area of lower pressure. Although the pressure outside the nose is relatively constant, the pressure in the nasopharynx changes with the respiratory movement of the chest. This change creates a pressure differential (the transnasal pressure) across the nose, and air moves back and forth through the nose with the phases of respiration.

**Measurement of Peak Nasal Airflow**

The readily available peak expiratory flowmeter has been used for assessment of the nasal airway, and the results are correlated with nasal resistance,[45] but may be unreliable possibly due to changes in effort.[46] A nasal peak inspiratory flowmeter has been studied.[47] In children, the measurement of peak nasal inspiratory flow has the drawback of depending on the extent of cooperation of the child and on the subjective impression of the observer about when a maximal effort has been made.[48] Measurement of peak inspiratory flow is less sensitive than rhinomanometry for detecting changes in nasal patency after histamine challenge[49] and with increasing doses of xylometazoline.[50] Measurements with the portable nasal spirometer have been shown to correlate well with results of rhinomanometry for the detection of the nasal cycle.[51] This is a simple measurement that requires minimal equipment.

**Simultaneous Measurement of Transnasal Pressure and Airflow: Rhinomanometry**

*Rhinomanometry* is the simultaneous measurement of transnasal pressure and airflow. Rhinorheomanometry, rhinomanometry, rhinometry, and rhinomanography are names that have been applied to these measurements. The International Standards Committee for the Objective Assessment of the Nasal Airway has chosen the term rhinomanometry.[52] In subsequent sections, we describe equipment and methods for performing rhinomanometry as well as reported results and clinical applications.

Other Methods of Objective Assessment of the Nose
Other objective tests have been performed for assessment of various components of the nasal airway. Investigators have used laser Doppler velocimetry to study mucosal blood flow in the nose.\[53\] Manometric rhinometry\[54\] is a technique in which the volume of air in the nose is assessed by closing off the nose, removing a volume of air, and then recording the resultant pressure change. In forced oscillation rhinomanometry,\[55-57\] the oscillation of a loudspeaker provides a complex signal of sinusoidal sound waves, which is coupled to the patient through a small mask and a pneumotachometer. Nasometry measures the oral and nasal acoustic ratio across a specified frequency range. This test may be performed more easily than rhinomanometry, particularly in children, because it does not require a mask or a pressure cannula.\[58\] Olfactory testing and tests of ciliary function are objective assessments of nasal function covered in other chapters.

Comparison of Acoustic Rhinometry and Rhinomanometry

Of all the methods described, rhinomanometry and acoustic rhinometry are the most commonly used. With the current microprocessor-assisted devices, equipment capable of rapid and sophisticated airway assessment has become readily available. There is a correlation between the cross-sectional area of the nasal airway measured by acoustic rhinometry and the area found from calculations based on data from rhinomanometry.\[32\] The results of both acoustic rhinometry and rhinomanometry are abnormal in habitual snorers.\[59\] There is a correlation between the results of rhinomanometry and acoustic rhinometry in a study of normal subjects before and after decongestion, but the relationship is weak.\[60\] Investigators have found comparable results for acoustic rhinometry and rhinomanometry when performing nasal challenge testing.\[61,62\] The two techniques provide complementary information.\[34\] Rhinomanometry determines nasal patency in terms more representative of how difficult it is for a person to breathe, and acoustic rhinometry is preferable to study rapidly changing mucovascular conditions and nasal volume changes. Both methods can give information about a site of obstruction, but acoustic rhinometry gives more precise anatomic information.

Equipment

A hollow plastic tube conducts a sound pulse (“click”) generated by a trigger module into the nasal cavity. An appropriate external nosepiece is placed against the nares, with care taken not to distort the nasal alae. (Most testers no longer use internal nosepieces because they may cause distortion of the nasal valve.) The acoustic wave is reflected from the nose and recorded as digital impulses by an analog-to-digital converter for computer analysis. Calculated area-distance graphs and volumes are generated onscreen and printed with the use of mathematical algorithms.

Technique

Testing should be performed in a quiet room, with the patient seated comfortably. A test acoustic wave is used for calibrating the equipment. The patient's head may be stabilized by fixing the gaze on a faraway object. The subject may be requested to
hold their breath, but this is not mandatory. The nosepiece is aligned against the nares at an angle parallel to the nose and held gently without causing alar distortion. A seal is facilitated by use of a surgical lubricant on the tip of the nosepiece. The acoustic pulse is then generated; the nosepiece should be held still for 10 seconds. An appropriate curve is generated on the computer screen. The procedure is then repeated on the other side. A second set of readings may be taken 10 minutes after application of oxymetazoline or another suitable topical decongestant. The graphs before and after decongestant application offer a way of quantifying both mucosal and structural components of obstruction. The curve generated on the computer from the reflected sound waves shows an estimated distance in centimeters on the x-axis and estimated cross-sectional areas in square centimeters on the y-axis. “0” is the nosepiece. The distance is commonly measured at 2, 4, and 6 cm; the results become less accurate after 6 cm.

A typical graph before and after administration of decongestant is shown in Figure 42-2. The minimal cross-sectional areas (CSAs) usually observed are CSA1, CSA2, and CSA3. Some publications may describe these as “valleys” or I-notch (isthmus-notch). Recommended standards and interpretation methods have been recorded for adults and children.[63-66]

**Reporting Results**

The graph is usually printed with results “before” and “after” decongestion; cross-sectional areas CSA1, CSA2, CSA3, and estimated volume are recorded. The congestion factor may be calculated and the sides compared with each other. A consensus report from the European Community by Clement and Gordts[67] provides standardization recommendations. CSA1 is usually the nasal valve area; CSA2 may be located at the anterior head of the inferior and/or middle turbinate. Nasal examination, endoscopy, or both should be used for correlating the area of CSA2 for an individual patient. The values of CSA1, CSA2, and CSA3 (mid-posterior end of the middle turbinate) are recorded and compared with normative values.

**Technical Concerns and Testing Pitfalls**

The accuracy of acoustic rhinometry decreases after 6 cm. Results are also distorted if there is a very small nasal constriction anteriorly. The room should be quiet and should have controlled temperature and humidity. The selection of nosepieces used, the quality of the seal, the position of the patient's head, probe position, and movement can also throw off readings. These are minor and can be avoided easily with instruction and standardization of the technique by the test operator.

**Equipment**

Various types of equipment have been developed for performing these measurements. A mask is attached to a device that measures transnasal pressure and flow and interfaces with a computer. Polymeric silicone (Silastic) tubing comes with the device. The manufacturer should provide a source for tape to connect the tubing
to the nostril for pressure detection. Current manufacturers of rhinomanometers can change with time and can be searched for on the Internet.

**Technical Concerns and Testing Pitfalls**

**Measurement of Transnasal Pressure in Rhinomanometry: Anterior versus Posterior Rhinomanometry**

Pressure across the nose must be measured at the front and back of the nose so that the transnasal pressure difference can be determined. Three methods of transnasal pressure detection are currently in use: anterior rhinomanometry, posterior (peroral) rhinomanometry, and postnasal (or pernasal) rhinomanometry. The major difference in these three approaches is the location of the pressure detector at the back of the nose. In the anterior method, it is placed at the opening to the nostril not being tested (see Figs. 42-5, 42-9, and 42-12). In the posterior method, the pressure detector is placed transorally in or close to the posterior oropharynx (Fig. 42-13). For the postnasal (pernasal) technique, the tube is placed in the posterior nose through one of the nostrils (Fig. 42-14). The tube is connected to a pressure-measuring device which allows a computer to record the transnasal pressure as the patient is breathing.

In general, anterior rhinomanometry is most widely used as a clinical tool because it is easily performed. Anterior and pernasal methods require little patient effort or cooperation, and the anterior method does not require a tube in the nose or mouth. By contrast, for the posterior method, the patient must be coached in the correct positioning of the tongue and palate to keep both the oropharynx and nasopharynx open so that the technique can be performed. It has been shown that 15% of patients are not able to perform this positioning. A limitation of the anterior method is that it cannot be used for measuring the nasal airway in patients who have a nasal septal perforation. None of the rhinomanometric methods can be used if the nose is totally obstructed.

Data from the pressure and flow curves can be used for calculating and reporting various parameters. The most commonly reported parameter is resistance as defined previously. Different methods of reporting resistance have yielded different results, in part because the resistance values are obtained at different locations on the pressure-flow curve (Fig. 42-18), which is nonlinear. Pressure-flow curves may have varying amounts of curvature, causing the resistance values obtained at
different points on the curve to vary in rank order, even when the same method is
used (Fig. 42-19). The resistance is generally higher at more distant points along the
nasal pressure-flow curve. For comparisons of the results for a given patient at
different times or between different patients, a consistent method would assign a
consistent site on the curve for obtaining this ratio (i.e., the resistance). Furthermore,
it would be best to report the parameter that has the best overall correlation with the
patient's subjective symptoms.