Journal of Clinical Anesthesia (2009) **21**, 264–267

ELSEVIER

Journal of Clinical Anesthesia

**Original contribution**

# Predicting difficult airways using the intubation difficulty scale: a study comparing obese and non-obese patients

**Ronit Lavi MD (Staff Anesthetist)[a,b,*], Dror Segal MD (Staff Anesthetist)[a,b], Avishai Ziser MD (Head, Division of Cardiothoracic Anesthesia)[a]**

[a]*Department of Anesthesiology, Rambam Medical Center P.O.B. 9602, Haifa 31096, Israel*
[b]*Rappaport Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, Israel*

Received 3 September 2007; revised 17 August 2008; accepted 21 August 2008

**Keywords:**
Body mass index;
Difficult intubation;
Mallampati test;
Obesity

**Abstract**
**Study Objective:** To compare intubation difficulty in obese and non-obese patients by intubation difficulty scale (IDS), intubation duration measurement, and oxygen saturation ($SaO_2$) levels.
**Design:** Prospective, controlled study.
**Setting:** Operating room of a tertiary-care hospital.
**Patients:** 204 ASA physical status I, II, and III adult patients who underwent elective surgery with endotracheal intubation.
**Interventions and Measurements:** Preoperative airway parameters, intubation duration, IDS scores, and lowest $SaO_2$ during intubation were recorded.
**Main Results:** IDS scores were higher in the obese group than the non-obese (2.29 ± 0.45 and 1.26 ± 0.2, respectively, $P = 0.03$). Intubation duration was 45.1 ± 6 sec for obese versus 36.8 ± 2.6 sec for the non-obese group ($P = 0.20$). The lowest $SaO_2$ recorded was 97%, with no difference noted between groups. Mallampati class ≥3 was found to positively predict intubation difficulty scores greater than 5.
**Conclusions:** Difficult intubation was more prevalent among obese than non-obese patients, but intubation duration and lowest $SaO_2$ levels during intubation were not. Moreover, the modified Mallampati test was found to be a moderately good (60%) predictor of difficult intubation among obese patients.
© 2009 Elsevier Inc. All rights reserved.

## 1. Introduction

Obesity is a worldwide epidemic, with a prevalence of 31.1% among men and 33.2% among women in the United States in 2003-2004. The prevalence of extreme obesity with body mass index (BMI) above 40 kg/m$^2$ was 2.8% in men and 6.9% in women in 2003-2004 [1]. The prevalence of obesity is expected to increase further due to the significant increase in obesity prevalence among young adults and children and, therefore, has been labeled an epidemic [2].

The increased obesity prevalence implies that anesthesiologists are treating in their practice an increasing number of obese patients who suffer from obesity-associated comorbidities. Airway management of the obese patient is a major challenge for the anesthesia care provider, requiring careful and detailed preoperative airway evaluation.

Body mass index is used to assess normal weight, overweight, and obese patients. Body mass index between

* Corresponding author. Tel.: +972 4 854 2487; fax: +972 4 854 2961.
*E-mail address:* lavironit@hotmail.com (R. Lavi).

0952-8180/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.jclinane.2008.08.021

18.5 and 25 kg/m$^2$ is normal, BMI 25-30, is defined as overweight, and BMI above 30 kg/m$^2$ is defined as obese [1]. An objective scoring system, the intubation difficulty scale (IDS), has been proposed to assess the intubation difficulty [3], and has been previously used and validated to compare difficult intubation prevalence between obese and non-obese patients [4].

Although the intubation difficulty scores were used previously to evaluate difficult intubation in obese and in lean patients, IDS scores were found to be significantly higher among the obese group [4]; and so the debate as to whether obesity per se is a predictor of difficult intubation continues [4-9].

Furthermore, comparison between intubation difficulty among the obese and non-obese using IDS scores and other objective measurements, such as intubation duration and lowest oxygen saturation ($SaO_2$) levels, has not been performed.

Preoperative airway evaluation is a mandatory part of the preoperative patient visit. However, the ability of airway parameters to predict laryngoscopy view and difficult intubation in the obese patient is questionable [10-12]. To evaluate and compare intubation difficulty in obese and non-obese patients, we performed a prospective, controlled study using IDS scores, intubation duration measurements, and lowest $SaO_2$ levels. Moreover, we evaluated the ability of preoperative airway parameters to predict high IDS scores.

## 2. Materials and methods

The study was approved by the Rambam Medical Center Institutional Review Board. Requirement for written, informed consent from study patients was waived, since the study did not require any modification in patient care and was only observational in nature.

A total of 204 ASA physical status I, II, and III adult patients undergoing elective surgery with general anesthesia and endotracheal intubation, were enrolled in this controlled, prospective study. Patients less than 18 years old, those with ASA physical status greater than III, and those patients requiring urgent or emergent surgery were excluded from the study. Airway evaluation for each patient included modified Mallampati classification without phonation, thyromental distance, range of head and neck motion, width of mouth opening (measured as the interincisor gap in cm, with the mouth fully opened), absence or presence of buck teeth, and mandibular recession. Abnormalities associated with difficult laryngoscopy (eg, loose teeth) were recorded. Patients' height and weight were measured, and BMI was calculated. Age, gender, ASA physical status, type of surgical procedure, and co-morbidities were recorded.

Following application of standard ASA monitoring, oxygen supplementation with mask was given during spontaneous breathing before anesthesia induction for at least 5 minutes, and mask ventilation was applied between intubation attempts. Patients were positioned in the sniffing position. All laryngoscopies were performed using a size 3 Macintosh blade, and the trachea was intubated with a cuffed endotracheal tube. An intubation stylet was not used routinely. Each intubation performed was evaluated according to the IDS score developed by Adnet et al., which uses 7 variables associated with difficult intubation [3]. The variables that constitute the IDS score and the rules for calculating IDS score are: N1, the number of additional intubation attempts with every additional attempt adding one point to the total score, one attempt was given zero; N2, the number of additional operators, each additional operator adds one point to the total score; N3, the number of alternative intubation techniques used (eg, patient reposition, change of blade or tube change approach) each modification added one point to the score; N4, glottic exposure as defined by Cormack and Lehane, whereas Cormack and Lehane grade 1 receive no points and every extra grade receives a point; N5, lifting force applied during laryngoscopy normal lifting force gets no points and increased force gets one point; N6, application of external laryngeal pressure to improve glottic exposure if needed, one point is added to the total score; and N7, the position of the vocal cords during laryngoscopy (abduction position receives no points whereas adduction position of the cords adds one point).

The IDS score is the sum of N1 through N7. A score of 0 indicates easy intubation, an IDS score from 1 to 5 indicates slight difficulty, and an IDS score > 5 indicates moderate to major difficulty. Two anesthesiologists were involved in each intubation: one performed the intubation and the second one observed. The independent observer measured the duration of intubation in seconds from the first opening of the patient's mouth to the first capnography waveform, and lowest $SaO_2$ level during intubation. After successful intubation with tube placement verified and secured, the observer anesthesiologist provided N1-N3 variables, and the intubation performer provided N4-N7 to the total score. The total IDS score was summed later by an independent anesthesiologist.

### 2.1. Statistical analysis

Continuous variables are expressed as means ± standard deviation. Non-continuous variables are expressed as the number of occurrences and percentage. For univariate analysis, the two-tail student's t test was employed for continuous variables and Chi-square or Fisher's exact test, as appropriate, for non-continuous variables. Multivariable logistic regression was used, with and without variable interactions, to identify independent predictors of difficult intubation. The interaction between different variables within the study groups (itself considered a variable) was studied to determine their combined effects as predictors of

**Table 1** Characteristics of patients in the obese and non-obese groups

| | Non-obese group (n = 99) | Obese group (n = 105) | *P*-value |
|---|---|---|---|
| Age (yrs) | 48 ± 16 | 42 ± 8 | 0.0008 |
| Gender (% women) | 58 | 67 | 0.47 |
| BMI (kg/m$^2$) | 24.4 ± 2 | 38 ± 7.6 | <0.001 |
| Hypertension | 10 | 30 | <0.001 |
| Diabetes | 3 | 28 | <0.001 |
| Mallampati ≥3 | 10 | 32 | <0.001 |
| Limited mouth opening (less than 40 mm) | 24 | 19 | 0.3 |
| Limited neck movement | 10 | 18 | 0.15 |
| Thyromental distance (<6.5 cm) | 12 | 8 | 0.35 |

BMI = body mass index.

difficult intubation. Statistical analysis was performed using GraphPad Prism (version 4.0; GraphPad software Inc., San Diego, CA). Statistical significance was defined as $P < 0.05$.

## 3. Results

This study included 204 patients, 105 were defined as obese (BMI ≥ 30 kg/m$^2$) and 99 as non-obese (BMI < 30 kg/m$^2$). Body mass index was 24.4 ± 3.6 kg/m$^2$ (range 15.8-29.8) for the non-obese group, and 38 ± 7.6 (range 30-70.3) for the obese group.

The obese patients were younger, had a higher prevalence of hypertension and diabetes, and their Mallamapti scores were significantly higher (Table 1). All laryngoscopies were possible and all intubations were successful, with no esophageal intubations. The IDS score was higher in the obese group than in the non-obese 2.29 ± 0.45 and 1.26 ± 0.2; respectively ($P$ = 0.03; Fig. 1). Average BMI for the group with IDS = 0 was 30 ± 12.2; average BMI for those with IDS 1-5 was 32 ± 11.6; and for the IDS > 5 group, average BMI was 44.4 ± 18.2 ($P$ = 0.01, for IDS = 0 vs. IDS 1-5, and $P$ = 0.008 vs. IDS > 5; Fig. 2).

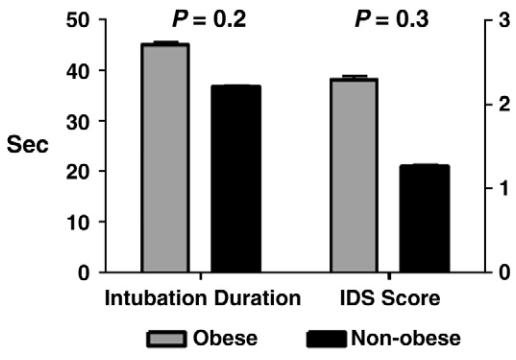


**Fig. 1** Intubation difficulty scale (IDS) scores and intubation duration among obese and non-obese patients. The IDS score was significantly higher in obese patients, but intubation duration did not differ significantly between the groups.

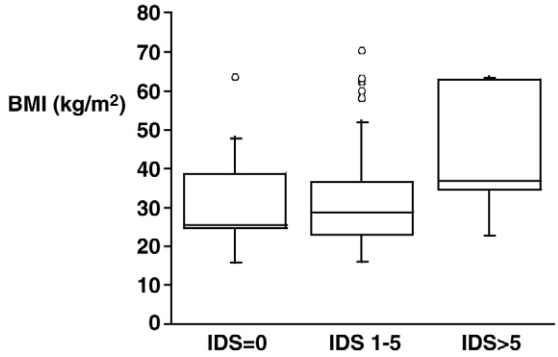


**Fig. 2** Patients were divided according to intubation difficulty scale (IDS) scores into three groups: IDS = 0, IDS 0-5, and IDS scores above 5, and their body mass index (BMI) evaluated accordingly. The IDS > 5 group had the highest BMI, although some overlap existed between the groups.

Multivariate analysis found association with the following factors and increased IDS scores in the obese group, glottic exposure (N4), need for increased lifting force during laryngoscopy (N5), and need to apply external laryngeal pressure to improve glottic exposure (N6).

Preoperative airway evaluation parameters were correlated with IDS score, and Mallampati score ≥3 was found to have a positive predictive value of 60% for those patients with IDS scores greater than 5.

Intubation duration was 45.1 ± 6 seconds for the obese patients and 36.8 ± 2.6 seconds for the non-obese ($P$ = 0.20; Fig. 1). The lowest $SaO_2$ recorded was 97%, with no differences noted between groups.

## 4. Discussion

In this prospective controlled study we showed that higher IDS scores are more prevalent among obese than non-obese patients. Despite the higher IDS scores, we showed no difference between the groups regarding intubation duration. Furthermore, Mallampati class 3-4 was found to predict difficult intubation in obese patients.

The IDS score uses several variables associated with difficult intubation to evaluate intubation [3]. The results of this study, showing that IDS scores are higher among obese than non-obese patients, concur with results of a previous study that compared IDS scores between obese and lean patients [4]. The IDS scores were found to be higher among obese patients: poor glottic exposure, increased lifting force needed during laryngoscopy, and need to apply external laryngeal pressure to improve glottic exposure (N4, N5, N6). The need for increased lifting force during laryngoscopy and

for external laryngeal pressure to improve glottic view is probably the result of airway characteristics of the obese patient. The airway of the obese patient may be narrowed, and difficulty with mask ventilation and tracheal intubation might be expected due to the increased bulk of soft tissue as a result of fat tissue accumulation in the cheeks, palate, pharynx, and airway. Furthermore, large breasts, short neck, large tongue, high and anterior larynx, restricted mouth opening, and limitation of cervical spine and atlanto-occipital flexion and extension all may have contributed to this situation [5].

However, although this study showed increased IDS scores among the obese patients, an objective measurement of intubation duration did not find statistically significant differences between the groups, and lower $SaO_2$ levels were not noted. The experienced anesthesiologists participating in this study managed successfully to intubate the trachea of the obese patients without prolonging intubation duration or causing lower $SaO_2$ levels. Therefore, the increased IDS scores among obese patients did not influence the successful intubations. We provided oxygen supplementation with mask during spontaneous breathing before anesthesia induction for at least 5 minutes, and mask ventilation was applied between intubation attempts. This management might have contributed to the high $SaO_2$ levels that were maintained in our patients, even during prolonged and difficult intubations.

On the other hand, we used the sniffing position in all patients, and did not place towels beneath the upper part of the obese patients. The technique was previously described as arranging blankets underneath the patient's upper body and head until horizontal alignment was achieved between the external auditory meatus and the sternal notch. This technique provides a better laryngoscopic view in the obese patient [13]. Using this technique might have provided decreased IDS scores and faster intubations.

Difficult airway was re-defined by the ASA Task Force on Management of the Difficult Airway as a clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both [14]. In this study, we did not evaluate face mask ventilation, and compared only intubation scores, duration, and $SaO_2$ among obese and non-obese patients. The IDS scores combine several parameters in a single number that provides an estimation of intubation difficulty. The IDS score is therefore inferior to assessment of intubation difficulty, but it can be used to assess difficult intubation in the obese patient by retrospectively evaluating airway characteristics and intubation management. It can help prepare for future additional intubations in a particular patient found to have difficult airway management.

The modified Mallampati test was previously suggested as a predictor of difficult laryngoscopy and intubation [9,11]. Our results confirm the results of these previous studies, since Mallampati class 3-4 correlated with IDS scores higher than 5, implying a moderate to difficult intubation. Thus, the modified Mallampati test can be used for preoperative airway evaluation in predicting difficult intubation among obese patients.

In summary, in this prospective observational controlled study we showed that IDS scores are higher among obese than non-obese patients, but intubation duration and lowest $SaO_2$ levels during intubation did not differ significantly. Indeed, the higher scores among the obese patients were the result of the obese patients' airway characteristics and were easily handled by the anesthesiologist without increasing intubation duration or causing a decrease in $SaO_2$ levels. Furthermore, the modified Mallampati score of 3-4 predicted increased IDS scores above 5. Thus, a preoperative Mallampati class of 3-4 should alert the anesthesiologist to the possibility of difficult intubation, especially in the obese patient.

## References


[1] Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. JAMA 2006;295:1549-55.

[2] Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. JAMA 2004;291:2847-50.

[3] Adnet F, Borron SW, Racine SX, et al. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology 1997;87:1290-7.

[4] Juvin P, Lavaut E, Dupont H, et al. Difficult tracheal intubation is more common in obese than in lean patients. Anesth Analg 2003;97:595-600.

[5] Adams JP, Murphy PG. Obesity in anaesthesia and intensive care. Br J Anaesth 2000;85:91-108.

[6] Brodsky JB, Lemmens HJ, Brock-Utne JG, Vierra M, Saidman LJ. Morbid obesity and tracheal intubation. Anesth Analg 2002;94:732-6.

[7] Wong SY, Coskunfirat ND, Hee HI, Li JY, Chen C, Tseng CH. Factors influencing time of intubation with a lightwand device in patients without known airway abnormality. J Clin Anesth 2004;16:326-31.

[8] Adnet F, Racine SX, Borron SW, et al. A survey of tracheal intubation difficulty in the operating room: a prospective observational study. Acta Anaesthesiol Scand 2001;45:327-32.

[9] Voyagis GS, Kyriakis KP, Dimitriou V, Vrettou I. Value of oropharyngeal Mallampati classification in predicting difficult laryngoscopy among obese patients. Eur J Anaesthesiol 1998;15:330-4.

[10] Hekiert AM, Mandel J, Mirza N. Laryngoscopies in the obese: predicting problems and optimizing visualization. Ann Otol Rhinol Laryngol 2007;116:312-6.

[11] Lee A, Fan LT, Gin T, Karmakar MK, Ngan Kee WD. A systematic review (meta-analysis) of the accuracy of the Mallampati tests to predict the difficult airway. Anesth Analg 2006;102:1867-78.

[12] Hung O, Murphy M. Unanticipated difficult intubation. Curr Opin Anaesthesiol 2004;17:479-81.

[13] Collins JS, Lemmens HJ, Brodsky JB, Brock-Utne JG, Levitan RM. Laryngoscopy and morbid obesity: a comparison of the "sniff" and "ramped" positions. Obes Surg 2004;14:1171-5.

[14] American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 2003;98:1269-77.