

**Breathe Right Nasal Strips Effectively**  
**Improve Nasal Airflow:**  
**Implications for Use in Patients With Nasal Congestion**

Michael Blaiss, MD  
Clinical Professor of Pediatrics and Medicine  
University of Tennessee Center for the Health Sciences  
College of Medicine  
Memphis, TN

---

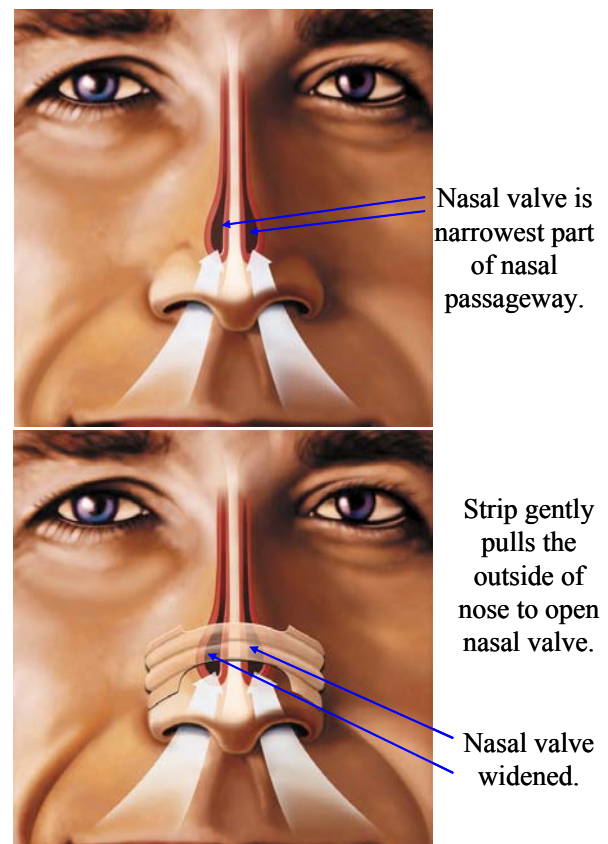
---

## Introduction

The nasal valve—the narrowest segment of the upper respiratory tract—is located about 1 to 3 cm from the nostril.<sup>1</sup> This triangular region is bounded on one side by the nasal septum, on the other side by the lower end of the upper lateral cartilage, and below by the inferior rim of the piriform aperture. It also extends several millimeters above the valve entrance as far as the anterior cavum.<sup>2</sup> The nasal valve includes the erectile tissue of the medial and lateral walls of the nose as well as the compliant soft tissue and cartilage of the alae. During resting breathing, the valve region withstands a wide range in negative intranasal pressures. Because of its narrowness, the valve region is a major determinant of airflow resistance. Importantly, as ambient air enters the nose and moves through the nasal valve, its laminar flow characteristics are disrupted, leading to increased turbulence.<sup>2</sup> This change in airflow is needed for effective air cleansing and conditioning.

The nasal valve segment contributes at least half of the resistance to airflow found in the entire respiratory tract during breathing at rest.<sup>2</sup> External nasal dilator strips (ENDS) or Breathe Right Nasal Strips® (BRNS) are designed to pull the outside walls of the nose laterally in order to increase the cross-sectional area of the nasal valve and make the nasal wall stable and resistant to collapse (**Figure 1**).<sup>1</sup> BRNS are spring-loaded plastic strips that have an adhesive bottom layer. They are attached by adhesion to the skin overlying the compliant nasal cartilage on both sides of the nose. When properly positioned, the plastic springs in the strip

pull the nasal cartilage in a lateral direction to dilate the nasal valve region. On the basis of clinical experience, it appears likely that BRNS may be more helpful in persons with nasal valve region obstruction than in healthy subjects



**Figure 1.** Mechanism of action of the *Breathe Right Nasal Strip*. Used with permission.

Nasal breathing provides two important advantages relative to mouth breathing. First, it protects against toxicity to the lower respiratory tract by filtering particles and extracting noxious gases.<sup>3</sup> Very large (>5  $\mu\text{m}$  in diameter) particles are efficiently deposited in the nose by inertial impaction, whereas very small (<0.01  $\mu\text{m}$  in diameter) particles are deposited via diffusion. Gases

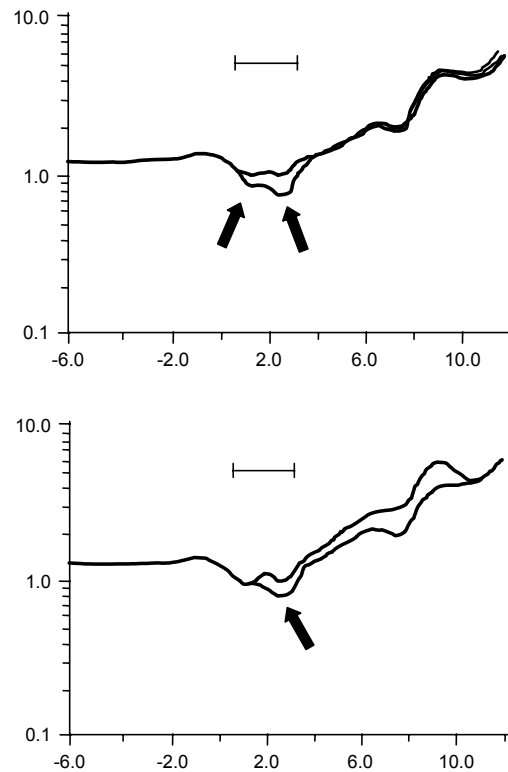
with high water solubility and reactivity can be extracted by up to 95% during resting nasal breathing. Second, nasal breathing plays an important role in conditioning inspired air by warming it to near body temperature and moisturizing it to 98% to 100% relative humidity. When cold, dry air is inspired, however, nasal receptors are activated to increase bronchomotor tone, which limits the amount of insufficiently conditioned air that reaches the lungs.<sup>4</sup>

Nasal resistance may increase by as much as 30% to 40% when individuals with normal nasal airflow are switched from an upright to recumbent position.<sup>5,6</sup> Furthermore, some individuals without daytime congestion may experience nocturnal nasal congestion when lying down.<sup>7</sup> When these changes in nasal resistance occur, pressure receptors in the nose and other parts of the upper airways trigger a change from nasal breathing to oronasal or mouth breathing.<sup>8</sup> This is accomplished by activating muscles that control the position of the soft palate. Nasal breathing is associated with lower resistance to airflow in the upper airways than mouth breathing.<sup>8</sup> This mechanical advantage may help to explain why most normal individuals breathe through their nose while sleeping, and, in turn, why lower nasal resistance may promote better sleep quality.

### Healthy Individuals

Several studies have shown that BRNS increase nasal cross-sectional area, reduce nasal resistance by up to 31%<sup>9</sup> and provide subjective improvement of nasal patency in healthy individuals. BRNS increased nasal valve cross-sectional area by 17% to 24% in three separate cohorts of healthy subjects

when measured by acoustic rhinometry.<sup>1, 10, 11</sup> On review of the acoustic rhinometry traces, two constrictions were seen in the nasal valve region: one located about 1.2 cm from the nostril and the other found 2.9 cm from the nostril (**Figure 2**).<sup>2</sup>



*Figure 2. Acoustic rhinometry trace of normal nasal cavity showing two constrictions in nasal valve region at a distance of 0.78 and 2.86 cm from the nostril. Breathe Right Nasal Strip increased cross-sectional area of both proximal and distal constrictions (panel A). Topical nasal decongestant (0.1% xylometazoline) increased cross-sectional area of only the distal constriction (panel B).<sup>2</sup> Used with permission.*

Notably, BRNS significantly increased the cross-sectional area of both nasal valve constrictions (both  $p < .0001$ ), whereas a topical nasal decongestant (0.1% xylometazoline) only increased the cross-

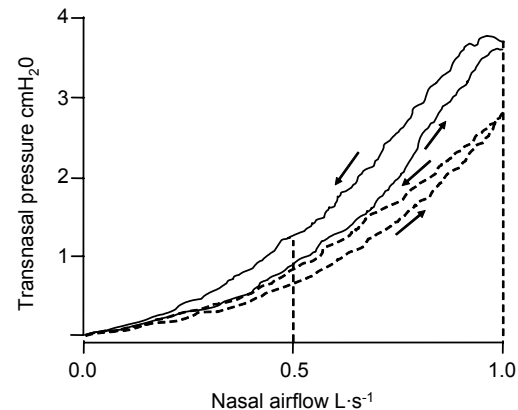
sectional area at the distal constriction ( $p < .0001$ ).

BRNS reduced nasal resistance whether or not a topical nasal decongestant was administered beforehand, and produced comparable decreases in nasal resistance during both inspiration and expiration.<sup>12</sup> For example, in one cohort, BRNS reduced nasal resistance by 22% when measured by active posterior rhinomanometry after administration of a topical decongestant xylometazoline (0.5% in each nostril).<sup>1</sup> In another cohort, the changes in inspiratory and expiratory nasal resistance with BRNS were directly correlated with the values measured without the nasal strips ( $r=0.58$ ,  $p = .01$  and  $r=0.47$ ,  $p = .04$ , respectively).<sup>13</sup> Subjects who responded to BRNS tended to have higher nasal resistance during the control assessment. Notably, the effects of BRNS on nasal resistance in this cohort were additive with those of a topical nasal decongestant (0.2 mg of oxymetazoline hydrochloride per nostril). BRNS produced subjective improvement in nasal breathing when measured with a visual analog scale (VAS) ranging from 0 (no effect) to 5 (nasal breathing became very much easier).<sup>1</sup> In a cohort of 27 healthy subjects, the mean ( $\pm$ SD) VAS score was 2.25 ( $\pm$ 0.95) units, and all but two subjects reported at least some improvement.<sup>1</sup> In another cohort (N=20), the subjective assessment of nasal patency before and after BRNS correlated with nasal resistance ( $r=0.54$ ,  $p < .001$ ).<sup>13</sup>

BRNS reduced inspiratory nasal resistance by 23% during voluntary hyperpnea, (high inspiratory flow).<sup>13</sup> A characteristic feature is inspiratory transnasal pressure/flow hysteresis, in which transnasal pressures are

higher during the latter part of inspiration when inspiratory flow is decreasing than during the early part of inspiration when inspiratory flow is increasing. BRNS also reduced inspiratory transnasal pressure/flow hysteresis by about 39% (**Figure 3**).

*Figure 3. Transnasal pressure/flow plots*



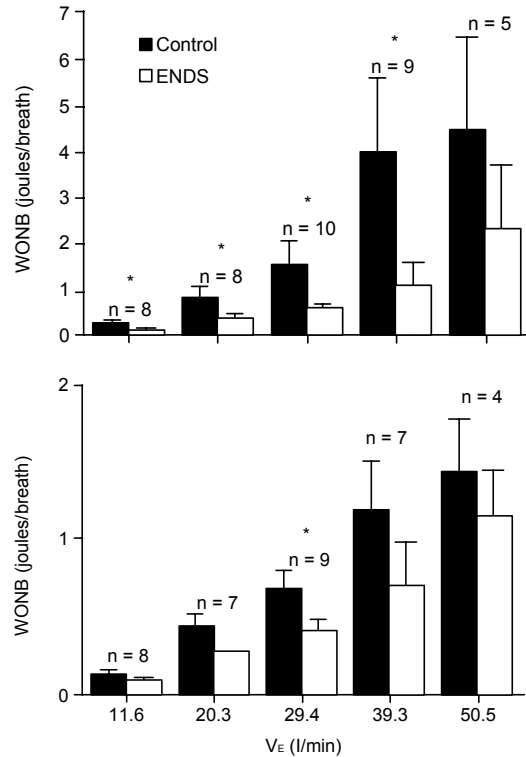
*showing hysteresis during voluntary hyperpnea in one healthy subject during a control period (solid line) or with Breathe Right Nasal Strip (BRNS; dotted line). Each plot represents the mean of 3 representative breaths. With BRNS, there is a decrease in nasal airflow resistance at 1 L/sec, as well as a reduction in hysteresis at 0.5 L/sec. The arrows indicate the direction of the inspiratory hysteresis.<sup>13</sup> Used with permission.*

The effects of BRNS were additive again with a topical nasal decongestant. The reduction in hysteresis suggests that BRNS may stabilize the lateral nasal wall, and thereby oppose collapse of the wall during late inspiration. Taken together, the reduction in nasal resistance combined with the reduction in hysteresis during inspiration suggests that BRNS reduces the inspiratory work of nasal breathing under conditions of high nasal airflow, such as those that might be encountered during exercise.

## Exercise

BRNS improve nasal breathing during exercise, as illustrated by two studies using cycle ergometry. In the first, 19 of 20 healthy adults perceived them to improve nasal breathing during a 15-minute exercise session at 70% of maximal heart rate.<sup>11</sup> Both BRNS and exercise independently increased the minimal nasal cross-sectional area at the inferior turbinate (acoustic rhinometry) and reduced nasal resistance (active anterior flow rhinomanometry). Notably, these effects of BRNS on nasal cross-sectional area and nasal resistance were additive.

The second study used a graded exercise paradigm, in which the externally imposed work rate was increased every 2 minutes until subjects were unable to maintain a constant pedal rate of 60 rpm with nasal breathing.<sup>14</sup> BRNS reduced resting inspiratory and/or expiratory nasal airflow resistance by  $>0.5$  cm H<sub>2</sub>O/L/sec in 73% of subjects (responders). Inspiratory and expiratory nasal resistance decreased as the inspired ventilation rate increased with progressively graded exercise.<sup>14</sup> Nasal resistance tended to be lower with BRNS than without the nasal strips ( $p < .05$ ). At an inspired ventilation rate of 35 L/min, BRNS reduced the hysteresis of the inspiratory transnasal pressure-flow curve in 10 subjects (67%). The tilt of the hysteresis curve was also lowered, consistent with an overall decline in nasal resistance. In responders, BRNS reduced the inspiratory work of nasal breathing per breath and the nasal power values during exercise (**Figure 4**).



*Figure 4. Inspiratory (panel A) and expiratory (panel B) work of nasal breathing (WONB) per breath during graded exercise with and without BRNS in healthy adults. The inspired ventilation rate plotted on the x-axis increased with graded exercise. Data are shown for responders (ie, those with increases in inspiratory and/or expiratory nasal resistance  $>0.5$  cm H<sub>2</sub>O/L/sec at rest).<sup>14</sup> Used with permission*

These findings suggest that BRNS may stiffen the lateral nasal vestibule walls, and in responders, may lower the energy needs for nasal ventilation during exercise. Airway function is improved with BRNS beyond that achieved via exercise-related decongestant effects. This improvement in nasal breathing during exertion may be particularly important in contact sports, when the oral component of oronasal breathing is impaired by use of chinstraps or mouth guards.<sup>11</sup>

---

---

During the study of maximal exercise BRNS led to a significant increase in pre-exercise nasal inspiratory flow.<sup>15</sup> One study tested the sustainability of moderate exercise at 75% of maximal oxygen consumption. Nine healthy male subjects completed treadmill sessions under three breathing conditions: control oronasal breathing, nasal breathing with BRNS, or nasal breathing with a placebo nasal strip.<sup>15</sup> The mean exercise time to exhaustion was 76.6 minutes under control for oronasal conditions. It was significantly reduced while nasal breathing with a placebo strip (60.6 minutes;  $p < .05$ ) but not with the BRNS (74.1 minutes). Although nasal breathing reduces the sustainability of moderate exercise as compared with oronasal breathing, BRNS increases exercise sustainability to a level comparable with that achieved with oronasal breathing.

During all-out intermittent exercise,<sup>15</sup> eight untrained men completed thirty 20-second bursts on a cycle ergometer. Each burst was followed by a 40-second recovery period, under normal breathing conditions and while wearing BRNS. The use of BRNS prevented the decline in maximum inspiratory pressure seen during the control period ( $p < .05$ ), suggesting that BRNS prevented development of inspiratory muscle fatigue. BRNS increased power output in 7 of the 8 subjects, and also significantly reduced ratings of perceived exertion and perceived magnitude of breathing effort (both  $p < .05$ ).

In field tests on a basketball court,<sup>16</sup> 30 male adolescents were evaluated under 3 conditions: short-term anaerobic power in a 40-meter sprint, long-term anaerobic power

in a shuttle sprint consisting of four shuttles of increasing length, and peak aerobic performance in a 20-meter shuttle run. Each test was conducted under control conditions and while subjects used BRNS or placebo nasal strips. No significant differences in performance variables were observed under anaerobic conditions. However, BRNS significantly improved peak aerobic performance by about 3% ( $p = .037$ ) and reduced the perceived breathing effort by nearly 4% compared with control conditions ( $p = .016$ ) and by 3.6% compared with a placebo nasal strip ( $p = .048$ ). Therefore, BRNS reduced the breathing effort and improved peak aerobic performance during field tests involving maximal running.

### **Nasal Valve Obstruction**

The benefits of BRNS seen in healthy individuals were also evident in patients complaining of postrhinoplasty nasal obstruction.<sup>2</sup> In a cohort of 26 patients with nasal obstruction confirmed by acoustic rhinometry, the minimum nasal cross-sectional area averaged 0.34 cm<sup>2</sup>, which is less than half the minimum cross-sectional area found in healthy subjects ( $p < .001$ ). When BRNS were applied by the subjects with nasal obstruction, the minimum nasal cross-sectional area increased significantly to 0.64 cm<sup>2</sup> ( $p < .0001$ ), and nasal resistance declined significantly from 6.94 to 2.66 cm H<sub>2</sub>O/L/sec ( $p < .001$ ). Moreover, BRNS significantly increased the nasal volume of the anterior nose in the segments located 0 to 4 cm and 4 to 8 cm from the nostril ( $p \leq .001$ ). Patients noted immediate relief of nasal obstruction on a VAS ranging from 0 (completely free) to 100 (completely

---

---

blocked): the mean score declined from 54 at baseline to 27 after application of BRNS ( $p < .001$ ). Therefore, BRNS are clinically effective for managing septal deviation-related nasal resistance by significantly increasing the minimum cross-sectional area, reducing nasal resistance, and improving the sensation of nasal patency.

### **Congestion**

BRNS are approved for use in managing transient causes of breathing difficulties, such as nasal congestion due to colds or allergies. The efficacy of BRNS in this setting is illustrated by a study of 29 patients with nasal obstruction secondary to mucosal congestion.<sup>17</sup> BRNS significantly increased the minimum nasal cross-sectional area (acoustic rhinometry) from 0.45 to 0.56 cm<sup>2</sup> ( $p < .01$ ) and reduced nasal resistance measured by pernasal rhinomanometry from 9.49 to 7.24 cm H<sub>2</sub>O/L/sec ( $p < .01$ ). Subjective assessment of nasal patency on a VAS from 0 (nose completely free) to 100 (nose completely blocked) tended to improve with the BRNS ( $p = .06$ ). These effects measured in patients with nasal congestion are consistent with those described above in healthy individuals.

Several other studies involving “healthy” individuals support the benefits of BRNS in nasal congestion. In one study in which nasal resistance ranged from 2.24 to 14.688 cm H<sub>2</sub>O/L/sec, 18 of 24 subjects (75%) had nasal resistance values above 2.17 cm H<sub>2</sub>O/L/sec—the upper limit of the normal range,<sup>18</sup> thereby suggesting that the majority of the study participants had nasal congestion.<sup>9</sup> Moreover, 8 subjects (33%) had nasal resistance values more than 2.5

times higher than the upper limit of normal. Overall, BRNS significantly lowered mean nasal resistance 31% (from 4.31 to 2.97 cm H<sub>2</sub>O/L/sec;  $p < .005$ ). Therefore, BRNS reduced nasal resistance across a wide range of baseline values, and this suggests that the nasal strips work on a “congested” or “resistant” nose, such as that found in rhinitis. This hypothesis is supported by a study conducted in patients with chronic rhinitis, nasal obstruction, and habitual snoring, which will be described in detail below.

In a crossover study, subjects reported a greater decrease in congestion with BRNS than placebo on a 100-point VAS (change from baseline: 8.3 vs. 1.7;  $p = .004$ ).<sup>19</sup> Similarly, they reported a significant ( $p < .001$ ) mean improvement in congestion from baseline by 1.5 units (vs. 3.1 with placebo) within 30 minutes using a 7-point ordinal scale, in which 0 indicated “nose much clearer,” 3 indicated baseline, and 6 indicated “nose much more blocked.” Placebo produced no change from baseline. These subjective ratings were maintained for as long as subjects continued to wear the BRNS and indicated that BRNS reduce subjective symptoms of nasal congestion in healthy subjects.

### **Nighttime**

#### *Snoring*

Indicators of nasal obstruction, such as self-reported congestion and measured air flow, were associated with sleep-disordered breathing as indicated by habitual snoring or sleep-disordered breathing. Habitual snoring was consistently associated with decreased nasal airflow.<sup>20</sup> Nasal obstruction

---

---

is more likely to cause snoring than mild or severe obstructive sleep apnea<sup>21</sup>

Subjects who are mild snorers can obtain remarkable effects with BRNS. In a study of 10 men and 10 women the loudness of snoring was evaluated by their bed partner. The loudness was reduced by 50% and the number of snorers was reduced by 75%.<sup>22</sup> Accompanying these results, the subjects reported less daytime sleepiness, fewer nocturnal awakenings and better sleep quality.

Patients with chronic rhinitis often suffer from habitual snoring and poor sleep quality, which appear related to increased nasal resistance. The effects of BRNS on snoring were shown by polysomnography in nonobese patients with chronic rhinitis, nasal obstruction, and habitual snoring in a randomized, double-blind, crossover study.<sup>23</sup> In a cohort of 12 subjects, application of the BRNS tended to reduce nasal resistance measured in an upright position as compared with use of a placebo nasal strip (0.73 vs. 0.89 cm H<sub>2</sub>O/L/sec;  $p = .06$ ). On polysomnography, BRNS significantly reduced the frequency of snoring compared with placebo (258 vs. 173 snores per hour;  $p = .016$ ), although it did not affect the loudness of snoring. Overall, BRNS reduced the snoring frequency in 10 of the 12 chronic rhinitis patients (83%). BRNS did not significantly affect total sleep time, sleep architecture, sleep fragmentation, or the apnea-hypopnea index. These findings are consistent with the hypothesis that BRNS may reduce snoring in chronic rhinitis patients by decreasing nasal resistance and congestion.

The use of ENDS to treat other forms of snoring was addressed by the Clinical Practice Review Committee of the American Academy of Sleep Medicine (AASM).<sup>24</sup> They identified five studies in which the safety and efficacy of ENDS had been addressed and concluded that “the use of ENDS appears to be safe and may be efficacious in people with mild, nonapneic snoring, but the data are inadequate to determine the patient characteristics associated with favorable treatment.”

### *Sleep*

Acute nasal obstruction in healthy subjects has been associated with fragmented sleep and increased risk of obstructive and central apneas.<sup>25</sup> Although nasal resistance is elevated in patients with obstructive sleep apnea (OSA), the chronic nasal obstruction does not appear to be important in its etiology or severity. Sleep disordered breathing, however, is associated with nasal obstruction, especially the nasal obstruction resulting from allergic rhinitis.<sup>26</sup> In addition, increases in nasal resistance can promote greater mouth breathing and further upper airways collapse during sleep. Despite their ability to reduce nasal resistance, BRNS are not intended for use in OSA. According to the Clinical Practice Review Committee of the AASM, the limited available data show that ENDS do not provide meaningful improvement in OSA.<sup>24</sup>

After publication of the AASM statement, a randomized, single-blind, crossover study was conducted to evaluate combination treatment with topical nasal decongestant and BRNS in OSA patients with nasal obstruction.<sup>27</sup> Ten patients underwent

---

---

overnight polysomnography after receiving oxymetazoline 0.05% in each nostril (1 hour before lights out and again after 4 hours) and a BRNS, or on the placebo night, sodium chloride 0.9% and a sham nasal strip. Active treatment produced a dramatic and persistent reduction in nasal resistance throughout the night, and it reduced the fraction of ventilation attributed to mouth breathing as compared with placebo (8% vs. 39%;  $p = .0043$ ). The BRNS-decongestant combination improved sleep architecture by reducing stage 1 sleep (17% vs. 24%;  $p = .02$ ) and increasing sleep efficiency (82% vs. 78%;  $p = .001$ ), rapid eye movement sleep (16% vs. 9%;  $p = .001$ ) and slow-wave sleep (13% vs. 8%;  $p = .028$ ). The apnea-hypopnea index declined by an average of 12, suggesting a modest but significant reduction in OSA severity ( $p < .02$ ). However, the active treatment did not affect the fraction of mouth breathing during obstructive events or their duration. Thus, despite the improvement in sleep architecture and reduced fraction of mouth breathing, these findings indicate that the BRNS-nasal decongestant combination does not effectively alleviate OSA.

The upper airways resistance syndrome (UARS) is a mild variant of obstructive sleep-disordered breathing, in which nasal obstruction is believed to contribute to airway collapsibility.<sup>28</sup> UARS may be identified by a history of snoring, excessive daytime sleepiness, apnea-hypopnea index  $<15$ , and more than five arousals per hour associated with snores, snorts, or brief breathing cessations. In a randomized, controlled, crossover study of UARS patients, BRNS significantly reduced stage 1

sleep as compared with placebo nasal strips (7.1% vs. 8.6% of total sleep time,  $p = .03$ ), without producing other significant effects on sleep architecture, sleep efficiency, total sleep time, arousal index, or apnea-hypopnea index.<sup>28</sup> Stage 1 sleep occurs at the beginning of the night and then as a transitional stage during the night.<sup>28</sup> Therefore, the reduction in stage 1 sleep with BRNS is suggestive of less sleep disruption. BRNS may also improve ventilation during sleep as indicated by a significant reduction of the percentage of time blood oxygen saturation was  $>2\%$  below the awake levels (9.1% vs. 12.2%,  $p = .04$ ).

## Other Applications

### *Pregnancy and Labor*

Many pregnant women complain of nasal congestion, particularly during the latter trimesters of pregnancy. This is believed to reflect nasal mucosal edema caused by the increase in circulating blood volume. The effect of BRNS on nocturnal nasal congestion during pregnancy was assessed in a randomized, controlled study involving 24 women between 16 and 39 weeks of gestation.<sup>29</sup> All had symptoms of nocturnal nasal congestion unrelated to allergy or infection. The women were randomly assigned to use BRNS or placebo strips on 3 consecutive nights. Subjects answered 10 questions about their symptoms and sleep quality in a diary during a 3-night baseline period and during the 3-night treatment period. BRNS significantly improved the ease of breathing as compared with placebo ( $p = .02$ ). Overall, BRNS were favored over placebo on 8 of the 10 questions ( $p = .05$  on

---

---

sign test); they reduced sleep disturbances and nocturnal awakenings and increased the depth and length of sleep.

During labor, BRNS were also associated with significantly higher overall satisfaction than placebo nasal strips in a randomized, controlled study of 150 women.<sup>30</sup> Using a 0 (no satisfaction) to 4 (full satisfaction) scale, the women gave BRNS a mean score of 2.4 and placebo strips a mean score of 1.0 ( $p = .0001$ ). Importantly, BRNS did not have any effect on other important variables associated with mother and baby, including the rate of induction or augmentation of labor, number of Montevideo units, frequency of membrane rupture, duration of labor, use of epidural analgesia, fetal heart pattern, meconium-stained amniotic fluid, neonatal well-being, and length or maternal and neonatal hospitalization. Therefore, BRNS improve the ease of breathing during pregnancy and labor. They also sustain the respiratory effort associated with the long labor process and may help to prolong the interval of nasal breathing before the switch to oronasal breathing.

#### *Patients Undergoing Dental Procedures*

BRNS facilitated nasal breathing during a dental procedure in an open-label study of 45 ambulatory dental patients.<sup>31</sup> Using pulse oximetry, patients were studied who had an initial arterial oxygen saturation ( $SpO_2$ ) of 95% or below. The BRNS was left in place throughout the dental procedure,  $SpO_2$  values were monitored continuously, and the slope of the  $SpO_2$  change was measured during the dental procedure. Use of the BRNS was associated with a positive  $SpO_2$  slope, indicating that oxygen levels

increased during the dental procedure. Conversely, the  $SpO_2$  slope was negative in those who did not use BRNS. Thus, BRNS help  $SpO_2$  levels to rise during a dental procedure that might otherwise see  $SpO_2$  fall.

#### *Aromas and Smell*

In 12 subjects tested for their ability to identify odors with or without BRNS,<sup>32</sup> odor identification increased significantly from 42% correct (control) to 54% correct when using BRNS ( $p < .01$ ). This improvement was paralleled by a reduction in the olfactory threshold measured by the phenethyl alcohol ascending testing procedure ( $p < .001$ ). In a separate group of 10 nonsmoking subjects, BRNS increased several parameters during a sniff (measured by pneumotachograph) including mean flow rate, maximum flow rate, sniff volume, and sniff duration ( $p \leq .03$ ). The sense of smell increased while using BRNS, which was due to an increase of both the amount and proportion of inspired odorant molecules that were directed to the olfactory mucosa and consequently available for odorant perception.

Smell and taste are complementary senses that work together to give the combined perception of flavor and intensity of foods. Eighty-eight students aged 18 to 22 years were asked to rate the pleasantness and intensity of 10 different food stimuli while wearing BRNS or a placebo nasal strip.<sup>33</sup> Ratings were made using a 0 to 10 point scale for pleasantness (ranging from “unpleasant” to “pleasant”) and intensity (ranging from “not intense” to “intense”). During use of BRNS, subjects rated the

---

---

foods as less pleasant (5.27 vs. 6.01;  $p < .001$ ) and more intense (7.25 vs. 5.66;  $p < .001$ ) than when using the placebo strips. The most dramatic reductions in food pleasantness ratings were seen for foods considered to be initially pleasant, including icing, pudding, peanut butter, berry sauce, and yogurt.

## Conclusions

Numerous studies demonstrate that BRNS increase the cross-sectional area at the nasal valve, reduce nasal resistance, reduce inspiratory transnasal pressure/flow hysteresis, and stabilize the lateral nasal vestibule walls to prevent their collapse during late inspiration. These effects facilitate nasal breathing and are beneficial to patients with nasal congestion, regardless of its cause.

BRNS:

- Improved nasal resistance in healthy subjects with above normal baseline nasal resistance (congestion) than in those with lower resistance<sup>13</sup>
- Increased nasal cross-sectional area and reduced nasal resistance in patients with mucosal congestion<sup>17</sup>
- Reduced subjective symptoms of nasal congestion in healthy subjects and tended to improve the subjective assessment of nasal patency in congested patients<sup>17, 19</sup>
- Reduced nasal resistance when used after a topical nasal decongestant, and provided additive effects when used in combination with a decongestant<sup>1, 13</sup>
- Reduced snoring frequency and intensity in patients in general, and in particular with nasal obstruction due to chronic rhinitis, consistent with an improvement in nasal airflow<sup>23</sup>
- Improved the ease of breathing in pregnant women with nasal congestion<sup>29</sup>; a similar improvement in breathing ease occurred during labor<sup>30</sup>

Therefore, BRNS effectively improved nasal airflow in patients with nasal congestion due to multiple causes. They appear to have a complementary effect through mechanical mechanisms and could be safely used with medications, such as decongestants, whenever nasal congestion occurs.

---

---

## References

1. Peltonen LI, Vento SI, Simola M, Malmberg H. Effects of the nasal strip and dilator on nasal breathing--a study with healthy subjects. *Rhinology* 2004; 42:122-5.
2. Roithmann R, Chapnik J, Zamel N, Barreto SM, Cole P. Acoustic rhinometric assessment of the nasal valve. *Am J Rhinol* 1997; 11:379-85.
3. Bennett WD, Zeman KL, Jarabek AM. Nasal contribution to breathing with exercise: effect of race and gender. *J Appl Physiol* 2003; 95:497-503.
4. Fontanari P, Burnet H, Zattara-Hartmann MC, Jammes Y. Changes in airway resistance induced by nasal inhalation of cold dry, dry, or moist air in normal individuals. *J Appl Physiol* 1996; 81:1739-43.
5. Hasegawa M. Nasal cycle and postural variations in nasal resistance. *Ann Otol Rhinol Laryngol* 1982; 91:112-4.
6. Kase Y, Hilberg O, Pedersen OF. Posture and nasal patency: evaluation by acoustic rhinometry. *Acta Otolaryngol* 1994; 114:70-4.
7. Stroud RH, Wright ST, Calhoun KH. Nocturnal nasal congestion and nasal resistance. *Laryngoscope* 1999; 109:1450-3.
8. Fitzpatrick MF, McLean H, Urton AM, Tan A, O'Donnell D, Driver HS. Effect of nasal or oral breathing route on upper airway resistance during sleep. *Eur Respir J* 2003; 22:827-32.
9. Summary of safety and efficacy data to the US food and drug administration (FDA) in support of 510(k) submission for: Breathe Right<sup>®</sup> External Nasal Dilators (Ref: K921220). 1992.
10. Ognibene NE, Merrick MA, Ingersoll CD. Intra- and intersession reliability of acoustic rhinometry in measuring nasal cross-sectional area. *Ear Nose Throat J* 2001; 80:536, 9-40.
11. Portugal LG, Mehta RH, Smith BE, Sabnani JB, Matava MJ. Objective assessment of the breathe-right device during exercise in adult males. *Am J Rhinol* 1997; 11:393-7.
12. Wong LS, Johnson AT. Decrease of resistance to air flow with nasal strips as measured with the airflow perturbation device. *Biomed Eng Online* 2004; 3:38.
13. Kirkness JP, Wheatley JR, Amis TC. Nasal airflow dynamics: mechanisms and responses associated with an external nasal dilator strip. *Eur Respir J* 2000; 15:929-36.
14. Gehring JM, Garlick SR, Wheatley JR, Amis TC. Nasal resistance and flow resistive work of nasal breathing during exercise: effects of a nasal dilator strip. *J Appl Physiol* 2000; 89:1114-22.
15. Tong TK, Fu FH, Chow BC. Nostril dilatation increases capacity to sustain moderate exercise under nasal breathing condition. *J Sports Med Phys Fitness* 2001; 41:470-8.
16. Macfarlane DJ, Fong SK. Effects of an external nasal dilator on athletic performance of male adolescents. *Can J Appl Physiol* 2004; 29:579-89.
17. Roithmann R, Chapnik J, Cole P, Szalai J, Zamel N. Role of the external nasal

---

---

dilator in the management of nasal obstruction. *Laryngoscope* 1998; 108:712-5.

18. McCaffrey TV, Kern EB. Clinical evaluation of nasal obstruction. A study of 1,000 patients. *Arch Otolaryngol* 1979; 105:542-5.

19. Latte J, Taverner D. Opening the nasal valve with external dilators reduces congestive symptoms in normal subjects. *Am J Rhinol* 2005; 19:215-9.

20. Young T, Finn L, Kim H. Nasal obstruction as a risk factor for sleep-disordered breathing. The University of Wisconsin Sleep and Respiratory Research Group. *J Allergy Clin Immunol* 1997; 99:S757-62.

21. Olsen KD, Kern EB. Nasal influences on snoring and obstructive sleep apnea. *Mayo Clin Proc* 1990; 65:1095-105.

22. Scharf MB, Brannen DE, McDannold M. A subjective evaluation of a nasal dilator on sleep & snoring. *Ear Nose Throat J* 1994; 73:395-401.

23. Pevernagie D, Hamans E, Van Cauwenberge P, Pauwels R. External nasal dilation reduces snoring in chronic rhinitis patients: a randomized controlled trial. *Eur Respir J* 2000; 15:996-1000.

24. Meoli AL, Rosen CL, Kristo D, Kohrman M, Gooneratne N, Aguillard RN, et al. Nonprescription treatments of snoring or obstructive sleep apnea: an evaluation of products with limited scientific evidence. *Sleep* 2003; 26:619-24.

25. Alwani A, Rubinstein I. The nose and obstructive sleep apnea. *Curr Opin Pulm Med* 1998; 4:361-2.

26. Rappai M, Collop N, Kemp S, deShazo R. The nose and sleep-disordered breathing: what we know and what we do not know. *Chest* 2003; 124:2309-23.

27. McLean HA, Urton AM, Driver HS, Tan AK, Day AG, Munt PW, et al. Effect of treating severe nasal obstruction on the severity of obstructive sleep apnoea. *Eur Respir J* 2005; 25:521-7.

28. Bahammam AS, Tate R, Manfreda J, Kryger MH. Upper airway resistance syndrome: effect of nasal dilation, sleep stage, and sleep position. *Sleep* 1999; 22:592-8.

29. Turnbull GL, Rundell OH, Rayburn WF, Jones RK, Pearman CS. Managing pregnancy-related nocturnal nasal congestion. The external nasal dilator. *J Reprod Med* 1996; 41:897-902.

30. Sadan O, Shushan S, Eldar I, Evron S, Lurie S, Boaz M, et al. The effects of an external nasal dilator on labor. *Am J Rhinol* 2005; 19:221-4.

31. Moses AJ, Lieberman M. The effect of external nasal dilators on blood oxygen levels in dental patients. *J Am Dent Assoc* 2003; 134:97-101; quiz 19.

32. Hornung DE, Smith DJ, Kurtz DB, White T, Leopold DA. Effect of nasal dilators on nasal structures, sniffing strategies, and olfactory ability. *Rhinology* 2001; 39:84-7.

33. Raudenbush B, Meyer B. Effect of nasal dilators on pleasantness, intensity and sampling behaviors of foods in the oral cavity. *Rhinology* 2001; 39:80-3.