REVIEW

The nose, snoring and obstructive sleep apnoea

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SUMMARY	*Snoring and obstructive sleep apnoea are both due to multilevel anatomical obstruction, and the nose and nasal pathology both contribute in many cases. This paper addresses some of the issues surrounding the problem and briefly discusses the role of medication and nasal dilators and in more detail the implication of nasal surgery in various aspects of sleep related breathing disorders (SRBD). Nasal obstruction leads to mouth breathing, which destabilises the upper airway and aggravates SRBD.*
	Key words: snoring, obstructive sleep apnoea, nasal obstruction, nasal surgery

Historically, even in the Hippocratic era it was thought that the nose played a role in snoring and caused restless sleep. Five years ago, in this journal, Rhombaux et al. [1] published a review article on nasal obstruction and its impact on sleep-related breathing disorders. Subsequently there has been a prolific increase in the number of articles published on the subject. Though nasal and sleep physiology as well as mechanisms relating to upper airway obstruction remain significantly unchanged, data and information derived from more recent medical and surgical trials have made a useful addition. In particular, evaluating treatment outcomes more objectively and the use of quality of life (QoL) questionnaires have added a different dimension.

Sleep-related breathing disorder (SRBD) is essentially a spectrum consisting of various clinical entities ranging from simple or primary snoring at one end to severe obstructive sleep apnoea at the other [2]. The prevalence of snoring in middle-aged men is in the range of 25-50% [3,4], whereas OSA affects 2 - 4% of males and 1 - 2% of females [5]. The use of dynamic MRI imaging, acoustic analysis, sedation endoscopy and pharyngeal luminal pressure recordings have helped establish the fact that both snoring and OSA exhibit a multilevel phenomenon [6-9] whereby obstruction occurs in the naso, oro and hypopharynx in differing proportions in different patients. The first port of entry for the air is indeed the nasal vestibule, thus the nose and various nasal pathology can have a significant impact on the collapsibility of different segments of the pharyngeal lumen [10,11].

Various laws of physics and theories of dynamics are required to fully explain the relationship between nasal airflow, obstruction and SRBD. Included in this would be the Starling resistor model, Bernoulli and Venturi effects. The main theories proposed to link nasal obstruction and SRBD have 3 main components namely increase in nasal resistance, the unstable oral breathing and the impaired nasal reflexes [10,12-17]. As a reflex compensatory mechanism secondary to nasal obstruction, mouth breathing commences resulting in narrowing of pharyngeal lumen, a decrease in the retroglossal dimension as a result of further posterior retraction of the tongue and an increase in the oscillation and vibration of the soft palate and redundant pharyngeal tissue. The influence of posture is well recognised in that the nasal resistance increases in the recumbent position due to the hydrostatic component [1,11]. This could be explained by an increase in the jugular venous pressure. Nitric oxide is also thought to play a role in maintaining upper airway patency by acting as an aerotransmitter between the nose and the lung [18].

Anatomically, the nose is far less collapsible than the pharynx as it has a rather rigid framework with the exception of the nasal valve region. Nasal obstruction experienced by patients could be due to structural abnormalities (e.g. deviated nasal septum, enlarged turbinates, and nasal valve collapse), mucosal disease (rhinitis, sinusitis, nasal polyposis) or more rarely due to neuromuscular problem. Imposed obstruction secondary to nasal packing can lead to reduced oxygen saturation levels and SRBD [19].

Numerous studies have demonstrated that chronic nasal congestion is associated with snoring [20,21] and daytime sleepiness [22,23]. An epidemiological study [24] has revealed that allergic rhinitis affects 9 - 42% of the population. The mechanism by which allergic rhinitis causes poor sleep quality and daytime fatigue is not entirely clear but it is thought that multiple factors are involved and these include the various inflammatory mediators, which may have a direct effect on sleep regulation [25,26], nasal obstruction, postural changes and adverse effects of some antihistamines used to treat the condition. A study by Kohler et al. [27] has addressed the issue of perception of nocturnal nasal obstruction in patients with chronic rhinitis, demonstrating the presence of nasal cycle during sleep.

To overcome nasal obstruction, treatment options available are medication, nasal dilators and surgical intervention. Clinical trials have been conducted in all above-mentioned categories but they lack uniformity in that, not all studies have looked at objective outcome measures. Many of the studies are non-randomised, lacking controls, have small number of patients included and the follow-up period is relatively short.

Medical treatment

In patients with chronic rhinitis, the main cause of the high nasal resistance is due to the excessive swelling and engorgement of nasal mucosa. In terms of conservative treatment, this could be overcome by the use of topical application of steroids or sympathomimetic decongestants. The way in which medication works is due to reduction in inflammatory mediators or indeed as a result of direct mechanical reduction of nasal congestion, thus leading to a decrease in nasal resistance and improved sleep.

Of the pharmacological agents, most work has been carried out on intranasal steroids such as budesonide, flunisolide and fluticasone [22,23,28]. The pooled data (Table 1) of these drugs have demonstrated significantly improved nasal symptoms and sleep quality resulting in less daytime somnolence. Only one study [28] however, has shown a slight lowering of the apnoea-hypopnoea index (AHI) with fluticasone when compared with placebo but no difference in the sleep architecture was noted. Studies on decongestant such as oxymetazoline [29,30] are limited and rather inconclusive; as data on snoring was not available but nasal resistance had improved in both studies as had the sleep architecture and the arousal index. However, it must be emphasised that such decongestants are only recommended for short-term use as prolonged usage will cause rhinitis medicamentosa.

Nasal dilators

These devices increase the ability to breathe through the nose by dilating the narrow nasal valve area by reducing the nasal resistance and thus theoretically improve snoring. There are two nasal dilators available: an externally applied Breathe Right® and an internal device Nozovent®. A handful of studies have been conducted with both devices and an improvement in snoring has been noted in a few [31-34], but improvement in objective sleep parameters in only one study [31]. Nasal dilators are generally not recommended in patients with OSA but may be beneficial in a simple snorer with rhinitis and/or nasal valve collapse. In any case, they have no side effects and are not too expensive so would be worthy of trial in selected patients. If they help in improving symptoms then it may be worthwhile for the patient to be considered for definitive nasal valve surgery.

Surgical treatment

Nasal surgery is usually conducted to alter structural abnormalities present in primary snorer complaining of nasal obstruction and/or snoring. In addition to this group of patients there is a smaller group of patients that may present to the rhinologist for surgical intervention not for curative purposes but for adjunctive treatment to improve efficacy of their main treatment option of nasal continuous positive airway pressure (CPAP). Surgical procedures performed for SRBD includes septoplasty, septorhinoplasty, functional endoscopic sinus surgery, turbinate reduction and nasal valve surgery.

Studies published in the 80's and 90's on effects of septoplasty on snoring demonstrated reduction in snoring by 50 - 75% [35-37]. In these studies the surgical outcomes were purely measured subjectively using questionnaires or visual analogue scale. A

Table 1. Randomised Controlled Studies assessing nasal pharmacological interventions for sleep disturbance.

Study	Study design	Patients	Nasal pathology	Intervention	Objective outcomes	Subjective outcome
Kiely 2004[28]	Double blind crossover RCT	10 simple snorers (mean AHI:3), 13 OSA patients (mean AHI: 26.5)	Allergic rhinitis, no septal deviation	Fluticasone 100mcg bd for 4 weeks	Median AHI reduced in OSA patients taking fluticasone from 30.3 to 23.0 (p<0.001)	Improvement daytime alertness for non apnoeic patients, not for OSA patients
Craig 2005[22]	Pooled results from 3 double blind randomised crossover trials	42 patients with self reported daytime somnolence and impaired sleep SA patients excluded	Subjective nasal obstruction	Nasal steroids od (fluticasone 200mcg, budesonide 128 mcg, flunisolide 200mcg) for 3 weeks	Measured only in fluticasone group: No polysomnographic changes in AHI or other sleep parameters	Decreased sleep problems and sleepiness
McLean 2005[30]	Double blind crossover study	10 OSA patients	Clinician assessed nasal obstruction	Topical xylometazoline (0.2mg twice) and external dilator strip for one night	AHI reduced by 12 , improved sleep architecture	No improvement in daytime sleepiness
Kerr 1992[29]	Double blind crossover study	10 OSA patients	6 had clinician and patient assessed nasal obstruction	Topical xylometazoline before sleep and internal nasal dilator for one night	No change in AHI, slightly reduced arousal episodes	Subjective improvement in sleep quality

more recent study by Virkkula et al. [38] claimed that snoring is not relieved by nasal surgery despite improvement in nasal resistance. This study conducted on 40 Finnish patients presenting with snoring looked at the outcomes objectively using rhinomanometry, polysomnography and snoring intensity index. They concluded that the snoring time and intensity did not improve significantly in their patients. In contrast to this Finnish study, studies from Korea [39] and Japan [40], which looked at a different ethnic group claimed to have significant improvement in sleep parameters. This may appear to be the case if p values are looked at e.g. reduction of the respiratory disturbance index (RDI) dropping from 39 preoperatively to 29.4 postoperatively giving a p value of 0.0001 as reported by Kim et al. [39], but closer analysis of the study reveals this not to be entirely true, particularly if Sher's criteria of reduction of more than 50% in RDI or AHI or the actual value to be less than 20 is applied [41].

Li et al. [42,43] have recently addressed the role of nasal surgery in patients with snoring and OSA from two different perspectives. Firstly, they looked at efficacy of nasal surgery to relieve snoring [42], and tried to identify predictive factors concluding that the tonsil size affected the outcome of nasal surgery for snoring. Secondly, they looked at the important issue of improvement in QoL after nasal surgery alone for patients with OSA and nasal obstruction [43]. In this study, they evaluated QoL by using generic and disease specific questionnaires. They utilised the short-form health survey (SF 36), snore outcome survey and a separate spouse/bed partner survey. They concluded that by correcting an obstructed nasal airway, they were able to significantly improve disease specific and generic QoL thus substantiating the role of nasal surgery in treating these patients. However, in spite of the significant improvement noted in QoL parameters, disappointingly, there was no statistically significant improvement in the objective polysomnographic data. The disappointment in the lack of improvement documented objectively is shared by numerous other similar studies following nasal surgery alone for SRBD. Verse et al. [44] studied a cohort of 26 patients of whom 19 had OSA and the remainder were simple snorers. A variety of nasal surgical procedures including septorhinoplasty, septoplasty, sinus surgery and nasal valve surgery were carried out. They concluded that although nasal surgery significantly improved sleep quality and daytime somnolence, the surgical response rate in the apnoeic group was in the region of 15% when looking at objective parameters of AHI. Four of their patients had worsening of OSA in spite of improving arousal index. This paradoxical effect can be explained by the so called 'first night effect' which implies that when the patient has the preoperative sleep study for the first time, they do not sleep well and as a result it may not truly reflect the severity of the SRBD; but with the subsequent postoperative sleep study they are already accustomed to the attachment of various leads and hence the recording on this occasion reflects more accurately the severity of the problem.

Morinaga et al. [45] have looked at the way in which pharyngeal morphology could have an impact on the outcome of nasal surgery in patients with obstructive sleep apnoea and nasal obstruction. The pharyngeal morphological features they looked at included tonsil size, Mallampati score, narrowness of fauces and the retroglossal dimension. They concluded that a favourable nasal surgical outcome in this group of patients was seen in individuals who had a high positioned soft palate and/or in those with a wide retroglossal space. Unlike Li et al. [42], they did not feel that the tonsil size affected the outcome of nasal surgery. The only randomised controlled study to date has been reported by Koutsourelakis et al. [46] in which they assigned 49 patients with OSA and deviated nasal septum to either septoplasty or sham surgery and found that despite improvement in nasal patency as measured subjectively and objectively, there was no change in AHI or daytime sleepiness as measured by Epworth Sleepiness Scale.

The second group of patients that may be considered for nasal surgery are those who have failed CPAP therapy. The treatment of choice for moderate or severe OSA is CPAP but unfortunately many patients find this form of therapy cumbersome and is poorly tolerated with a compliance rate of less than 70% [47]. CPAP therapy itself may cause rhinitis and may be poorly tolerated in the first place if the patient has any additional structural abnormality of the nose. More than 50% of CPAP users complain of significant nasal symptoms, including nasal congestion, rhinorrhoea, dryness and sneezing [48]. Thus it is vital that patients who do not comply with or adhere poorly to CPAP therapy should undergo detailed evaluation of their upper airway to identify obstructive pathology that may be surgically correctable. This may lead to a reduction in the CPAP pressure and therefore improve the compliance of this form of therapy. Powell [49] demonstrated this in a group of CPAP patients undergoing radiofrequency turbinate reduction. Patients in this study reported a subjective improvement in nasal obstruction, which in turn was linked to improved CPAP use. Similarly, Friedman et al. [50] showed a significant decrease in CPAP titration levels following nasal surgery alone. In this study, reduction of pressure requirement for CPAP therapy was noted in patients with mild, moderate and severe OSA. The mean reduction of CPAP titration level was from 9.3 cm H_2O preoperatively to 6.7 cm H_2O postoperatively. This reduction in pressure would certainly help in improving the CPAP compliance.

CONCLUSION

It is now well recognised that reducing nasal resistance medically, surgically or with the use of dilators can improve sleep quality; however significant improvement in objective sleep parameters remain to be proven. In cases of severe nasal obstruction, as a compensatory response, patient starts mouth breathing, which can exacerbate the symptoms of SRBD. Although there is no role for nasal surgery alone in treating OSA, it is quite useful in improving symptoms

in simple snorers and useful as part of multilevel surgery in many patients with SRBD. In CPAP failures if upper airway evaluation demonstrates an obstructive nasal passage then treating this certainly improves CPAP compliance and adherence. In general, if there is a positive response to medical treatment or with using nasal dilators then these patients may benefit from nasal surgical intervention.

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