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Open and clean: the healthy nose

Guest Editors: Matteo Gelardi, Giorgio Ciprandi

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Open and clean: the healthy nose

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Summary. The nose exerts many functions, mainly for the respiration and the olfaction and represents the first doorway for the oxygen, but also for pathogens. The present Supplement reports some clinical experiences concerning the use of a new internal nasal dilator in different settings, including nasal obstructive disorders, obstructive sleep apnea syndrome, continuous positive active pressure (CPAP), and sport activity. The outcomes support the concept that a healthy nose should be maintained ever patent and free from secretions, as impaired nasal function can significantly affect quality of life. Therefore, an "open and clean nose" contributes in a relevant way to the subjective wellness. (www.actabiomedica.it)

Key words: nasal functions, nasal obstruction, nasal lavage, internal nasal dilator, external nasal dilator, nasal strip

The nose exerts many functions, mainly for the respiration and the olfaction (1-3). Upper airways represent the first doorway for the oxygen, but also for pathogens, including virus, bacteria, and fungi, allergens, cigarette smoke, and pollutants. The nose provides to defend the organism from noxious agents exerting three main activities: warming, moistening, and filtering the inspired air. The last function is guaranteed by an effective and efficient mechanism: the muco-ciliary clearance. The nasal goblet cells produce the mucus covering the mucosa: this mucus layer is actively and continuously transported from the nose to the rhino-pharynx (4-6). The mucus entraps and removes noxious matters so preserving the respiratory system. In addition, an active immune response occurs at nasal level: macrophages and microphages embed foreign matters that arrive, conveniently processed, to the draining nodes where the immune adaptive response begins (7, 8). Innate immunity is also present in the nose where it represents the first non-specific defensive barrier against aggressive factors (9). Therefore, the nose exerts a crucial role in defending the organism like a first-line sentinel.

On the other hand, the nose is a high-resistance tract where the inspired airflow becomes turbulent thanks to the turbinate structure. The turbinate actually serves to create a whirl air movement and to offers a wide surface to warm and moisten the inspired air. Altogether these mechanisms guarantee a physiological nasal health (10). However, these complex functions may easily alter in consequence of several pathophysiologic mechanisms, including infection, inflammation, trauma, mechanical abnormalities, physical stimuli, and so on.

In clinical practice, two main pathophysiological mechanisms cause an impaired nasal physiology: the nasal obstruction and the mucus hyperproduction (11-14). The nasal obstruction may be due to several causes, including allergy and infection, and implicates reduced oxygenation, with severe systemic consequences, such as hypoxemia, and oral breathing, such as the primary mechanism promoting exercise-induced asthma. On the other hand, the mucus stagnation allows microbial overgrowth, rhinosinusitis and otitis, and post-nasal drip-triggered cough.

Another relevant issue is the close link between upper and lower airways, namely between rhinitis and asthma (15) and between nasal obstruction and obstructive sleep apnea (16). Therefore, a close and "dirty" nose results in a vicious circle that promotes, maintains, and amplifies the respiratory infections and inflammatory disorders.

On the basis of this background, opening and cleaning the nose is the most simple and useful relief that has to be pursued in the common practice and at all ages.

Nasal obstruction may be controlled by physical, medical, and surgical treatments. In this regard, the nasal lavage represents the most safe and effective way to obtain a normal nasal patency. Hypertonic or isotonic saline solution may be used by different ways of administration, including spray, nasal shower, irrigation, insufflation, fumigation, and aerosol. However, nasal irrigation represents the most effective way to remove mucus as abundant quantity of saline solution pass across the nasal cavities (17, 18). However, it has to be highlighted that only sterile solutions must be used as infections (also fatal!) may occur with improper home-made nasal lavage (19).

Another simple, rapid, and cheap way to open the nose is the use of dilators, both external and internal (20). They act by a mechanical dilation of the nasal external valve so the nasal resistance significantly diminishes.

This Supplement reports some clinical experiences concerning the use of a new internal nasal dilator in different settings, including nasal obstructive disorders, obstructive sleep apnea syndrome, continuous positive active pressure (CPAP), and sport activity. In addition, nasal cytology is a diagnostic technique that investigates the presence of inflammatory cells in the nose (21-23). It may be also useful to evaluate the well-being of nasal epithelial cells. In this regard, nasal cytology may allow to detect the ciliocytophthoria phenomenon, such as a degenerative process in the ciliated cells observable during infections, mainly of viral origin. Therefore, nasal cytology may define the nose wellness.

In conclusion, many nasal disorders may significantly improve with two simple actions: to open and to clean the nose. These actions may be easily obtained by with nasal lavage and dilator. Actually, a healthy nose should be maintained ever patent and free from secretions, as impaired nasal function can significantly affect quality of life (23). Thus, an "open and clean nose" contributes in a relevant way to the subjective wellness.

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Original article

Ciliocytophthoria of nasal epithelial cells after viral infection: a sign of suffering cell

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Summary. Ciliocytophthoria (CCP) defines a degenerative process of the ciliated cells consequent to viral infections, and it is characterized by typical morphological changes. We evaluated the distinct and characteristic phases of CCP, by means of the optical microscopy of the nasal mucosa (nasal cytology), in 20 patients (12 males and 8 females; aged between 18 and 40 years). Three phases of CCP by nasal cytology are detected. This outcome confirms that CCP represents a sign of suffering nasal epithelial cell. (www.actabiomedica.it)

Key words: virosis, ciliocytophthoria, nasal cytology, rhinitis

It is well known that the term ciliocytophthoria defines a degenerative process of the ciliated cells consequent to viral infections, and it is characterized by typical morphological changes. Joseph Leidy firstly described *asmathosis ciliaris* in samples recovered from asthmatic patients: i.e. damaged respiratory cells (1). Later, Hilding reported aberrant nasal cells similar to parasitic cells (2). Papanicolau coined the term ciliocytophthoria (CCP) to identify the degenerative process in the bronchial ciliated cells observed during virosis and bronchial carcinoma (3). After that, other terms (pseudoprotozoa and "pseudomicrobe") were used rather than CCP. It confirms the confusion between degenerative process of ciliated cells and flagellated protozoa frequently found in airways (4-7). Further, electron microscopy exactly characterized CCP and allowd to correctly include it into the degenerative phenomena during respiratory infections (8, 9).

Experimental CCP has been reproduced in an animal model, exposing porcine and equine respiratory epithelium to a wide variety of pathogens (10, 11). In human studies, CCP is observed during acute tonsillitis and viral infections (12, 13), as well as in vaginal smear and peritoneal lavages (3, 14-17). Most of studies report CCP as characterized by "cellular fragments", without nuclei, with a regular rhythmic movement of the cilia at one edge and a well distinguishable "terminal bar".

On the basis of this background, we evaluated the distinct and characteristic phases of CCP, by means of the optical microscopy of the nasal mucosa (nasal cytology), in 20 patients (12 males and 8 females; aged between 18 and 40 years), who attended the outpatient Center of Rhinology of the University Hospital of Bari (Italy). All patients were affected by viral infections of the upper airways. All patients signed an informed consent and the procedure was approved by the Review Board. Serological data confirmed virous infection (i.e. Influenza virus type A). All patients had nasal congestion, sneezes, watery rhinorrhea, cough, fever, headache, and chills. Anterior rhinoscopy showed hyperemia of the inferior turbinate and clear and abundant mucous. Oropharyngoscopy showed hyperemia of the tonsillar pillars and the oropharyngeal posterior wall. All patients underwent nasal cytology (20, 21).

All patients had pathological rhinocytograms, characterized by cytopathic alterations consequent to viral infections, including numerous neutrophils and lymphocytes, some columnar cells, part of the ciliated cells, with various degrees of CPP. Figure 1a shows that the typical normal ciliated cell is visible, with its well-conformed ciliary apparatus, with a homogeneous cytoplasm, a finely represented chromatin in the nucleus, an easily recognizable nucleolus and the characteristic supranuclear hyperchromatic *stria* (SHS +). Notably, at least three distinct phases of CCP are distinguishable during viral infection. The first phase (Figure 1b) is characterized by an initial rarefaction of the ciliary apparatus, with disappearance of the SIS, early cytoplasmic vacuolization and internal reorganization of the chromatin (heterochromatin) forming little clumps. The second phase (Figure 1c) consists of further rarefaction of the ciliary apparatus, leading to its disappearance and confluence of the intracytoplasmic vacuoles; in the nucleus, chromatin tends to coalescence and to compact, with a peripheral halo where the nucleolus is clearly visible. The third phase (Figure 1d) is characterized by the "decapitation" of the apical portion of the ciliated cell, secondary to the latero-lateral confluence of the cytoplasmic vacuoles, so only the caudal portion of the cell (represented by the nucleus and its nucleolus, surrounded by a thin cytoplasm remnants) is visible.

Acute upper airways inflammation is usually caused by viruses, even though after the viral infection a bacterial overlapped infection may occur, partly favored by the cytopathic effect of the virus itself on the mucosa. Ciliated cells are the most differentiated cells of the nasal mucosa and therefore they are more prone to attack by infections. The most common viruses are Rhinovirus, Myxovirus (Influenza virus), Paramyxovirus (Parainfluenza virus), Coronavirus, Adenovirus and Respiratory Syncytial Virus (RSV).

CCP has a relevant diagnostic importance. However, a clear description of the cytomorphologic phases of this phenomenon are not depicted in the currently available literature. Nowadays, nasal cytology, a branch of Rhinology, allows to detect and define the different phases of CCP. The current findings are consistent with previous reports (22), except for the presence of the perinuclear halo, surrounding the nuclear chromatin, is just that portion of the nucleus where the chromatin is absent. The condensation of the hyperchromatic nuclear content could be responsible for formation of the rarefied "intranuclear halo" where the nucleolus is visible.

Of course, further studies of electron microscopy focused on CCP are needed to confirm our preliminary impressions.

In conclusion, the current study precisely describes the three phases of CCP by nasal cytology and confirms that CCP represents a sign of suffering nasal epithelial cell.

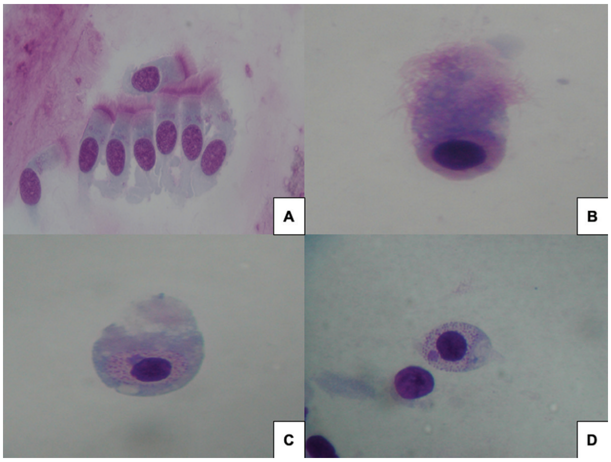

Figure 1. a) normal ciliated cell with hyperchromatic stria; b) initial rarefaction of cilia and disappearance of the stria; c) further rarefaction with disappearance of intracytoplasmic vacuoles; d) decapitation of apical part of ciliated cell

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Internal and external nasal dilatator in patients who snore: a comparison in clinical practice

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Summary. Snoring is a common symptom. The nasal valve area has the minimal cross-sectional area of the upper airways. So, nasal dilation may significantly reduce resistance to airflow and consequently could reduce snoring. Mechanical dilators may be used: they are external or internal. Nas-air® is a new internal nasal dilator. It was compared to a nasal strip (Rinazina Breathe Right®) in 41 outpatients who snore in an open study conducted in clinical practice. Snoring duration, assessed by smartphone, and visual analogue scale for the perception of sleep quality were measured before and during Nas-air® or nasal strip use. A significant reduction of snoring time and an improvement of sleep quality were achieved by wearing both devices. However, Nas-air® was effective in a larger number of patients and induced a better sleep quality than nasal strip. In conclusion, the present study demonstrates that Nas-air® is an internal nasal dilator able to reduce snoring time and to improve sleep quality, and may be preferred to the nasal strip by snoring patients. (www.actabiomedica.it)

Key words: snoring, nasal valve, obstruction, internal nasal dilator, Nas-air®, external nasal dilator, nasal strip

Introduction

Snoring is a very common symptom, as it affects from 5% of females to 20% of males in young adult people (1). However, old people snore more commonly: about 40% of females and 60% of males (2). Moreover, the awareness that nasal obstruction could modify breathing during sleep and also daytime is long-standing. In fact, it is well known that nasal obstruction is associated with disturbed sleep, insomnia, and intellect and memory impairment.

About half of the total respiratory resistance to airflow passage is in the nose, so a direct relationship exists between increased nasal resistance, due to nasal obstruction, and obstructive sleep breathing (3,4). Sleep-disordered breathing can be divided in three main clusters: simple snoring, sleep apnoea syndrome, and upper airway resistance syndrome. Snoring occurs by high-frequency oscillations of the soft palate as well as the pharyngeal walls, epiglottis, and tongue. These oscillations alternately occlude and open a narrowed airway. Notably, increasing nasal patency improves snoring (5, 6).

Nasal obstruction due to nasal valve abnormalities may result from either dynamic or static problems. The normal airflow passing the nasal valve depends on the Bernoulli principle and the Poiseuille law. The Bernoulli principle states that when the flow of air increases through a fixed space, the pressure in that space decreases consequently. If the decrease in pres-

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sure overcomes the inherent rigidity of the flexible nasal sidewall, collapse can occur resulting in obstruction. Clinically, the collapse of the nasal sidewall during inspiration is termed dynamic obstruction. The Pouseille law states that the flow is inversely proportional to the fourth power of the radius, which means that small decreases in the radius of a space have dramatic impacts on the flow of air through the nose. In the clinical setting, an anatomically narrowed portion of the nasal valve is defined as a static obstruction.

The management of snoring includes careful evaluation and correction of upper airway obstruction. Septoplasty alone or associated with lateral osteotomies corrects a narrowed nasal valve creating a 2.5 times reduction in nasal respiratory resistance (2). Even in the presence of septal deviation, airflow may be improved with repair of an obstructing nasal valve. However, a potential alternative to surgical procedures may be represented by the mechanical nasal alar dilators. The nasal dilators may be classified as external and internal (3). There are some studies that explored the possibility of relieving snoring by wearing them. For these reasons, we aimed to compare a new internal nasal dilator (Nas-air®) with an external dilator (Rinazina Breathe Right®) in a group of snoring outpatients.

Materials and Methods

The present open study included 41 outpatients who snore, and was conducted in a real-world setting, such as a rhinologic clinic.

Inclusion criteria were: adult age and snoring history in the past month. Exclusion criteria were: anatomical clinically relevant problems (e.g. very severe septal deviation and/or turbinate hypertrophy, such as grade IV), obstructive sleep apnea syndrome, disorders and current medications potentially able to interfere with findings.

The outpatients were visited and undergone otorhinolaryngological visit, including anterior rhinoscopy. The Nas-air® (E.P. Medica, Fusignano, Italy) and Rinazina Breathe Right® (GSK Consumer Healthcare, Milan, Italy) were given with appropriate instruction for their use. All patients signed an informed consent to participate in the study.

Briefly, the internal nasal dilator should be applied into the nose at bedtime, whereas the nasal strip should be applied on the bridge of the nose at bedtime too. Both devices should be worn the whole night.

Snoring assessment was performed by the app “Do I Snore®” using a smartphone and recorded at home during the sleep. This app measures the time of snoring during sleeping.

Patients were instructed to measure snoring the first night (without any device), the further second (with Nas-air®) and the third night (with Rinazina Breathe Right®).

During the otorhinolaryngological visit, the following parameters were considered: age, gender, body mass index (BMI); a fibro-endoscopy was also performed.

Subjective parameters included perception of nasal obstruction, sleep quality, and olfaction. It was measured by a visual analogue scale (VAS). VAS score for nasal obstruction ranged from 0 (=completely blocked nose) to 10 (=completely patent nose); VAS score for olfaction ranged from 0 (=no smell) to 10 (=optimal smell); VAS score for quality of sleep ranged from 0 (=worst sleeping) to 10 (optimal sleeping). In addition, VAS was used for assessing the satisfaction for the Nas-air® and the nasal strip (0=bad; 10=best). These parameters were recorded by the patients at baseline, after the second night with Nas-air®, and after the third night with nasal strip.

Demographic and clinical characteristics are described using means with SDs for normally-distributed continuous data and absolute frequencies and percentages for categorical variables. Any statistically significant difference between or among mean values of each continuous variable was evaluated with the Paired t test (comparisons between two groups) or the Repeated Measures ANOVA (comparisons among three groups), followed by Bonferroni›s Multiple Comparison Test as post-hoc test, respectively. Chi-square test or Fisher’s exact test, in case of expected frequencies lower than 5, was used to compare frequencies. Correlations were evaluated with Pearson correlation coefficient. Statistical significance was set at $p < 0.05$, and the analyses were performed using GraphPad Prism software, GraphPad Software Inc, CA, USA

Results

In the current study, 41 patients were enrolled: 31 males and 10 females (mean age 44.7±13.3 years). The mean BMI was 25.2 (±3.6), overweight/obese subjects were 20 (48.8%).

The application of both Nas-air® and nasal strip significantly reduced snoring time (expressed as % snoring during the nighttime) in comparison with baseline (p<0.05 and <0.001 respectively), but without difference between them, as reported in Figure 1.

There was a significant difference (p<0.05) between Nas-air® and nasal strip concerning the percentage of patients reporting a reduced snoring, as shown in Figure 2.

Nas-air® use was associated with the best perception of good sleep (p<0.05), as reported in Figure 3. Sleep quality VAS score significantly correlated with Nas-air® preference (r=0.413, p<0.01) and nasal strip preference (r=0.35, p<0.05).

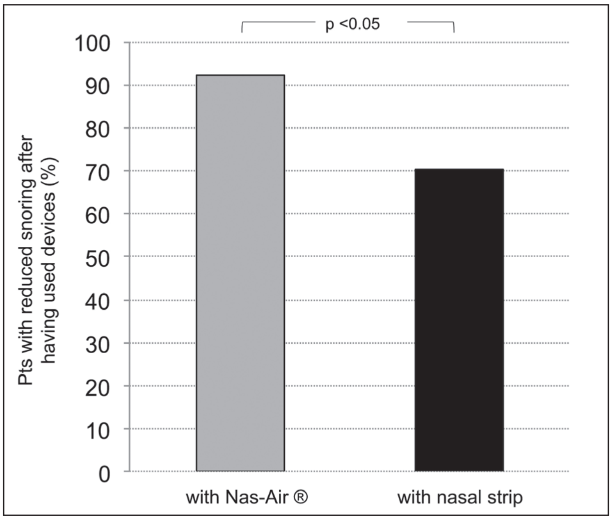

Figure 2. Percentage of patients with reduced snoring after having used both the devices

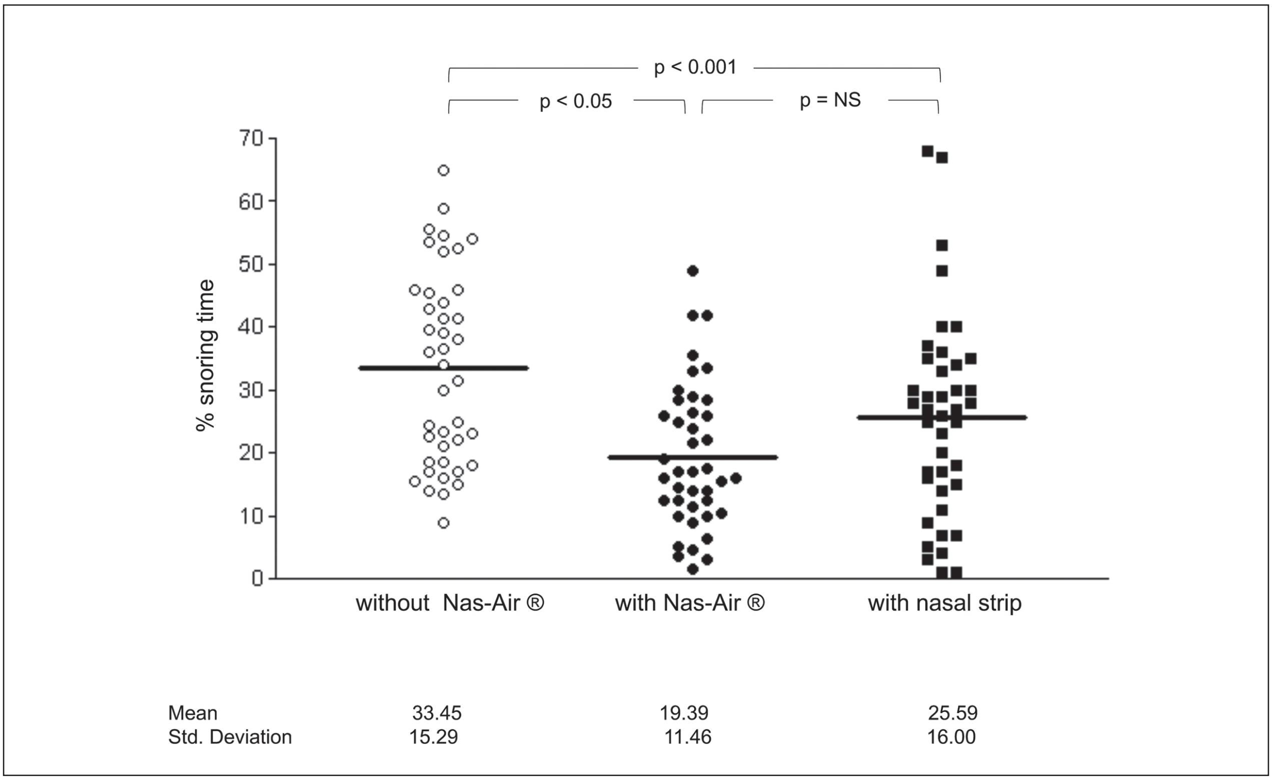

Figure 1. Snoring (expressed as % snoring time during the nighttime) during the first night (without device), the second night (with Nas-air®), and the third (with nasal strip). Horizontal bars represent mean values

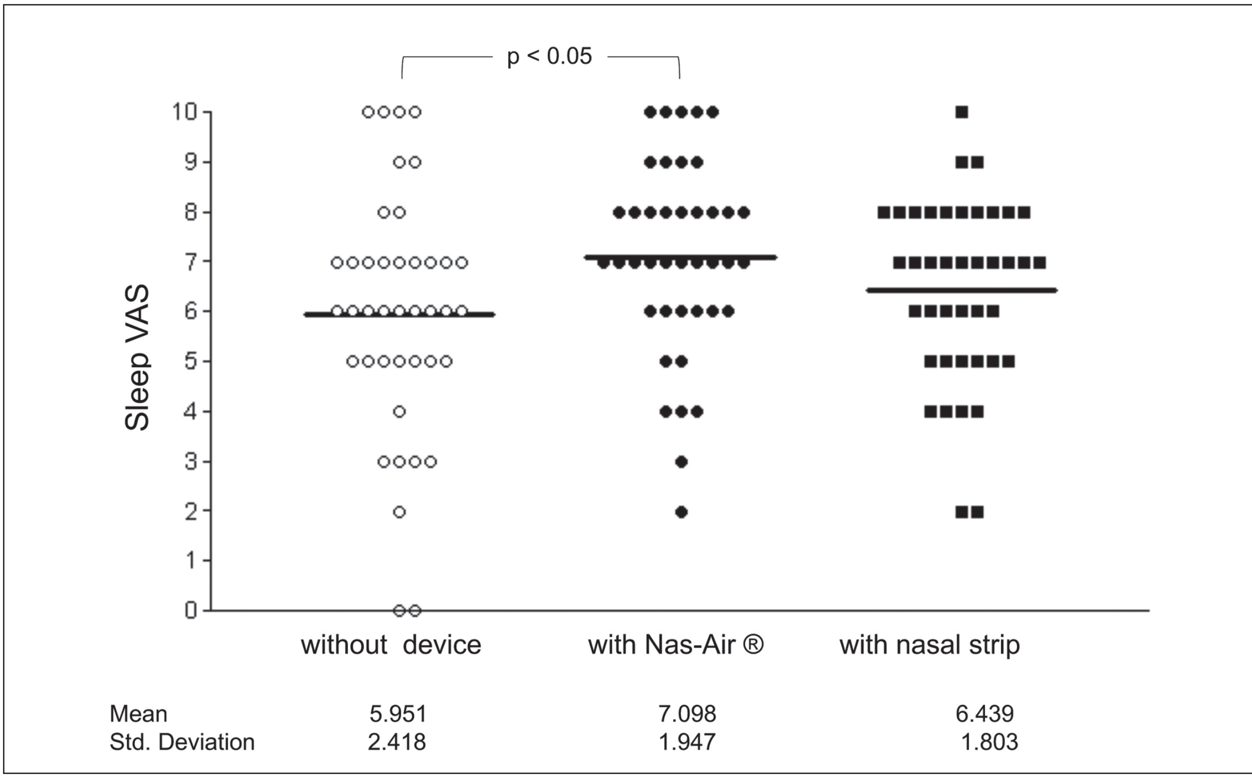

Figure 3. Sleep visual analogue scale (VAS) score during the first night (without device), the second night (with Nas-air®), and the third (with nasal strip). Horizontal bars represent mean values

Discussion

Snoring is a very disturbing symptom and affects a good social and familiar life. In fact, the snorer's partner in a relationship is the one who suffers the most from these nightly noises in the beginning. However, during the following years also the snorer becomes aware of his/her problem. So, he/she wakes himself up, gets a dry throat, and is sleepy and tired in the morning.

The nasal valve area is the narrowest passage in the respiratory tract, causing more than half of the total resistance to nasal respiration in a healthy subject. In this regard, the proportional ratio between the cross-sectional area of the nasal valve and the bony piriform aperture is about 1:1.4. The cross-sectional area surfaces vary into the nasal cavity: in the nasal valve is about 30 mm^2, in the middle of the cavity is 120 mm^2, and in the rhino-pharynx about 150 mm^2. After mechanical dilation the nasal airflow can increase up to 25%; interestingly, this change is comparable with that observed after decongestant use (3, 4).

Many disorders may result in pathologically narrow upper airways, including adeno-tonsillar enlargement, cancers, chronic rhinitis, traumatic or congenital anatomical defects and so on. In particular, nasal obstruction represents the most common cause for snoring (6). Nasal valve obstruction is the crucial point for snoring pathogenesis. Some studies investigated the role of nasal valve and its subjective and objective measurement (7, 8). However, in clinical practice the most important parameter is the snoring perception of the partner and/or of the patient.

From a therapeutic point of view, mechanical dilation of nasal valve is the best non-surgical approach in snorers (3, 4). Many dilators exist, both external and internal. Some studies investigated their efficacy and most of them were positive (9-12). Very recently, we demonstrated that a new internal dilator (Nas-air®) was able to significantly reduce the snoring time and was well accepted by the patients (13). So, the current study compared the efficacy of Nas-air® with a nasal strip (Rinazina Breathe Right®).

Interestingly, both devices significantly reduced the snoring time, without relevant intergroup difference. However, the Nas-air® device was effective in a larger number of subjects than the nasal strip. In addition, the patients perceived the better improvement of the sleep quality during the night with Nas-air®. There was a significant relationship between the perceived improvement of sleep quality and the appreciation of the device for both dilators, even if more relevant for Nas-air®. Therefore, it is evident that the use of nasal dilators could significantly improve snoring already after the first night of use, and the Nas-air® seems to be more effective and appreciated than the nasal strip.

The findings of the present study are consistent with the previous literature that reported efficacy of nasal dilators (14, 15). However, a recent systematic review of over-the-counter nasal dilators concluded that these devices may be an alternative to surgical intervention in some patients, but the level of evidence is not optimal for many studies (6). Moreover, there is only one study that had compared external dilators to internal dilators (16).

However, this study has some limitations, including the open design, the limited number of enrolled patients, the lack of a follow-up, and the absence of validated objective parameters. Therefore, the current experience should be confirmed by further studies designed according to more robust methodology.

In conclusion, the present study demonstrates that Nas-air® is an internal nasal dilator able to reduce snoring time and to improve sleep quality, and might be preferred to the nasal strip by snoring patients.

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Original article

The role of the nasal valve in patients with obstructive sleep apnea syndrome

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Summary. The nasal valve area has the minimal cross-sectional area of the upper airways. A problem at this level may easily induce impaired breathing. Obstructive sleep apnea syndrome (OSAS) is a common disorder. It has been reported that nasal obstruction may be associated with OSAS. The aim of this study was to investigate the role of nasal valve in a group of OSAS patients. Polysomnography was performed. Patients with bilateral valve incontinence had lower SaO_2-nadir than patients with unilateral (or no) one. In conclusion, the present study demonstrates that a bilateral nasal valve incontinence is associated with more severe nocturnal respiratory pattern in patients with OSAS. (www.actabiomedica.it)

Key words: nasal valve, airflow obstruction, obstructive sleep apnea syndrome, polysomnography, Nas-Air®

Introduction

The internal nasal valve is the narrowest portion of the nasal cavity (1). It is formed by the junction of the upper lateral cartilages with the nasal septum. The normal angle between these 2 structures ranges between 10° and 15°. The nasal valve offers the greatest resistance to nasal airflow in the nasal cavity. The narrower the site, the more vulnerable is the nose to pathologic nasal obstruction. Nasal obstruction due to nasal valve abnormalities may result from either dynamic or static problems and is one of the most important and common reasons for nasal obstruction. Despite these facts, nasal valve collapse is a frequently overlooked cause of nasal obstruction (2, 3). In particular, the normal airflow through the nasal valve depends on the Bernoulli principle and Poiseuille law. The Bernoulli principle states that as the flow of air increases through a fixed space, the pressure in that space decreases. If the decrease in pressure overcomes the inherent rigidity of the flexible nasal sidewall, collapse can occur resulting in obstruction. Clinically, the collapse of the nasal sidewall during inspiration is termed dynamic obstruction. Pouseille law states that the flow is inversely proportional to the fourth power of the radius, which means that small decreases in the radius of a space have dramatic impacts on the flow of air through the nose. In the clinical setting, an anatomically narrowed portion of the nasal valve is defined as a static obstruction.

On the other hand, obstructive sleep apnea syndrome (OSAS) is a common disorder (4). Notably, 2 meta-analysis pointed out that nasal obstruction represents a common problem in OSAS patients treated with continuous positive airway pressure (CPAP) (5, 6). Very recently, nocturnal nasal obstruction has been found in more than one-third of OSA patients who had, on average, one nasal valve with a smaller minimum cross-section area (7). For these reasons, we aimed to investigate the role of nasal valve in a group of OSAS patients recruited in clinical practice.

Materials and Methods

The present open study included 19 inpatients with OSAS diagnosis.

Inclusion criteria were: adult age and OSA diagnosis according to validated criteria (8). Exclusion criteria were: anatomical clinically relevant problems (e.g. very severe septal deviation and/or turbinate hypertrophy, such as grade IV), disorders and current medications potentially able to interfere with findings.

The patients were visited and undergone also an otorhinolaryngological visit, including anterior rhinoscopy.

Subjective parameters were evaluated by the patients, and include perception of nasal obstruction, sleep quality, and olfaction; they were measured by a visual analogue scale (VAS). VAS score for nasal obstruction ranged from 0 (=completely blocked nose) to 10 (=completely patent nose); VAS score for olfaction ranged from 0 (=no smell) to 10 (=optimal smell); VAS score for quality of sleep ranged from 0 (=worst sleeping) to 10 (optimal sleeping). In addition, VAS was used for assessing the satisfaction for the Nas-Air® (0=bad; 10=best).

Daytime sleepiness was evaluated with the Epworth Sleepiness Scale (ESS): an ESS score of ≥10 was considered excessive daytime sleepiness (9). In addition, the STOP-Bang (10) and Restorative Sleep (11) questionnaires, and Mallampati scale (12) were used.

Cardiorespiratory nocturnal monitoring was performed in all patients was done in ambient air and spontaneous breathing using a portable 4-channel/8-track polygraph (WristOx$_2$, Nonin, the Netherlands). Oxyhemoglobin saturation, heart rate, body posture, oral-nasal air flow, snoring sounds, and thoracic and abdominal movements were recorded in detail. AHI (apnea-hypopnea index), ODI (oxygen desaturation index), TST90 (total sleep time with oxyhemoglobin saturation below 90%), SaO2-Nadir % and Restoring Sleep were calculated

Clinical characteristics were reported as mean $\pm$ standard deviation (SD) for continuous variables and as percentage for categorial variables. The normal distribution of continuous variables was verified. Continuous parameters were analyzed by Student's T-test, discontinuous parameters were analyzed by X^2 test. The percentage of precision of cross-validation was calculated by the "leave-one-out" method. A ROC curve was performed to verify the precision of this method. Significance values assumed for p <0.005 All the analysis have been conducted with SPSS 21 software.

Results

This study included 19 inpatients (mean age 61.1$\pm$13.5 years, range 41-87; 4 females). Patients were subdivided in two groups: Group 1 had bilateral incontinence of nasal valve and Group 2 unilateral or absent incontinence.

Clinical data of the two groups are reported in detail in Table 1.

Group 1 had a significantly ($p<0.05$) lower Nadir of SaO_2 (70.9±11.06) than Group 2 (80.9±9.5) during nocturnal sleep, as reported in Figure 1.

Group 1 had a significantly ($p<0.05$) less severe Mallampati score than Group 2 (category 5: 36.4% vs 100% respectively) as reported in Table 1.

Group 1 showed a trend for higher AHI in comparison with Group 2 (47.5±34.1 vs 26.7±22.1 respectively).

Discriminating analysis confirmed that AHI and Nadir SaO_2 correctly differentiated 68.4% of patients as reported in Figure 2 with good reliability (AUC= 0.78; $p<0.05$).

Discussion

From a pathophysiological point of view, the nasal valve area represents the narrowest passage in the respiratory tract, causing more than half of the total resistance to nasal respiration in a healthy subject. Therefore, nasal obstruction may have relevant impact on breathing, mainly concerning in patients with OSAS. As it has been reported a relationship between nasal obstruction and respiratory parameters in patients with OSAS, we aimed to confirm these outcomes in a group of inpatients in a real-world setting. In particular, we considered the role of bilateral versus unilateral (or no) incontinence of the nasal valve.

The findings showed that patients with bilateral

Table 1. Clinical characteristics in Group 1 and Group 2

	Group 1 (n=11)	Group 1 (n=8)	P value
Mean age±SD	62.9±12.24	58.62±15.59	0.53
Smokers n (%)	5 (45.5)	4 (50)	0.72
Gender females	2 (18.2)	2 (25)	0.574
BMI Mean±SD	33.7±7.1	30.7±6.3	0.348
Sleepiness n (%)	8 (72.7)	7 (87.5)	0.426
Neck circumference M±SD	41.9±1.6	40.4±2.6	0.169
Weakness n (%)	5 (45.5)	5 (62.5)	0.395
Sleep hours	6.45±0.93	6.75±1.38	0.612
ESS Mean±SD	5.09±3.04	8.5±4.14	0.072
STOP BANG Mean±SD	5.45±1.57	5,25±1.38	0.768
MALLAMPATI			**0.018**
0	0 (0)	0 (0)	
1	0 (0)	0 (0)	
2	1 (9.1)	0 (0)	
3	6 (54.5)	0 (0)	
4	4 (36.4)	8 (100)	
Turbinate hypertrophy			0.481
1	0 (0)	1 (12.5)	
2	5 (45.5)	3 (37.5)	
	6 (54.5)	4 (50)	
VAS nasal obstruction Mean±SD	6.81±1.77	6.62±2.2	0.841
VAS sleep quality Mean ± SD	4.9±1.92	3.75±2.7	0.314
VAS smell Mean±SD	8.18±2.96	7.37±2.87	0.560
PO_2 Mean±SD	78.18 ±11.48	80.87±1.21	0.616
PCO_2 Mean±SD	42.27±5,16	40.62±3.7	0.429
pH Mean±SD	7.42±0.03	7.42±0.02	0.755
HCO_3 Mean±SD	27.7±2.58	26.1±2.44	0.209
SaO_2 Mean±SD	94.9±2.84	95.75±1.48	0.416
HR bpm Mean±SD	79.54±12.3	77.25±6.86	0.612
Frequent awakes n (%)	2 (18.2)	2 (25)	0.574
Chocking n (%)	0 (0)	3 (37.5)	0.058
Reported Apnea n (%)	8 (72.8)	7 (87.5)	0.426
Snoring n (%)	8 (81.8)	7 (87.5)	0.624
AHI Mean±SD	47.5±34.1	26.71±22.1	0.127
ODI events/h Mean±SD	44.01±34.7	26.71±22,14	0.394
TST90 Mean±SD	31.83±33.26	21,68±29.4	0.492
Restoring Sleep Mean±SD	47.6±26.2	64.8±24.	0.150
SaO_2 % (Nocturnal Mean±SD)	89.9±4	92.5±2.65	0.112
SaO_2-Nadir % Mean±SD	70.9±11.06	80.9±9.5	**0.050**

nasal valve incontinence had less severe Mallampati scale scores. On the other hand, patients with unilateral (or no) nasal valve incontinence had higher SaO_2-nadir than patients with bilateral one. In addition, patients of Group 1 showed a trend to have higher AHI than Group 2.

These outcomes suggest that the nasal valve may have a role in OSAS patients as bilateral impairment was associated with a worst nocturnal respiratory pattern. These findings are consistent with previous observations that underlined the relevance of nasal obstruction in patients with OSAS (7). In particular, the

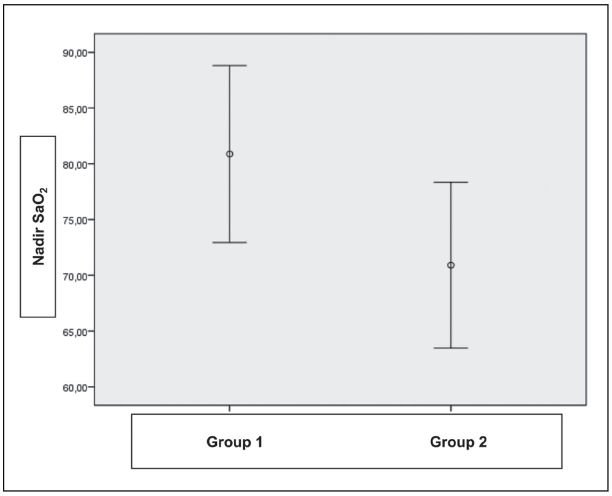

Figure 1. Nadir of SaO_2 in patients of Group 1 and Group 2

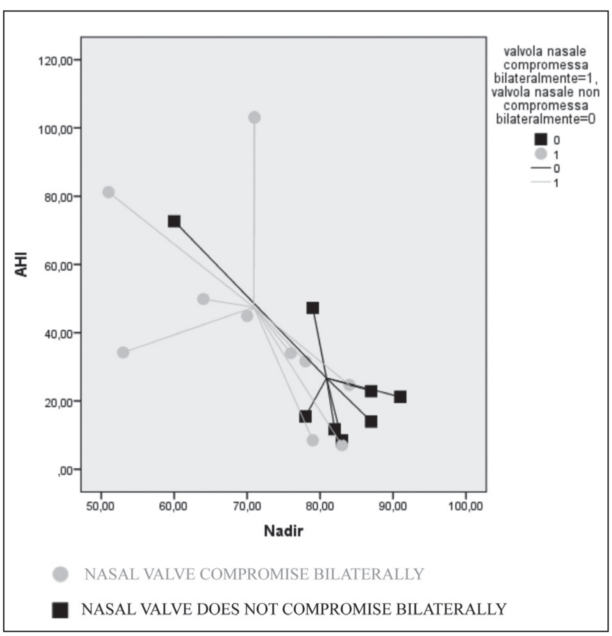

Figure 2. Nadir of SaO_2 and AHI in Group 1 and Group 2

current outcomes suggest that to improve nasal valve function may be clinically relevant in OSAS patients.

However, the present study was conducted in a restricted number of patients and was designed as a cross-sectional study. Thus, further studies should be performed to confirm these preliminary findings.

In conclusion, the present study demonstrates that a bilateral nasal valve incontinence is associated with more severe nocturnal respiratory pattern in patients with OSAS.

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Internal nasal dilator in patients with obstructive sleep apnea

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Summary. The nasal valve area has the minimal cross-sectional area of the upper airways. Obstructive sleep apnea (OSA) is a common disorder. It has been reported that nasal obstruction may be associated with OSA. The aim of this study was to investigate whether the use an internal nasal dilator may be able to affect respiratory pattern in a group of patients with OSA. The use of internal nasal dilator was able to significantly reduce two relevant respiratory outcomes, such as the apnea-hypopnea index and the oxygen desaturation index, notably there was also a positive trend for the reduction of total sleep time with HbO_2 <90%). Nas-air® was also able to significantly improve restorative sleep performance. In conclusion, the present study demonstrates that Nas-air® is a new internal nasal dilator potentially capable to significantly improve respiratory outcomes and sleep quality. (www.actabiomedica.it)

Key words: nasal valve, internal nasal dilator, Nas-air ®, obstructive sleep apnea, respiratory parameters

Introduction

Obstructive sleep apnea (OSA) is a serious, potentially life-threatening disorder characterized by recurrent episodes of upper-airway collapse during sleep. The intermittent partial or complete occlusion of the upper airway (termed hypopneas and apnea, respectively), due to a combination of excess tissue and inappropriate upper airway muscle relaxation, often leads to hypoxemia and hypercapnia (1). Symptomatic OSA is common, and the disease prevalence is higher in different population subsets, including overweight or obese people, and older individuals (2). In fact, OSA affects 5% to 10% of middle-aged adults and up to 20% of adults over 65 years of age (3).

Sleep apnea has been associated with many health-related illnesses ranging from cognitive impairment, memory loss, depression, metabolic disorders, and, most seriously, cardiovascular diseases, such as ischemic heart disease, stroke, and chronic heart failure (4). Notably, the prevalence of adverse outcomes is typically dose-dependent: an increased number of apneas and hypopneas per hour of sleep is reflected in the apnea/hypopnea index (AHI), and the severity of oxygen desaturation (5).

Typical treatments for patients with OSA include continuous positive airway pressure (CPAP) therapy, oral appliances (those that advance the mandible and those that prevent relapse of the tongue), various surgeries that modify the upper airway, and/or weight loss (dietary, pharmacologically, and surgically induced).

Actually, CPAP is considered the “standard of care” for OSA treatment, as the therapeutic use of CPAP is able to significantly improve many of the acute pathophysiologic responses that result from sleep-disordered breathing (6). However, despite these relevant benefits, the therapeutic acceptance, compliance, and adherence remain significant challenges to patients and clinicians. Indeed, the real adherence to CPAP therapy averages about 50%, ranging from 30 to 70% (7). Therefore, many efforts are tried to improve this problem and/or to use other ways. In this regard, nasal obstruction is a common problem as reported by almost 20% of the general population, and about one-third of the sleep apnea patients (8). Significantly, OSA patients with nasal obstruction are more likely to suffer from daytime sleepiness and to have impaired quality of life than other OSA patients.

Interestingly, the anterior portion of the nasal cavities, from the nostrils to the nasal valve, is the region of the greatest nasal airflow resistance and where there is the narrowest segments of the nasal cavity (9). Therefore, this segment is very important for the nasal physiology and the main nasal symptom: obstruction. The relevance of nasal anatomy assessment has been deeply investigated in OSA patients by Leitzen and colleagues (10). They concluded that a careful nasal examination, clinical and functional, should be performed in all OSA patients. Consequently, some studies aimed to investigate whether nasal dilation could be useful in OSA patients. Colrain and colleagues studied an intranasal device, consisting of a small valve inserted into each nostril, in 32 OSA patients (11). The apnea-hypopnea index (AHI) and oxygen desaturation index (O_2DI), and snoring score significantly decreased after using this device. This interesting outcome was partially confirmed by another study that investigated an internal nasal dilator (Nozovent) as some patients were responders to it and snoring was significantly diminished (12). Further, McLean and colleagues evaluated an external dilator strip (Breathe Right) in 10 patients with OSA and nasal obstruction (13). They reported that dilating the nose reduced mouth breathing during sleep and OSA severity. However, these outcomes were conflicting with a previous study that demonstrated no effect of nasal device on snoring and quality of sleep (14). On the other hand, it has been recently reported that an internal nasal dilator (Nas-air®) was able to significantly reduce snoring score (15). As this issue is controversial, we performed a study in a group of OSA patients with the aim to demonstrate the effectiveness of Nas-air® on respiratory pattern.

Materials and Methods

The present cross-sectional study included 19 in-patients with OSA diagnosis.

Inclusion criteria were: adult age and OSA diagnosis according to validated criteria (16). Exclusion criteria were: anatomical clinically relevant problems (e.g. very severe septal deviation and/or turbinate hypertrophy, such as grade IV), disorders and current medications potentially able to interfere with findings.

The patients were visited and undergone otorhinolaryngological visit, including anterior rhinoscopy. During the otorhinolaryngological visit, the following parameters were considered: age, gender, body mass index (BMI); a fibro-endoscopy was also performed.

Subjective parameters were evaluated by the patients, and include perception of nasal obstruction, sleep quality, and olfaction; they were measured by a visual analogue scale (VAS). VAS score for nasal obstruction ranged from 0 (=completely blocked nose) to 10 (=completely patent nose); VAS score for olfaction ranged from 0 (=no smell) to 10 (=optimal smell); VAS score for quality of sleep ranged from 0 (=worst sleeping) to 10 (optimal sleeping). In addition, VAS was used for assessing the satisfaction for the Nas-Air® (0=bad; 10=best).

Daytime sleepiness was evaluated with the Epworth Sleepiness Scale (ESS): an ESS score of ≥10 was considered excessive daytime sleepiness (17). In addition, the STOP-Bang (18), the Restorative Sleep (19) questionnaires, and Mallampati scale (20) were used.

Cardiorespiratory nocturnal monitoring was performed in all patients and was done in ambient air and spontaneous breathing using a portable 4-channel/8-track polygraph (WristOx$_2$, Nonin, the Netherlands). Oxyhemoglobin saturation, heart rate, body posture, oral-nasal air flow, snoring sounds, and thoracic and abdominal movements were recorded in detail. AHI (apnea-hypopnea index), ODI (oxygen desaturation index), TST90 (total sleep time with oxyhemoglobin saturation below 90%), SaO2-Nadir % and Restoring Sleep were calculated

The Nas-air® (E.P.Medica, Fusignano, Italy) was given with appropriate instruction for the use, such as the internal nasal dilator should be applied into the nose at bedtime. All patients signed an informed consent to participate in the study. Patients were evaluated the first night (without any device) and the second one (with Nas-air®).

Clinical characteristics were reported as mean ± standard deviation (SD) for continuous variables and as percentage for categorial variables. The normal distribution of continuous variables was verified. Continuous parameters were analyzed by Student's T-test for paired samples. Significance values assumed for $p < 0.005$ All the analysis have been conducted with SPSS 21 software.

Results

The present study included 19 patients (4 females, 5 males, mean age 61±13.5 years) suffering from severe OSA with mean AHI 38.7±30.8. Mean BMI was 32.4±6.7; mean neck circumference 41.3±2.2).

Table 1 shows clinical characteristics of the patients in detail.

Table 2 shows the principal polygraphic parameters without and with the use of Nas-air® in the OSA patients. The use of Nas-air® significantly reduced AHI values (38.7±30 vs 31.1±27.4; p=0.000) and ODI scores (36.4±30.6 vs 29.0±26.4; p=0.001) as shown in Figure 1. In addition, the use of Nas-air® significantly increased the restoring sleep score (54.8±26.2 vs 73.3±21.7; p=0.000).

Moreover, there was a favorable trend for the use of Nas-air® concerning TST90, nocturnal SaO_2 and Nadir-SaO_2 as shown in Table 2.

Table 1. Clinical characteristics of the OSA patients. Data are expressed ad mean±SD or absolute number (and percentage).

	Population (n=19)
Mean age	61.0±13.5
Smokers n (%)	4 (21.1)
Gender females	4 (21.1)
BMI	32.4±6.7
Sleepiness n (%)	15 (78.9)
Neck circumference	41.3±2.2
Weakness n (%)	5 (45.5)
Sleep hours	6.6±1.1
ESS	6.5±3.8
STOP BANG	5.4±1.5
MALLAMPATI	
0	0 (0)
1	0 (0)
2	1 (5.3)
3	6 (31.6)
4	12 (63.2)
Turbinate hypertrophy	
0	1 (5.3)
1	8 (42.1)
2	10 (52.6)
Bilaterally compromised nasal valve n (%)	11 (57.9)
VAS nasal obstruction	6.7±1.9
VAS sleep quality	4.4±2.3
VAS smell	7.8±2.9
PO_2	79.3 ±11.1
PCO_2	41.6±4.6
pH	7.42±0.03
HCO_3	27.0± 2.6
SaO_2 Mean	95.3± 2.3
HR bpm Mean±SD	78.6±10.2
Frequent awakes n (%)	4 (21.1)
Chocking n (%)	3 (15.8)
Reported Apnea n (%)	15 (78.9)
Snoring n (%)	16 (84.2)

Discussion

OSA is a breathing disorder characterized by narrowing of the upper airway that impairs normal ventilation during sleep. Recent reviews on the evaluation and management of CSA and sleep-related hypoventilation have been published as recently discussed (21). The clinical relevance of OSA depends on the large impact on the general population (22).

The consequences of untreated OSA are wide and may significantly vary, in fact, it has been postulated that they result from the fragmented sleep, intermittent hypoxia, and hypercapnia, intrathoracic pressure swings, and increased sympathetic nervous activity that accompanies disordered breathing during sleep. Individuals with OSA often feel unrested, fatigued, and sleepy during the daytime. They may suffer also rom impairments in vigilance, concentration, cognitive function, social interactions, and quality of life. Unfortunately, these declines in daytime function can translate into higher rates of job-related and motor vehicle accidents. Moreover, patients with untreated OSA may be at increased risk of developing cardiovascular

Table 2. Comparison of polygraphic parameters without and with NasAir®

	Without NasAir®	With NasAir®	P- value
AHI Mean±SD	38.7±30.8	31.1±27.4	**0.000**
ODI events/h Mean±SD	36.4±30.6	29.0±26.4	**0.001**
TST90 Mean±SD	27.6±31.3	19.7±25.0	0.055
Restoring Sleep Mean±SD	54.8±26.2	73.3±21.7	**0.000**
SaO_2 % Nocturnal Mean±SD	91.0±3.6	92.1±3.0	0.052
SaO_2-Nadir % Mean±SD	75.1±11.3	76.2±10.6	0.588

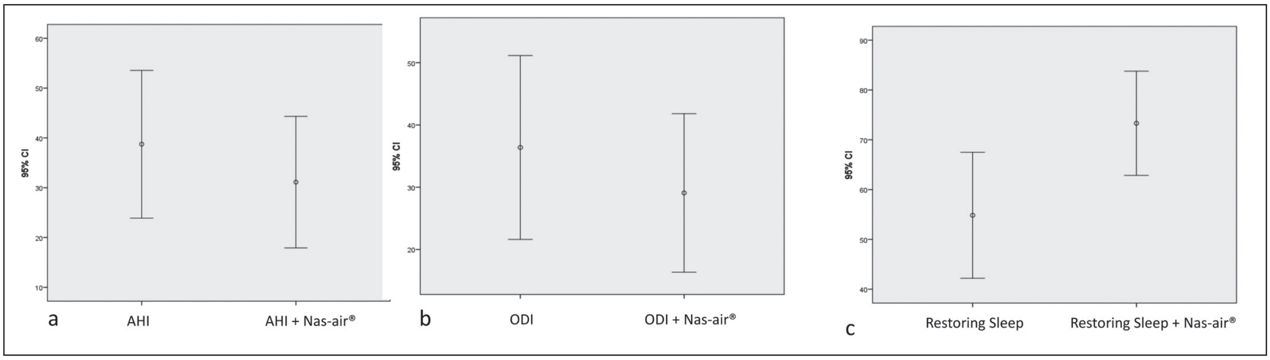

Figure 1. a=AHI values without and with Nas-air®; b= ODI scores without and with Nas-air®; c= Restoring sleep without and with Nas-air®

disease, including difficult-to-control blood pressure, coronary artery disease, congestive heart failure, arrhythmias and stroke (23). OSA is also associated with metabolic dysregulation, mainly concerning the risk for diabetes. Consequently, undiagnosed and untreated OSA is a significant burden on the healthcare system, with increased healthcare utilization seen in those with untreated OSA, highlighting the importance of early and accurate diagnosis of this common disorder, as just pointed out (24). Therefore, recognizing and adequately treating OSA is a compelling issue for these copious reasons.

The treatment of OSA has been shown to improve quality of life, lower the rates of motor vehicle accidents, and reduce the risk of the chronic health consequences of untreated OSA mentioned above (25). There are also data supporting a decrease in healthcare utilization and cost following the diagnosis and treatment of OSA (26). However, there are challenges and uncertainties in making the management. In this regard, CPAP has low level of acceptance, compliance, and adherence; consequently, new strategies are attempted.

Nas-air® is a new internal nasal dilator that has been found able to significantly reduce snoring (15). The current study demonstrated that this device was able to significantly reduce two relevant respiratory outcomes, such as the apnea-hypopnea index and the oxygen desaturation index, notably there was also a positive trend for the reduction of total sleep time with HbO_2 <90%). Nas-air® was also able to significantly improve restorative sleep performance.

These outcomes are consistent with previous studies exploring the capability of nasal dilators to improve sleep-related disorders (11, 13). However, the present preliminary experience was conflicting with other studies (10, 14).

On the other hand, our study has some limitations, including the open study design, the lack of follow-up, and the low number of enrolled patients. Thus, further studies should be conducted to answer these unmet needs. Another interesting future extension of this study could be the use in patients with mild OSA to test the hypothesis that the use of an internal nasal dilator may avoid CPAP therapy. Anyway, the strength of the current study was the demonstration that a single application of the device was able to significantly improve respiratory outcomes and consequently improve the quality of the sleep.

In conclusion, this study showed that Nas-air® is a new internal nasal dilator potentially capable to significantly improve respiratory outcomes and sleep quality.

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Original article

Internal nasal dilator in patients with obstructive sleep apnea syndrome and treated with continuous positive airway pressure

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Summary. The nasal valve area has the minimal cross-sectional area of the upper airways. Obstructive sleep apnea syndrome (OSAS) is a common disorder. It has been reported that nasal obstruction may be associated with OSAS. The aim of this study was to investigate whether the use an internal nasal dilator may be able to affect respiratory pattern in a group of patients with OSAS and treated with continuous positive airway pressure (CPAP). The use of internal nasal dilator significantly reduced the pressure of CPAP (from 11.4±1.5 to 10.8±1.5; p=0.012) able to resolve apnea episodes. In conclusion, this study showed that Nas-air® is a new internal nasal dilator potentially capable to significantly improve adherence and compliance to CPAP. (www.actabiomedica.it)

Key words: nasal valve, internal nasal dilator, obstructive sleep apnea syndrome, cardiorespiratory monitoring, continuous positive airway pressure, Nas-air®

Introduction

The nasal dilators are used as a mechanical tool for reducing nasal airflow resistance (1). By lowering nasal resistance, they reduce the work of breathing and consequently the supply of oxygen into the body could increase (2). Signally, the nostril size represents a relevant limitation to the amount of air entering into the body as there is the nasal valve that accounts for relevant resistance to airflow. Nasal dilators may be external, usually strips, or internal, mechanical devices. The nasal strip is placed along the nasal valve of the nose, so it dilates the nose and allows more air to flow into the nose (3,4). On the other hand, internal dilators open up the nostrils by lifting aside the soft tissues in the nasal wings (5).

The primary effect of the nasal dilators could be either to dilate the air passage of the nose or to stiffen the nasal wall. Either mechanism would reduce nasal resistance and allow higher airflow. Stiffening the nasal wall would have its most profound effect at higher flows where the Bernoulli effect would decrease internal nasal pressures and tend to constrict nasal passage diameter. Air passage dilation would tend to decrease nasal resistance more uniformly over a range of air flows.

During breathing, there is expansion of the chest and it creates a negative intra-thoracic pressure and air is sucked into the lungs through the airways. The valve region mean cross-sectional area is 1.4 cm^2 (6). This area is smaller than the zone in the bony opening of the nose (2.0 cm^2) and in the interior part of the nose (6 cm^2). According to Pouiseuille's law, the narrowest cross-sectional area is the most important important when the pressure is calculated. Actually, increasing from 1.4 cm^2 to 2.0 cm^2, the intrathoracic negative pressure can be reduced (7). This means that it is much easier to inhale through the nose.

On the basis of this background, nasal dilators have been proposed also in patients with obstructive sleep apnea syndrome (OSAS). OSAS is a prevalent sleep disorder with significant public health outcomes (8,9). Continuous positive airway pressure (CPAP) is considered the primary medical treatment for patients with moderate to severe OSAS, as evidenced by several randomized controlled trials (10,11).

In this regard, an internal nasal dilator (Nozovent®) has been studied in 21 patients with OSAS (12). Unfortunately, most of patients had no significant improvement of polysomnographic parameters. A recent study evaluated nasal dilator strip as placebo intervention in 26 patients with severe OSAS (13). The device had no significant effect on polysomnographic issues. However, nasal dilator strips significantly improved somnolence, depressive symptoms, wake up at morning, daily activities, and quality of life. Therefore, we investigated the role of a new internal nasal dilator (Nas-air®) as add-on treatment in patients using CPAP.

Materials and Methods

The present cross-sectional study included 19 inpatients with OSAS diagnosis.

Inclusion criteria were: adult age and OSAS diagnosis according to validated criteria (14). Exclusion criteria were: anatomical clinically relevant problems (e.g. very severe septal deviation and/or turbinate hypertrophy, such as grade IV), disorders and current medications potentially able to interfere with findings.

The patients were visited and undergone otorhinolaryngological visit, including anterior rhinoscopy. During the otorhinolaryngological visit, the following parameters were considered: age, gender, body mass index (BMI); a fibro-endoscopy was also performed.

Subjective parameters were evaluated by the patients, and include perception of nasal obstruction, sleep quality, and olfaction; they were measured by a visual analogue scale (VAS). VAS score for nasal obstruction ranged from 0 (=completely blocked nose) to 10 (=completely patent nose); VAS score for olfaction ranged from 0 (=no smell) to 10 (=optimal smell); VAS score for quality of sleep ranged from 0 (=worst sleeping) to 10 (optimal sleeping). In addition, VAS was used for assessing the satisfaction for the Nas-air® (0=bad; 10=best).

Daytime sleepiness was evaluated with the Epworth Sleepiness Scale (ESS): an ESS score of ≥10 was considered excessive daytime sleepiness (15). In addition, the STOP-Bang (16), the Restorative Sleep (17) questionnaires, and Mallampati scale (18) were used.

Cardiorespiratory nocturnal monitoring was performed in all patients and was done in ambient air and spontaneous breathing using a portable 4-channel/8-track polygraph (WristOx$_2$, Nonin, the Netherlands). Oxyhemoglobin saturation, heart rate, body posture, oral-nasal air flow, snoring sounds, and thoracic and abdominal movements were recorded in detail. AHI (apnea-hypopnea index), ODI (oxygen desaturation index), TST90 (total sleep time with oxyhemoglobin saturation below 90%), SaO2-Nadir % and Restoring Sleep were calculated

All patients were treated with auto-CPAP (AirSense 10, ResMed, Italy) and evaluated for two consecutive days.

The Nas-air® (E.P.Medica, Fusignano, Italy) was given with appropriate instruction for the use, such as the internal nasal dilator should be applied into the nose at bedtime. All patients signed an informed consent to participate in the study. Patients were evaluated the first night (without any device) and the second one (with Nas-air®).

Clinical characteristics were reported as mean± standard deviation (SD) for continuous variables and as percentage for categorial variables. The normal distribution of continuous variables was verified. Continuous parameters were analyzed by Student's T-test for paired samples. Significance values assumed for $p<0.005$ All the analysis have been conducted with SPSS 21 software.

Results

The present study included 19 patients (4 females, 5 males, mean age 61±13.5 years) suffering from severe OSA with mean AHI 38.7±30.8. Mean BMI was 32.4±6.7; mean neck circumference 41.3±2.2). All patients suffered from severe OSA with mean AHI value 38.7±30.8

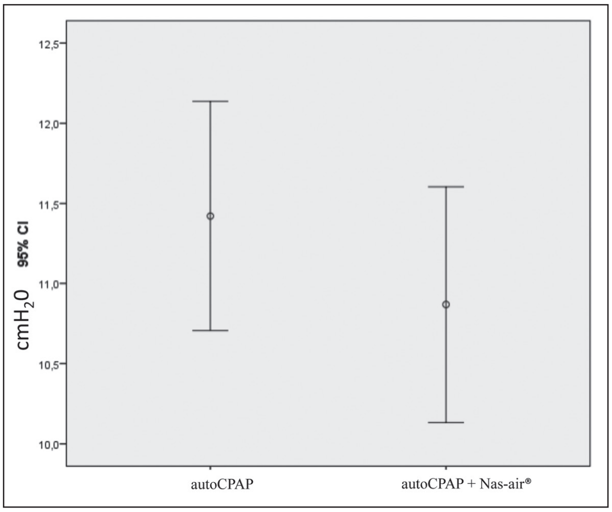

Figure 1. Operating pressure of Auto-CPAP without and with the internal nasal dilator

Notably, all patients conferred the value 10 about the liking of the internal nasal dilator.

The use of the internal nasal dilator significantly reduced the pressure of CPAP (from 11.4±1.5 to 10.8±1.5; p=0.012) able to resolve apnea episodes, as reported in Figure 1.

Discussion

Obstructive sleep apnea syndrome (OSAS) is a condition in which the upper airway becomes obstructed during sleep, so causing hypoxia, hypercarbia, disturbed sleep, and a variety of medical complications including daytime drowsiness and an increased risk of hypertension, diabetes, and cardiovascular disease (19). OSAS is highly associated with obesity and is becoming increasingly common as the obesity epidemic continues (20). Unfortunately, about 80% of patients with OSAS are unrecognized before surgery, putting them at increased risk of complications during the perioperative period (21).

Therefore, patients with OSAS represent a challenge for the doctors. In this regard, the nose may have a relevant role in OSAS patients as it accounts for about half of the total airways resistance.

Nas-air® is a new device that dilates the nasal valve so increases the nasal airflow and reduces snoring as recently reported (22).

The present study showed that Nas-air® was able to significantly reduce the CPAP pressure. The clinical relevance of this outcome could be the possibility to improve the long-term compliance and adherence to CPAP, as it might allow to reduce the mean operating pressure. Of course, further studies should be designed to confirm this hypothesis.

On the other hand, the current study has some limitations, including the open study design, the lack of follow-up, and the low number of enrolled patients. Thus, further studies should be conducted to answer these unmet needs. However, the strength of the current study was the demonstration that a single application of the device was able to significantly reduce the CPAP operating pressure.

In conclusion, this study showed that Nas-air® is a new internal nasal dilator potentially capable to significantly improve adherence and compliance to CPAP.

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Original article

The role of an internal nasal dilator in athletes

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Summary. The nasal valve area has the minimal cross-sectional area of the upper airways. Nasal dilators have been found able to improve sport performance in athletes. The aim of this study was to investigate whether the use an internal nasal dilator may be able to affect respiratory pattern in a group of athletes. The use of internal nasal dilator induced a significant reduction of fatigue perception (p=0.000) and was optimally accepted. In conclusion, the present study demonstrates that Nas-air® is an internal nasal dilator able to reduce the fatigue perception and is preferred to external nasal dilator. (www.actabiomedica.it)

Key words: nasal valve, internal nasal dilator, athletes, sport performance, Nas-air®

Introduction

Nasal dilators were developed over a century ago and introduced successively in the nineties, they became very popular during the Olympic Games in Atlanta (GA, USA) in 1996 (1-3). A nasal dilator is considered efficient if is able to alleviate sleep disorders and snoring. The mechanism of action is based on reductions in nasal resistance.

Nasal dilators may be useful during physical exercise as reduced nasal resistance may induce a consequent reduction in the nasal breathing effort, increase in nasal ventilation, and delay in oral breathing onset during physical exercise (4, 5).

Many studies were conducted in athletes, mainly in adults, using nasal dilators as recently analysed by Dinardi and colleagues (3). However, the results of these studies are conflicting and no conclusive shared consent has been reached still now.

Nas-air® is a new internal nasal dilator that has been found able to significantly improve snoring (6). Therefore, the present study investigated the potential benefit of internal nasal dilator in a group of athletes.

Materials and Methods

The present open study included 19 athletes.

Inclusion criteria were: adult age. Exclusion criteria were: anatomical clinically relevant problems (e.g. very severe septal deviation and/or turbinate hypertrophy, such as grade IV), obstructive sleep apnea syndrome, disorders and current medications potentially able to interfere with findings.

The Nas-air® (E.P. Medica, Fusignano, Italy) and Rinazina Breathe Right® (GSK Consumer Healthcare, Milan, Italy) were given with appropriate instruction for their use. All patients signed an informed consent to participate in the study.

The athletes should run on a treadmill for 3 km in 23 minutes (angle of inclination 0°).

Briefly, the internal nasal dilator should be applied into the nose before the run, whereas the nasal strip should be applied on the bridge of the nose at the same time. Both devices should be worn during the whole exercise. The athletes were evaluated at baseline (without any dilator), after one week (with Nas-air®), and after another week (with Breathe Right®).

During the otorhinolaryngological visit, the following parameters were considered: age, gender, body mass index (BMI); a fibro-endoscopy was also performed.

Subjective parameters included perception of nasal obstruction, sleep quality, and olfaction. It was measured by a visual analogue scale (VAS). VAS score for nasal obstruction ranged from 0 (= completely blocked nose) to 10 (= completely patent nose). HR and SaO_2 were recorded at each visit. The perception of fatigue was scored as low, medium, and high. The device judgment was poor, good, or excellent

Clinical characteristics were reported as mean ± standard deviation (SD) for continuous variables and as percentage for categorial variables. The normal distribution of continuous variables was verified. Continuous parameters were analyzed by the ANOVA test, whereas non continuous variables were analyzed by the Pearson Chi-square test. The software SPSS23 was used.

Results

Globally, 19 athletes (16 males, mean age 22.9±4 years) were enrolled.

HR at rest was 70.6±8.8 bpm, SaO_2 at rest was 97.5±1%. BMI was 22.6±2.

The distribution of the nasal valve incontinence was: 5 subjects had normal valve, 10 had unilateral incontinence, and 4 had bilateral one. The VAS of nasal obstruction was 7±1.2.

The findings at baseline and after wearing every device are reported in Table 1. HR and SaO_2 data were similar in the three tests. Fatigue perception was significantly lower in subjects after Nas-air®. The device judgment was significant better for Nas-air®.

Discussion

The nasal dilators are a non-pharmacological treatment for nasal obstruction and may be also used by athletes as nasal dilators have been found able to improve respiration and consequently exercise capacity (7,8). In this regard, there is a body of experience on the use of nasal dilators in athletes, but the outcomes are conflicting. Therefore, we investigated the potential capability of a new internal nasal dilator (Nas-air®) to improve sport performance in a group of athletes.

The findings showed that Nas-air® significantly reduced the fatigue perception and was optimally accepted. Cardiorespiratory parameters were no affected by both devices.

The current outcomes are consistent with some recent reports. Dinardi and colleagues compared an external nasal dilator with a placebo nasal strip in 48 healthy adolescent athletes performing a 1000 m race (7). The results showed that the external nasal dilator was significantly superior to placebo and improved maximal oxygen uptake, nasal patency, and respiratory effort. Another study conducted by the same team investigated an internal nasal dilator compared to a placebo dilator (9). The study found that the internal nasal

Table 1. Clinical data at baseline, and after external or internal nasal dilator

	No device	External dilator	Nas-air®	p
HR mean±SD	152.5±21.1	144.2±22.1	142.9±24.9	0.430
SaO_2 mean±SD	96.2±1.4	96.5±1.2	96.5±0.8	0.625
Fatigue perception n (%)				0.000
low	2 (10.5)	4 (21.1)	16 (84.2)	
medium	14 (73.7)	10 (52.6)	3 (15.8)	
high	3 (15.8)	5 (26.3)	0 (0)	
Device judgment n (%)				0.007
Poor		6 (31.6)	0 (0)	
Good		10 (52.6)	9 (47.4)	
Excellent		3 (15.8)	10 (52.6)	

dilator was able to significantly improve nasal patency in adolescent athletes; however, there was no difference concerning cardiorespiratory parameters between nasal dilator and its placebo. A further study evaluated adolescent athletes with or without allergic rhinitis using an external nasal dilator and its placebo (10). The findings demonstrated that the external dilator significantly diminished nasal resistance, improved maximal oxygen uptake and rating of perceived exertion after a maximum cardio-respiratory test; the nasal device was effective on both healthy and rhinitic adolescents. A recent study enrolled 13 healthy triathletes without nasal symptoms and randomly tested 3 different conditions: no nasal dilator, wearing two different external dilators (11). These authors demonstrated that the two nasal dilators had similar effects, both improved the perception of nasal patency, the nasal respiration time and the nasal VO_2max.

Therefore, the current study is consistent with these reports and confirms the reliability of improving nasal patency and consequently the nasal respiration.

On the other hand, this study has some limitations, including the open design, the limited number of enrolled subjects, the lack of a follow-up, and the absence of validated objective parameters. Therefore, the current experience should be confirmed by further studies designed according to more robust methodology.

In conclusion, the present study demonstrates that Nas-air® is an internal nasal dilator able to significantly reduce the fatigue perception and is optimally accepted.

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Conclusion

The clinical importance of the nasal valve

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Summary. The nasal valve deserves relevant in patients presenting with nasal obstruction. In particular, the nasal valve plays an important role in nasal airflow control, it is relevant for the otolaryngologist to not only consider but also fully evaluate the nasal valve when seeing a patient with nasal obstruction. These data reported in this Supplement confirms the clinical relevance of the nasal valve in different groups of patients and normal subjects. In fact, an integrity of nasal valve is fundamental to ensure a physiological nasal breathing that in turn guarantees a correct pulmonary function. The possibility to use the non-surgical and well-accepted option constituted by the nasal internal dilator represent an interesting opportunity for both the physician and the patient. (www.actabiomedica.it)

Key words: nasal valve, nose, nasal dilator, airway obstruction, Nas-air®

The nasal valve deserves relevant in patients presenting with nasal obstruction. However, there is controversy about the anatomy, terminology, evaluation, and management of the nasal valve. Innumerable techniques with variable effects have been described in the literature. The evidence quality of many studies is unfortunately poor (1). Therefore, there is need of performing news studies with rigorous methodology, as very recently pointed out (2).

It is well known that nasal obstruction is a frequent and highly subjective complaint, but data deriving from objective examination do not always correlate with patients' symptoms (3). Many studies trued to validate clinical, instrumental and qualitative questionnaires to quantify degrees of nasal obstruction (4-7). In this regard, the American Academy of Otolaryngology clinical consensus statement stated that the internal nasal valve plays a distinct role in nasal obstruction separate from other anatomical issues and/or disorders, including allergy. Anyway, there is consent that surgery is an effective treatment option for such cases (8). Structural nasal obstruction can be caused by different problems, including a deviated nasal septum (DNS), internal nasal valve (INV) obstruction or external nasal valve (ENV) obstruction. Grading systems are in place for a DNS and ENV collapse but not INV obstruction (9). Internal nasal valve obstruction can be caused by a static structural abnormality (high septal deviation or an enlarged turbinate) or by a dynamic collapse abnormality of the upper lateral cartilage/lateral nasal wall on inspiration secondary to a weakness in the integrity of the upper lateral cartilage/nasal side wall. Static and dynamic INV collapses are distinct entities but can also coexist. The internal nasal valve (INV) is located approximately 1.3 cm from the nares and is typically the narrowest portion of the nasal cavity. It is a cross-sectional area bounded medially by the dorsal septum, laterally by the caudal portion of the upper lateral cartilage and inferiorly by the head of the inferior turbinate (6). The average angle of the INV ranges from 9° to 15° and inter-individual variance is well recognized, in part due to the size of the inferior turbinate. Collapse of the valve is thought to obey Bernoulli's principle and as such, is a common cause for nasal obstruction (7).

The visual analogue score is often thought to represent the best outcome measure for identifying nasal obstruction (10). In addition, nasal obstruction is closely associated with the intensity of mucosal inflammation (11).

On the basis of this background, as the nasal valve plays an important role in nasal airflow, it is relevant for the otolaryngologist to not only consider but also fully evaluate the nasal valve when seeing a patient with nasal obstruction. If not the primary cause of obstruction, it is often a contributing factor. If NVD is discovered, it should be addressed during surgical intervention to avoid a suboptimal outcome. Consequently, the management of the nasal valve may consider many surgical options. Most of the techniques used have been shown to have positive effects, though there is a lack of randomized controlled trials directly comparing techniques. A large part of the problem is that the selection of the surgical method has to be tailored to the patients and their specific pathology. There is no one-size-fits-all approach. However, the possibility of managing impaired nasal valve by non-surgical strategies may be particularly attracting. In this regard, nasal dilators could represent a fruitful alternative option to surgery procedures.

Actually, the present Supplement includes a series of studies that investigated the possibility to restore nasal patency in different settings.

A first study explored the possibility to contrast snoring. The study design considered the comparison between internal and external nasal dilators. The findings showed that both devices were able to reduce snoring, but internal dilator was preferred by most patients.

Another study explored the pathophysiological role of the nasal valve in patients with obstructive sleep apnea syndrome (OSAS). Severe nocturnal respiratory pattern was associated with a bilateral nasal valve incontinence.

A further study evaluated the effect of internal nasal dilator on respiratory pattern in OSA patients. The outcomes demonstrated that this device significantly improved respiratory parameters and sleep quality. The same internal nasal dilator was used in OSAS patients during continuous positive airway pressure (CPAP) treatment. The most important finding evidenced that this nasal device significantly improved adherence and compliance to CPAP. This issue is particularly relevant as a major shortcoming of CPAP is really low adherence and compliance.

Finally, it has been compared external and internal nasal dilators in a group of athletes. Both devices improved sport performance, but the internal dilator was significantly more appreciated than the external one.

Therefore, these data underline the clinical relevance of the nasal valve in different groups of patients and normal subjects. In fact, an integrity of nasal valve is fundamental to ensure a physiological nasal breathing that in turn guarantees a correct pulmonary function. The possibility to use the non-surgical and well-accepted option constituted by the nasal internal dilator represent an interesting opportunity for both the physician and the patient.

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