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Main Article

Identifying patients who need close monitoring during and after upper airway surgery for obstructive sleep apnoea

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Abstract

Potentially serious complications have been documented in patients undergoing upper airway surgery for obstructive sleep apnoea (OSA). Consensus is lacking regarding peri- and post-operative monitoring and identification of those patients likely to suffer post-operative complications.

This retrospective review of 118 patients treated and 152 surgical procedures undertaken, from January 1998 to December 2003, addresses this issue. The overall peri- and post-operative complication rate was 13.8 per cent, with one patient experiencing upper airway compromise, five patients experiencing post-operative oxygen desaturation within 150 minutes of extubation, six patients experiencing persistent hypertension and four patients suffering secondary haemorrhage. All patients were treated accordingly and recovered well, with no mortality. From these results, it is concluded that patients with severe OSA (apnoea–hypopnoea index >60 and lowest oxygen saturation <80 per cent) are at higher risk of post-operative oxygen desaturation. Post-operative hypertension is more likely in patients with a prior history of hypertension. Routine post-operative admission to an intensive care unit for all OSA patients is unnecessary (including patients with severe OSA). However, all patients with OSA should be closely monitored in the post-anaesthesia care area for at least three hours after surgery; based on the outcome of this period and the clinical judgment of the clinician, the patient can then be observed overnight in either the high dependency unit or on a general ward. Patients with mild OSA may be admitted to the 23-hour ambulatory unit post-operatively. Use of continuous positive airway pressure in the immediate post-operative period can reduce the incidence of post-operative respiratory compromise and complications and is strongly recommended.

Key words: Sleep Apnoea Syndromes; Post Operative Complications; Otolaryngologic Surgical Procedures

Introduction

Sleep disordered breathing (SDB) is a spectrum of diseases that includes snoring, upper airway resistance syndrome (UARS) and obstructive sleep apnoea (OSA). These disorders have one common denominator – the presence of a collapsible airway. Obstructive sleep apnoea is a common sleep disorder; Young *et al*. studied 602 state employees with a formal overnight polysomnogram and found that the incidence of SDB was 24 per cent in men and nine per cent in women.[1] Most such patients are undiagnosed; it is estimated that up to 93 per cent of females and 82 per cent of males with moderate to severe OSA remain undiagnosed.[2] It is well documented that OSA has profound effects on the cardiovascular and respiratory systems and on neurocognitive function. The sleep heart health study and the Wisconsin sleep cohort[3,4] have demonstrated a strong link between SDB and hypertension. This is believed to be due to sleep fragmentation, nocturnal hypoxaemia and increased sympathetic tone.[5] This increased sympathetic tone is manifested not only during the nocturnal hypoxic events but also during the day as systemic hypertension. There is convincing evidence of the association between SDB and cardiovascular disease.[6] The physiologic changes that are the result of recurrent apnoeas and hypoxaemia can cause acute thrombotic events,[7,8] atherosclerosis[9,10] and cerebrovascular accidents. There is a higher mortality rate among patients with cardiovascular disease who also have SDB.[11,12]

Upper airway surgical procedures performed to treat OSA include: septoplasty, submucous resection, inferior turbinate reduction, uvulopalatopharyngoplasty, genioglossus advancement, genioglossus suspension, midline glossectomy, hyoid myotomy and maxillo-mandibular advancement. These operations have been associated with potentially life-threatening complications. It is well accepted that patients with OSA are at higher risk of airway

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compromise in the post-operative period. Since the introduction of such surgical procedures in the early 1970s, there have been reports of acute upper airway complications post-operatively.[13–15] Katsantonis *et al*. reviewed the efficacy of uvulopalatopharyngoplasty in 35 OSA patients and found that two patients required oral intubation post-operatively due to upper airway obstruction.[16] Extensive effort has been directed toward identifying those OSA patients who are likely to have post-operative airway and respiratory complications, in the hope of directing resources and preventing complications. Riley *et al*. noted that patients with an apnoea index of greater than 70 and a lowest oxygen saturation of less than 80 per cent were at higher risk of post-operative complications.[17] Terris *et al*. suggested that post-operative OSA patients should be monitored closely for the first two hours, when complications were more likely to occur.[18]

The purpose of this study was to review the specific incidence of post-operative complications in OSA patients undergoing upper airway surgery, to identify patients at risk of developing complications and to emphasize the importance of peri-operative monitoring, so as to enable resource allocation according to patients' needs.

Methods and materials

A retrospective review was performed of 118 patients undergoing surgery for OSA, from January 1998 to December 2003. All these patients were referred to the tertiary hospital by the family physician, the endocrinologist, the bariatric surgeon, the oro-maxillo-facial surgeon, other otolaryngologists or other internal physicians. Eighty-five patients attended the sleep apnoea sub-specialty clinic, while other consultants in the department assessed the other 33 patients. A comprehensive pre-operative assessment was conducted, including a thorough history and physical examination. Patients also completed the Epworth's sleepiness scale and other questionnaires; height, weight, neck circumference, body mass index (BMI) and blood pressure were also documented. All patients who had undergone some form of surgical procedure for OSA were included.

Examination included the documentation of soft palatal redundancy, uvula size and thickness, Mallampati grade, and adenoid and tonsillar size. Nasal cavity and laryngeal examination with a flexible fibre-optic nasoendoscope was also performed. Mueller's manoeuvre was performed and graded on a five point scale, with attention paid to the level of collapse according to Fujita type I, II and III.[19] Dental occlusion, over-jet and overbite were noted.

Lateral cephalometry was also obtained prior to consultation. Maxillary deficiency (SNA angle), mandibular deficiency (SNB angle), the posterior airway space, soft-palatal length and hyoid mandibular distance (according to cephalometric analysis by deBarry-Borowiecki *et al*.)[20] were documented.

All 118 patients underwent a level I, attended, overnight, full polysomnogram (PSG) in hospital. The PSG systematically monitored the electroencephalogram, electro-oculogram, electromyelogram of the chin, electrocardiogram (ECG), body positions, nasal and oral airflow, thoracic and abdominal effort, limb movements, pulse oximetry, and snoring sound level. The polysomnographic variables evaluated included sleep parameters, complete sleep staging, sleep time, sleep latency, sleep efficiency, rapid eye movement (REM) and non-REM events, arousals, respiratory events (such as respiratory disturbance index, apnoea–hypopnoea index (AHI) and oxygen desaturations), snoring level, body position and limb movements. The polysomnograms were all scored by the sleep technologist and reviewed by the sleep physician.

All patients were offered, and counselled on the use of, continuous positive airway pressure (CPAP) and were strongly advised to undergo a free trial of CPAP. In the event that the patient cannot tolerate the use of CPAP, surgical options were discussed. Surgical intervention was in the form of septoplasty/submucous resection for deviated nasal septum, anterior/total inferior turbinectomy (bilateral) for enlarged hypertrophied inferior turbinates, and multi-level pharyngeal surgery (in the form of uvulopalatopharyngoplasty, genioglossus advancement mandibulotomy, lingualplasty and transpalatal advancement pharyngoplasty).

Intra-operatively, short-acting narcotics were used for all patients. Inhalational anaesthesia was used for maintenance. All patients were administered 8 mg of dexamethasone intravenously and subsequently 4 mg every eight hours during the first post-operative day. If the operating surgeon felt that there could possibly be an airway compromise post-operatively, the patient was observed overnight in the intensive care unit or in the high dependency unit, depending on bed availability, regardless of OSA severity.

Post-operatively, all patients were monitored in the post-anaesthesia care unit (PACU) for two to three hours before they were sent to the respective units. In general, patients with severe OSA (AHI $>$ 40) were observed overnight in the surgical intensive care unit; moderate OSA patients (AHI 20–40) were monitored in the high dependency unit, while patients with mild OSA (AHI $<$ 20) stayed overnight in the general ward. Complications and adverse events occurring post-operatively and during the patients' stay were documented and described. Specific parameters occurring during the complications were documented; these parameters included AHI, pre-operative lowest oxygen saturation (LSAT) on PSG, current medications, blood pressure measurements, narcotic and steroid use, and pulse oximetry post-operatively.

Exclusion criteria were: age less than 18 years; refusal of surgical intervention; use of CPAP with no surgical intervention, use of an oral appliance with no surgical intervention; and lack of fitness for surgery.

Results

The study population consisted of 118 patients, with a total of 152 surgical procedures. There were 98 men

TABLE I

SURGICAL PROCEDURES PERFORMED

Procedure	Patients (*n*)
Nasal surgery	10
Nasal surgery/UPPPT	18
UPPPT	75
UPPPT/GGA	9
UPPPT/TPA	3
UPPPT/lingualplasty	3
Total	118

UPPPT = uvulopalatopharyngoplasty/tonsillectomy; GGA = genioglossus advancement; TPA = transpalatal advancement pharyngoplasty

and 20 women. The age range was from 23 to 61 years (mean ± standard deviation, 42.5 ± 9.4 years). The mean BMI was 29.6 (range, 22.3 to 36.8). All patients had a free trial of CPAP therapy for a minimum of two to three weeks. The average amount of CPAP used per night was 2 hours and 43 minutes (range, 1 hour and 23 minutes to 3 hours and 56 minutes). Most patients only used CPAP for about three to four nights per week.

The mean AHI was 50.1 (range, 21.7 to 82.5) and the mean LSAT was 75.4 per cent (range, 64.5 to 91.0 per cent). The 152 procedures were performed either as single or multiple procedures, tailored to the site of obstruction (Table I). All procedures were performed on an in-patient basis. The mean hospital stay was 1.6 ± 1.1 days (range, one to four days). Forty-two patients (35.6 per cent) stayed overnight in the intensive care unit for observation, while 49 patients (41.5 per cent) spent one night in the high dependency unit. The overall complication rate was 13.5 per cent (16/118). This included five patients who had post-operative oxygen desaturation, six with persistent hypertension, four with post-operative bleeding and one patient who had upper airway compromise. One hundred and two patients had uneventful surgical procedures and hospitalizations.

Thirty-five patients were nasally intubated under regional anaesthesia, with the rest of the 83 patients being intubated orally. The method of intubation was determined by the anaesthetist and discussed with the patient pre-operatively. Post-operatively, only 38 patients (32.2 per cent) used CPAP; the other patients were non-compliant.

TABLE II

PERI- AND POST-OPERATIVE COMPLICATIONS

Complication	Patients*	
	n	%
Airway compromise	1	0.8
Persistent hypertension	6	5.1
Oxygen desaturation	5	4.2
Bleeding	4	3.4
Total	16	13.5

*Of a total of 118 patients.

Oxygen desaturation

Five patients had a single episode of post-operative oxygen desaturation while in the PACU. All of these five patients' desaturation episodes occurred within 150 minutes post-operatively. Four patients had desaturations within the first two hours post-operatively, while one patient desaturated to 85 per cent approximately two and a half hours post-operatively. All five patients were given 100 per cent oxygen by mask and recovered from the episode without further desaturations in the hospital. These five patients did not have desaturations below that of their pre-operative LSAT level found on PSG. However, all five of these patients had severe OSA, with a mean AHI of 65.3 ± 15.2 and a mean LSAT of 82 ± 9 per cent.

Hypertension

Six patients (5.1 per cent) had persistent post-operative hypertension. Their systolic pressures ranged from 190 to 210 mmHg and their diastolic pressures ranged from 100 to 125 mmHg. These patients were given short-acting anti-hypertensive (e.g. labetolol) for control of their hypertension. They were also given adequate analgesia for pain relief. According to their responsiveness to the medication, they were observed in the high dependency unit or the general ward. None of these patients had any chest discomfort, ECG changes or complaints of neurological deficits. Interestingly, only four out of these six patients were known hypertensives; the other two patients had not been previously diagnosed with hypertension. Four patients had moderate OSA, one had mild OSA and the other had severe OSA. There were no instances of cardiac arrhythmias noted in any of these patients.

Bleeding

There were four instances of post-operative bleeding, none of which occurred in the hospital. All haemorrhages occurred between the eighth and the 15th post-operative day. All bleeding was from the tonsillar bed. Two out of the four patients required a return to the operating theatre for examination under anaesthesia and haemostasis, while the other two patients were admitted to hospital for observation, with one patient requiring silver nitrate ($AgNO_3$) application to the bleeding tonsillar bed.

Airway

There was one patient who had significant airway compromise, occurring 20 minutes after reversal and extubation. This patient had stridor and oxygen desaturation to a low of 76 per cent; he was given naloxone and 100 per cent oxygen by mask. He responded to the naloxone and was observed in the intensive care unit overnight, where he had only one further oxygen desaturation, to 89 per cent. He had no more respiratory events after this and was discharged well on the third post-operative day.

There were no other airway events documented and none of the patients required re-intubation post-operatively.

Nasopharyngeal stenosis

Although this is not an immediate peri-operative complication, it is included here for completeness. There were two patients who had mild nasopharyngeal stenosis, noticed at the post-operative six month follow-up visit. One patient had accompanying recurrence of OSA symptoms, namely, snoring, a choking sensation at night, apnoeas witnessed by his wife and excessive daytime somnolence. The other patient was asymptomatic. No surgical intervention was required for either patient.

Discussion

Sleep disordered breathing is a common entity and includes snoring, UARS and OSA. Most authors concur that patients with OSA have a higher incidence of post-operative airway complications. This risk is made pronounced as many of these patients have small mandibles, large tongues, and short and fat necks, adding to the anaesthetist's challenge to establish an artificial airway.[21]

Narcotics and the airway

Respiratory depression and repetitive apnoeas often occur soon after extubation in patients with OSA.[22] The use of opioids also increases this risk, and intravenous administration can cause prolonged respiratory depression in OSA patients (up to 4 to 12 hours after administration).[23] Similarly, in our patient with airway compromise and oxygen desaturation, this occurred 20 minutes post-extubation and was quickly reversed with naloxone and oxygen administration. We did not find such a high incidence of post-operative laryngeal oedema as Katsantonis *et al.*[16] (5.7 per cent), probably due to the prophylactic administration of steroids to all our patients. Ostermeier *et al.*[23] have stated that patients with OSA are at risk of developing respiratory complications post-operatively in the absence of pain. It is accepted that pain prevents the rebound of REM sleep and stage three and four sleep, which predisposes to collapse of the upper airway around the third post-operative day. Most OSA patients have REM-deprived sleep due to their nocturnal apnoeic events, and this, coupled with pre-operative anxiety leading to poor sleep quality, leads many patients to experience post-operative REM rebound, making them prone to increased upper airway collapse during periods of atonia (REM sleep). This phenomenon is mostly seen beyond the third or fourth post-operative day,[23] usually when the patient has been discharged from hospital and is at home. Hence, in the post-operative period before discharge, there is a need to identify patients who are likely to desaturate. Similar to the findings of Terris *et al.*,[18] most of our patients who experienced oxygen desaturations had them within two and a half hours after surgery; these were all no worse than their respective pre-operative PSG LSATs, and they all recovered uneventfully following supplemental oxygen therapy. None of our patients were treated on an out-patient basis, as suggested by Spiegel and Raval;[24] all our patients stayed a minimum of one night in hospital. However, with the introduction of a 23-hour ambulatory facility in our hospital (and in many other institutions around the world), use of this facility may represent a good alternative to post-operative in-patient care.

Severity of obstructive sleep apnoea

The severity of OSA also needs to be considered as it influences the risk of complications.[24] Riley *et al.*[17] reported a higher rate of complications in patients with a pre-operative apnoea index of greater than 70 events/hour and a minimum oxygen saturation of below 80 per cent. Esclamado *et al.*[25] found that the frequencies of apnoeas and reductions in oxygen saturations were predictors of complications. However, Gupta *et al.*[26] noted that even mild OSA patients had a higher risk of peri-operative complications following orthopaedic surgery. We found that patients with severe OSA (mean AHI 65.3 ± 15.2 and mean LSAT 82 ± 9 per cent) had a higher risk of post-operative oxygen desaturation and that all of these desaturations occurred within two and half hours post-extubation. However, we did not find a statistically significant ($p > 0.1$) difference in AHI or LSAT levels between the group with complications and the group without complications. We advocate that routine admission of all OSA patients to an intensive care unit is unnecessary. We suggest that all OSA patients be monitored in the PACU for a minimum of three hours. Based on the outcome during this period and the clinical judgment of the clinician, the patient can be observed overnight in either the high dependency unit or on the general ward. Patients with mild OSA may utilize the 23-hour ward facility, if available.

Hypertension

Hypertension made up 5.1 per cent of all our complications. We found that such hypertension was not mild and required intravenous administration of short-acting anti-hypertensive. It was also noted that four of our six patients with post-operative hypertension had a history of established pre-operative hypertension. Gal and Cooperman[27] showed, in 1844 surgical patients, that the incidence of post-operative hypertension (defined as two consecutive reading of diastolic > 100 mmHg or systolic > 190 mmHg) was 3.3 per cent and that 58 per cent of these patients had a pre-operative history of hypertension. Our results also favour this theory, that patients with a history of hypertension are at higher risk of post-operative hypertension. Pain can also contribute to post-operative transient hypertension. The use of non-steroidal

anti-inflammatory drugs may be very helpful during this period. Narcotics may be used judiciously and continuous monitoring cannot be overemphasized. Our patients with post-operative hypertension were monitored in the high dependency unit overnight.

Peri-operative continuous positive airway pressure

Powell *et al*.[28] proposed the use of CPAP in the immediate post-operative period in order to overcome unexpected post-operative upper airway oedema. The use of this 'pneumatic splint' has permitted the consideration of nonintensive methods of post-operative patient monitoring, as the risk of obstruction is minimized. Jain and Dhand[29] have also supported such use of CPAP and have suggested that OSA patients should use CPAP before and after surgery. This practice has also been shown to reduce the risk of respiratory depression in the immediate post-operative period.[30]

Conclusion

Patients with OSA have a higher incidence of post-operative airway complications. They typically have difficult airways and present as difficult intubations to the anaesthetist. Moreover, they are sensitive to anaesthetic agents, such as muscle relaxants and narcotics, that might predispose to respiratory depression. Many authors have attempted to establish indicators of peri- and post-operative complications. From this study, we note that:

(1) Patients with OSA are sensitive to anaesthetic agents and narcotics, and they have higher incidences of post-operative respiratory compromise.
(2) Severity of OSA does have an impact on peri- and post-operative complications. Patients with severe OSA (AHI $>$ 60 and LSAT $<$ 80 per cent) are at a higher risk of post-operative oxygen desaturation.
(3) Routine post-operative admission of all OSA patients to the intensive care unit is unnecessary (including patients with severe OSA).
(4) All patients with OSA should be closely monitored in the PACU for at least three hours after surgery. Based on the outcome during this period and the clinical judgment of the clinician, the patient can be observed overnight in either the high dependency unit or on the general ward.
(5) Patients with mild OSA may be admitted to the 23-hour ambulatory unit post-operatively.
(6) Post-operative hypertension is more likely in patients with a prior history of hypertension. Pain control should also be adequate.
(7) Use of CPAP in the immediate post-operative period can reduce the incidence of post-operative respiratory compromise and complications and is strongly recommended.

It is highly recommended that the clinician manage the OSA patient with caution and prudence, bearing in mind that OSA patients have a higher risk of airway compromise and respiratory depression peri- and post-operatively.

- **This retrospective study documented peri- and post-operative complications in 118 patients undergoing airway surgery for obstructive sleep apnoea (OSA)**
- **Patients with OSA are sensitive to anaesthetic agents and narcotics, and have a higher incidence of post-operative respiratory compromise. Severity of OSA has an impact on peri- and post-operative complications**
- **The authors make recommendations regarding the peri- and post-operative management of patients with OSA in order to minimize potential serious complications**

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