Preoperative predictors of difficult intubation in patients with obstructive sleep apnea syndrome

[Prédicteurs préopératoires d'une intubation difficile chez des patients qui présentent de l'apnée obstructive du sommeil]

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Purpose: It has been speculated that the severity of obstructive sleep apnea syndrome (OSAS) is related to difficult intubation. However, this has not been confirmed in OSAS patients. Thus, we undertook a retrospective study to assess this relationship in patients who had undergone uvulopalatopharyngoplasty (UPPP) surgery for OSAS.

Methods: A retrospective case-control study was undertaken following approval from the Institutional Review Board on human studies. The data from 90 patients with a polysomnograph-confirmed diagnosis of OSAS, who had undergone UPPP surgery under general anesthesia, were used to evaluate the apnea-hypopnea index (AHI), the preoperative lowest arterial saturation, the occurrence of difficult intubation as assessed by the operator intubation difficulty scale score, extubation time, lowest arterial saturation in postanesthesia care unit, and length of stay in postanesthesia care unit. We compared OSAS patients with 90 age and sex-matched control patients with respect to the prevalence of difficult intubation.

Results: The prevalence of difficult intubation was higher in the OSAS group than in the control group (16.7% vs 3.3%, $P = 0.003$). When evaluating the OSAS group according to the occurrence of difficult intubation, AHI was significantly higher in the difficult intubation subgroup (67.4 ± 22.5 vs 49.9 ± 28.0 , $P = 0.026$), and patients with an AHI ≥ 40 showed a significantly higher prevalence of difficult intubation.

Conclusion: This study shows that the occurrence of difficult intubation can be predicted using AHI in patients who undergo UPPP surgery for OSAS.

Objectif: On a émis l'hypothèse que la sévérité du syndrome d'apnée obstructive du sommeil (SAOS) était reliée à l'intubation difficile. Notre étude rétrospective a donc évalué cette relation chez des patients qui avaient subi une uvulopalatopharyngoplastie (UPPP) pour le SAOS.

Méthode : L'étude rétrospective cas-témoins a été réalisée avec l'accord du Comité d'éthique sur les études chez les humains. Les données de 90 patients, chez qui un diagnostic de SAOS avait été confirmé par polysomnographie et qui avaient subi une UPPP sous anesthésie générale, ont été utilisées pour évaluer : l'index d'apnée-hypopnée (IAH), la plus basse saturation préopératoire en oxygène du sang artériel, l'occurrence d'intubation difficile déterminée par le score à l'échelle des difficultés d'intubation de l'opérateur, le temps d'extubation, la plus basse saturation artérielle à la salle de réveil et la durée de séjour à la salle de réveil. Les patients atteints du SAOS ont été comparés à 90 témoins appariés selon l'âge et le sexe pour la prévalence d'intubation difficile.

Résultats : La prévalence d'intubation difficile était plus élevée dans le groupe SAOS que dans le groupe témoin (16,7 % vs 3,3 %, $P = 0,003$). L'évaluation du groupe SAOS pour l'occurrence d'intubation difficile a montré que l'IAH était significativement plus élevé dans le sous-groupe d'intubation difficile ($67,4 \pm 22,5$ vs $49,9 \pm 28,0$, $P = 0,026$) et les patients chez qui l'IAH était ≥ 40 ont affiché une prévalence significativement plus haute d'intubation difficile.

Conclusion : Cette étude montre que l'occurrence d'intubation difficile peut être prédite en utilisant l'IAH chez les patients qui vont subir une UPPP pour SAOS.

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OBSTRUCTIVE sleep apnea syndrome (OSAS) is a complex disorder with potentially serious physiologic consequences. It is characterized by repetitive episodes of upper airway obstruction resulting in the disruption of sleep and hypoxemia with daytime sequelae. It has been estimated to affect 4% of men and 2% of women in middle age and has been identified as a major health problem. Several studies have been conducted on the anesthetic management of these patients,¹⁻³ but studies assessing factors related to perioperative risk are rare.

Upper airway control is one of the most important aspects of anesthesia management in patients with OSAS. An association between the severity of OSAS and the occurrence of difficult intubation has been speculated, and a prospective case-control study elicited the conclusion that patients with difficult intubation and OSAS are related significantly and share anatomical features.⁴ Other authors speculated that clinical factors that predict difficult intubation could also predict OSAS.⁵ Another retrospective study showed that difficult intubation occurred more often in OSAS patients than in controls, but failed to confirm the relationship between the severity of OSAS and the occurrence of difficult intubation in OSAS patients.⁶

Here, we undertook a retrospective case-control study to determine the occurrence of difficult intubation in OSAS patients compared to patients without OSAS, to assess the relationship between the severity of OSAS and the occurrence of difficult intubation in OSAS patients, and to search for any factor capable of predicting difficult intubation in patients with OSAS.

Methods

A retrospective review of 153 patients undergoing surgery between March 1997 and December 2004 was performed after obtaining approval from our Institutional Review Board on human studies. From 153 patients who were diagnosed as having OSAS and who were admitted to an otolaryngology ward, 90 with a polysomnography-confirmed diagnosis of OSAS who had undergone uvulopalatopharyngoplasty (UPPP) surgery under general anesthesia were selected. The remaining 63 patients were excluded for the following reasons: pediatric patients, patients with chronic follicular hypertrophy and patients who had not undergone general anesthesia. In addition, patients with craniofacial or cervical abnormalities were also excluded.

Polysomnographic data, anesthesia/recovery room records and progress notes were reviewed. Polysomnography was checked routinely in the OSAS patients who had undergone UPPP surgery. The sleep stage (electroencephalogram (C4/A1), the right and

left electro-oculogram and submental electromyogram), oronasal airflow (thermistors), ribcage and abdominal wall motion (inductance plethysmography), arterial oxyhemoglobin saturation (pulse oximetry), electrocardiogram and sound were recorded and analyzed automatically (EmblaN7000, Medcare, Reykjavik, Iceland). Obstructive sleep apnea syndrome severity was measured using the apnea hypopnea index (AHI), and using the lowest oxygen saturation associated with an abnormal respiratory event during sleep (LSAT-PREOP). Apnea was defined as cessation of breathing more than ten seconds. Hypopnea was a decreased effort to breathe at least 50% less than the baseline and with at least a 4% decrease in SaO_2 . Apnea hypopnea index was calculated as the sum of total events (apneas and hypopneas) per hour.⁷

For each OSAS patient, the next control patient from the same month's list of endoscopic sinus surgery was included in the study if he (she) had the same sex, and a similar age (± 2 yr). Factors previously described as being importantly related with OSAS during the perioperative period were defined. These factors included a history of smoking, excessive alcohol intake, arterial hypertension, and a history of diabetes mellitus. Preoperative hemoglobin values were also recorded.

Operator's subjective judgment as to the ease of intubation performance was defined with the subjective operator intubation difficulty scale score,⁸ as assessed by one of two board-certified anesthesiologists with more than five years experience. Operator intubation difficulty scale score was checked and recorded routinely in those patients who had undergone general anesthesia in our hospital. Endotracheal intubation was rated as easy when immediate visualization of the glottis (Cormack and Lehane grade I or II)⁹ was obtained and tube progression into the trachea was achieved without the use of any intubation aid within three attempts. Endotracheal intubation was rated as difficult in the presence of poor visualization of the glottis (Cormack and Lehane grade III or IV),⁹ when an intubation aid (stylet, intubating laryngeal mask airway, fiberoptic bronchoscope) was needed, or when three or more intubation attempts were required. Data pertaining to stay in the postanesthesia care unit (PACU) were recorded, i.e., extubation time, lowest oxygen saturation and length of stay.

Statistical analysis

Data were analyzed using SPSS 11.0 for windows (SPSS Inc., Chicago, IL, USA). Data are presented as means $\pm$ standard deviation or percentages as appropriate. Assuming the overall occurrence of dif-

TABLE I Preoperative and intraoperative characteristics of control patients and patients with OSAS

Variables	OSAS (n = 90)	Control (n = 90)	P value
Age (yr)	44.1 ± 9.7	44.1 ± 9.5	1.0
Gender (male/female)	86/4	86/4	1.0
Height (cm)	168.8 ± 5.5	169 ± 5.8	0.849
Weight (kg)	79.5 ± 9.3	73.0 ± 9.75	< 0.001*
BMI (kg·m ²)	27.9 ± 2.9	25.3 ± 3.3	< 0.001*
Smoking (%)	46.7	42.2	0.653
Alcohol (%)	60	58.9	1.0
Arterial hypertension (%)	28.9	12.2	0.018*
Diabetes mellitus (%)	4.4	4.4	1.0

OSAS = obstructive sleep apnea syndrome; BMI = body mass index. Values are mean ± standard deviation. *P < 0.05.

TABLE II Demographics of OSAS patients with or without difficult endotracheal intubation

Variables	OSAS patients with difficult intubation (n = 15)	OSAS patients without difficult intubation (n = 75)	P value
Age (yr)	46.1 ± 9.2	43.6 ± 9.9	0.378
Height (cm)	167.9 ± 5.3	169.0 ± 5.6	0.482
Weight (kg)	78.8 ± 9.9	79.5 ± 9.3	0.776
BMI (kg·m ²)	28.0 ± 3.9	27.8 ± 2.6	0.808
Hb >15 g·dL (%)	46.7	68.5	0.188
AHI (n·hr ⁻¹)	67.4 ± 22.5	49.9 ± 28.0	0.026*
LSAT-PREOP (%)	72.7 ± 10.7	77.2 ± 10.2	0.141
Extubation time (min)	11.7 ± 3.1	9.5 ± 1.1	0.064
Length of stay in PACU (min)	79.6 ± 18.0	77.8 ± 17.7	0.706
LSAT-PACU (%)	95.0 ± 3.2	96.0 ± 1.3	0.057

OSAS = obstructive sleep apnea syndrome; AHI = apnea-hypopnea index; BMI = body mass index; Hb = hemoglobin; PACU = postanesthesia care unit; LSAT-PACU = lowest saturation in the postanesthesia care unit; LSAT-PREOP = preoperative lowest saturation. *P < 0.05.

difficult intubation in control patients of 5%, we decided that a 15% difference in overall occurrence of difficult intubation between groups would be clinically important. Seventy-five patients in each group would thus be necessary with $\alpha = 0.05$ and $\beta = 0.2$. To take into consideration possible protocol variances we enrolled 90 patients per group. Chi-square analysis was used to compare proportion of subjects in the two study groups with difficult intubation, and the Student's t test and the Mann-Whitney U test were used to compare other variables between the two groups. The OSAS patients were divided into three subgroups according to AHI (patients with AHI of < 40: mild to moderate OSAS,¹⁰ from 40 to 70: severe OSAS, > than 70: extremely severe OSAS) and the

FIGURE Difficult intubation in obstructive sleep apnea syndrome (OSAS) according to apnea-hypopnea index AHI (P = 0.039).

incidence of difficult intubation was compared using Chi-square analysis. We divided the OSAS patients into two subgroups according to intubation difficulty and compared them with the Student's t test and the Mann-Whitney U test. Values of P < 0.05 were defined as statistically significant.

Results

The general characteristics of the two groups of patients are shown in Table I. Weight and body mass index (BMI) were significantly higher in OSAS than in the control patients. Arterial hypertension was more frequently encountered in OSAS patients, difficult intubation occurred more often in OSAS patients (16.6% *vs* 3.3%). When we divided the OSAS patients into two subgroups according to intubation difficulty, a significant difference in AHI was observed. In OSAS patients with difficult intubation, age, height, weight, LSAT-PREOP, BMI, and hemoglobin were not significantly different from those of OSAS patients with easy intubation. In the PACU, extubation time, LSAT, and length of stay were similar in these two subgroups (Table II).

When OSAS patients were divided into three subgroups according to AHI, the incidence of difficult intubation was 27.6% for the 29 patients with an AHI of > 70 (mean AHI; 84 ± 10.9), 19.3% for the 31 patients with an AHI from 40 to 70 (mean AHI; 53.0 ± 7.9), and 3.3% for the 30 patients with an AHI of < 40 (mean AHI; 20.8 ± 10.2), (Figure). Moreover, the incidence of difficult intubation was the same for OSAS patients with an AHI of < 40 as in the control group.

Discussion

This study demonstrates that the occurrence of difficult intubation in OSAS patients is higher than in age and sex matched control patients. Moreover, this prevalence of difficult intubation was related to a high AHI, which was one of the most commonly used indexes to describe the severity of OSAS.⁷ In our study, AHI was identified as a predictor of difficult intubation in OSAS patients, and OSAS patients with an AHI > 40 were found to have a significantly higher risk of difficult intubation. This is the first study to report an association between difficult intubation and the severity of OSAS in patients who underwent UPPP surgery.

The relationship between difficult intubation and the severity of OSAS has been speculated upon for a long time,^{1-3,11} but few reports have shown an association between difficult intubation and OSAS.⁴⁻⁶ Esclamado *et al.*¹¹ showed that OSAS patients with perioperative complications, including failed intubation, have LSATs and higher apnea indexes in a preoperative sleep study. However, they did not compare patients with failed intubation to patients with successful intubation with respect to AHI. Friedman *et al.*⁵ found that the modified Mallampati index, BMI, and tonsil size were not only predictive of OSAS but also correlated well with AHI. Recently, Siyam *et al.*⁶ reported that intubation was more difficult in 36 OSAS patients than in controls. However, they found no significant relationship between AHI and difficult intubation in OSAS patients. Our data regarding the relationship between OSAS severity and difficult intubation were different from that of Siyam *et al.*⁶ Several possible explanations for this difference exist. Our study was performed on a larger population. Accordingly, this difference may be due to the higher statistical power of the present study. Another possible explanation may be that our patients had a higher AHI than their patients (53.3 ± 27.8 vs 41.7 ± 22.1).⁶ When we divided patients according to AHI, those with an AHI of < 40 were found to have the same difficult intubation incidence as the control group. Only patients with an AHI of > 40 showed a higher incidence of difficult intubation.

The most plausible explanation for the observed relationship between difficult intubation and OSAS is that they may share the same anatomical characteristics. Hiremath *et al.*⁴ affirmed strong relationships between increased Mallampati scores and difficult intubation and OSAS after performing a radiographic evaluation of both patient types. According to their study, difficult intubation and OSAS are both associated with a greater Mallampati score and anterior

mandibular depth, and smaller mandibular and cervical angles; these share anatomical features that act to reduce the skeletal confines of the tongue.

Though BMI was related significantly with AHI in the present study, we did not find any correlation between BMI and the occurrence of difficult intubation. A large prospective study of 1,833 patients identified obesity is a factor predisposing difficult intubation.¹² The mean BMI of our OSAS patients was 27.9 ± 2.9 , which would place our patients in their non-obese category.

In the postoperative period, patients with difficult intubation tended to have slightly longer extubation times and lengths of stay in PACU than patients without, but there were no statistical significances. This may be due to our hospital patient management guidelines for OSAS, namely, that the endotracheal tube be removed after full awakening, and time to full awakening might be related to the anesthetic agent.

In conclusion, the present study indicates that the occurrence of difficult intubation can be predicted from AHI values in the patients who undergo UPPP surgery for OSAS.

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