logistic regression methodology about the time order of the dependent and independent variables, and there is no requirement that there be a population at risk.[2] Logistic regression analysis is applied legitimately without an identified population at risk and where the outcome is identified after the potential risk factors. The analysis of case-control studies is such an example in which the entire sample is identified at the time of occurrence of an outcome. The analysis of the closed claims is analogous, where cases are those claims with death and brain damage and controls are those claims with other outcomes. The interpretation of the results in the closed claims studies is limited to the closed claims population and not the general anesthesiology population at large. Hence, the challenge arises with the interpretation of what a positive association means, and inferring from the closed claims population to the anesthesia population at large.

We agree with Dr. Orkin that the American Society of Anesthesiologists Closed Claims Project does offer rich and unique qualitative descriptions of various complications. However, we also believe that more sophisticated statistical analysis can provide useful additional information concerning associations of independent variables and outcomes among the closed claims population.

Karen B. Domino, M.D., M.P.H.,* Gene N. Peterson, M.D., Ph.D., Robert A. Caplan, M.D., Karen L. Posner, Ph.D., Lorri A. Lee, M.D., Frederick W. Cheney, M.D., Nayak L. Polissar, Ph.D.
*University of Washington, Seattle, Washington.
kdomino@u.washington.edu

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Anesthesiology 2006; 104:617

Obesity and Difficult Intubation: Where Is the Evidence?

To the Editor:—We read Shiga *et al.*'s meta-analysis of predictors of difficult tracheal intubation.[1] They analyzed four studies involving obese patients[2–5] and concluded that intubation problems are three times more likely to occur in this patient population compared with normal-weight patients.

Although the standard sniffing position for tracheal intubation is achieved in nonobese patients by raising the occiput 8 to 10 cm with a pillow or head rest, obese patients require much greater elevation of their head, neck, and shoulders to produce the same alignment of axes for intubation. We demonstrated that elevating the upper body and head of morbidly obese patients to align their sternum and ear in a horizontal line (head-elevated laryngoscopy position) results in significant improvement in laryngoscopic view.[6] In two of Shiga *et al.*'s four references, head position was described only as sniffing and may therefore have been suboptimal. Suboptimal positioning would result in a higher incidence of grade 3 and 4 Cormack-Lehane laryngoscopy views, making direct laryngoscopy and hence tracheal intubation more challenging. Until a standard intubating position for obese patients is adopted for research purposes, comparing studies using different positions will continue to confound the issue.

Shiga *et al.* defined difficult intubation as a Cormack-Lehane grade 3 or 4 view during direct laryngoscopy using a standard laryngoscopy blade. However, they used a different definition for two of the four studies, although each of the original references included standard grading of laryngoscopy. For example, they incorrectly cited a 12% incidence of problematic intubations in our study rather than the actual 9% incidence of grade 3 views we encountered.[4] Similarly, in another study the actual incidence of grade 3 or 4 views was 10%, but they listed difficult intubation as 15% based on their own intubation difficulty scale.[3] Such inconsistencies contributed to their conclusions.

We would like to emphasize that difficult laryngoscopy is not synonymous with difficult intubation. The American Society of Anesthesiologists Task Force on the management of the difficult airway defines a difficult airway as the "clinical situation in which a conventionally trained anesthesiologist experiences problems with (a) face *mask ventilation* of the upper airway or (b) *tracheal intubation*, or both."[7] The airways of morbidly obese patients are more difficult to ventilate by mask, but whether they are more difficult to laryngoscope is not substantiated by Shiga *et al.*'s study. There were a total of 378 obese patients in the studies they reviewed, and every patient except one was intubated successfully by direct laryngoscopy. All four of the studies they analyzed specifically stated that the magnitude of obesity does not influence laryngoscopy difficulty.[2–5]

Based on both our clinical experience at an active bariatric surgical center and on the few prospective studies that have addressed this issue, we question the validity of the general statement that obese patients are three times more difficult to intubate than their slimmer counterparts. The tracheas of a smaller subgroup of morbidly obese patients, that is, those with obstructive sleep apnea, high Mallampati class (III and IV), and large neck circumferences, are more difficult to intubate.[2,4]

The incidence of obesity in the adult population is growing. More obese and morbidly obese patients are undergoing surgery. As with any patient, the anesthesiologist must always be prepared to manage airway problems. However, there is no evidence that obesity *per se* is a risk factor for difficult laryngoscopy and tracheal intubation.

Jeremy S. Collins, M.B., Ch.B., F.R.C.A.,* Harry J. M. Lemmens, M.D., Ph.D., Jay B. Brodsky, M.D. *Stanford University Medical Center, Stanford, California. jeremycollins@stanford.edu

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David C. Warltier, M.D., Ph.D., acted as Handling Editor for this exchange.

Anesthesiology 2006; 104:618

Predicting Difficult Intubation

To the Editor:—In their meta-analysis, Shiga *et al.*[1] review the diagnostic accuracy of bedside tests for predicting difficult intubation in patients with no airway pathological features. This analysis did not take into account tests proposed by other authors, such as the upper lip bite test[2] or indirect laryngoscopy,[3] probably because of the exclusion criteria that were applied. The authors carried out an analysis with a Bayesian focus based on sensitivity, specificity, and likelihood ratios in which they suggest that "combinations of individual test or risk factors add some incremental diagnostic value in comparison to the value of each test alone." This would lead us to think that the addition of likelihood ratios from various tests is useful in predicting difficult laryngoscopy. However, this focus makes two big assumptions. The first is that sensitivity, specificity, and likelihood ratios are not modified with the incidence, and the second is that the tests used to modify the probability are completely independent. Although the first assumption is not true, that is not a limitation for clinical application of this tool. However, the second assumption does not permit application of this approach to the prediction of difficult laryngoscopy, in that the tests are based on physical examination of the head and neck, which makes it impossible to suppose that they are independent. Also, the authors do not directly take into account the agreement between observers, which is another factor that interferes with the operational performance of a diagnostic test.

In addition, the evaluated outcome is only useful for predicting difficult laryngoscopy. Other studies have shown the poor correlation between the Cormack classification and difficulty in intubation.[4] Given the above, it is clear that clinical research on the prediction of a difficult airway should focus on multivariable analysis to predict difficult intubation[5] and difficult mask ventilation,[6] which both permits the combination of interdependent tests and also evaluates outcomes with greater clinical interest.

David A. Rincón M.D., Universidad Nacional de Colombia, Bogotá, Colombia. darinconv@unal.edu.co

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In Reply:—We thank Drs. Collins and Rincón for their interest in our study.[1] Both doctors emphasized that difficult intubation is not synonymous with difficult laryngoscopy. We used the term *difficult intubation* because most studies use a Cormack-Lehane grade of 3 or more to define difficult intubation. The American Society of Anesthesiologists Task Force on Difficult Airway Management[2] defines difficult tracheal intubation as that requiring multiple attempts, in the presence or absence of tracheal pathological features, whereas difficult laryngoscopy is defined as being impossible "to visualize any portion of the vocal cords after multiple attempts at conventional laryngoscopy." We could have altered the title to a more appropriate one such as "Predicting Difficult Laryngoscopy in Apparently Normal Patients," rather than "Predicting Difficult Intubation in Apparently Normal Patients." We agree with both doctors in that, strictly speaking, our findings are validated only in cases of difficult laryngoscopy, not in cases of difficult intubation or difficult airway. Nevertheless, both words were often confused in many of the studies and reviews we cited.

Dr. Collins pointed out that we incorrectly cited his results regarding the incidence of difficult laryngoscopy in an obese population. Misinterpretation of the data in the process of data extraction for a meta-analysis is possible unless additional information is requested from every author cited, which is unduly challenging. We recalculated the incidence of difficult intubation (more precisely, difficult laryngoscopy) in obese patients according to corrected data provided by Dr. Collins. Our revised analysis showed the incidence of difficult laryngoscopy in obese patients to be 12.7% (95% confidence interval, 11.5–14.0%), which was 15.8% (95% confidence interval, 14.3–17.5%) in our original data and is still more than twice as high as that in nonobese patients. This suggests that difficult laryngoscopy is more likely to occur in obese patients than in nonobese patients. More than a decade ago, Wilson showed obesity to be a risk factor for difficult intubation or difficult laryngoscopy,[3] but whether it is indeed a risk factor remains controversial. Further discussion on this topic is needed.

We think the average anesthesiologist is not as skilled in dealing with airways of obese patients as are those who experience a high volume of these cases, such as those at Dr. Collins' bariatric surgical center. We believe that the head-elevated laryngoscopy position is very useful in working with obese patients, but further randomized controlled trials are required.

Dr. Rincón noted that our analysis excluded both the upper lip bite test and indirect laryngoscopy. In searching MEDLINE and the Cochrane Central Register (1980 through May 2004), we could find only one or two reports on these methods; furthermore, these tests are not as popular or generally used as are the Mallampati classification or Wilson risk score. Therefore, we did not include these tests. Dr. Rincón also said that our conclusions are based on the big assumptions that sensitivity, specificity, and likelihood ratios are not modified by incidence. However, the general understanding is that positive and negative predictive values depend on the prevalence of abnormality in the study sample, but sensitivity, specificity and likelihood ratios are independent of prevalence.[4] We may not be able to answer adequately the latter question from Dr. Rincón because we are not statistical experts, but we believe that generalization of the test results to other sample populations is possible whether the tests are based on physical examination or laboratory testing. We think that it is not the characteristic of the test, but prevalence of abnormality, that matters.

We did not take into account the interobserver agreement because it was not specified in most of the studies included in our meta-analysis. Yet, we agree on that this is an important factor influencing the diagnostic accuracy of bedside screening tests.

Toshiya Shiga, M.D., Ph.D.,* **Zen'ichiro Wajima, M.D., Ph.D., Tetsuo Inoue, M.D., Ph.D.** *Nippon Medical School, Chiba Hokusoh Hospital, Chiba, Japan. qzx02115@nifty.com

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An Unusual Event with the Bispectral Index® Monitoring System

To the Editor:—We have had concerns with the new Bispectral Index® Monitoring System (BIS®) Quatro sensor electrode from Aspect Medical Systems (Newton, MA) with respect to the possibility of causing frequent "paper cuts," or pressure groove injuries, to the foreheads of patients because of its design, in particular, its sharp proximal edge.

During one recent cardiac case, a BIS® Quatro sensor was placed properly on a patient's forehead at induction with specific attention given to avoid injury to the patient's forehead by the proximal edge. However, at the onset of cardiopulmonary bypass, the pulmonary artery catheter was withdrawn 2 cm, which caused the electrode's position to shift, as demonstrated in figure 1. It was not until later that a pressure groove was noted on the patient's forehead, as shown in figure 2, and the electrode was repositioned.

Fig. 1. The electrode's position during cardiopulmonary bypass.

Fig. 2. The pressure groove on the patient's forehead.

We suggest that Aspect Medical should reconsider the design of its electrodes. Practitioners should also consider placing a small piece of gauze under the proximal edge of the electrode to reduce any harm.

Bachar Hachwa, M.D.,* **Andrew Brewer, M.D., Glenn Gravlee, M.D.** *The Ohio State University, Columbus, Ohio. hachwa.1@osu.edu

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Difficult Tracheal Intubation Is More Common in Obese Than in Lean Patients

Philippe Juvin, MD, PhD, Elisabeth Lavaut, MD, Hervé Dupont, MD, Pascale Lefevre, MD, Monique Demetriou, MD, Jean-Louis Dumoulin, MD, and Jean-Marie Desmonts, MD

Department of Anesthesia and Intensive Care, Bichat Claude-Bernard Hospital, Paris, France

Whether tracheal intubation is more difficult in obese patients is debatable. We compared the incidence of difficult tracheal intubation in obese and lean patients by using a recently validated objective scale, the intubation difficulty scale (IDS). We studied 134 lean (body mass index, <30 kg/m2) and 129 obese (body mass index, ≥35 kg/m2) consecutive patients. The IDS scores, categorized as difficult intubation (IDS ≥5) or not (IDS <5), and the patient data, including oxygen saturation (SpO2) while breathing oxygen, were compared between lean and obese patients. In addition, risk factors for difficult intubation were determined in obese patients. The IDS score was ≥5 in 3 lean and 20 obese patients ($P = 0.0001$). A Mallampati score of III–IV was the only independent risk factor for difficult intubation in obese patients (odds ratio, 12.51; 95% confidence interval, 2.01–77.81), but its specificity and positive predictive value were 62% and 29%, respectively. SpO2 values noted during intubation were (mean ± SD) 99% ± 1% (range, 91%–100%) and 95% ± 8% (range, 50%–100%) in lean and obese patients, respectively ($P < 0.0001$). We conclude that difficult intubation is more common among obese than nonobese patients. None of the classic risk factors for difficult intubation was satisfactory in obese patients. The high risk of desaturation warrants studies to identify new predictors of difficult intubation in the obese.

(Anesth Analg 2003;97:595–600)

Airway management is a major responsibility for the anesthesiologist. Difficulties with tracheal intubation significantly contribute to the morbidity and mortality associated with anesthesia. Identifying situations and patients at frequent risk for airway management problems is a key to optimal care and has been the focus of numerous publications (1,2).

Several reviews have reported that endotracheal intubation is more difficult in obese than in lean patients (2–7). However, this assertion remains debated because others studies have found no evidence that tracheal intubation is more difficult in obese than in lean individuals (1,8,9). One of the reasons for these discrepancies is the lack of consensus on the definition of the term "difficult intubation," which varies between authors. However, an objective scoring system has been proposed to assess the intubation difficulty: the intubation difficulty scale (IDS) score, which has been validated (10). This score uses several variables associated with difficult intubation. Comparisons of the conditions of tracheal intubation between obese and lean patients have not been performed with this objective score. The objective of this study was to compare the incidence of difficult tracheal intubation between lean and obese patients by using the IDS score.

Methods

After IRB approval and written, informed consent were obtained, all obese (body mass index [BMI] ≥35 kg/m2) adult (older than 18 yr) patients scheduled for laparoscopic gastroplasty in our university hospital during a period of 10 mo were included in this prospective study. Concomitantly, all the lean (BMI <30 kg/m2) adult patients who were scheduled for inguinal hernia repair or laparoscopic cholecystectomy during the same period and who were intubated by the same anesthesiologists were included in the control group. Noninclusion criteria consisted of an ASA class III or IV or a BMI between 30 and 35 kg/m2.

Preoperative airway assessment was performed by an attending anesthesiologist. Five attending anesthesiologists participated in the recruitment and induction of patients.

For each patient, five variables that may predict difficult intubation were collected: (a) the modified

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Address correspondence and reprint requests to Philippe Juvin, MD, PhD, Department of Anesthesia and Intensive Care, Bichat Claude-Bernard Hospital, 46 Rue Henri Huchard, 75018 Paris, France. Address e-mail to philippe.juvin@bch.ap-hop-paris.fr.

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Mallampati classification without phonation (class I: soft palate, fauces, uvula, and pillars visible; class II: soft palate, fauces, and uvula visible; class III: soft palate and base of uvula visible; and class IV: soft palate not visible) (11,12); (b) range of head and neck motion, measured as described by Wilson et al. (7) (with differentiation of two groups: <80° and ≥80°); (c) width of mouth opening, measured as the interincisor gap in centimeters with the mouth fully opened (with differentiation of two groups: <35 and ≥35 mm); (d) presence or absence of buck teeth; and (e) presence or absence of mandibular recession. Abnormalities associated with difficult laryngoscopy (e.g., malformations, airway tumor, and loose teeth) were also recorded. In addition, before surgery, all obese patients and controls underwent a clinical evaluation and all obese patients underwent a polysomnographic study to detect significant comorbidities, including snoring, obstructive sleep apnea syndrome (OSAS), and diabetes mellitus.

Each patient was routinely monitored by an electrocardioscope, pulse oximetry, noninvasive blood pressure, and measurements of end-tidal carbon dioxide and oxygen tensions in the operating room. Hydroxyzine (100 mg) was given orally as premedication 2 h before surgery. Effervescent cimetidine (800 mg) was also given in the obese patients. Before induction, the patient was placed in a semirecumbent position (30°) with the head in the sniffing position (13). A tight face mask was applied to ensure preoxygenation, which was maintained until end-tidal oxygen reached 85% (Capnomac Ultima; Datex Engström, Helsinki, Finland). The duration of preoxygenation was noted. Anesthesia was then induced with propofol (2–2.5 mg/kg) and succinylcholine (1 mg/kg), with the dosages previously recommended (14,15). Cricoid pressure was applied as described by Sellick (16). A Macintosh No. 3 laryngoscope blade was used for the first laryngoscopy in every case. The oxygen saturation (SpO2) value obtained at the end of preoxygenation and the minimal value of SpO2 measured during the intubation procedure were noted.

Visualization of the glottis during laryngoscopy was assessed with the modified Cormack classification (class I, complete visualization of the vocal cords; class II, visualization of the inferior portion of the glottis; class III, visualization of the epiglottis only; and class IV, inability to visualize the epiglottis) (17). Intubation difficulty was assessed with the IDS developed by Adnet et al. (10) on the basis of seven variables associated with difficult intubation. They are as follows: N1, number of additional intubation attempts; N2, number of additional operators; N3, number of alternative intubation techniques used; N4, glottic exposure as defined by Cormack and Lehane (17) (grade 1, N4 = 0; grade 2, N4 = 1; grade 3, N4 = 2; and grade 4, N4 = 3); N5, lifting force applied during laryngoscopy (N5 = 0 if inconsiderable and N5 = 1 if considerable, as assessed subjectively); N6, need to apply external laryngeal pressure to improve glottic pressure (N6 = 0 if no external pressure or only the Sellick maneuver was applied and N6 = 1 if external laryngeal pressure was used); and N7, position of the vocal cords at intubation (N7 = 0 if abducted or not visible and N7 = 1 if adducted). The IDS score is the sum of N1 through N7. A score of 0 indicated intubation under ideal conditions, performed on the first attempt by the first operator, who used a single technique and applied minimal force to insert the tube through a fully visualized glottis. An IDS score from 1 to 5 indicated slight difficulty, and an IDS score >5 indicated moderate to major difficulty (10). In this study, we defined two groups of patients according to the IDS values: those with an IDS score <5 (i.e., easy and slight difficulty) and those with an IDS score ≥5 (i.e., difficult intubation).

Assuming a percentage of difficult intubation (i.e., IDS ≥5, which was the primary outcome) of approximately 2% (13) in the lean patients, we calculated the appropriate sample size with use of $\alpha = 0.05$ and $\beta = 0.20$. Because a previous study suggested that the incidence of difficult laryngoscopy was 13% in obese patients and that the incidence of morbidly obese patients requiring awake intubation was 8% (18,19), we postulated that the incidence of difficult tracheal intubation in obese patients would be 11%. With this assumption that obesity might increase the incidence of difficult tracheal intubation from 2% to 11%, at least 115 patients per group would be necessary. We included 140 patients per group.

We first compared the IDS values, patient characteristics, and preoxygenation data between obese and lean patients by using a univariate analysis. A $\chi 2$ test with Yates correction or a Fisher's exact test was used for comparisons of qualitative variables. Nonparametric tests (Mann-Whitney *U*-tests or Kruskal-Wallis tests) were used for comparisons of quantitative variables.

In a second step, a univariate analysis was performed to determine the risk factors for difficult tracheal intubation in the obese patients alone. We compared the obese patients with an IDS score <5 and ≥5. All the significant variables in this univariate analysis were entered in a binary stepwise multivariate logistic regression (backward-Wald) model to determine independent risk factors for difficult tracheal intubation. Continuous variables were transformed into binary variables by using the median value of the population as a cutoff. Odds ratios and 95% confidence intervals were calculated.

Values are given as mean ± SD (range), number of patients, or percentages. $P < 0.05$ was considered statistically significant.

ANESTHESIA & ANALGESIA

Results

One-hundred-thirty-eight obese (2 patients with incomplete data) and 140 lean patients met the conditions required for evaluation in the operating room. Nine obese and six lean patients were eliminated because tracheal intubation was performed by a resident. Finally, 129 obese and 134 lean patients were included in this prospective study.

No intubation was impossible in this series. Laryngoscopies were possible for all patients. The incidence of difficult intubation was more frequent in the obese than in the lean patients; 83 (61.9%), 48 (35.8%), and 3 (2.3%) lean patients had an IDS score of 0, >1, <5, and ≥5, respectively, whereas the numbers for obese patients were 56 (43.3%), 53 (41.1%), and 20 (15.5%), respectively ($P < 0.001$). During the intubation procedure, the number of attempts was 1 (range, 1–4) and 1 (range, 1–8), the number of operators involved in the procedure was 1 (range, 1–3) and 1 (range, 1–4), and the number of techniques used was 1 and 1 (range, 1–6) in the lean and obese patients, respectively. Other patient characteristics are displayed in Table 1. The incidence of comorbidities was more frequent in the obese than in the lean patients. The incidence of difficult laryngoscopy (Cormack class III or IV) was similar between lean (10.4%) and obese (10.1%) patients (P = not significant). The duration of preoxygenation and the value of SpO2 at the end of preoxygenation were similar between lean and obese patients. The minimal value of SpO2 noted during the procedure was higher in lean than in obese patients (Table 1). Among the 20 obese patients for whom the IDS value was ≥5, the mean minimal value of Spo_2 during the tracheal intubation procedure was 89% ± 10% (range, 50%–99%), whereas it was 96% ± 7% (range, 64%–100%) in the obese patients for whom the IDS value was <5 (P = 0.0006). The time to intubation was not recorded during the study.

A univariate analysis was then performed with the obese patients only to determine the risk factors for difficult intubation in this population. We compared obese patients with an IDS score <5 and those with an IDS score ≥5 (Table 2). A multivariate analysis was performed with the significant variables of the univariate analysis (Table 3). The multivariate analysis demonstrated that a Mallampati score of III or IV was an independent risk factor for difficult intubation in obese patients, whereas obesity (i.e., BMI) was not. The sensitivity of the Mallampati score was 100% and 85%, its specificity was 74% and 62%, its positive predictive value was 8% and 29%, and its negative predictive value was 100% and 96% in lean and obese patients, respectively.

Discussion

These results indicate that difficult tracheal intubation is more frequent in obese than in lean patients. In this study, the rate of difficult intubation was 15.5% in the obese patients and 2.2% in the lean patients. The latter figure is in keeping with the 1% to 4% range found in earlier studies of nonobstetrical unselected patients (2,13). Our data agree with several review articles supporting an association between obesity and difficult intubation (2–5,7,19,20). However, this association has been challenged because the studies that demonstrated that obesity was a risk factor for difficult intubation presented methodological limitations that call into question the validity of their findings, whereas others studies demonstrated that obesity was not associated with an increased incidence of difficult intubation.

First, the studies that previously demonstrated that obesity was a risk factor for difficult intubation presented methodological limitations. The association between obesity and difficult intubation was previously found in noncomparative studies (4,19) or in studies of small numbers of patients (7,20). For instance, in a study showing that intubation was more difficult in obese than in nonobese women during delivery, the statistical analysis included only 17 and 8 patients in these 2 groups, respectively (20). Similarly, Wilson et al. (7), who identified obesity as a risk factor for difficult intubation, were able to include only two obese patients and one lean patient with intubation difficulties. It is more important to note that all these previous studies failed to distinguish between difficult intubation and difficult laryngoscopy. The two do not necessarily go together, however. For instance, in our study, intubation was more difficult in the obese patients, whereas the incidence of difficult laryngoscopy (i.e., Cormack class III or IV) was similar in obese and lean patients. This is not surprising, because factors complicating laryngoscopy do not reflect the full spectrum of complex events that can make intubation difficult or easy. The need for a clinically relevant definition of difficult intubation prompted us to use the IDS score, which improved the reliability of identifying difficult tracheal intubation (10,21). The use of the IDS score allowed us to demonstrate that tracheal intubation, not laryngoscopy, was more difficult in obese than in lean patients. Second, the negative previous studies, which suggested that obesity and weight were not risk factors for difficult intubation, also failed to distinguish between difficult intubation and difficult laryngoscopy (1,6,8,9). In addition, some of these studies were performed with a small number of patients (9), without control (i.e., lean) patients (8), or even without obese patients (1).

A multivariate analysis restricted to the obese group was conducted to look for factors predicting difficult

Table 1. Patient Characteristics

Variable	Lean patients (n = 134)	Obese patients (n = 129)	P value
Age (yr)	42 ± 13 (18–79)	40 ± 10 (19–61)	0.62
Sex (M/F)	47/87	27/102	0.01
Height (cm)	169 ± 8 (150–184)	167 ± 9 (151–190)	0.02
Weight (kg)	66 ± 11 (44–98)	128 ± 24 (87–230)	<0.0001
BMI (kg/m^2)	23.2 ± 3.7 (15.1–30)	45.9 ± 7.1 (33.1–70.9)	<0.0001
Snoring (n)	13	96	<0.0001
Sleep apnea syndrome (n)	0	46	<0.0001
Diabetes melitus (n)	3	18	0.005
Mallampati class III–IV (n)	37	58	0.003
Mouth opening <35 mm (n)	33	34	0.75
Neck movement <80° (n)	10	20	0.04
Tooth missing (n)	15	6	0.10
Mandibular recession (n)	3	10	0.03
Buck teeth (n)	19	6	0.007
Duration of preoxygenation (min)	4.0 ± 1.1 (1–10)	4.1 ± 1.2 (1–9)	0.56
Spo_2 value after preoxygenation (%)	100 ± 1 (97–100)	100 ± 1 (96–100)	0.29
Minimal Spo_2 value noted during the intubation procedure (%)	99 ± 1 (91–100)	95 ± 8 (50–100)	<0.0001

Data are given as n or mean ± SD (range).
BMI = body mass index.

Table 2. Univariate Analysis Comparing Obese Patients with an Intubation Difficulty Scale (IDS) Score <5 and Obese Patients with an IDS Score ≥5

Variable	IDS <5 (n = 109)	IDS ≥5 (n = 20)	P value
Age (yr)	39 ± 10 (19–61)	40 ± 9 (21–55)	0.78
Female (n)	89	13	0.09
BMI (kg/m^2)	48 ± 14 (33–71)	46 ± 8 (39–71)	0.52
Snoring (n)	83	13	0.29
Sleep apnea syndrome (n)	38	8	0.65
Diabetes melitus (n)	17	1	0.36
Mallampati class III–IV (n)	41	17	<0.0001
Mouth opening <35 mm (n)	26	8	0.13
Neck movement <80° (n)	15	5	0.21
Tooth missing (n)	6	0	0.41
Mandibular recession (n)	7	3	0.39
Buck teeth (n)	4	2	0.23

The statistical analysis was performed with a Fisher's exact test. Data are given as mean ± SD (range) or n.
BMI = body mass index.

Table 3. Multivariate Analysis Performed in the Obese Patients to Determine the Independent Risk Factors for Difficult Intubation in This Population

Variable	β	SD	P value	Odds ratio	95% CI Lower	95% CI Upper
Mallampati class III–IV	2.53	0.93	0.007	12.51	2.01	77.81
Constant	−4.69	0.97	<0.001			

CI = confidence interval.

intubation in these patients. In keeping with the results reported by Brodsky et al. (8), we found that a Mallampati score of III or IV was a risk factor for difficult intubation in obese patients. However, as previously described, the sensitivity, specificity, and negative predictive value of the Mallampati score were poor (2), and this calls into question the validity of this predictive factor in clinical practice. One can suggest that the clinical predictive value of the Mallampati score is overridden by the degree of jaw mobility, which is often limited in obese patients by simple mass effect. In agreement with Brodsky et al., we also found that the BMI was not an independent risk factor for difficult tracheal intubation in obese patients (8). In other words, among obese patients, this result suggests that the most severely overweight were not more difficult to intubate than the others. In addition, we observed that in obese patients, difficult intubation was not significantly associated with any of the other risk factors established in the general (lean) population, including those demonstrated by Wilson et al. (7) (snoring, abnormal spinal mobility, receding mandible, buck teeth, and <35 mm of mouth opening). Furthermore, OSAS, a well known risk factor for difficult laryngoscopy in lean individuals (22,23), was not associated with difficult intubation in our obese patients. The alteration of the anatomy of upper airways in the obese patients may explain these discrepancies between lean and obese. Moreover, as described previously, all the previously described risk factors were in fact risk factors for difficult laryngoscopy and not for difficult intubation.

We also observed that hypoxemia occurred more often in obese than in lean patients during anesthesia induction, despite a similar preoxygenation. These data are in agreement with the report that apnea-induced desaturation develops more rapidly in obese than in lean patients, despite preoxygenation (24). This fact is classically related to a reduction in functional residual capacity, which is usual in obese patients (3,25). This reduction of functional residual capacity is also accompanied by a decrease in compliance, an increase in airway resistance, and an increase in pulmonary vascular resistances (3). It is worth mentioning that, in this study, a desaturation occurred more frequently and was more important in the obese patients with a difficult intubation than in those without difficult intubation. This result suggests that difficult intubation is another common and important factor that contributes to the increased risk of hypoxemia in obese patients during the induction of anesthesia by increasing the time needed to insert the tracheal tube. Routine awake intubation of patients with morbid obesity has, therefore, been recommended as a means of minimizing this risk of desaturation (5,9,25). However, this aggressive approach, which has not been validated, is cumbersome and generates patient discomfort. In addition, it is unnecessary in most cases (26), as demonstrated in this study, in which tracheal intubation by direct laryngoscopy was successful in all obese patients. Thus, routine awake intubation is not mandatory in obese patients.

Our study has several limitations. The IDS score could have been intentionally increased because the anesthesiologists knew the primary purpose of this study, but it was impossible to maintain blindness of the study group. However, the fact that the same anesthetic procedure was used for all patients, the fact that the IDS was assessed by a small number of anesthesiologists, and the nature of the IDS score may have minimized the investigator bias. Another limitation of our results was the small sample used to identify the risk factors for difficult tracheal intubation in obese patients. However, studying the risk factors for difficult intubation in the obese was not the primary endpoint, and the sample size was appropriate for the primary outcome. It is nevertheless a fact that more obese patients with difficult intubation are needed to exhaustively identify the risk factors for difficult intubation in this population. Finally, the Sellick maneuver has been reported to cause upper airway obstruction and more difficult intubation over difficult laryngoscopy (27). However, because the Sellick maneuver was applied in both lean and obese subjects, we suggest that its effect did not alter our conclusions.

We conclude that difficult tracheal intubation is more common among obese than nonobese patients. Among the classic risk factors for difficult intubation, only a Mallampati score of III or IV is a risk factor in obese patients. However, its value in daily practice is poor. The increased risk of desaturation during difficult intubation should be borne in mind when anesthesia is induced in obese patients. Skilled anesthetic assistance and a wide range of equipment to facilitate intubation should be available. The risk of hypoxemia and the paucity of elements predicting difficult intubation warrant studies aimed at identifying new predictors of difficult intubation in obese patients.

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