Rhinology, 41, 107-112, 2003

Upper lateral cartilage transposition in the surgical management of nasal valve incompetence*

M. Armengot, A. Campos, E. Zapater, J.R. Alba, J. Basterra

Otorhinolaryngology Department, Valencia University General Hospital and Medical School, Valencia, Spain

SUMMARY

Introduction: *The treatment of nasal valve dysfunction is very controversial and many otorhinolaryngologists do not always take surgery into consideration. The purpose of this paper is to present the author's surgical technique and the description of 13 patients on which it may work.*

Material and method: *Thirteen cases presenting with nasal obstruction secondary to nasal valve dysfunction are reviewed. All of the patients presented with internal valvulary incompetence and in three of them an alar collapse was associated. Diagnosis was achieved by means of the clinical findings and physical examination. An open rhinoplasty approach was employed. The surgical technique consisted in a transposition of the upper lateral cartilage over the alar cartilage. In the three patients with alar collapse a fixation graft from the septal cartilage was also employed.*

Results: *Nasal obstruction and valvular incompetence seemed improved in all of the cases.*

Conclusion: *Upper lateral cartilage transposition seems to be an adequate method to solve the nasal valve incompetence.*

Key words: nasal respiratory function, upper lateral cartilage collapse, alar cartilage collapse

INTRODUCTION

The fact that the middle and distal portions of the nasal pyramid play a dynamic role in the control of nasal ventilatory flow has been well established for over a century. However, when examining a patient presenting with nasal obstruction these areas are easily overlooked or misdiagnosed. Clinical exam by means of rhinoscopy and nasal endoscopy may prove insufficient for an accurate inspection of these key zones of critical importance for nasal ventilation.

In 1882, Zuckerkandl, professor of Anatomy in Vienna, was the first one to point out that the small opening limited between the upper lateral cartilage and the septum was the narrowest part of the nasal airway, thus naming it *ostium internum* (Zuckerkandl, 1882)

Mink introduced a more dynamic concept, the nasal valve, as the mobile portion of the upper lateral cartilage and attributing it with an airflow regulatory function (Mink, 1902; Mink, 1920). Uddströmmer (1940) and Van Dishoeck (1942) confirmed the importance of the nasal valve as a regulator of nasal patency. Bridger and Proctor (1970) proposed the concept of a collapsible mechanism that would act as a flow limiter rather than as a regulator, naming it the "flow limiter segment".

Nowadays, although a key role is attributed to this area, some degree of controversy still remains regarding its exact function and also about its name, location and extension (Cole, 1992a). From a functional point of view, the nasal valve airflow regulation is somehow qualitative, inducing changes in the airflow from laminar to turbulent that promote an intimate contact between the air and the nasal mucosa, thus facilitating the moistening, heating and filtration of inhaled air (Swift et al., 1977; Cole, 1992b). Despite the fact that strictly speaking, the term "nasal valve" is not adequate attending to its function, it has been widely accepted and spread. The valvular area can be anatomically defined as the segment laterally limited by the caudal aspect of the upper lateral cartilage and the fibrous tissue of the lateral nasal wall, posterior by the head of the inferior turbinate, medially by the septum and inferior by the nasal floor. The term nasal valve is usually applied to the opening limited by the caudal aspect of the upper lateral cartilage and the nasal septum, in fact the so called *ostium internum* by Zuckerkandl (Bruintjes, 1996). Both static and dynamic structures maintain the nasal valve function. The static components are the cartilage and bony septum. The dynamic components are the erectile tissue of the head of the inferior turbinate and the nasal septum, and the cartilages and muscles of the lateral nasal wall (Bruintjes, 1996).

* Received for publication: April 2, 2002; accepted: November 22, 2002

As a counterpart to this anatomic concept, most authors agree that, functionally speaking, two valvulary regions must be considered: the internal and external nasal valves (Constantian, 1994; Teichgraeber et al., 1994; Fuleihan, 1999). The external nasal valve is constituted by the cutaneous and cartilaginous support of the mobile nasal alar rim, this is, the *crus laterallis*, the alar lobule and the fibrous tissue adjacent to the pyriform opening. Its dysfunction generates the alar collapse. The internal nasal valve, as we have previously stated, corresponds to the *ostium internum* of Zuckerkandl. It is considered the narrowest area of the nasal airway, with a surface of 55-60 mm^2 and a septolateral angle of 10-15° between the caudal aspect of the upper lateral and the septal cartilages (measurements for the white Caucasian race) (Aiach, 1994; Constantian, 1994; Teichgraeber et al., 1994; Fuleihan, 1999).

The treatment of nasal valve dysfunction is very controversial, and many otorhinolaryngologists do not always take surgery into consideration. The purpose of this paper is to present a surgical technique aiming to resolve those nasal ventilatory insufficiencies due to the dysfunction of the external and internal nasal valves: the transposition of the upper lateral cartilage over the alar cartilage.

MATERIAL AND METHODS

Patients

Thirteen patients, 11 men and 2 women, with ages from 23 to 56 years, have undergone this surgical technique (Table 1). All of them presented with a nasal ventilatory insufficiency during inspiration. The history and clinical examination, paying special attention to the inferior 2/3 of the nasal pyramid established the diagnosis.

The patients were asked to subjectively evaluate their nasal airflow on a 5-point visual analogue scale (VAS), preoperatively and at approximately 30th, 90th and 180th days postoperatively. This self-assessment form graded the nasal obstruction from 0 (no obstruction) to 5 (complete obstruction) (Watson et al., 1995) (Table 2).

The nasal valve area was evaluated during normal and forced inhalation and exhalation by means of inspection, rhinoscopy, nasal endoscopy and Cottle's test. The inspection showed whether the upper lateral and alar cartilages collapsed during the inhalation. Rhinoscopic examination with a nasal speculum permitted a correct visualisation of the caudal aspect of the upper lateral cartilage and whether the angle that it created with the nasal septum was abnormally closed. A cotton applicator was used for palpation and elevation of upper lateral cartilage, assessing how this manoeuvre affected nasal ventilation. The nasal septum and inferior turbinate were now also examined. A nasal endoscope was employed for the examination of the posterior 2/3 of the nasal cavity and the rhinopharynx.

In all 13 patients a collapse of the upper lateral cartilage could be demonstrated during medium (not forced) inhalation. In two of them a bilateral alar collapse was diagnosed, and in one a unilateral alar collapse. Although false positive Cottle tests can be seen in patients with alar collapse, all of our patients presented a positive Cottle test. Two cases presented a concomitant anterior septal deviation that contributed to the ventilatory problem. In 10 cases the cause for nasal valve dysfunction was unknown. Two patients had previously undergone a rhinoplasty and another one had a hyperprojected nose that caused incompetence of the external and internal valves.

Table 1. Report of the cases.

Case	Sex/Age	Etiology	INV	ENV	Treatment
1	M/35	Congenital	Collapse	Collapse	ULT+G
2	M/27	Congenital	Collapse	Normal	ULT
3	F/26	Congenital	Collapse	Collapse	ULT+G
4	M/32	Congenital.HP	Collapse	Collapse	ULT+G+RR
5	M/23	Congenital	Collapse	Normal	ULT
6	M/35	Congenital	Collapse	Normal	ULT+S
7	M/25	Congenital	Collapse	Normal	ULT
8	F/40	Rhinoplasty	Collapse	Normal	ULT
9	M/56	Rhinoplasty	Collapse	Normal	ULT
10	M/47	Congenital	Collapse	Normal	ULT
11	M/35	Congenital	Collapse	Normal	ULT
12	M/32	Congenital	Collapse	Normal	ULT
13	M/28	Congenital	Collapse	Normal	ULT+S

Abbreviations: I.N.V.: Internal Nasal Valve; E.N.V.: External Nasal Valve; M: Male; F: Female; HP: Hyperprojected nose; U.L.T.: Upper Lateral Transposition; G: Graft; R.R.: Reduction Rhinoplasty; S: Septoplasty.

Table 2. Self assessment of the nasal obstruction by a visual analogue scale (VAS) preoperatively and at approximately 30th, 90th, and 180th days following surgery (0 = no obstruction; 5 = complete obstruction). Case number is correlated with cases in Table 1.

Case	Preoperatively	Postop 30^{th}	Postop 90^{th}	Postscript 180^{th}
1	4	3	1	1
2	4	2	1	1
3	5	1	0	0
4	4	1	1	1
5	4	2	2	1
6	4	2	1	1
7	4	1	0	1
8	5	2	1	1
9	5	2	1	1
10	4	1	1	1
11	4	2	1	1
12	4	2	2	2
13	4	1	1	1

Treatment

The aim of the treatment was to correct the nasal valve incompetence. Thus, the following goals must be achieved: 1) Augmentation of the septolateral angle when it was dimin-

ished; 2) Stabilisation of the free edge of the upper lateral cartilage to avoid its collapse; 3) Increasing the resistance to inhalator negative pressure by juxtapositioning the upper lateral and alar cartilages, and when necessary by adding a cartilaginous graft. The associated alterations such as an anterior septal deflection or an excessively projected nose are to be corrected during the same operation.

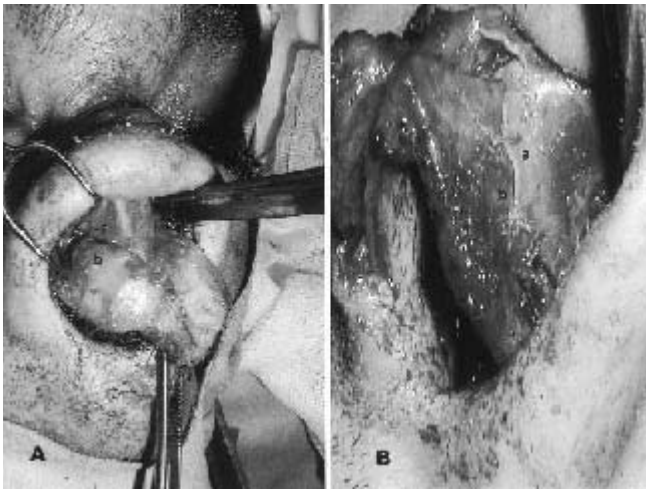

Figure 1A. Anatomical view of the normal location of the Upper Lateral Cartilage (a) under the Alar Cartilage (b).
Figure 1B. Upper lateral Cartilage (a) transposition and suture over the alar cartilage (b).

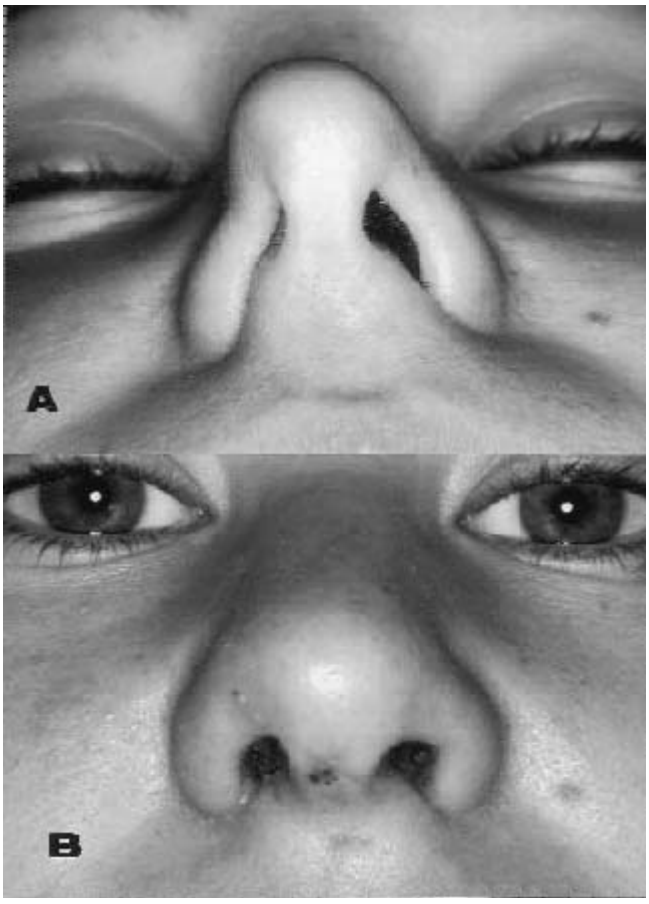

Figure 2A. Preoperative view of the alar collapse.
Figure 2B. Result after surgery: no collapse can be seen.

An open rhinoplasty approach was performed. After careful dissection of the alar and upper lateral cartilages, the inferior aspect of the latter, always located under alar cartilage, was exposed. In all of our patients a weakness of the cartilages could be seen, therefore generating the valvular collapse. Then, the inferior edge of the upper lateral cartilage was transpositioned over the alar cartilage and fixated by 3/0 dexon stitches (Figure 1). In the three patients with alar collapse, a septal cartilage graft was sutured to the alar cartilage, laterally to the dome about halfway to 2/3 of the crus laterallis. The septal graft was trimmed down to about half of its thickness in order to avoid cosmetic deformities of the nasal tip. Reposition of the skin flap and suture with 3/0 dexon is then performed. Stabilisation is obtained with adhesive tape and a nasal splint for 12 days. A Merocel-type nasal packing is left in place for 48 hours.

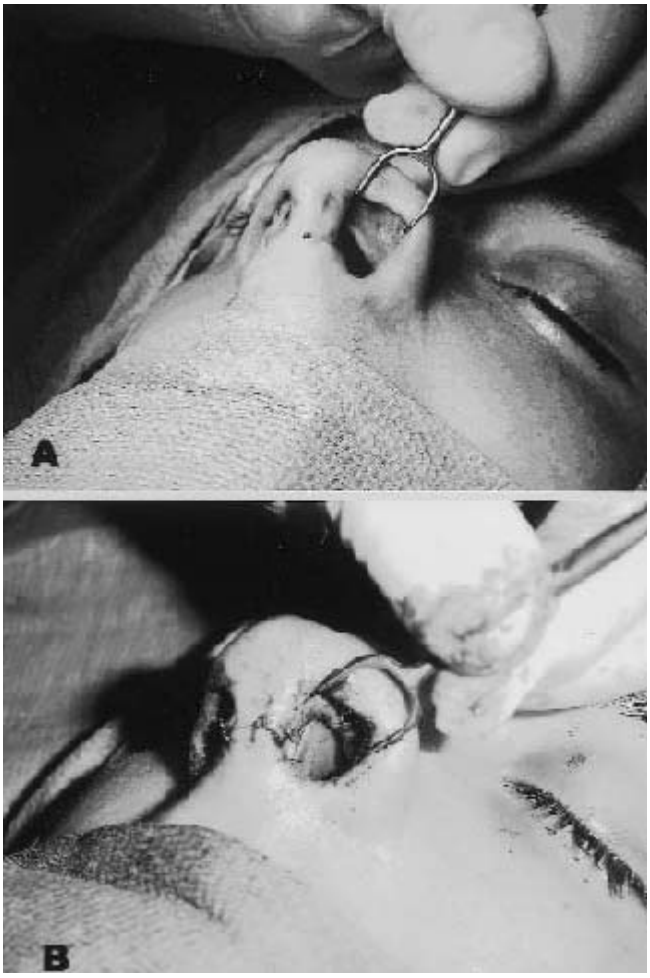

Figure 3A. In the preoperative view the inferior margin of the upper lateral cartilage (ULC) protudes thus collapsing the valve area.
Figure 3B. Postoperative image shows no protusion of inferior margin of the ULC.

Figure 4. Close up view of the midface of patient number 10.
A. Preoperative view. B. Postoperative view 6 months after surgery. Note mild widening of the midthird of the nose.

The evaluation of the results of this treatment was done by means of a clinical examination and a subjective questionnaire (VAS) at approximately the 30th, 90th and 180th days postoperatively.

RESULTS

All of the patients felt an improvement in their nasal ventilation, compared to their preoperative status (Table 2). This improvement was observed from the first month following surgery, but is more important after the third month, when the postoperative oedema has been resolved.

Some interesting findings can be seen upon clinical examination: 1) After surgery neither the upper lateral cartilage nor the alar cartilage is collapsed even with the forced inspiration (Figure 2); 2) The inferior margin of the upper lateral cartilage can no longer be seen by anterior rhinoscopy, even in the immediate postoperative period, with a regular continuity and absence of the typical flange of the *limen nasi* (Figure 3); 3) The septolateral angle is now open, due to the displacement of the upper lateral cartilage over the alar cartilage. On the other hand no undesirable effects have been found upon the nasal appearance (Figure 4).

DISCUSSION

A number of causes may lead to obstruction of the areas of the external or the internal nasal valves (Kern, 1978; Aiach, 1994; Lueg et al., 1998; Ponteli et al., 1998; Whalman et al., 1998; Fuleihan, 1999; Kunkel et al., 1999; Reynolds et al., 1999). These alterations can affect the rigid elements of the system, most frequently by anatomic causes such as an anterior septal deviation and surgical treatment is not difficult (Kern, 1978). Nevertheless in cases of valvular incompetence due to the collapse of the alar or the upper lateral cartilages during inspiration constitute a diagnostic and therapeutic challenge. Its clinical consequence is nasal ventilatory dysfunction, which may lead to severe problems in patients with obstructive sleep apnoea syndrome, not only because this condition is aggravated by nasal insufficiency but also because its treatment by means of a CPAP is difficult (Pasidero et al., 1994; Lustro et al., 1998). Besides nasal obstruction qualitative changes in the nasal airflow can be seen in this situation, yielding in a diminished efficacy of the nose as a filter for inhaled particles (Schwab et al., 1998).

It has already been said that the diagnosis of nasal valve incompetence will be sustained upon the clinical history and examination findings (Kern, 1978; Fuleihan, 1999). Inspection of the middle third of the nasal pyramid during inspiration will demonstrate the collapse of the upper lateral and/or alar cartilages. Although a certain degree of collapse during forced inhalation may be considered physiological, this is clearly not the case for medium inhalation or calm breathing.

It is not uncommon to see a collapse of both external and internal nasal valves, and, in these cases surely an alar collapse will drag along the upper lateral cartilage producing a global valvular dysfunction. This is the situation that can be found in noses with excess of projection, the so-called “tension noses”, with long and concave alar cartilages, also with elongated *crus medialis*, sometimes open at its base by a wide anterior maxillary crest. Frequently a thin skin with little support may also be seen, all of which will facilitate the valvular collapse (Kern, 1978). A dropped nasal tip will yield in identical consequences (Aiach, 1994). Inspection of the upper lateral cartilage, by raising the nasal tip with our finger or with the aid of a nasal speculum, is of the greatest interest. A closed septolateral angle is the rule, sometimes even with contact of the upper lateral cartilage and the septum. During inhalation the collapse of the upper lateral cartilage will also create this situation of septolateral angle collapse. Raising the upper lateral cartilage with a cotton applicator will significantly improve nasal breathing.

Cottle’s test is a valuable and simple test used to confirm an abnormality in the nasal valve. While the patient breathes quietly, the cheek can be drawn laterally away from the midline, opening the nasal valve and the patient is asked if this

manoeuvre improves airflow through the test side. If this relieves the nasal obstruction, the Cottle test is considered positive and indicates that the abnormality of the nasal valve is probably a significant factor in the genesis of a symptomatic nasal airway obstruction. When this manoeuvre does not markedly improve airflow, the sign is negative. Although Cottle´s test relies on subjective data and most of the patients will refer some improvement with this test, this test seems to be useful in the assessment of these patients (Kern, 1978). False negative can occur in the presence of adhesions or retracted scar tissue. False positive can be seen in patients with alar collapse (Kern, 1978).

Rhinomanometry and more so acoustic rhinometry might be of help in diagnosing valvular incompetence, but, as argued in a recent and thorough update, clinical and examination findings should suffice (Fuleihan, 1999). Also Kern in his basic paper on the nasal valve (Kern, 1978) indicated that history and physical examination are most valuable in the diagnosis. On the other hand, the correlation between subjective sensation of nasal obstruction measured by a VAS and rhinomanometry is good in 75-85 % of cases (Sipila et al., 1995). Nevertheless, we believe that a rhinomanometric study of the pre and postoperative status can be of great importance and will be considered in a future paper.

Valvular incompetence may be of congenital or acquired origin. Iatrogenic lesions are of importance due to their high frequency and because they ought to be prevented. Only two of our patients had the previous record of a rhinoplasty, but surely this percentage shall increase as the series of cases become larger. A few principles must be kept in mind when performing a rhinoplasty or a septorhinoplasty in order to avoid an iatrogenic valvular incompetence. These are: avoiding any extra damage to the alar or upper lateral cartilages; excessive resections should not be common practice; when cutting and creating a discontinuity in the cartilages, special care should be put in their reconstruction; lateral osteotomities must be carefully designed.

The treatment of nasal valve incompetence requires precise surgical techniques, and has been facilitated by the open rhinoplasty approach, recommended by most authors. Non-surgical treatment with external nasal dilators can be useful in selected cases, but the reported results are contradictory (Lustro et al., 1998; Roithmann et al., 1998; Shinkawa et al., 1998; Sarriá et al., 1999), with efficacy depending upon morphological circumstances such as racial features (Portugal et al., 1997). Surgical treatment has been based on cartilaginous grafts (septal or concha cartilage). These grafts may be for fixation, intending to provide solidity and avoid the collapse of the cartilaginous pyramid, or for expansion (Aiach, 1994; Constantian, 1994; Teichgraeber et al., 1994; Fuleihan, 1999). Spreader grafts are more frequently employed, especially in the cases of post-rhinoplasty valvular incompetence with an inverted V-shape deformity (Sheen, 1984; Aiach, 1994). However, these grafts may produce unwanted cosmetic alterations (Guyyuron et al., 1998). Placement of the graft is usually in the submucosal plane, between the septum and upper lateral cartilages. Nasal valve suspension is another procedure for the treatment of nasal valve collapse (Paniello, 1996), but this procedure involves accessing the orbital rim by a transconjuntival incision, which is an uncommon approach for otolaryngologists.

In our opinion, the upper lateral cartilage transposition broaches the problem of nasal valve incompetence from a more complete perspective, because on one hand it opens up the angle of the internal nasal valve and on the other hand it gives firmness by juxtaposition of the alar and upper lateral cartilages. This technique is obviously limited by those cases in which the upper lateral cartilage has been previously resected, leaving no cartilage left to be transpositioned.

Fixation grafts can be placed over the alar cartilage and the fibrous tissue next to the pyriform opening, behind the upper lateral cartilage and the root of the nasal ala (Troell et al., 2000). We advocate this measure in the cases presenting with alar collapse, with or without an associated internal valve dysfunction. As previously stated, the anterior part of the septum and the head of the inferior turbinate constitute a part of the valve and must be corrected when necessary during the same surgical operation (Cole, 1992a).

In conclusion, upper lateral cartilage transposition, occasionally with the aid of fixation grafts over the alar cartilage, seems to be useful in the surgical management of nasal ventilatory insufficiency due to nasal valve incompetence. Valvular area defects associated with the collapse must be corrected in the same operation.

REFERENCES

1. Aiach G (1994) Atlas de rinoplastia y de la vía de abordaje externo. Editorial Masson SA, Barcelona.
2. Bridger GP, Proctor DF (1970) Maximum nasal inspiratory airflow and nasal resistance. Ann Otol 79: 481-488.
3. Bruintjes TJD (1996) On the functional anatomy of the nasal valve and lobule. Thesis Universiteit Utrecht. Faculteit Geneeskunde, Universiteit Utrecht.
4. Cole P (1992a) The respiratory role of the upper airways. Mosby Year Book, St. Louis.
5. Cole P (1992b) Nasal and oral airflow resistors. Site, function and assessment. Arch Otolaryngol Head Neck Surg 118: 790-793.
6. Constantian M (1994) The incompetent external nasal valve: pathophysiology and treatment in primary and secondary rhinoplasty. Plast Reconstr Surg 93: 919-931.
7. Fuleihan N (1999) The evaluation and management of nasal valve dysfunction. Curr Opin Otolaryngol Head Neck Surg 7: 26-32.
8. Gyyuron B, Michelow B, Englebardt C (1998) Upper lateral splay graft. Plast Reconstr Surg 102: 2169-2177.
9. Kern B (1978) Surgical approaches to abnormalities of the nasal valve. Rhinology 16: 165-189.
10. Kunkel M, Ekert O, Wagner W (1999) Changes in the nasal airway by transverse distraction of the maxilla. Mund Kiefer Gesichtschir 3: 3-12.
11. Lueg E, lrish J, Roth Y, Brown D, Witterick I, Chapnik J, Gullane P (1998) An objective analysis of the impact of lateral rhinotomy and medial maxillectomy on nasal airway function. Laryngoscope 108: 1320-1324.

12. Lustro G, Rombaux P, Dury M, Pieters T, Aubert G, Rodenstein D (1998) Effects of Breathe Right on snoring: a polysomnographic study. Respir Med 92: 1076-1078.
13. Mink PJ (1902) De neus als luchtweg. Geneesbladen uit Kliniek en Laboratorium 9(1V): 75(1)-115(41).
14. Mink PJ (1920) Physiologie der Oberen Luftwege. Leipzig: Verlag von FCW Vogel.
15. Paniello R (1996) Nasal valve suspension. Arch Otolaryngol Head Neck Surg 122: 1342-1346.
16. Pasidero M (1994) The nose and its impact on snoring and obstructive sleep apnoea. In Fairbanks D. and Fujita S (eds.). Snoring and obstructive sleep apnoea. Raven Press, New York, pp. 179-193.
17. Ponteli J, Slavit D, Kern E. (1998) The role of outfracture in correcting post-rhinoplasty nasal obstruction. Ear Nose Throat J 77: 106-108, 111-112.
18. Portugal L, Mehta R, Smith B, Sabnani J, Matava M (1997) Objective assessment of the Breathe-right device during exercise in adult males. Am J Rhinol 11: 393-397.
19. Reynolds M, Gourdin F (1999) Nasal valve dysfunction after Mohs' surgery for skin cancer of the nose. Dermatol Surg 24: 1011-1017.
20. Roithmann R, Chapnik J, Cole P, Szalai J, Zael N (1998) Role of the external nasal dilator in the management of nasal obstruction. Laryngoscope 108: 712-715.
21. Sarriá P, Soler R, Mas S, Romaguera A, Tomás M (1999) Eficacia de las tiritas nasales en la obstrucción ventilatoria nasal. Realidad objetiva o placebo? Acta Otorrinolaringol Esp 50: 377-380.
22. Schwab J, Zenkell M (1998) Filtration of particulates in the human nose. Laryngoscope 108: 120-124.
23. Sipila J, Suonpaa J, Silvoniemi P, Laippala P (1995) Correlations between subjective sensation of nasal patency and rhinomanometry in both unilateral and total nasal assessment 57: 260-263.
24. Sheen J (1984) Spreader graft: A method for reconstructing the roof of the middle nasal vault following rhinoplasty. Plast Reconstr Surg 73: 230-239.
25. Shinkawa A, Sakai M (1998) A clinical study of the nasal dilator Novozent in Japanese subjects. Tokai J Exp Clin Med 23: 13-17.
26. Swift DL, Proctor DF (1977) Access of air to the respiratory tract. In Brain JD, Proctor DF, Reid LM (Eds) Respiratory defence Mechanisms. M. Decker, New York pp: 63-93.
27. Teichgraeber J, Wainwright D (1994) The treatment of nasal valve obstruction. Plast Reconstr Surg 93: 1174-1182.
28. Troell R, Powell N, Riley R, Li K (2000) Evaluation of a new procedure for nasal alar rim and valve collapse: nasal alar rim reconstruction. Otolaryngol Head and Neck Surg 122: 204-211.
29. Uddstromer M (1940) Nasal inspiration. Acta Otolaryngol Suppl 42: 3-146.
30. Van Dishoeck H (1942) lnspiratory nasal resistance. Acta Otolaryngol 30: 431-439.
31. Wahlman U, Kunkel M, Wagner W (1998) Preoperative assessment of airway patency in the planning of corrective cleft nose surgery. Mund Kiefer Gesichtschir 2 Suppl 1: S153-157.
32. Watson W, Roberts J, Becker A, Gengreau-Reid L, Simons E (1995) Nasal patency in children with allergic rhinitis: correlation of objective and subjective assessments. Annals Allergy, Asthma Immunol 74: 237-240.
33. Zuckerkandl E (1882) Normale und Pathologische Anatomie der Nasenhohle und ihren Pneumatischen Anhange. Band I. Wien: Braumuller.

Miguel Armengot
C/ Mediterrani 17
46134 Foios (Valencia)
Spain

Fax: + 34-963503964
E-mail: miar@eresmas.net