ECRONICON OPEN ACCESS

EC PULMONOLOGY AND RESPIRATORY MEDICINE

Research Article

Improved Nasal Volume Utilizing Hyperosmotic Saline Xylitol Mixture (Effective Alternative or Adjunct to Decongestants and Antihistamines)

Steven Olmos* and Joseph Baba

TMJ and Sleep Therapy Centre International, USA

***Corresponding Author:** Steven Olmos, TMJ and Sleep Therapy Centre International, USA.

Received: February 20, 2019; **Published:** April 29, 2019

Abstract

This paper quantifies the reduction of soft tissue hypertrophy of the nasal complex resulting in an increase of nasal volume and increased flow using a mixture of Xylitol and Saline. The health benefits of improved nasal breathing through increased inspired nasal NO (nitric oxide) and the antimicrobial benefits of Xylitol are discussed. Restoration of functional breathing (nasal) and it's relationship to uprighting head posture is reviewed.

Keywords: *Xlear; Xylitol; Nasal Obstruction; Forward Head Posture; Nitric Oxide*

Abbreviations

AR: Acoustic Reflection; CBCT: Cone Beam Computed Tomography; CPAP: Continuous Positive Airway Pressure; FHP: Forward Head Posture; NO: Nitric Oxide; OSA: Obstructive Sleep Apnea; RERA: Respiratory Effort Related Arousal; SCM: Sternocleidomastoid Muscles; SRBD: Sleep Related Breathing Disorder; TMD: Temporomandibular Disorder

Background

It is important to define physiologic functional breathing from obstructive sleep apnea (OSA). Proper or physiologic functional breathing is through the nose, whereas OSA is collapse of the oropharyngeal airway muscles. Nasal obstruction and OSA are often comorbid. Therapies to increase nasal volume, air flow, in patients with compromise have significant benefit by reducing symptoms of nocturnal and diurnal breathing disorders.

The nose accounts for over 50% of the total upper airway resistance and plays an important role in establishment of physiological functions such as humidification, heating, and air filtration [1]. The nasal mucosa is a dynamic organ controlled by the autonomic nervous system. Periodic nasal congestion and decongestion have been termed the "nasal cycle" [2]. In patients with permanent unilateral nasal obstruction, the nasal cycle may contribute to a significant increase in total airway resistance [3]. Corrective nasal surgery has been demonstrated to significantly improve subjective sleep quality [4].

Every nasal breath mixes Nitric Oxide (NO) gas from the maxillary sinuses and is carried into the lungs. NO is necessary for cilia movement in the sinuses to carry out debris, it is anti-fungal, anti-bacterial, and anti-viral, also is important in peripheral vasodilation of the blood vessels [5-15]. It has been recommended that the final endpoint in treating OSA is restoration of nasal breathing [16]. Nasal obstruction can result in increased blood pressure. Mouth breathing has none of the physiologic protective mechanisms so people with this condition are more prone to respiratory infections as well as the dental sequela (gum disease, anterior openbite).

Establishing/developing patency of the four points of obstruction (Figure 1) are necessary to prevent orthodontic relapse, (anterior or posterior openbite). This is most evident in cases that have been retained with bonded anterior archwires (Figure 2) [17]. Harvold in his work with primates was the first to demonstrate craniofacial deformations and skeletal openbite with silicon obstruction of their noses [18].

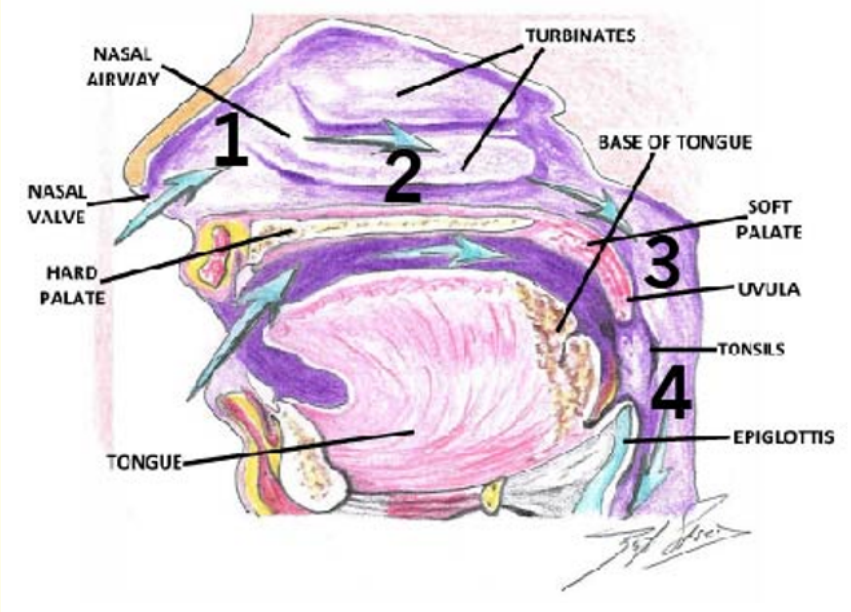

Figure 1: *4 Points of obstruction.*

Figure 2: *(Anterior openbite with wire fixation max and mand).*

Patients with OSA have been shown to lower their blood pressure by utilizing nasal CPAP by restoring levels of NO. Infants born with hypoxemic respiratory failure associated with pulmonary hypertension are treated with inhaled NO [19].

Research has demonstrated that chronic face/jaw pain, and primary headaches (migraine, tension type, and cluster) have a high comorbidity with OSA (obstructive sleep apnea) and functional breathing disorders [20]. Patients with OSA are 3.6 times more likely to have TMD [21].

In a study published in the American Journal of Dentistry 2016, of almost 1,200 patients we found that patients with sleep related fatigue measured by an Epworth scale greater than 6 were 1.39 times more likely to have jaw locking and primary headaches. This is the first paper to link jaw locking to sleep related fatigue [22]. Sleep related fatigue (excessive daytime sleepiness) is more often the result of nasal obstruction (mouth breathing), than OSA [23].

Patients with OSA often also have a functional breathing problem (nasal obstruction). The nasal valve is the first point of entry. In patients with severe apnea it has been found that utilization of nasal dilators in combination with CPAP significantly improved daytime sleepiness than with CPAP alone [24].

Forward head posture (FHP)

For every inch the head is forward of the shoulders it adds approximately 10 pounds of weight to the cervical and lumbar spine. The compressive load can result in osteoarthritis and nerve entrapment [25].

Craniofacial pain and internal derangement of the TM joints (TMD) manifests in forward head posture [26]. The most common symptom of painful jaw joints is occipital cephalalgia at 94% [27]. The FHP is secondary to painful swallowing a postural adaption to injury. The injury described is in the absence/or in addition to a macro-trauma and is the result of repetitive jaw compression (bruxism) originated by sympathetic stimulation during sleep. The patient wakes with temporal headaches and facial pain and jaw joint inflammation that now produces postural compensation. The cantilever strain of FHP, the result of extensor muscles of the neck (trapezius, splenius capititus, semispinalis capititus), produces acute inflammation at their tendon insertions on the occiput. Decompressing inflamed jaw joints utilizing oral appliances, produced with a phonetic technique, has found to upright the head 4.43 inches on average of a population of patients aged 13 - 74. This relates to relief of close to 45 pounds of weight from the cervical and lumbar spine [28]. Uprighting the head can eliminate the need for common therapies for migraine, which include botox injections for the tendon insertions on the occiput of the skull as well as the mouth closing muscles (temporalis and masseter), or severing the greater and lesser occipital nerves (often entrapped by the extensor muscle tendons they pass through).

FHP has also been found to be related to bruxism and nasal obstruction in children. “Bruxism seems to be related to altered natural head posture and more intense dental wear. A more anterior and downward head tilt was found in the bruxist group, with statistically significant differences compared to controls” [29]. Bruxism in children has been found to be related to RERA and OSA [30]. Expansion of the maxilla in mouth breathing children restores proper nasal breathing and uprights the head [31,32]. Surgical retrusion of the mandible in prognathic conditions results in significant FHP, perhaps in defense of a compromised oropharyngeal airway [33].

Xylitol

Xylitol is a 5-carbon sugar that can lower the airway surface salt concentration, thus enhancing innate immunity.

Xylitol is an artificial sweetener that has been successfully used in chewing gums to prevent dental caries [34,35]; it has been used as an oral sugar substitute without significant adverse effects [36]. Clinical studies have demonstrated significant reductions in Acute Otitis Media in young children as well as the safety of Xylitol on human nasal/respiratory luminal tissues [37-40]. Nasal application to normal human subjects was found to decrease colonization with coagulase negative staphylococcus [41].

Mechanisms of benefit:

1. Disruption of bacterial colonization through the anti-quorum sensing effect [42,43].
2. Increased activation of endogenous antimicrobials, rather than a direct effect on bacteria themselves [37].

3. Reduction of apical tissues surface salt (NaCl) concentration resulting in a surface tissue environment which is less hospitable to bacteria, fungi and viri as well as assisting in the maintenance of intracellular osmolarity [37-40].
4. Low transepithelial permeability [37].
5. Poor bacterial carbon source disrupting carbohydrate metabolism [39-43].
6. Increased mucosal clearance [39].

The combination of xylitol and saline (Xlear) was found to be superior to saline alone in a prospective, randomized study of patients with nasal obstruction and hypertrophied turbinate mucosa that was refractory to medical treatment [44]. Hyperosmolarity of the solution keeps the nasal passages and sinuses moist and clean for a much longer time than saline alone.

Methods

The participants consisted of 45 men and 74 women (mean 46) years of age.

Patients included in the study were seeking care for chronic pain and/or SRBDs (Sleep related breathing disorders) at 5 international dental treatment facilities where practices are limited to the treatment of craniofacial pain, temporomandibular disorders (TMD), and OSA. These included: The TMJ and Sleep Therapy Centres of San Diego, Conejo Valley, Boston, and Vancouver Canada. Informed consent was obtained from all individual participants included in the study giving permission to use photographs, X-rays, and records for the purpose of research, education, or publication in professional journals. Craniofacial pain was defined as painful conditions present in the cranium and face, including jaw joint-related pathology and primary headache conditions.

Patients were randomly selected, and all had some degree of turbinate mucosa hypertrophy verified by CBCT (Cone Beam Computed Tomography) imaging (i-CAT, Imaging Sciences International, LLC).

Baseline volumetric evaluations of each nasal passage were performed using acoustic rhinometry (Sleep Group Solutions). Volumes were recorded in centimeters squared from nasal valve to the velopharynx. Acoustic reflection (AR), first described over 25 years ago, has been used in many industries and is probably one of the most accepted tools for studying collecting data and calculating volumes and areas of maximum constriction. Its accuracy and reliability have been examined with special focus on the anterior nasal passage and the most constricted areas in both the nasal passage and the oropharynx (pharyngometry) [45-47]. This noninvasive technique uses sound waves that go through the airway and back, collecting data and calculating volumes and areas of maximum constriction. Its accuracy and reliability have been examined with special focus on the anterior nasal passage and the most constricted areas in both the nasal passage and the oropharynx. CBCT imaging and acoustic reflection was shown to have a high correlation in anterior nasal volume and minimal cross-sectional area [48].

Total volumes were calculated for both right and left nasal passages.

The patients applied two sprays per nostril of Xlear Nasal Spray. 3 minutes following spraying acoustic rhinometry was performed. Volumes were calculated in the same manner as baseline.

Xlear Nasal Spray is an over the counter product used for nasal congestion. Xlear Nasal Spray (Xlear, Inc.), is a hyperosmotic solution, which contains xylitol, purified water, and salt, with grapeseed extract as a preservative.

There were four different groups of measurements, the volume before the Xlear and the volume after Xlear was recorded for both the left and right nasal passages. The data was separated into two groups by the median age of 47 years to compare older and younger patients. The differences for all four groups each group appeared to be skewed (See figure 3). All four groups had a higher mean volume after the use of Xlear (See table 1). The normality of the difference in volume for each group was examined using Shapiro-Wilk test and

was rejected since each group had P-Values less than 0.01. Due to the skew and data being uneven, the non-parametric Wilcoxon Rank Sum test was performed to test if the mean change in volume after the use of Xlear is less than zero. P-values < 0.05 were considered statistically significant.

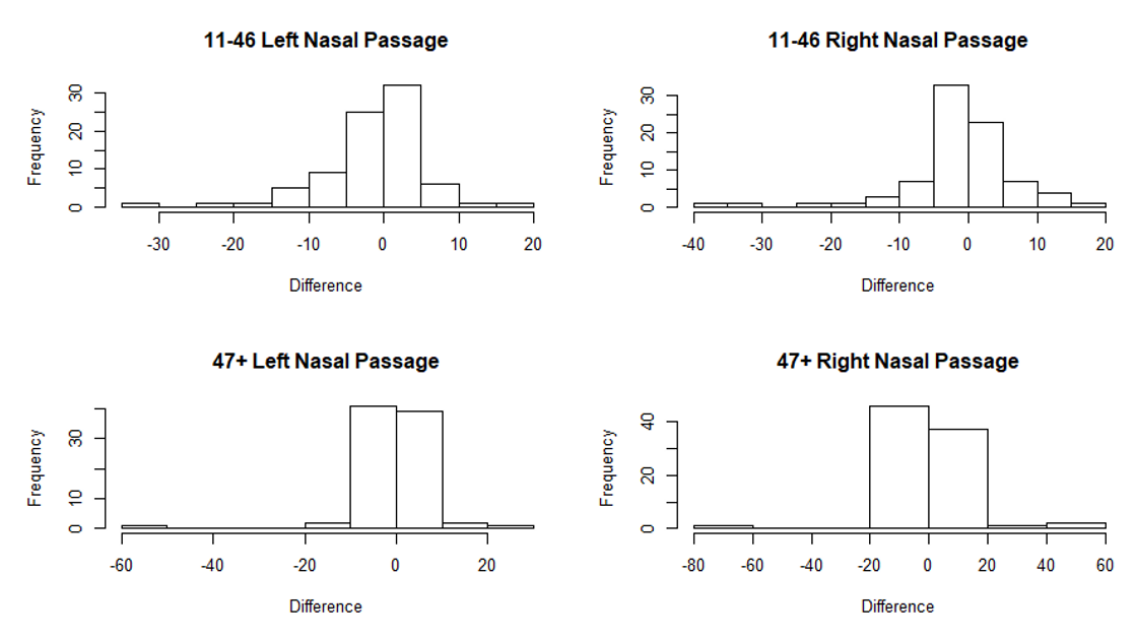

Figure 3

	Mean Before Xlear	Mean After Xlear	Mean Difference
11 - 46 Left (N = 86)	10.01	12.07	-2.06
11 - 46 Right (N = 86)	12.73	14.64	-1.91
47+ Left (N = 87)	11.44	11.51	-0.07
47+ Right (N = 87)	14.19	14.31	-0.12

Table 1: *Summary statistics for each group.*

Results

The rank sum test showed that the left nasal passage for the 11 - 46 age group had a P-value of 0.0346, the right nasal passage for the 11 - 46 age group had a P-value of 0.0491, the left nasal passage for the 47 and older group had a P-value of 0.2046, and the right nasal passage for the 47 and older group had a P-value of 0.6674. The P-values for both the left and right nasal passages for patients aged 11 - 46 under the Wilcoxon Rank Sum Test was below the test threshold of 0.05, but not for the 47 and older group. Therefore, there is evidence to suggest that the use of Xlear causes a statistically significant increase in volume for the patients in the 11 - 46 age group, but not enough evidence for the patients 47 and older.

Discussion

The pathophysiology of NO is a relative newcomer to pharmacology and has changed our understanding of the value of nasal breathing. It's widespread roles include: maintenance of vascular tone, inhibiting platelet aggregation and adhesion, modulates smooth muscle cell proliferation, neurotransmitter function in both the central and peripheral nervous systems, and mediation of cellular defense. In addition, NO interacts with mitochondrial systems to regulate cell respiration. Reduced basal NO synthesis or action leads to vasoconstriction, elevated blood pressure and thrombus formation [49].

Maxillary palatal expansion has been demonstrated to increase nasal airway volume at a ratio of 2.35% for every 1 mm of transverse expansion [50]. The flow rate is increased to the fourth power for every 1% increase in volume. Greater flow rate creates a greater mix of NO from the maxillary, frontal, ethmoid and sphenoidal sinuses.

Grinding of the teeth has been demonstrated to be related to forward head posture and that expansion of the maxilla has been shown to decrease forward head posture. Restoration of nasal breathing as opposed to mouth breathing results in a reduction of muscle contraction of the extensor muscles at the back of head and their counters the SCM (sternocleidomastoid muscles), which refer pain to the base of skull and forehead. This results in reduction of chronic pain complaints for neck, shoulders and craniofacial pain.

Soft tissue hypertrophy of the nasal structures reduces flow rates and without NO's anti-microbial benefits there is a greater incidence of respiratory infection as air is no longer filtered, warmed, and humidified. Hyperosmotic saline/Xylitol (Xlear) spray rehydrates and shrinks inflamed swollen nasal tissue to increase volume, reduce incidence of nasal respiratory infection, and uprights head posture to reduce chronic head/neck pain, and jaw locking.

Conclusion

Utilizing a mixture of hyperosmotic saline and xylitol (Xlear) is effective in reducing soft tissue hypertrophy of the nasal complex (turbinates, vomer, maxilla). There is evidence to suggest that the use of Xlear causes a statistically significant increase in volume for the patients in the 11 - 46 age group. Saline and xylitol does not have the rebound effect found in decongestants and antihistamines. This safe, cost effective alternative or adjunct to decongestants or antihistamine spray should be considered for both prevention and treatment of soft tissue obstruction.

The health benefits of increased nasal volume and flow improve sleep breathing disorders, respiratory disease. Increase in nasal breathing results in uprighting head posture results in a reduction of chronic facial pain, headaches and jaw locking. Further studies are needed to confirm these findings.

Bibliography

1. BG Ferris Jr., *et al*. "Partitioning of respiratory flow resistance in man". *Journal of Applied Physiology* 19 (1964): 653-658.

2. DR Heetderks. "Observations on the reactions of normal nasal mucosa membrane". *The American Journal of the Medical Sciences* 174.2 (1927): 231-244.

3. KO Olsen and EB Kern. "Nasal influences on snoring and obstructive sleep apnea". *Mayo Clinic Proceedings* 65.8 (1990): 1095-1105.

4. L Stapleton., *et al*. "The Impact of Nasal Surgery on Sleep Quality: A Prospective Outcomes Study". *Otolaryngology-Head and Neck Surgery* 15.5 (2014): 868-873.

5. Imada M., *et al*. "Functional Roles of Nasal Nitric Oxide in Nasal Patency and Mucociliary Function". *Acta Oto-Laryngologica* 122.5 (2002): 513-519.

6. Maniscalco., *et al*. "Nitric oxide in upper airways inflammatory diseases". *Inflammation Research* 56.2 (2007): 58-69.

7. Mancinelli., *et al*. "Effects of nitric oxide and nitrogen dioxide on bacterial growth". *Applied and Environmental Microbiology* 46.1 (1983): 198-202.

8. Nathan., *et al*. "Role of nitric oxide synthesis in macrophage antimicrobial activity". *Current Opinion in Immunology* 3.1 (1991): 65-70.

9. Fang. "Mechanisms of nitric oxide-related antimicrobial activity". *Journal of Clinical Investigation* 99.12 (1997): 2818-2825.

10. Sanders., *et al*. "Role of nasal nitric oxide in the resolution of experimental rhinovirus infection". *Journal of Allergy and Clinical Immunology* 113.4 (2004): 697-702.

11. Sanders., *et al*. "Nitric oxide inhibits rhinovirus-induced cytokine production and viral replicationin a human respiratory epithelial cell line". *Journal of Virology* 72.2 (1998): 934-942.

12. Jorissen., *et al*. "Nasal nitric oxide". *Allergy* 56.11 (2001): 1026-1033.

13. Runer., *et al*. "Nitric oxide is a regulator of mucocillary activity in the upper respiratory tract". *Otolaryngology-Head and Neck Surgery* 119.3 (1998): 278-287.

14. Jain., *et al*. "Modulation of airway epithelial cell ciliary beat frequency by nitric oxide". *Biochemical and Biophysical Research Communications* 191.1 (1993): 83-88.

15. Lindberg., *et al*. "Low levels of nasal nitric oxide correlate to impaired mucocillary function in the upper airways". *Acta Oto-Laryngologica* 117.5 (1997): 728-734.

16. Guilleminault C and Sullivan SS. "Towards Restoration of Continuous Nasal Breathing as The Ultimate Treatment Goal in Pediatric Obstructive Sleep Apnea". *Enliven: Pediatrics and Neonatal Biology* 1.1 (2014): 1.

17. Olmos S. "CBCT in the evaluation of airway-minizing orthodontic relapse". *Journal Orthodontic Practice* 6.2 (2015): 46-49.

18. Harvold E., *et al*. "Primate experiments on oral respiration". *American Journal of Orthodontics* 79.4 (1981): 359-372.

19. Todd Tzanetos DR., *et al*. "Implementation of an Inhaled Nitric Oxide Protocol Decreases Direct Cost Associated With It's Use". *Respiratory Care* 60.5 (2015): 644-650.

20. Olmos S. "Comorbidities of chronic face pain and obstructive sleep apnea". *Current Opinions in Pulmonary Medicine* 22.6 (2016): 570-575.

21. Sanders AE., *et al*. "Sleep apnea symptoms and risk of temporomandibular disorder: OPPERA cohort". *Journal of Dental Research* 92.7 (2013): 70S-77S.

22. Olmos S., *et al*. "Headache and jaw locking comorbidity with daytime sleepiness". *American Journal of Dentistry* 29.3 (2016): 161-165.

23. Hussain SF., *et al*. "Association of self-reported nasal blockage with sleep-disordered breathing and excessive daytime sleepiness in Pakistani employed adults". *Sleep Breathing* 14.4 (2010): 345-351.

24. Yahihara F., *et al*. "Nasal dilator strip is an effective placebo intervention for severe obstructive sleep apnea". *Journal of Clinical Sleep Medicine* 13.2 (2017): 215-221.

25. Cailliet R. "In: Head and Face Pain Syndromes". F.A. Davis Company (1992).

26. An J., *et al*. "Influence of temporomandibular joint disc displacement on craniocervical posture and hyoid bone position". *American Journal of Orthodontics and Dentofacial Orthopedics* 147.1 (2015): 72-79.

27. Simmons HC and Gibbs SJ. "Anterior Repositioning Appliance Therapy for TMJ Disorders: Specific Symptoms Relieved and Relationship to Disk Status on MRI". *Journal of the Tennessee Dental Association* 89.4 (2009): 22-30.

28. Olmos S., *et al*. "The Effect of Condyle Fossa Relationships on Head Posture". *Cranio* 23.1 (2005): 48-52.

29. Velz AL., *et al*. "Head posture and dental wear evaluation of bruxist children with primary teeth". *Journal of Oral Rehabilitation* 34.9 (2007): 663-670.

30. Ribeiro Ferreira NM., *et al*. "Sleep bruxism associated with obstructive sleep apena syndrome in children". *Cranio* 33.4 (2015): 251-255.

31. Tecco S., *et al*. "Changes in head posture after rapid maxillary expansion in mouth-breathing girls: a controlled study". *Angle Orthodontist* 75.2 (2005): 171-176.

32. McGuinness NJ and McDonald JP. "Changes in natural head position observed immediately and one year after rapid maxillary expansion". *European Journal of Orthodontics* 28.2 (2006): 126-134.

33. Cho D., *et al*. "Changes in natural head position after orthognathic surgery in skeletal Class III patients". *American Journal of Orthodontics and Dentofacial Orthopedics* 147.6 (2015): 747-754.

34. Makinen KK., *et al*. "Xylitol chewing gums and caries rates: a 40-month cohort study". *Journal of Dental Research* 74.12 (1995): 1904-1913.

35. Soderling E., *et al*. "Effect of sorbitol, xylitol, and xylitol/sorbitol chewing gums on dental plaque". *Caries Research* 23.5 (1989): 378-384.

36. Makinen KK. "Long-term tolerance of healthy human subjects to high amounts of xylitol and fructose: general and biochemical findings". *Internationale Zeitschrift für Vitamin- und Ernährungsforschung. Beiheft* 15 (1976): 92-104.

37. Durairaj L., *et al*. "Safety Assessment of Inhaled Xylitol in Subject with Cystic Fibrosis". *Journal of Cystic Fibrosis* 6.1 (2007): 31-34.

38. Uhari M., *et al*. "Xylitol chewing gum in prevention of actue otitus media: double blind randomised trial". *British Medical Journal* 313.7066 (1996): 1180-1184.

39. Zabner J., *et al*. "The Osmolyte Xylitol Reduces the Salt Concentration of Airway Surface Liquid and may Enhance Bacterial Killing". *Proceedings of the National Academy of Sciences (PNAS)* 97.21 (2000): 11614-11619.

40. Uhari Matti and Kontiokari Tero. "A Novel use of Xylitol Sugar in Preventing Acute Otitis Media". *Pediatrics* 102.4 (1998): 879-884.

41. Durairaj L., *et al*. "Safety assessment of inhaled xylitol in mice and healthy volunteers". *Respiratory Research* 5.1 (2004): 13.

42. Ferreira Aline S., *et al*. "Bypassing Microbial Resistance: Xylitol Controls Microorganisms Growth by Means of its Anti-Adhesive Property". *Current Pharmaceutical Biotechnology* 16.1 (2015): 35-42.

43. Hoffman R. "The Role of Biofilms in Chronic Infections". CNS The Clinical Advisor (2016).

44. Cingi C., *et al*. "Comparison of nasal hyperosmolar xylitol and xylometazoline solutions on quality of life in patients with inferior turbinate hypertrophy secondary to nonallergic rhinitis". *International Forum of Allergy and Rhinology* 4.6 (2014): 475-479.

45. Numminen J., *et al*. "Reliability of acoustic rhinometry". *Respiratory Medicine* 97.4 (2003): 421-427.

46. Cakmak O., *et al*. "Value of acoustic rhinometry for measuring nasal valve area". *Laryngoscope* 113.2 (2003): 295-302.

47. Wang DY., *et al*. "Acoustic rhinometry in nasal allergen challenge study: which dimensional measures are meaningful". *Clinical and Experimental Allergy* 34.7 (2004): 1093-1098.

48. Tsolakis IA., *et al*. "When static meets dynamic: Comparing cone-beam computed tomography and acoustic reflection for upper airway analysis". *American Journal of Orthodontics and Dentofacial Orthopedics* 150.4 (2016): 643-650.

49. S Moncada and EA Higgs. "The discovery of nitric oxide and it's role in vascular biology". *British Journal of Pharmacology* 147.1 (2006): S193-S201.

50. M Motro., *et al*. "Rapid-maxillary-expansion induced rhinological effects: a retrospective multicenter study". *European Archives of Oto-Rhino-Laryngology* 273.3 (2016): 679-687.

Volume 8 Issue 5 May 2019