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Upper airway surgery benefits patients with obstructive sleep apnoea who cannot tolerate nasal continuous positive airway pressure

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Abstract

Nasal continuous positive airway pressure (CPAP) is the mainstay of treatment for patients with moderate to severe obstructive sleep apnoea (OSA). However, tolerance and compliance are poor.

An audit using the Christchurch Hospital ORL surgery database identified patients who underwent upper airway surgery for OSA. Tracheostomy and bimaxillary advancement patients were excluded. Adults with moderate to severe OSA (Desaturation Index (DI) >10 n.h-1), who had failed a trial of nasal CPAP, and had pre-operative and post-operative sleep study data were identified. Objective (DI) and Subjective (Epworth Sleepiness Score (ESS)) outcome measures were recorded.

The database identified 69 patients who underwent surgery for snoring or OSA; of these, 25 patients formed the study group. Sixteen out of 25 improved (64 per cent) after surgery, seven out of 25 showed no change (28 per cent), two patients (eight per cent) showed deterioration in their DI. Forty-eight per cent of patients had >50 per cent post-operative improvement in DI. Fourteen out of 25 (56 per cent) had a post-operative DI <20 n.h-1. Seven out of 25 (28 per cent) had a post-operative DI <10 n.h-1. Upper airway surgery has a role in the management of selected patients with OSA who cannot tolerate nasal CPAP.

Key words: Sleep Apnoea Syndromes; Sleep Apnoea Obstructive; Polysomnography

Introduction

Obstructive sleep apnoea (OSA) affects two to four per cent of middle-aged adults and is associated with significant morbidity and mortality. Increasing apnoea severity in untreated patients is associated with a likelihood of death.[1,2] Nasal CPAP or tracheostomy are the recognized 'gold standards' to treat OSA, but many patients cannot tolerate CPAP and do not wish to consider tracheostomy, except as a last resort.[3]

Apnoea hypopnoea index (AHI) is an objective measure of the severity of OSA, and is the average number of apnoeas (complete cessation of airflow) and hypopnoeas (reduced airflow) per sleep hour. It is calculated from level III, II or I sleep studies.[4] AHI correlates strongly with the risk of morbidity from OSA.[3] The desaturation index (DI) is recorded using overnight pulse oximetry (Level IV study, according to American Sleep Disorders Association Guidelines), and aims to identify patients with significant obstructive sleep apnoea using a simple single parameter study. DI correlates well with AHI, particularly in patients with moderate to severe OSA.[4,5,6]

Christchurch Hospital provides tertiary services to a population of approximately 490 000 people. It is the largest hospital in the South Island of New Zealand. A multidisciplinary sleep team comprising of an otolaryngologist, two respiratory physicians, a dental surgeon and two sleep physiologists, assesses and manages patients with sleep-related breathing disorders. A comprehensive database is kept of all otolaryngology procedures; a separate database is kept of all patients treated in the sleep service.

Our sleep service performs approximately 400 level IV sleep studies per year, (as well as higher level sleep studies) and more than 150 nasal CPAP trials each year. The otolaryngology department performs approximately 30 adult operations each year for snoring and OSA.

This study reviews the surgical treatment of adults with moderate to severe obstructive sleep apnoea, who cannot tolerate nasal CPAP therapy. Do these patients benefit from surgery and are our outcomes

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in Christchurch consistent with outcomes from overseas centres?

Materials and methods

An audit of patients was undertaken, using the ORL surgery database at Christchurch hospital (treated over a seven-year period February 1995 to September 2002). Patients with a diagnosis of obstructive sleep apnoea (OSA) were identified. Inclusion criteria for the study were age greater than 18 years, an unsuccessful trial of nasal CPAP and moderate to severe OSA (defined as a pre-operative DI $\geqslant$ 10 n.h-1). Patients who underwent tracheostomy or bimaxillary advancement surgery for OSA were excluded.

Tonsillouvulopalatopharyngoplasty (TUPP) was performed under general anaesthesia using a modified, conservative technique. After dissection tonsillectomy, a conservative resection of the uvula was undertaken, joining this incision to the line of the posterior pillars. A Z-plasty technique was then used to separate the lateral pharyngeal wall defect from the palatal defect, allowing palatal advancement with the superior limb of the z-plasty. The inferior limb aids closure of the tonsillar fossa, with obliteration of the underlying dead space. Interrupted absorbable sutures are used. This technique was undertaken in the majority of patients, having evolved from a technique used by the senior otolaryngology author to treat several patients referred with nasopharyngeal stenosis following UPPP.

DI was used as an objective marker of outcome (a desaturation is a fall in oxygen saturation $\geqslant$ four 4 per cent from the baseline. DI is the mean number of desaturations per hour of reported sleep, using overnight pulse oximetry).

The DI was measured pre- and post-operatively. To allow for the known night-to-night variability of level IV sleep studies ($\pm$7 n.h-1),[7] patients were divided into three groups: those whose sleep study results improved (reduction in DI $\geqslant$ 14 n.h-1), those whose results did not change (change in DI < 14 n.h-1), and those whose results deteriorated (increase in DI $\geqslant$ 14 n.h-1).

The number of patients with a reduction in DI of at least 50 per cent was identified, as was the number of patients with a post-operative DI below 10 n.h-1 and below 20 n.h-1 respectively. Epworth sleepiness scores (ESS) were reported as a subjective marker of outcome, where available.

The type of surgery was identified as nasal, nasal and pharyngeal, or pharyngeal. Nasal surgery procedures included septoplasty, polypectomy and turbinate surgery. Pharyngeal surgery included tonsillectomy and TUPPP.

All patients were reviewed in a combined clinic, where they were assessed jointly by an otolaryngologist and sleep physician. A full clinical assessment, including flexible endoscopy and rigid endoscopy (where appropriate) was undertaken. Neither the Muller manoeuvre nor sedated nasal endoscopy was undertaken, due to the poor predictive value of these manoeuvres.[8] Patients offered nasal surgery had day-time nasal obstruction, in addition to OSA.

Results and analysis

Sixty-nine patients, were initially identified using the ORL database. All were older than 18 years (who had surgery for OSA/snoring). Thirty-four patients were excluded from the study group for the following reasons:

Two underwent surgery to facilitate use of nasal CPAP, their OSA was successfully controlled with this treatment; 24 had not had a trial of nasal CPAP, (they had antisocial snoring or upper airways resistance syndrome); three had only mild OSA (pre-operative DI < 10); two had bimaxillary advancement surgery and three underwent tracheostomy. Thirty-five patients remained, four were lost to follow up and six had incomplete sleep study data (missing pre-operative or post-operative studies). One patient had two separate OSA procedures with pre-operative and post-operative sleep study information and was therefore recorded twice. Twenty-five patients formed the final study group.

All patients were male. The mean age was 46 years, (range 23–72 years). The mean body mass index (BMI) was 36.1, SDS 7.5. The mean time post-operatively to a follow-up sleep study was seven months (range two to 41 months).

Twenty-one patients had nasal and pharyngeal surgery, three had pharyngeal surgery, and one had nasal surgery alone. The mean BMI in these groups was similar. Seven out of 21 patients (33 per cent) who underwent nasal and pharyngeal surgery had a BMI > 40 (Table I). The mean reduction in DI in this group (BMI > 40) was 29 n.h-1 $\pm$ 42.1, which is not significantly different from the mean change in DI of the group as a whole.

Statistical analysis of the group showed a mean reduction in the DI of 22.1 n.h-1 $\pm$ 30.7; (95 per cent CI = 9.4 n.h-1 to 34.8 n.h-1; Student's t = 3.6; df = 24; p = 0.002).

TABLE I
BMI DISTRIBUTION ACROSS THE THREE SURGICAL GROUPS

Type of surgery	Mean BMI	BMI <30	BMI 30–40	BMI >40
Pharyngeal (n = 3)	34	1	2	
Nasal and pharyngeal (n = 21)	37.1	5	9	7
Nasal (n = 1)	33		1	

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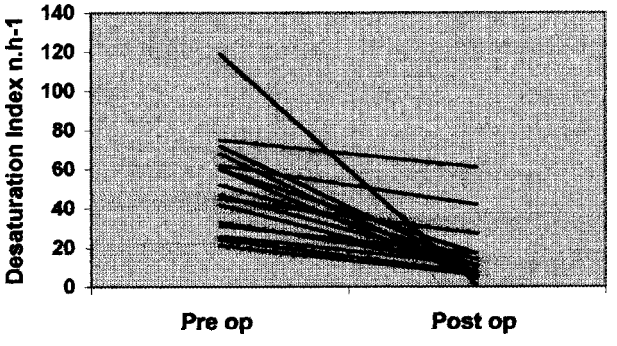

FIG. 1
'Improved group' pre-operative and post-operative DI results.

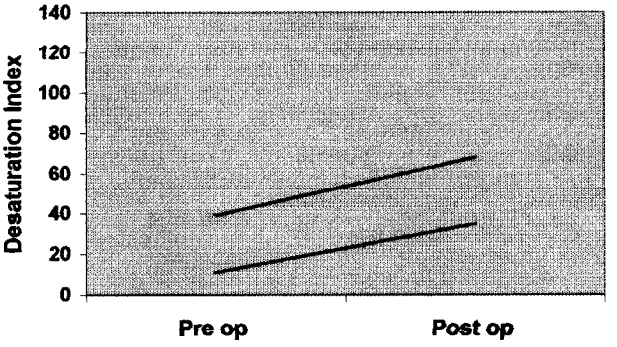

FIG. 3
'Worse group' pre-operative and post-operative DI results.

The mean reduction in ESS was 4.8 ± 6.1; (95 per cent CI = 1.8 n.h-1 to 7.9 n.h-1; Student's t = 3.3; df = 17; p = 0.004).

Sixteen out of 25 (64 per cent) patients formed the 'improved' group, seven out of 25 (28 per cent) the 'no change group' and two out of 25 (eight per cent) the 'deteriorated' group (Figures 1–3).

In the 'improved' group, the mean pre-operative DI was 52 n.h-1 (range 21–119 n.h-1), the mean post-operative DI was 21 n.h-1 (range 1–61 n.h-1). The mean reduction in DI was 37 n.h-1 (range 14–118 n.h-1). On average, DI post-operative values are 67 per cent of those recorded pre-operatively.

Twelve out of 25 patients (48 per cent) of patients had > 50 per cent post-operative improvement in their desaturation index.

Overall, 14 of 25 patients (56 per cent) had a final post-operative DI < 20 n.h-1. Seven of 25 patients (28 per cent) had a final post-operative DI < 10 n.h-1.

The ESS was recorded in 18 out of the 25 patients. Analysis of data showed little relationship between DI and ESS variables, however there was a statistically significant improvement in ESS alone.

Discussion

We have identified and treated a small group of patients with moderate to severe OSA who have failed a trial of nasal CPAP. The majority of patients who did not continue with nasal CPAP cited reasons such as claustrophobia, discomfort, poor mask fit, or machine noise not tolerated by patients or partners. Surgery was offered to reduce the excess mortality and morbidity of leaving their OSA untreated. (Many otolaryngologists treat patients with OSA, but treatment protocols vary. A careful staged approach to this patient group appears to have advantages).

The Stanford Sleep Centre conducted a staged surgical approach to treating patients in this situation, with a two-phase protocol.[9] In their centre, all patients undergo a level I sleep study (full polysomnography) and cephalometry to identify the primary site of airway obstruction. Phase I surgery involves UPPP, genioglossal advancement with hyoid suspension, or a combination of both, depending on the primary site of obstruction. Nasal surgery is performed during phase one surgery if indicated. Success rates for those completing phase one surgery range from 75 per cent in patients with mild to moderate OSA to 40 per cent in patients with severe OSA. Outcome is reported on a six-month post-operative polysomnogram (level I sleep study). Phase two surgery is an aggressive surgical approach of maxillary and mandibular advancement osteotomy and is reserved for phase 1 failures. Phase two surgery success rates are approximately 95 per cent, which is the same as the effectiveness of nasal CPAP in highly compliant patient groups.[9]

In Christchurch an approach has evolved which mirrors the Stanford philosophy, with modifications. Level IV sleep studies are used as a screening tool to identify OSA patients, polysomnography is used selectively, usually when there is clinical suspicion of other sleep-related breathing disorders. Nasal surgery is performed during phase one surgery if nasal obstructive symptoms are present. Previous studies have shown a better post-operative outcome after UPPP in patients who have patent nasal airways (98 per cent versus 78 per cent in those with high nasal airway resistance).[10]

Post-operative level IV sleep studies are performed to aid assessment of outcome following surgery. Four patients were excluded from the study due to lack of post-operative study data, this was identified as a weakness in our department and has been addressed.

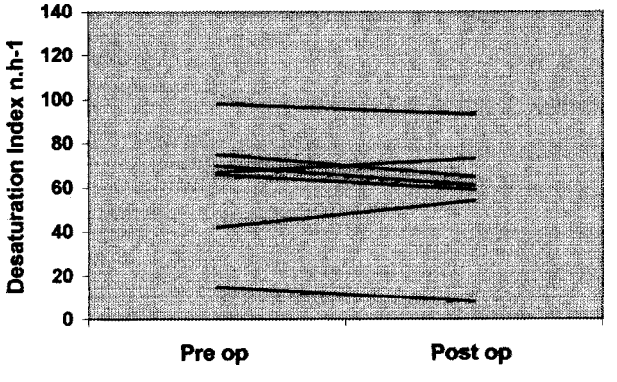

FIG. 2
'No change group' pre-operative and post-operative DI results.

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During phase one of the Stanford protocol, oropharyngeal surgery is often combined with genioglossus advancement. We have not utilized this combination of procedures, however our results remain similar (forty to 75 per cent of patients had > 50 per cent improvement in AHI for phase 1 surgery in Stanford, compared to 48 per cent of patients who had > 50 per cent improvement in DI in Christchurch). Cephalometry is reserved for patients being considered for bimaxillary advancement procedures in our centre. This is mainly due to the limited resources available. Bimaxillary advancement surgery has been used in two young males with severe maxillary and mandibular retrusion, wishing to avoid tracheostomy and its associated co-morbidities. Results of these two cases are encouraging at this stage. Tracheostomy is utilized in selected cases refractory to other treatment options, in particular patients with established cor pulmonale and biventricular failure. With this simple, stepwise approach, the majority of our patients requiring surgery to treat their OSA have responded to phase one surgery, avoiding more extensive procedures.

The patient whose DI deteriorated significantly had serial level IV sleep studies performed. Severe medical co-morbidities including prostate carcinoma and iron deficiency anaemia were thought to contribute to the deterioration in his DI.

ESS uses a structured questionnaire and has been recognized as a valid measure of daytime hypersomnolence. At best, we found only a loose correlation between DI and ESS, statistical analysis showed little relationship however. It has been shown previously, that ESS is not a good predictor of outcome after uvulopalatopharyngoplasty.[11]

With a small sample of 25 patients, the variability in the amount of change is wide, indicated by the large standard deviation, SD = 30.7. One particular outlier that contributes to this variability showed the largest post-operative improvement in DI. His DI improved by 118 n.h-1, from a pre-operative DI of 119 n.h-1 to a post-operative DI of 1 n.h-1. As a group, however, with a one sample *t*-test, $p = 0.002$ (95 per cent CI = 9.4 n.h-1 to 34.8 n.h-1). There is therefore a significant change in these patients.

Conclusion

In a study group of 25 patients, 16 (67 per cent) showed an objective improvement after surgery. Forty-eight per cent of patients had at least a 50 per cent improvement in DI post-operative, 56 per cent of patients had a post-operative DI < 20. This is consistent with surgical outcomes from larger centres internationally.[12,13,14]

This is a challenging group of patients to treat. They illustrate that surgery can be considered as an alternative to lifelong CPAP. Appropriate staged surgery, with outcomes confirmed by sleep study data, can avoid aggressive interventions in a significant number of patients.

- **OSA is a common medical condition (2 per cent to 4 per cent of population) associated with significant morbidity and mortality**
- **Nasal CPAP is a very effective treatment but compliance and tolerance is poor**
- **Tracheostomy is an effective surgical treatment but is considered a last resort**
- **The benefit of upper airways surgery for these patients with moderate to severe OSA has been questionable**
- **Our results showed 64 per cent improved with surgery and 48 per cent of patients had > 50 per cent improvement in desaturation index post-operatively**
- **Overnight pulse oximetry is a simple, economical and reproducible test to objectively assess patients with OSA**
- **A multidisciplinary sleep team is essential to assess and manage these patients optimally**
- **Upper airways surgery does have a role in the management of selected patients with OSA who cannot tolerate nasal CPAP, and appropriate staged surgery can avoid aggressive interventions in a significant number**

A multidisciplinary sleep team is essential when assessing and managing these patients. In Christchurch, we believe that surgery has a role in treating selected patients with moderate to severe OSA.

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References

1 Stradling JR. *Handbook of Sleep Related Breathing Disorders.* New York: Oxford University Press, 1993
2 Li KK, Riley RW, Powell NB, Gervacio L, Troell RJ, Guilleminault C. Obstructive sleep apnoea surgery: Patient perspective and polysomnographic results. *Otolaryngol Head Neck Surg* 2000;**123**:572–5
3 Javier Nieto F, Young TB, Lind BK, Shahar E, Samet JM, Redline S, *et al.* Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. *J Am Med Assoc* 2000;**283:**1829–36
4 Polysomnogrpahy Task Force, American Sleep Disorders Association Standards of Practice Committee. Practice parameters for the indications for polysomnography and related procedures. *Sleep* 1997;**20**:406–22
5 Yamashiro Y, Kryger MH. Nocturnal oximetry: Is it a screening tool for sleep disorders? *Sleep* 1995;**18**:167–71
6 Stradling JR, Crosby JH. Predictors and prevalence of obstructive sleep apnoea and snoring in 1001 middle aged men. *Thorax* 1991;**46**:85–90
7 Sparks BC, Kerdemelidis M, Drennan C, Stevenson DS, Becker L. *Oximetry as a Case Finding Tool for Sleep-Disordered Breathing: One Night or Two?* Proceedings, Annual Scientific Meeting, Australasian Sleep Association 2000. Australasian Sleep Association. GPO Box 295, Sydney 2001

8 Badawey EI, McKee G, Heggie N, Marshal H, Wilson JA. Predictive value of sleep nasendoscopy in the management of habitual snorers. *Ann Otol Rhinol Laryngol* 2003;**112**:40–4
9 Riley RW, Powell NB, Li KK, Troell RJ, Guilleminault C. Surgery and obstructive sleep apnea: Long term clinical outcomes. *Otolaryngol Head Neck Surg* 2000;**122**:415–21
10 Malmberg H, Lehtonen H, Virkkula P. The effect of nasal obstruction on outcomes of uvulopalatopharyngoplasty. *Acta Otolaryngol* (Stockh) 1997;**529**(Suppl):195–8
11 Giudici S, Farmer W, Dollinger A, Andrada T, Torringhton K, Rajagopal K. Lack of predictive value of the Epworth sleepiness scale in patients after uvulopalatopharyngoplasty. *Ann Otol Rhinol Laryngol* 2000;**109**:646–9
12 Fugita S, Conway WA, Zorick FJ, Sicklesteel JM, Roehs TA, Wittig RM, *et al.* Evaluation of the effectiveness of uvulopalatopharyngoplasty. *Laryngoscope* 1985;**95**:70–4
13 Katsantonis GP, Walsh JK, Schweitzer PK, Friedman WH. Further evaluation of uvulopalatopharyngoplasty in the treatment of obstructive sleep apnea syndrome. *Otolaryngol Head Neck Surg* 1985;**93**:244–50
14 Reily RW, Powell NB, Guilleminault C. Obstructive sleep apnea syndrome: A review of 306 consecutively treated surgical patients. *Otolaryngol Head Neck Surg* 1993;**108**:117–25

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