

Summary:

Objective measurement of nasal airway dimensions using acoustic rhinometry: methodological and clinical aspects. Allergy 2002;57 Suppl 70:5-39

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INTRODUCTION: Nasal congestion is an important symptom in many diseases of the upper airways. Nasal congestion may also affect personal well-being and quality of life. Furthermore, as the nasal mucosa is the first part of the airways in contact with the environment, objective evaluation of nasal congestion or nasal patency is important. Systematic evaluation of nasal patency was described in the last part of the 19th century by Zwaardemaker. Measurement of the pressure drop over the nasal cavity at a passive dow has been described in 1903 by Courtade and is one of first descriptions rhinomanometry. The technique is still in use and computer technology has made the measurements much easier but the method has not yet been accepted for wide clinical use. **METHODOLOGY:** Acoustic methods have also been used for evaluation of nasal patency. A qualitative method was the hum-test by Spiess (1902), where external occlusion of the nonoccluded side of the nasal cavity is experienced as a change in the timbre of the sound during humming. Acoustic reflections have been used in geophysical investigations especially with regard to search for oil. The use of acoustic reflections from the airways gained special interest in 1960-70 for determining the geometry of the vocal tract shape with regard to speech reconstruction. A method described by A. Jackson (1977) was adopted and for the first time applied to the nasal cavity. The method for determining the cross-sectional area as function of distance in the airways by acoustic reflections is impulse or relatively simple. The incident sound pseudorandom noise in the audible frequency range is compared with the response - the reflections from the airways. Intuitively, if the size of the entrance to the airways is known, the size of the reflections may represent changes of the airway size and the time between reflections may give the distance between the changes, dependent on the speed of sound. In this way it is possible to determine the area as function of distance in the airways. The technique has some assumptions and the major effort has been to validate use in the nose and elucidate aspects with regard to sound loss in the airways and resolution. Therefore, the acoustic reflection technique - named acoustic rhinometry - was compared with other methods like MRI, CT, and rhinomanometry. Allergic and nonallergic subjects were also compared. **RESULTS:** Acoustic rhinometry showed reasonable correlation with CT in a cadaver and in 10 subjects in comparison with MRI for the first 6 cm of the nasal cavity. Models based on MRI scanings of subjects also showed good correlation for the first 6

cm of the nasal cavity. Posteriorly in the nasal cavity and the epipharynx, differences were found mainly due to 'sound loss' to the paranasal sinuses. Sound loss due to viscous loss or friction at increasing surface/area ratio (the complex geometry in the nose) and loss due to nonrigidity the nasal mucosa were also examined. Neither these factors affected the area-distance function significantly. Acoustic rhinometry seems to reflect the area-distance function in the nose reasonably accurately. In allergic subjects acoustic rhinometry has been used to evaluate hypersensitivity. More pronounced spontaneous variation in nasal mucosa congestion was found in patients suffering from hay fever compared to nonallergic subjects. Furthermore, a tendency to a more swollen mucosa in the allergic subjects compared to the normal state, and increased sensitivity to histamine was found. This and reduction in swelling of the mucosa in allergic subjects during nasal steroid treatment out of the pollen season indicate an ongoing inflammatory process or hypersensitivity in allergic subjects out of the pollen season. During allergen challenge the change in nasal cavity dimension as well as inflammation may affect olfaction in hay fever patients. **DISCUSSION:** Acoustic rhinometry has not only been used to examine hay fever patients but in many different aspects of rhinology. Since the introduction of the acoustic reflection technique in the nose more than papers using the technique have been published. Most of the papers find the technique valuable for evaluation of nasal patency. Fortunately, some critical papers have drawn attention to some practical aspects of the technique. Standard operating procedures, and calibration checks as well as training operators will enhance the accuracy and reproducibility of results. **CONCLUSION AND PERSPECTIVES:** A decade after its introduction acoustic rhinometry is a well-established method for evaluation of nasal patency, but further improvement can be obtained by continued validation and adjustments of the technique.