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One-stage nasal and multi-level pharyngeal surgery for obstructive sleep apnoea: safety and efficacy

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Abstract
A collapsible airway is often the common denominator in sleep-disordered breathing (SDB). The upper respiratory tract includes the nasal passage, nasopharynx, oral cavity, oropharynx, base-of-tongue region and the hypopharynx. It is believed that the highest amount of resistance in the upper respiratory tract is in the nasal cavities, and particularly the nasal valve. Most authors believe that when considering surgical options for patients with obstructive sleep apnoea (OSA) it is imperative to correct nasal pathology together with the other sites of airway obstruction. In this retrospective study, I sought to investigate the safety and efficacy of one-stage nasal and multi-level pharyngeal surgery. I compared two groups of patients: group 1, receiving one-stage nasal and multi-level pharyngeal surgery; and group 2, receiving only multi-level pharyngeal surgery. In group 1, nine out of 12 patients (75 per cent) met the criteria for surgical success, with a mean pre-operative apnoea-hypopnoea index (AHI) decreasing from 36.3 to 8.9 post-operatively ($p < 0.0002$), while in group 2, 25 out of 40 patients met the surgical success criteria (62.5 per cent), with their mean AHI decreasing from 52.6 to 10.2 ($p < 0.0000$). When comparing the surgical success rates between the two groups, it was not statistically significant, at $p > 0.106$. There were no post-operative respiratory-related complications despite having bilateral nasal Merocel (tampon) packing in place (in group 1), and none of the patients in either group had any desaturation, hypoxaemia, apnoea or OSA-related complications. This series suggests that, with adequate post-operative monitoring, it is both safe and efficacious to perform both nasal and multi-level pharyngeal surgery in the one surgical session.

Key words: Sleep Apnoea Syndrome; Nasal Cavity; Pharynx; Surgical Procedures

Introduction

Snoring is caused by the vibration of the structures in the mouth - the soft palate, uvula, tonsils, base of tongue, epiglottis and pharyngeal walls - during respiration. Snoring has been traditionally believed to be just a social nuisance, with no detrimental medical effects. However, it is now well accepted that snoring represents an alarm alerting one to the possibility of a sleep disorder. Obstructive sleep apnoea (OSA) is a common sleep disorder; Young *et al*. studied 602 state employees with a formal overnight polysomnogram and found that the prevalence of SDB was 24 per cent in men and 9 per cent in women.[1] Most sleep-disordered breathing (SDB) patients are undiagnosed, and it is estimated that up to 93 per cent of women and 82 per cent of men with moderate to severe OSA remain undiagnosed.[2]

Sleep-disordered breathing is a spectrum of diseases that includes snoring, upper airway resistance syndrome (UARS) and OSA. These disorders all have one common denominator: the presence of a collapsible airway. As humans are obligate nasal breathers, one can imagine that the patency of the nasal passage is of utmost importance in the pathophysiology of sleep-related disorders and in the treatment of sleep-disordered breathing. In 1987, Lavie[3] illustrated the importance of nasal breathing in sleep. Cline[4] and Wells[5] showed that surgical correction of nasal disease could relieve excessive daytime sleepiness. Mayer-Brix *et al*.[6] found highly limited nasal ventilation in 14.3 per cent of 431 patients with OSA. Other authors have also shown a strong correlation between nasal obstruction and OSA.[7–10]

It is well known that reduced nasal cross-sectional area causes increased nasal resistance and predisposes the patient to inspiratory collapse of the oropharynx, hypopharynx or both.[11,12] Patients with nasal abnormalities such as septal deviation, inferior turbinate hypertrophy, nasal polyps, sinusitis or choanal atresia have been shown to have high nasal resistances, resulting in worsening of their OSA. Hence, surgical correction of the underlying nasal condition has been documented to alleviate OSA

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and increase patient compliance with nasal continuous positive airway pressure (CPAP).

Upper airway surgery performed to treat OSA may involve the nasal passages, palatopharyngeal area and hypopharynx/base-of-tongue region. The operations to these multiple sites may be done in a staged fashion or simultaneously. It is well accepted that patients with OSA are at higher risk of airway compromise in the post-operative period. Anaesthetic agents and narcotics may decrease muscle tone of the upper airway, in addition to post-operative oedema in the airway; these may result in airway compromise and hypoxaemia. The need for nasal packing after nasal surgery further raises concerns about the safety of performing one-stage nasal and palatopharyngeal surgery for OSA patients.

Subjects and methods

The combined sleep clinic at the Tan Tock Seng Hospital is jointly run by three consultants, namely, an otolaryngologist, a respiratory physician and an orthodontist. Patients are referred to this specialist clinic by the family physician, the endocrinologist, the bariatric surgeon, the oro-maxillo-facial surgeon, another otolaryngologist or by other internal physicians. A comprehensive pre-operative assessment is conducted, including a thorough history documentation with a particular focus on allergic rhinitis, duration of medical treatment, use of nasal steroid sprays, oral anti-histamines, oral steroids and history of prior nasal surgery. Patients complete the Epworth's Sleepiness Scale and various other questionnaires; height, weight, neck circumference, body mass index (BMI) and blood pressure are also assessed. Patients are then interviewed by the three consultants together and undergo a thorough physical examination. In the oral examination, the oropharyngeal area, soft palatal redundancy, uvula size and thickness, Mallempati grade, and adenoid and tonsil size are all documented. Nasal cavity examination with a flexible fibre-optic endoscope is also performed, paying attention to the nasal septum position (and any deviations), inferior turbinate size, nasal valve area patency, presence of nasal polyps, adenoid size and posterior nasal space pathology. Laryngeal examination is performed, looking for any epiglottic abnormalities, vocal fold pathologies and signs suggestive of laryngopharyngeal reflux. Particular attention is given to the soft palatal area, lateral pharyngeal walls and the base-of-tongue area, during the Mueller's manoeuvre. This identifies the level of obstruction according to Fujita type I, II and III,[13] (type I being obstruction mainly at the soft palate region, type III obstruction at the base-of-tongue level, and type II obstruction at both levels). Dental occlusion type, any over-jet and overbite are also noted. Patients are also classified into Friedman's stage I, II or III.[14] This aids in better patient selection, counselling and prognostication for uvulopalatopharyngoplasty.

A lateral cephalometry is also obtained prior to consultation, and assessed for signs of maxillary deficiency (SNA angle), mandibular deficiency (SNB angle), the posterior airway space (PAS), soft-palatal length (PNS-P) and hyoid-mandibular distance (MP-H), according to the cephalometric analysis system of deBarry-Borowiecki *et al*.[15]

All patients undergo a level I, attended, overnight, full polysomnogram (PSG) in hospital. The PSG systematically monitors electroencephalogram (EEG), electro-oculogram (EOG), electromyelogram (EMG) of the chin, electrocardiogram (ECG), body positions, nasal and oral airflow, thoracic and abdominal effort, limb movements, pulse oximetry and snoring sound level. Polysomnographic variables evaluated include sleep parameters, complete sleep staging, sleep time, sleep latency, sleep efficiency, rapid eye movement (REM) and non-REM events, arousals, respiratory events according to the respiratory disturbance index (RDI), apnoea-hypopnoea index (AHI), oxygen desaturations, snoring level, body position and limb movements. The polysomnograms are all scored by the sleep technologist and reviewed by the sleep physician.

All overweight patients are given a strict trial of weight loss, exercise, nutritionist consultation, regular close follow up and a CPAP trial. Patients with a BMI greater than 40 are also sent to the bariatric surgeon for consultation. Occasionally, weight-reduction medications are considered for patients who fail six months of life-style modification; throughout this period, CPAP must be strictly adhered to. Those patients with morbid obesity and co-morbid diseases such as congestive heart failure, cor pulmonale and pulmonary hypertension are offered a tracheostomy.

All patients seen at our combined sleep clinic are counselled on the use of CPAP and are strongly advised to undergo a free trial. If this fails, surgical options are discussed.

As the objective of the current study was to assess the safety and efficacy of one-stage nasal and multi-pharyngeal surgery, only patients who underwent these procedures were included. I excluded patients less than 18 years of age, patients who refused surgical intervention, patients on CPAP with no surgical intervention, patients using oral appliances without surgical intervention, patients not fit for surgery, patients who defaulted from treatment before or after surgery, patients with upper airway resistance syndrome, patients with simple snoring, patients who refused a post-operative polysomnography for whatever reason (either resolution of symptoms, financial reasons and failure to present for follow up) and patients who were not seen in the combined sub-specialty clinic.

Criteria for success required that the post-operative PSG showed a reduction to less than 50 per cent of the pre-operative AHI and an AHI of below 20, and an improvement in the Epworth's Sleepiness Scale.

Patients with symptoms and signs suggestive of allergic rhinitis, and who had an adequate minimum six-month period of medical treatment (comprising

TABLE I

PRE- AND POST-OPERATIVE PARAMETERS FOR SAME-STAGE NASAL AND PHARYNGEAL SURGERY PATIENTS (GROUP 1)

	'Success' ($n = 9$)		'Failure' ($n = 3$)	
	Pre-op	Post-op	Pre-op	Post-op
AHI	*36.3	*8.9	†44.8	†41.6
LSAT (%)	**85.6	**90.0	‡66.0	‡81.0
BMI	28.1	27.8	29.3	29.7
Epworth's	14.7	7.9	13.9	10.8

*$p < 0.0002$, †$p < 0.79$, **$p < 0.027$, ‡$p < 0.187$; p (for success rate *vs* failure rate) < 0.003 using Student's *t*-test. Pre-op = pre-operative; post-op = post-operative; AHI = apnoea-hypopnoea index; LSAT = lowest oxygen saturation; BMI = body mass index

allergen avoidance, topical nasal steroid sprays and oral anti-histamines) were offered nasal surgery. Nasal surgery took the form of either a septoplasty/submucous resection for deviated nasal septum or an anterior/total inferior turbinectomy (bilateral) for enlarged hypertrophied inferior turbinates. Multi-level pharyngeal surgery included uvulopalatopharyngoplasty (UPPP), genioglossus advancement mandibulotomy (GAM), lingualplasty and transpalatal advancement pharyngoplasty (TAP).

Results

A total of 85 patients who attended the combined sleep clinic and underwent some form of surgery for obstructive sleep apnoea was included. Other patients who received surgery for OSA but who did not attend the combined sleep clinic were excluded for standardization purposes. Out of these 85 patients, 33 did not receive a post-operative polysomnogram (for whatever reason) and were also excluded. Hence, the data and results of the remaining 52 patients were analysed.

There were 12 patients who had same-stage nasal and pharyngeal surgery performed (group 1). This group consisted of 11 men and one woman, with a mean age of 34.6 years (age range, 27 to 45 years). Nine out of these 12 patients (75 per cent) met the criteria for surgical success, with a mean pre-operative AHI decreasing from 36.3 to 8.9 post-operatively ($p < 0.0002$). The lowest oxygen saturation and Epworth scores also improved post-operatively from 85.6 to 90 per cent and from 14.7 to 7.9, respectively (Table I). All these 12 patients had a UPPP and tonsillectomy, combined with a septoplasty/submucous resection and bilateral inferior turbinectomy with insertion of bilateral nasal splints and Merocel (tampon) nasal packing for 48 hours post-operatively. One patient had combined septoplasty, inferior turbinectomy, UPPP and GAM, while another had combined septoplasty, inferior turbinectomy and a TAP. All 12 patients were monitored in a high dependency ward, with continuous pulse oximetry, continuous ECG and hourly parameters monitored for a minimum of one day, before going back to the general ward. Patients with severe OSA were monitored in the surgical intensive care unit overnight. There were no post-operative respiratory-related complications; despite having bilateral nasal Merocel (tampon) packing in place, none of the 12 patients in this group had any desaturations, hypoxaemia, apnoeas or OSA-related complications. However, two patients had secondary haemorrhage from the tonsillar bed between post-operative day 10 and 12 (Table II). This was treated in the emergency room with silver nitrate cautery and did not require any operative intervention.

Forty patients who had some form of palatopharyngeal or multi-level pharyngeal surgery were classified as group 2 (i.e. without nasal surgery done in the same surgical sitting). This group of 40 patients consisted of 36 men and four women, with a mean age of 38.6 years (age range, 30 to 61 years). Other than the 27 patients who received a UPPP, this group also included eight patients who underwent UPPP and GAM, three patients who had UPPP and lingualplasty and two patients who had TAP. Twenty-five out of these 40 patients met the surgical success criteria (62.5 per cent), with their AHI decreasing from 52.6 to 10.2 ($p < 0.0000$) (Table III). The lowest oxygen saturation also increased from 79.6 per cent to 88.1 per cent, while Epworth's scores improved from 15.6 to 7.4 post-operatively. Similarly, patients with severe OSA were observed overnight in the surgical intensive care unit; moderate OSA patients were monitored in the high dependency ward, while patients with mild OSA stayed in the general ward. There were also no major respiratory, cardiopulmonary or OSA-related complications post-operatively, and none of the 52 patients used nasal CPAP post-operatively. There were two patients who had mild nasopharyngeal stenosis, noticed at the post-operative six-month follow-up visit (Table II). No surgical intervention was required, as both patients were asymptomatic and well.

TABLE II

TYPE OF SURGERY AND COMPLICATIONS FOR PATIENTS RECEIVING EITHER SAME-STAGE NASAL AND PHARYNGEAL SURGERY (GROUP 1) OR MULTI-LEVEL PHARYNGEAL SURGERY ALONE (GROUP 2)

	Group 1 ($n = 12$)	Group 2 ($n = 40$)
Type of surgery	Septoplasty/SMR/IT UPPPT/GAM/TAP Lingualplasty	UPPPT/GAM/TAP Lingualplasty
Complications	Secondary tonsillar bed haemorrhage (2)	Mild nasopharyngeal stenosis (2)

UPPPT = uvulopalatopharyngoplasty + tonsillectomy; SMR = submucous resection; IT = inferior turbinectomy; GAM = genioglossus advancement mandibulotomy; TAP = transpalatal advancement pharyngoplasty

TABLE III

PRE- AND POST-OPERATIVE PARAMETERS FOR PATIENTS RECEIVING EITHER SAME-STAGE NASAL AND PHARYNGEAL SURGERY (GROUP 1) OR MULTI-LEVEL PHARYNGEAL SURGERY ALONE (GROUP 2)

	Group 1 ($n = 9$)		Group 2 ($n = 25$)	
	Pre-op	Post-op	Pre-op	Post-op
AHI	*36.3	*8.9	†52.6	†10.2
LSAT (%)	85.6	90	79.6	88.1
BMI	28.1	27.8	28.7	27.9
Epworth's	14.7	7.9	15.6	7.4

*$p < 0.0002$, †$p < 0.0000$; p (for group 1 *vs* group 2 difference) < 0.106 using Student's t-test. Pre-op = pre-operative; post-op = post-operative; AHI = apnoea-hypopnoea index; LSAT = lowest oxygen saturation; BMI = body mass index

When comparing the surgical success rates between the two groups there were very comparable results, with group 1 (same-stage nasal and pharyngeal surgery) producing a slightly better success rate of 75 per cent, compared with group 2 (multi-level pharyngeal surgery alone) at 62.5 per cent ($p < 0.106$) (Table III).

- **Nasal and pharyngeal pathology often co-exist in patients with obstructive sleep apnoea syndrome (OSA)**
- **This study investigates the safety of simultaneous nasal and pharyngeal surgery in OSA**
- **With adequate post-operative monitoring, one-stage nasal and multilevel pharyngeal surgery is safe**

Discussion

Sleep-disordered breathing is a common entity and includes snoring, UARS and OSA. Most authorities concur that nasal obstruction plays a small but essential role in the pathophysiology of OSA. As early as in 1977, Simmons *et al.*,[16] showed that there was no distinct improvement in the apnoea index (AI) after treating only the nose, in patients with OSA. Other studies also revealed similar poor results of nasal surgery in OSA patients. Rubin *et al.*,[17] in 1983, showed no improvement in AI; Dayal and Phillipson,[18] in 1985, showed some improvement, but nothing statistically significant, in the post-operative AHI results; and Aubert-Tulkens *et al.*,[19] Utley *et al.*,[20] Verse *et al.*[21] and Friedman *et al.*[22] actually found worsening of the AI and/or AHI after nasal surgery for OSA. Verse *et al.*, in 2002, reported that the overall success rate of nasal surgery alone for OSA patients was only 15.8 per cent.[23]

There has been suggestion, in the literature, that the surgical success rates of OSA are improved with combined nasal and pharyngeal surgery. In this series, I compared two groups of patients: group 1, receiving one-stage nasal and multi-level pharyngeal surgery; and group 2, receiving only multi-level pharyngeal surgery. The two groups were fairly well matched for age, sex, co-morbidities and polysomnographic data. This series showed that the success rates between the two groups were fairly comparable, with group 1 (same-stage nasal and pharyngeal surgery) having a slightly better success rate, of 75 per cent, compared with group 2 (multi-level pharyngeal surgery alone), at 62.5 per cent ($p < 0.106$) (Table III). In general, most authors would concur that nasal surgery for OSA, especially in patients with nasal obstruction or nasal pathology, should be addressed and treated as well. This would not only reduce the need for high nasal CPAP pressures but also improve compliance with CPAP. However, the question remains, should nasal and multi-level pharyngeal surgery be performed within the one surgical session or in different surgical sittings?

Nasal obstruction plays a role in the pathogenesis of SDB and OSA. Gleeson *et al.*[24] demonstrated that high nasal resistance increases negative inspiratory pressures, which amplifies the tendency of the upper airway muscles to collapse in patients with OSA. Moreover, oral breathing alters the functional dynamics of the upper airway and predisposes it to further collapse.[25] These results would imply that OSA patients with post-operative nasal packing (Merocel/tampon) would render the upper airway more prone to collapse and obstruction. Coupled with the oedema and swelling from the multi-level pharyngeal surgery, it would be reasonable to question the safety of such combined nasal and pharyngeal procedures within the one surgical session. In addition, patients with OSA are well known to be sensitive to the anaesthetic agents and narcotic agents that might cause respiratory depression.

In this series, all patients were monitored in the general ward, high dependency ward or surgical intensive care unit, depending on the severity of their OSA. No patients from either group suffered any airway compromise, hypoxaemia, oxygen desaturation or cardiopulmonary events. In addition, neither the one patient who received nasal surgery, UPPP and GAM nor the one patient who received nasal surgery and TAP experienced any respiratory-related complications. Similar to Busaba's review,[26] this series did not find any incidents of airway compromise, cardiopulmonary events nor respiratory complications related to OSA in patients receiving one-stage nasal and multi-level pharyngeal surgery for OSA. This may be explained by the fact that, due to the post-operative pain, most patients recovering from nasal and/or pharyngeal surgery will not be able to rest or sleep well in hospital; hence, the risk of airway collapse is lower. Many authors also advise the use of post-operative nasal CPAP in order to splint the airway open. However, this is not a simple task for patients who have just undergone nasal surgery, much less patients who have nasal packing in place.

Conclusion

Obstructive sleep apnoea patients with nasal pathology should have both the nose and the palatopharyngeal region addressed during surgery. However, is it safe and reasonable to operate on both the nose and palatopharyngeal area at the same stage? This small series suggests that it is both safe and efficacious to perform both nasal and multi-level pharyngeal surgery in the one surgical session, provided there is adequate post-operative monitoring and proper understanding of the pathophysiology of OSA.

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