Reprinted from the Archives of Otolaryngology--Head & Neck Surgery December, 1996 Volume 122

ORIGINAL ARTICLE

Improved Nasal Breathing Reduces Snoring and Morning Tiredness

A 6-Month Follow-up Study

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Background: Dilation of the nasal valve region can increase the ability to breathe through the nose and reduce the negative intrathoracic pressure required for inspiration. Vibrations of the palate and soft tissues of the throat, which generate snoring sounds, can be prevented when patients inhale less heavily.

Objectives: To evaluate the effect a nostril dilator has on patient snoring and tiredness in the morning and to determine how many patients would continue to use the device for half a year.

Design: For 6 months, 42 men who were heavy snorers graded their average tiredness in the morning and the patient's sleeping partner graded the average snoring using a visual analog scale from 0 to 100.

Setting: All patients were examined at the Department of Otorhinolaryngology, Central Hospital, in Skövde, Sweden.

Results: When the nostril dilator was used there was a significant decrease in snoring after both 1- and 6-month reports. There was a significant correlation between diminution of snoring and less tiredness in patients in the morning. The compliance was good since 60% of patients continued to use the device during the 6-month test period.

Conclusions: This study illustrates the benefits that reducing nasal airway resistance during sleep has on snoring and morning tiredness in patients.

Arch Otolaryngol Head Neck Surg. 1996;122:1337-1340

THE ANTERIOR part of the nose is the most narrow passage in the upper airway and it accounts for more than half the total airway resistance during nasal respiration.[1-3] In patients with a weakness in ala nasi, the nasal wings may not resist the negative air pressure during inspiration, which may decrease the airflow. When the nostrils are dilated with a nostril dilator medical device (Nozovent, Prevancure Ltd, V Frölunda, Sweden), the bony opening of the nose becomes the most narrow part of the nose because the soft tissues in the anterior part of the nose are pushed aside by the dilator.

With the dilator, the cross-sectional area for breathing is increased and, if the Poiseuille law of physics for laminar airflow ($\Delta p = 1/d^n$, $n=4$) is applied, it is easy to understand that a small increase in diameter (d) and area can reduce the pressure (Δp) to a remarkable degree. The intrathoracic pressure can be reduced to half, from an average of 4 cm to 2 cm of water by dilatating the nostrils. When only half the negative intrathoracic pressure is required for inspiration, less energy is used by the respiratory muscles while inhaling the same amount of air.[4-6]

During the day people breathe through the nose in an upright position. At night, in a supine position, the congestion of the venous sinusoids in the turbinates increases the resistance of the airflow through the nose and lower intrathoracic pressure is required for inspiration.[7]

If people cannot breathe easily through the nose, they automatically open their mouths and breathe this way too. The mucosa in the mouth and throat become dry and irritated, but more importantly, the relaxed tongue falls back and occludes the pharynx when the jaw is open, thereby increasing the upper airway resistance of the airflow.[8]

The aim of this study was to investigate the effect a nostril dilator, which can

See Materials and Methods on next page

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MATERIALS AND METHODS

PATIENTS

From the outpatient waiting list for snorers at the Department of Otorhinolaryngology, Central Hospital, in Skövde, Sweden, 42 men who were willing to test the nostril device for 6 months were selected (**Figure 1** and **Figure 2**).

Before the test period started all patients were examined clinically. The patient's snoring was scored by his sleeping partner and the morning tiredness by the snorer, who had to choose between 4 answers: (1) I am not tired in the mornings (n=11); (2) I am a bit tired in the mornings (n=15); (3) I am rather tired in the mornings (n=11); or (4) I am very tired in the mornings (n=5).

After using the device every night for at first 1 and then 6 months, evaluations were made.

The patients' mean age was 45 years (range, 28-62 years), mean body mass index (BMI) was 26 (range, 20-39), and mean apnea hypopnea index (AHI) was 9 (range, 2-45).

Five patients dropped out of the study and did not report after 1 month, 10 dropped out after 1 month, and 2 could not be graded for snoring because their wives slept in another room. Thirty-five patients were evaluated after 1 month and 25 after 6 months of using the nostril dilator.

The study was approved by the Ethics Committee at the Sahlgrenska University Hospital, Göteborg, Sweden.

CALCULATIONS

The BMI was calculated from the patient's weight in kilograms divided by the square of height in meters (kg/m^2).

The AHI was calculated from the number of apnea and hypopnea occurrences per hour of sleep. Apnea and hypopnea were defined as oxygen fluctuations of more than 4%, when the apnea was longer than 10 seconds and the respiratory ventilation reduced (measured as amplitude on the respiratory graph) at least 50% under the hypopnea, as registered on a static charge sensitive bed system (Bio-Matt SCSB system with preamplifier, BR Biorec oy, Turku, Finland) and a pulsoximeter (Ohmeda Biox 3740, Louisville, Colo).

The sleeping partner (usually the wife) scored the average snoring during the test period using a visual analog scale (VAS) from 0 to 100 (0=no snoring, 100=continuous snoring). The grading was done before the test started and after 1- and 6-month periods.

QUESTIONNAIRE

The patients were asked to grade their average morning tiredness after 1 and 6 months of using the nostril dilator. The following answers to the question of tiredness could be selected: I am more tired in the morning than before, I have not been tired in the morning, or I am less tired in the morning now.

STATISTICS

The Wilcoxon rank sum test and the Fisher exact test for paired comparisons were used in the statistical calculations.

reduce nasal resistance, has on snoring and tiredness in patients in the morning. Another purpose was to find out how many patients continued to use the device for half a year.

RESULTS

After 1 month the patient's sleeping partner graded the snoring before the test at 83 VAS points.

After 1 month of the test, the snoring was significantly reduced ($P<.001$) to 63 points (**Figure 3**). The pretest mean value for the 25 snorers who used the device for 6 months was 84 VAS points and after 6 months it was 61. After 1 month, 21 of the 42 snorers had a decrease of more than 10 VAS points (average scores, 84-51). After 6 months, 15 of 25 snorers had a decrease of more than 10 points (average scores, 89-52).

When the patients graded their tiredness in the morning, 15 (41%) of 37 were less tired in the morning after 1 month and 13 (48%) of 27 after 6 months of using the nostril dilator every night.

There was a significant correlation using the Wilcoxon rank sum test between decreased snoring and less tiredness in the morning ($P<.01$) (Figure 3). On the other hand, there was no significant correlation between decreased snoring and a high or low BMI, nor was there any correlation between decreased snoring and the patient's age or high or low AHI.

COMMENT

Normally people breathe through the nose and feel comfort from the air-conditioning capacity of the nose. During the night in a supine position in bed, congestion of the venous sinusoids in the nasal mucosa minimizes the cross-sectional area that can be used for breathing.[7] To overcome the increase in nasal resistance more inspiratory force is necessary, so many patients open their mouths and inhale more heavily.[9] The snoring sounds from the vibrating soft palatine, uvula, and tongue base are reinforced by the increased airflow through the pharynx.

According to the Bernoulli principle ($P+\frac{1}{2}\rho V^2 = c$), the sum of the static pressure and the velocity head are constant. Thus, if a gas is accelerated, a reversible pressure drop will be in the region of high velocity.[10] When people have to inhale heavily through the nose, it is far easier to experience a partial or complete airway collapse in the pharynx as the static pressure is reduced. If, on the other hand, the upper airflow resistance is reduced in the narrow passage between the vestibulum and the nasal cavity, the air velocity through the upper airway diminishes and the soft tissues in the pharynx do not collapse as easily. When there is less occlusion, it may be possible to prevent snoring. In 2 different studies[11,12] it has been shown that dilation of the nostrils can significantly reduce snoring. The test periods were 10 days;

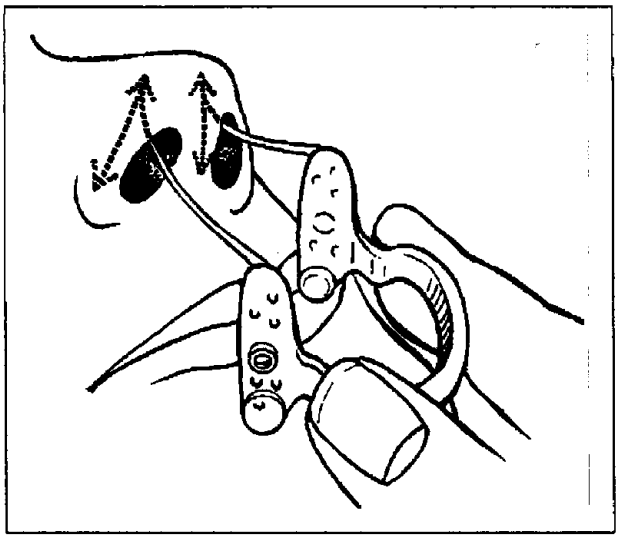

Figure 1. *The introduction of the nostril dilator.*

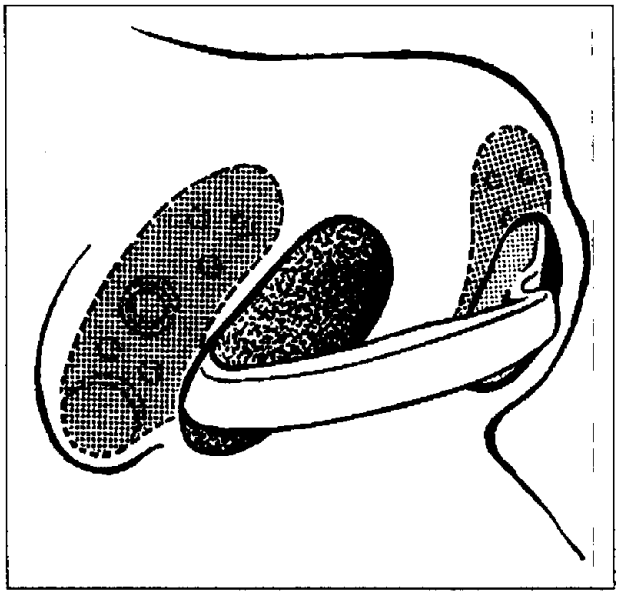

Figure 2. *The nostril dilator in position.*

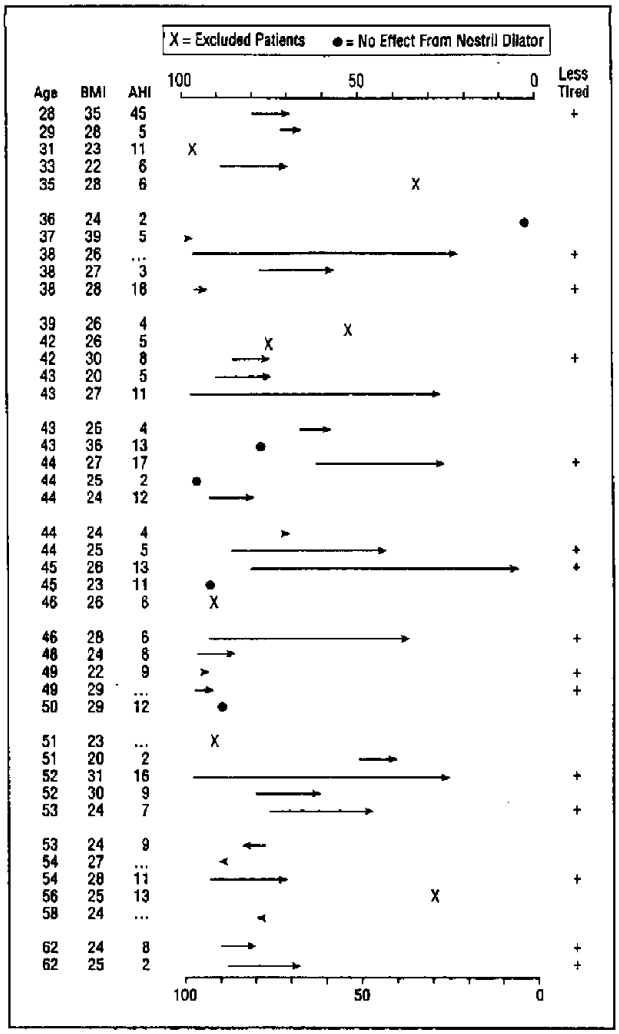

Figure 3. *After 1 month of using the nostril dilator every night, the patient's snoring was rated by his female sleeping partner using a visual analog scale (VAS) from 0 (no snoring) to 100 (continuous snoring). She graded the average snoring before the test and during the test period. A decrease in snoring during the test period is indicated with an arrow to the right. The pretest values of the excluded patients are indicated with X's and patients who experienced no effect from the nostril dilator with dots. The age, body mass index (BMI), and apnea hypopnea index (AHI) are shown for each patient. Patients who were less tired in the morning when they slept with dilated nostrils are indicated with plus signs. Ellipses indicate 0 on the VAS scale.*

half of the time the patients slept with dilated nostrils and half without. In this study we wanted to have a long follow-up period, choosing half a year as a suitable time. It was not possible to use snoring sound recordings and it was inconvenient for the patients to have their snoring graded every morning. We therefore decided that the sleeping partner should grade the average snoring during the test period using a VAS scale from 0 to 100. Because the sleeping partner who heard the snoring sounds every night was asked to rate the average snoring, we hoped to avoid the influence of occasional irregularities in the grading of the snoring. Using a VAS scale enabled us to observe small changes. When the nostril dilator was used, snoring significantly diminished during the 6-month test period.

When the snoring sounds decreased, according to the female sleeping partner, the man who snored was less tired in the morning after both 1 and 6 months of using the nostril device. The compliance was good; 6 of 10 patients used the device for 6 months. One reason for this may be that we followed up the patient during this long test period. More patients might have dropped out if this had not been a clinical test.

The patients were informed about the function of the dilator. The size of the dilator that provided the most comfort was determined by choosing between the different sizes of the nostril dilator (small, medium, and large).

The patients who dropped out did so because the device did not help them with snoring, it fell out during the night, or they sensed some kind of discomfort.

No correlation was found between snoring and tiredness and BMI, age, and AHI. We were therefore not able to determine which snorer was helped most. This

means that everyone who snores and does not have free airflow through the nose in the supine position could benefit from a dilator that decreases the airway resistance of the nose.

Breathing through the nose during sleep is important and must not be ignored when the cause of snoring is analyzed. Silent sleep cannot be expected if there is high airflow resistance in the nose. In our study, we used a nostril dilator to diminish the airflow resistance and decrease snoring. The device is easy to use and has no serious side effects. The natural feeling of a foreign body in the nose will be diminished if patients put in the device 10 minutes before going to sleep.

Accepted for publication August 16, 1996.

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REFERENCES

1. Van Dishoeck HAE. Inspiratory nasal resistance. *Acta Otolaryngol (Stockh).* 1942;30:431-439.
2. Uddströmer M. L'Importance des Cornets pour la Resistance dans le Nez Normal. *Acta Otolaryngol (Stockh).* 1940;28:364-375.
3. O'Neill G, Tolley NS. Theoretical considerations of nasal airflow mechanics and surgical implications. *Clin Otolaryngol.* 1988;13:273-277.
4. Lenders H, Pirsig W. Diagnostic value of acoustic rhinometry: patients with allergic and vasomotor rhinitis compared with normal controls. *Rhinology.* 1990; 28:5-16.
5. Petruson B. The importance of nose-breathing for the systolic blood pressure rise during exercise. *Acta Otolaryngol (Stockh).* 1990;109:461-466.
6. Petruson B. Improvement of the nasal airflow by the nasal dilator Nozovent. *Rhinology.* 1988;26:289-292.
7. Rundcrantz H. Postural variations of nasal patency. *Acta Otolaryngol (Stockh).* 1969;68:435-443.
8. Olsen KD, Eugene B, Kern EB. Nasal influences on snoring and obstructive sleep apnea. *Mayo Clin Proc.* 1990;65:1095-1105.
9. Lavie P, Fischel N, Zomer J, Eliaschar I. The effects of partial and complete mechanical occlusion of the nasal passage on sleep structure and breathing in sleep. *Acta Otolaryngol (Stockh).* 1983;95:161-166.
10. Swift DL. Physical principles of airflow and transport phenomena influencing air modification. In: Proctor DF, Andersen I, eds. *The Nose, Upper Airway Physiology and the Atmospheric Environment.* Amsterdam, the Netherlands: Elsevier Science Publishers; 1982:337-349.
11. Petruson B. Snoring can be reduced when the nasal airflow is increased by the nasal dilator Nozovent. *Arch Otolaryngol Head Neck Surg.* 1990;116:462-464.
12. Höijer U, Ejnell H, Hedner J, Petruson B, Eng LB. The effects of nasal dilation on snoring and obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg.* 1992;118:281-284.

Printed and Published in the United States of America