Acta Otorrinolaringol Esp. 2010;**61(3)**:215-219

Acta Otorrinolaringológica Española

www.elsevier.es/otorrino

ORIGINAL ARTICLE

Correlation between active anterior rhinomanometry and nasal endoscopy

Lorena Sanz,* Josefa Ana Guerrero, and Teresa Rivera

Servicio de Otorrinolaringología, Hospital Universitario Príncipe de Asturias, Madrid, Spain

Received October 19, 2009; accepted December 8, 2009

KEYWORDS
Nasal obstruction;
Active anterior rhinomanometry;
Nasal endoscopy

Abstract
Objective: Nasal permeability is related to functional and anatomical parameters, which are objectified by active anterior rhinomanometry (AAR). The study aims to compare alterations visualised through Nasal Endoscopy (NE) with nasal flow parameters in AAR.
Material and methods: We carried out a prospective observational study of 45 patients suffering from nasal obstruction and septal deviation. They were explored through AAR and NE, and the deviations were classified into anterosuperior and anteroinferior quadrants. The degree of agreement between observers and the validity of the diagnostic test was then analysed.
Results: A sensitivity of 74.6% and a specificity of 60.5% were obtained comparing AAR and EN globally.
Conclusion: A reduced flow of the expiratory phase is correlated to inferior obstructions observed through NE. In the narrow nasal vestibule this correlation is not predictive.

PALABRAS CLAVE
Insuficiencia respiratoria nasal;
Rinomanometría anterior activa;
Endoscopia nasal

Correlación entre la rinomanometría anterior activa y la endoscopia nasal

Resumen
Objetivo: La permeabilidad nasal se correlaciona con unos parámetros funcionales y anatómicos, que se objetivan mediante la rinomanometría anterior activa (RNMAA).
Se pretende comparar las alteraciones visualizadas mediante endoscopia nasal (EN) con los parámetros de la RNMAA.
Material y métodos: Se realiza un estudio observacional prospectivo de 45 pacientes afectos de obstrucción nasal y desviación septal. Se exploran mediante RNMAA y EN, clasificando las desviaciones en cuadrantes anterosuperior y anteroinferior. Se analiza el grado de concordancia interobservador y la validez de la prueba diagnóstica.

*Corresponding author.
E-mail address: lorena_sanzlopez@yahoo.es (L. Sanz).

Resultados: Se obtiene una sensibilidad y especificidad del 74,6% y 60,5% respectivamente, comparando globalmente la RNMAA con la EN.
Conclusión: La disminución del flujo en fase espiratoria se correlaciona con las obstrucciones inferiores objetivadas en la EN. En el estrecho vestíbulo fosal, esta correlación no es predictiva.

Introduction

The knowledge of nasal permeability, the study of resistance to airflow and the physiology of nasal breathing cycles, occupy an important role within rhinology.[1]
Nasal respiratory failure (NRF) is one of the most prevalent pathologies in the area of ENT. It is of great importance for all otolaryngologists to be aware of the diagnostic tools that are available in order to objectify and quantify the nasal permeability of patients who present this pathology.

The simple inspection and analysis of the anatomical findings of the nasal passages are not sufficient to know the nasal respiratory function; in addition, we must consider that nasal obstruction has an important subjective component.

Therefore, the need arose in our department to conduct a study to attempt to objectify nasal permeability, due to the discrepancy found in many patients with symptoms of severe NRF who presented an absolutely normal exploration, and vice versa, patients with nearly obstructive septal deviations who suffered from no functional impact.

The main objectives of the study were to confirm that there is a correlation between intranasal morphological alterations and their functional repercussion, through nasal endoscopy (NE) and active anterior rhinomanometry (AAR), as well as to analyse intra- and interobserver variability.

Material and methods

A prospective observational study was performed on a sample of 45 patients, aged between 18 and 66 years. All the patients in the study were recruited from hospital outpatient clinics, all referred NRF and also presented septal deviation in their physical examinations that could be associated or not with pyramidal dysmorphia.

We established that all patients with a history of previous sinonasal surgery, septal perforation, concurrent inflammatory-infectious pathology at the time of the examination (sinusitis, polyps and allergic substrate) and who were regular users of topical corticosteroids and nasal vasoconstrictors would be excluded from the present study.

All patients underwent a complete anamnesis, paying special attention to the following symptoms: 1) unilateral or bilateral NRF, 2) rhinorrhea, 3) hyposmia, and 4) history of trauma in the nasal pyramid.

Physical exploration

All patients were examined through anterior rhinoscopy and NE, by 3 different otolaryngologists.

The anterior rhinoscopy analysed the following parameters: 1) appearance of the mucosa and the nasal secretions; 2) status and deformities of the nasal septum; 3) state of engorgement of the turbinates, and 4) presence of alar collapse and evaluation of valvular space.

All patients underwent a NE with a rigid optic of 0º, 4 mm in diameter, and all examinations were recorded (Endodigi®). The body of the inferior turbinate was taken as axis and depending on where the septal deviations were found, above or below it, each nostril was divided into quadrants; antero- and posteroinferior, antero- and posterosuperior.

Finally, we carried out a basal AAR as a complementary test, following the criteria of the International Standardization Committee on Objective Assessment of Nasal Airway.[2] The rhinomanometer used was Rhinospir-pro®, and the test was always conducted in the same room, with the same humidity and temperature conditions, and by the same medical staff.

The basal AAR systematically assessed inspiratory and expiratory flows at 150 PA, taking as normal values those defined by Fabra.[3] Patients who presented an altered basal AAR were treated with a vasoconstrictor (2 sprays of oxymetazoline in each nostril, with an interval of 5 minutes between them) and then the rhinomanometry was repeated after half an hour. Patients suffering alar collapse were subjected to a dilation test and then underwent rhinomanometry after mechanically opening the nasal valve (pulling the nasal ala with an adhesive and a thread).

The findings obtained were coded as (+) and (−) according to whether there was obstruction, in both the NE and in the AAR; the data was collected in a pivot table.

For the statistical analysis, we carried out a study of diagnostic test validity of the AAR compared with the NE (taking the endoscopy as the reference test); we calculated its sensitivity and specificity with a 95% CI. We used the statistical program SPSS 15.0.

In a first phase we carried out a global analysis and then one for each of the anatomical quadrants described above. Subsequently, we analysed the variability of the degree of interobserver concordance of the physical examination, through the kappa coefficient.

Results

The study found that 71% (32) of patients were male and 29% (13) were female. The average age was 37.4 years (range 18-66 years).

Clinical manifestations

The main reason for consultation was NRF, with unilateral NRF being much more frequent (67% of the total) than bilateral

(33%). We also observed a prevalence of obstruction in the left nostril. Patients also referred rhinorrhea (18%), history of previous nasal trauma (14%) and hyposmia (13%).

Rhinoscopy

The rhinoscopy findings showed a discrepancy with the clinical manifestations, in that a septal deviation was observed; it was to the right in 32% of patients and to the left in 28%. However, as noted previously, patients referred clinical predominance of left NRF. We also found patients suffering from turbinate hypertrophy (20%), dislocation of the quadrangular cartilage (12%) and alar collapse (8%).

Endoscopy

The main morphological alteration observed in the NE was septal deviation in the anteroinferior quadrants of both nostrils; again, this was more frequent in the right nostril (24 patients). This was followed by hypertrophy of the inferior turbinates, hypertrophy of the middle turbinates and posterosuperior, anterosuperior and posteroinferior deviations. However, the last were more frequent in the left nostril (8, 7, and 5 patients, respectively) (Figure 1).

Active anterior rhinomanometry

In 17.7% (8) of patients, despite referring NRF, we found a normal basal AAR. Classifying the NRF according to the degree of obstruction, in descending order, we could observe that the clinical manifestation most frequently presented by patients was moderate nasal obstruction, followed by mild, severe and very severe. All patients who presented an altered AAR underwent rhinomanometry with vasoconstrictor and it was observed that in 40.6%(24) of patients, the application of oxymetazoline produced a normalisation of inspiratory airflows. Finally, in 3 patients suffering from alar collapse, we also observed flow normalisation after conducting a dilation test (Figure 2).

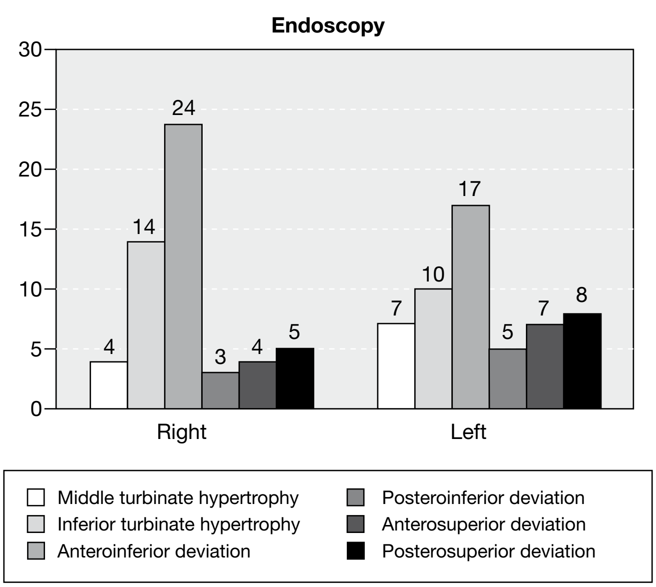

Figure 1 Endoscopic findings. This graph shows the endoscopic findings in both nostrils, classifying them into middle turbinate hypertrophy, inferior turbinate hypertrophy and anteroinferior, posteroinferior, anterosuperior and posterosuperior deviations.

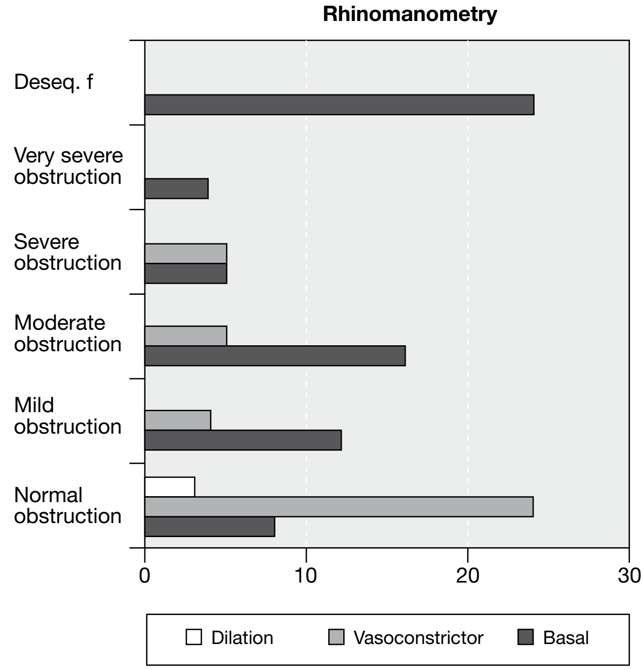

Figure 2 Rhinomanometry findings. This graph represents the number of patients in each of the groups created according to rhinomanometry parameters (normal, mild, moderate, severe or very severe obstruction) and also reflects the number of patients in whom inspiratory flows became normalised after applying a vasoconstrictor and the dilation test.

Statistical analysis

When comparing AAR against NE in the study, using contingency tables, we observed that the AAR was able to globally detect patients with nasal obstruction with a sensitivity of 74.6% and a specificity of 60.5% with a 95% CI (Figure 3).

The analysis of the anatomical quadrants offered the following data: AAR was much more sensitive in the lower quadrants than globally, specifically in the right nasal cavity (sensitivity of 87.5% and specificity of 41.3%; left fossa: 81.8% sensitivity and 52.1% specificity). However, the complete opposite was true in the superior quadrants; AAR was much more specific and sensitive in the right nostril (57.1% sensitivity and 77.4% specificity; left nostril with sensitivity of 68.4% and specificity of 69.2%).

Studying the variability in the clinical impression of three different examiners when inspecting the same patients, moderate concordance (kappa coefficient of 0.48) was found. A moderate agreement is considered when K is between 0.4 and 0.6 and a good agreement when K is greater than 0.6. We obtained the highest degree of concordance in the inferior quadrants of the right nostril with K=0.69 (0.46 to 0.91) (Figure 4).

DISEASE	Present	Absent	Total
Positive test	53	43	96
Negative test	18	66	84
TOTAL	71	109	180

Index		IC 95%
Sensitivity	74.65	64.5-84.7%
Specitivity	60.55	51.3-67.7%
Positive prediction value	55.21	45.2-65.1%
Negative prediction value	78.57	69.8-87.3%

DCHOSUP	Present	Absent	Total
Positive test	8	7	15
Negative test	6	24	30
TOTAL	14	31	45

Index		IC 95%
Sensitivity	57.14	31.2-85.0
Specitivity	77.42	62.7-92.1
Positive prediction value	53.33	28.06-78.5
Negative prediction value	80	65.69-94.31

DCHOINF	Present	Absent	Total
Positive test	13	8	21
Negative test	6	18	24
TOTAL	19	26	45

Index		IC 95%
Sensitivity	68.42	47.52-89.32
Specitivity	69.23	51.49-89.97
Positive prediction value	61.9	41.13-82.62
Negative prediction value	75	57.68-93.32

IZQSUP	Present	Absent	Total
Positive test	14	17	31
Negative test	2	12	14
TOTAL	16	29	45

Index		IC 95%
Sensitivity	87.5	71.29-100
Specitivity	41.38	23.46-59.30
Positive prediction value	45.16	27.57-52.58
Negative prediction value	85.71	67.38-100

IZQINF	Present	Absent	Total
Positive test	18	11	29
Negative test	4	12	16
TOTAL	22	23	45

Index		IC 95%
Sensitivity	81.82	65.7-97.99
Specitivity	52.17	31.76-72.59
Positive prediction value	62.07	41.91-79.73
Negative prediction value	75	53.78-96.22

Figure 3 Validity of the diagnostic test. Contingency table; the AAR is encoded as a positive or negative test depending on the presence of obstruction, and compared with NE (establishing the presence of disease as the standard if a septal deviation was observed on the endoscopy). DCHOINF: inferior deviations of the right nostril; DCHOSUP: superior deviations of the right nostril; IZQINF: inferior deviations of the left nostril; IZQSUP: superior deviations of the left nostril.

Discussion

In the study of nasal aerodynamics, there are multiple ways to learn more about nostril permeability. It is known that, during inspiration, the airflow moves through the middle-upper portion of the fossa through the middle meatus to the choana, while during expiration the airflow circulates in the opposite direction through the inferior meatus towards the vestibule.[4,5] These phenomena that occur with airflow are difficult to extrapolate; it is important to bear in mind both "anatomical-static" structures (nasolabial angle <90º or >180º, bone and cartilage ridges, septal deviations) and dynamics (narrow vestibule-fossa, congestion-decongestion phase of the nasal mucosa, condition of the turbinate complex, redistribution of laminar to turbulent flow in narrow places, etc.).[5,6]

When reviewing the literature, we found that most studies correlate anatomical findings with acoustic rhinometry (AR) and with different imaging techniques.[7] AR is a test which enables an indirect measurement of nasal permeability, assessing nasal geometry and its different cross section areas.

Kim and Bachman[8] emphasise that AAR is only consistent with the physical examination and rhinoscopy of patients who refer NRF in 66% of cases. There are a number of limitations due to which these techniques alone do not justify or explain NRF signs and symptoms, but they should still be complementary.

AAR is an objective, noninvasive, useful technique in daily clinical practice, but it has a number of considerations that prevent this correlation from being complete. These factors can be due to the examiner's technical failure, electrical artefacts, the position of the mask, transducers or the adhesive, or even to temperature and humidity factors. However, the most important fact is that the patient's cooperation is crucial.[1,3,9]

AR also studies nasal permeability objectively, but the information obtained is different than with AAR, because it passively analyses different aspects of the same phenomenon, without requiring patient cooperation.

Orús,[10] in his doctoral thesis, carried out a study in a sample of 56 patients comparing AAR, rhinoscopy and NE; the data obtained on sensitivity and specificity (72% sensitivity and 69.1% specificity) are quite consistent with those found in our study.

In 2000, Szucs et al.[11] reported that AAR was sensitive for the diagnosis of anterior septal deviations. In addition, they found that the sensitivity was greater as the deviation was more anterior or severe, and less sensitive for changes in the medial and posterior segment of the nasal fossae.

It is known that small anatomical changes may cause some exponential increases in nasal resistance. This is why it is so important not to overestimate obvious anterior deviations or to underestimate small changes in the valvular area that produce a large functional impact.

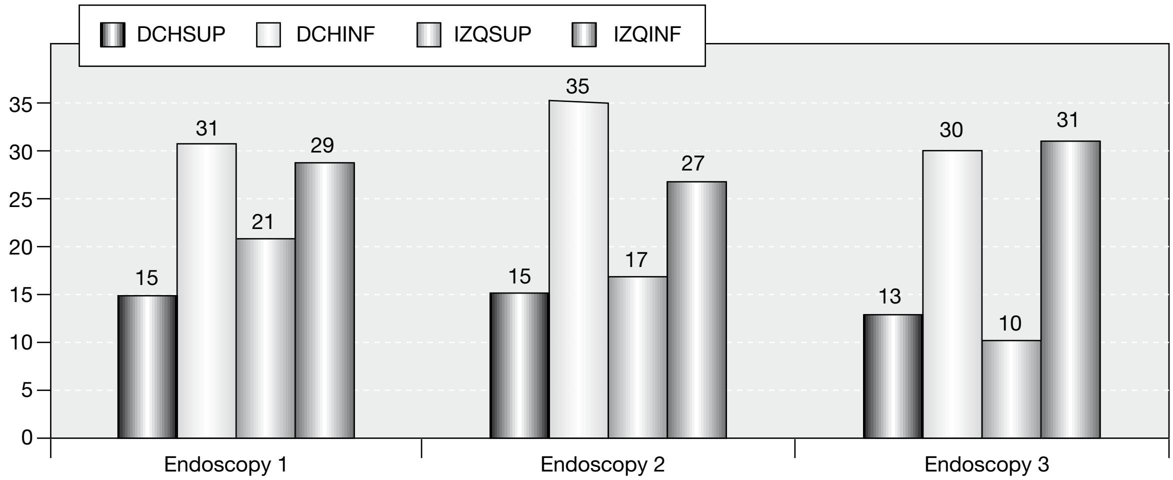

Figure 4 Degree of interobserver concordance. We collected data from the endoscopic examinations performed by 3 different examiners and classified the deviations into DCHINF: inferior right nostril; DCHSUP: superior quadrants of the right nostril; IZQINF: inferior left nostril; IZQSUP: superior quadrants of the left nostril. The highest degree of concordance was found in the DCHINF quadrants.

Kern[12] describes the phenomenon of paradoxical nasal breathing, consisting of referring a nasal obstruction in a permeable nostril and not perceiving an obstruction in one completely occluded by a mechanical deformation. Since it is a phenomenon with a long evolution, the patient only refers symptoms when the good nostril becomes blocked. This finding may justify the fact that we collected more data of unilateral left NRF, and yet observed more deviations on the right side; and even by changes in the erectile tissue of the turbinate mucosa depending on the nasal cycle phase in which they were.[13]

The degree of variability obtained in examinations led Corey, in 1999, to study this intraobserver K=0.42 and interobserver K=0.38 concordance parameter; the resulting level was lower than that found in our study.[7,14]

Conclusion

It is essential to compare the clinical data and physical examination of all patients with NRF; this will prevent underestimation or overestimation of the functional impact of anatomical abnormalities found during examination.

Clinical data, physical examination, AAR and NE are complementary techniques; each of them alone does not adequately explain NRF.

AAR is a sensitive, useful and inexpensive technique in the diagnosis of septal deviations; in addition, its sensitivity is higher when the septal deviation is more severe or more anterior.

The decrease of airflow assessed through AAR correlates with lower septal deviations objectified in the NE. However, in superior deviations and in narrow fossa vestibule, the correlation between inspiratory flows and morphological endoscopic findings is not conclusive.

References

1. Clement PA. Committee report on standardization of rhinomanometry. Rhinology. 1984;22:151-5.
2. Clement PA, Gordts F. Consensus report of acoustic rhinometry and rhinomanometry. Rhinology. 2005;43:169-79.
3. Fabra JM. Rinometría anterior activa. PhD Thesis. Universidad Autónoma de Barcelona. Facultad de Medicina. Barcelona. 1990.
4. Roithmann R, Cole P, Chapnik J. Acoustic rhinometry, rhinomanometry, and the sensation of nasal patency: a correlative study. J Otolaryngol. 1994;23:454-8.
5. Hilberg O, Pedersen OF. Acoustic rhinometry: recommendations for technical specifications and standard operating procedures. Rhinology. 2000;16:3-18.
6. Grymer LF, Hilberg O, Elbrond O. Acoustic rhinometry: evaluation of the nasal cavity with septal deviations, before and after septoplasty. Laryngoscope. 1989;99:1180.
7. Corey JP, Facs MD, Vincent P, Nalbone MD, Bernard A. Anatomic correlates of acoustic rhinometry as measured by rigid nasal endoscopy. Otolaryngol Head Neck Surg. 1999;121:572-6.
8. Kim CS, Moon BK, Jung DH, Min Y. Correlation between nasal obstruction symptoms and objective parameters of acoustic rhinometry and rhinomanometry. Auris Nasus Larynx. 1998;25:45-8.
9. Mir N, Barceló XB, Diez S. Evaluación diagnostica de las deformidades septopiramidales. Nuestra casuística. Acta Otorrinolaringol Esp. 2003;54:339-46.
10. Orús C. Rinometría acústica: criterios de normalidad y correlación rinomanométrica. PhD Thesis. 2004.
11. Szucs E, Clement PA. Acoustic rhinometry and rhinomanometry in the evaluation of nasal patency of patients with nasal septal deviation. Am J Rhinol. 1998;12:345-52.
12. Kern EB. The non-cycle nose. Rhinology. 1981;19:59-74.
13. Naito K, Miyata S, Kenji Takeuchi K. Comparison of perceptional nasal obstruction with rhinomanometric and acoustic rhinometric assessment. Eur Arch Otorhinolaryngol. 2001;258:505-8.
14. Silkoff P. Reproducibility of rhinomanometry and acoustic rhinometry in normal subjects. Am J Rhinol. 1999;13:131-5.