Original Article

The prediction of difficult intubation in obese patients using mirror indirect laryngoscopy: A prospective pilot study

Arne O Budde, Matthew Desciak[1], Venugopal Reddy, Octavio A Falcucci, Sonia J Vaida, Leonard M Pott

Department of Anesthesiology, [1]Geisinger Health System, Wilkes-Barre, PA; Penn State University College of Medicine, Hershey, PA, United States

Abstract

Background: The incidence of difficult laryngoscopy and intubation in obese patients is higher than in the general population. Classical predictors of difficult laryngoscopy and intubation have been shown to be unreliable. We prospectively evaluated indirect mirror laryngoscopy as a predictor of difficult laryngoscopy in obese patients.

Materials and Methods: 60 patients with a body mass index (BMI) greater than 30, scheduled to undergo general anesthesia, were enrolled. Indirect mirror laryngoscopy was performed and was graded 1-4 according to Cormack and Lehane. A view of grade 3-4 was classified as predicting difficult laryngoscopy. Additional assessments for comparison were the Samsoon and Young modification of the Mallampati airway classification, Wilson Risk Sum Score, neck circumference, and BMI. The view obtained upon direct laryngoscopy after induction of general anesthesia was classified according to Cormack and Lehane as grade 1-4.

Results: Sixty patients met the inclusion criteria; however, 8 (13.3%) patients had an excessive gag reflex, and examination of the larynx was not possible. 15.4% of patients who underwent direct laryngoscopy had a Cormack and Lehane grade 3 or 4 view and were classified as difficult. Mirror laryngoscopy had a tendency toward statistical significance in predicting difficult laryngoscopy in these patients.

Conclusions: This study is consistent with previous studies, which have demonstrated that no one individual traditional test has proven to be adequate in predicting difficult airways in the obese population. However, the new application of an old test - indirect mirror laryngoscopy - could be a useful additional test to predict difficult laryngoscopy in obese patients.

Key words: Difficult airway, mirror indirect laryngoscopy, obesity, prediction

Introduction

Assessment of the airway and anticipation of the "difficult airway" are fundamental skills for an anesthesiologist. Although the traditional methods of assessing the airway by Mallampati score[1] and Wilson risk sum score[2] are widely accepted, these tests suffer from poor sensitivity with only moderate specificity and have a limited positive predictive value.[3,4] The airways of obese patients present the anesthesiologist with additional challenges, such as redundant neck soft tissue, impaired neck mobility, and large chest and breasts. The incidence of difficult intubation in the obese population with a BMI of greater than 30 has been reported in a large meta-analysis to be 15.8% compared to 5.8% in the general population.[5] Unfortunately, the classical predictors of difficult intubation have been shown to be even less reliable in the obese with only increasing neck circumference of more than 43 cm measured at the level of the thyroid cartilage[6] and Mallampati score being reproducible risk factors in the obese population[7,8] and not BMI.[4,8,9] Rosenblatt *et al.* demonstrated that additional examination of the upper airway anatomy can change a previously established airway management plan in up to one fourth of patients with potential difficult airways.[10] Using a simpler method than Rosenblatt, Yamamoto *et al.*[11] demonstrated the usefulness of an additional airway examination. Their study showed that indirect mirror laryngoscopy is superior to both the Mallampati score and Wilson risk sum score in regards to positive predictive value and specificity in predicting difficult intubation (defined as Cormack and Lehane grade III or

Address for correspondence: Dr. Arne O. Budde, Department of Anesthesiology, Penn State Milton S. Hershey Medical Center, 500 University Drive, United States.
E-mail: abudde@hmc.psu.edu

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IV view).[11] The patient population in their study group had an average weight of 55 kg; therefore, it is unknown if this method of assessing the airway is applicable to the obese population with potentially difficult airways.

We prospectively evaluated indirect mirror laryngoscopy as a predictor of difficult intubation defined as Cormack and Lehane[12] score of 3 or 4 in the obese population compared to Samsoon and Young's modification of the Mallampati score,[13] Wilson risk sum score, neck circumference, and BMI. Our hypothesis was that indirect mirror laryngoscopy would be superior to the traditional methods.

Materials and Methods

The study protocol was approved by the institutional internal review board, and written informed consent was obtained from all participating patients. Inclusion criteria were patients scheduled to undergo general anesthesia with endotracheal intubation for elective surgery, age greater than 18 years, and BMI greater than 30. Exclusion criteria included patients with known distortion of anatomy (such as head and neck cancer), use of a cervical collar, obstetrical patients, age < 18 years, inability to sit up, and patient refusal. The indirect mirror laryngoscope used was the Welch Allyn 3.5v Larynx Illuminator (Welch Allyn Inc., Skaneateles Falls, NY). Measurements of neck circumference and inter-incisor gap were made with a standard tape measure. 60 patients were enrolled. The authors indentified patients presenting on the day of surgery in the pre-operative holding area. All pre-operative airway assessments were made by a single author (MD). After obtaining an informed consent, the patient was asked to sit up, and the Samsoon and Young modification of the Mallampati airway classification assessment was made by instructing the patient to maximally open their mouth and protrude their tongue without phonation while the observer stood in front of the patient. The Samsoon and Young modification of the Mallampati airway score was recorded as follows: Grade I for view of soft palate, uvula, and tonsillar pillars; grade II for view of soft palate and uvula; grade III for view of soft palate and base of the uvula; grade IV for no view of soft palate at all. Grade III and IV were classified as predicting difficult intubation (defined as grade III or IV view by Cormack and Lehane classification). The components of the Wilson risk sum score were then measured with the patient in the sitting position. Wilson risk sum score consists of measurements of head and neck movement, jaw movement, presence and degree of receding mandible, the presence of prominent maxillary incisors, and body weight. Each variable received a score of 0-2 [Table 1] for a possible sum score of 0-10. A total score of two or greater is classified as predicting difficult intubation.

Table 1: Wilson risk sum score 2

Parameter	Parameter risk score
Weight	0<90 kg 190-110 kg 2>110 kg
Head/Neck movement	0 above 90° 1 approx. 90° (±10°) 2 below 90°
Jaw movement	0 IG* ≥5 cm; or SLux**>0 1 IG<5 cm and SLux=0 2 IG<5 cm and SLux<0
Receding mandible	0 normal 1 moderate 2 severe
Prominent incisors	0 normal 1 moderate 2 severe

IG=Incisor gap,SLux=Mandibular subluxation, SLux>0 demonstrates ability to sublux mandible past upper incisors, SLux=0 implies that patient can bring mandibular incisors equal to upper incisors, SLux<0 implies that the patient cannot sublux the mandibular incisors equal to or past the upper incisors*

Neck circumference was measured in the upright and seated position at the level of the thyroid cartilage using a standard tape measure. Neck circumference of 43 cm or greater was classified as predicting a difficult intubation. Indirect mirror laryngoscopy was performed with the patient in sitting position and leaning slightly forward with slight neck extension and protrude his/her tongue. The examiner used a 4 × 4 gauze to gently grasp the patients tongue with his left hand and introduced the indirect mirror laryngoscope into the patient's mouth. The laryngoscope was used to elevate the soft palate and visualize the glottis. The view obtained from indirect mirror laryngoscopy was recorded as grade 1-4 as follows: Grade 1- view of vocal cords; grade 2- view of posterior commissure only; grade 3- view of epiglottis only; grade 4- no glottis structures visible. A view of grade 3-4 was classified as predicting difficult intubation. The primary anesthesia team performed a separate airway examination but was blinded to the results of the pre-operative examination conducted by the investigators. Induction and intubation methods were at the discretion of the primary anesthesia team. The view obtained upon laryngoscopy was classified according to Cormack and Lehane as follows: Grade 1- full view of glottis; grade 2- only posterior commissure visible; grade 3- only epiglottis visible; grade 4- no glottic structure visible. Grade 3-4 were classified as difficult laryngoscopy.

Demographical data is expressed as mean and standard deviation (SD) or median and range as appropriate. Each method was analyzed with the Wilcoxon Ranks Sum Test, and Receiver Operator Characteristics (ROC) curves were constructed for each predicting method. All ROC curves were compared to the indirect laryngoscopy

ROC curve for statistical significance; alpha was set at 0.05. The statistical analysis was done using JMP 9.0 (SAS Institute Inc. Cary, NC), the power analysis with PASS 11 (NCSS, Kaysville, UT), and the ROC curves comparison with Medcalc 12.2.1.0 (Medcalc Software, Mariakerke, Belgium).

Results

Indirect mirror laryngoscopy was attempted in all 60 patients; however, 8 (13.3%) patients had an excessive gag reflex, making examination of the larynx impossible and were excluded from the study. Direct laryngoscopy was performed with a Macintosh blade in all but three patients. In all of these three patients, a Miller blade was used resulting in a good view of the larynx with subsequent easy intubation. Eight out of the 52 patients (15.4%) who underwent direct laryngoscopy had a Cormack and Lehane grade 3 or 4 view and were classified as "difficult." Patient characteristics can be seen in Table 2.

When analyzed independently, no method showed that it could predict a difficult airway at the $P < 0.05$ level. Indirect mirror laryngoscopy was the closest, with a P value = 0.0503 [Table 3].

We also constructed ROC curves for all methods and calculated their respective areas under the curve. Again, the best method was indirect mirror laryngoscopy, followed by the Mallampati score and the neck circumference measurement [Table 3]. When we compared indirect mirror laryngoscopy against all the other methods using AUC [Table 4], we determined that there were no statistically significant differences between them, although the largest difference (indirect Laryngoscopy vs. BMI at 0.15) showed a tendency towards significance. Results are also displayed in a scatterbox [Figure 1].

Discussion

The literature is rich with studies and meta-analyses attempting to determine the best single method or combination of methods to aid the anesthesiologist in predicting difficult intubation. The rate of difficult laryngoscopy (Cormack and Lehanegrade 3 or 4 view) in patients with apparently normal airways was determined by two recent meta-analysis to be 5.8%.[14] It was shown that tests such as Mallampati score, Wilson Risk score, thyromental distance, sternomental distance, and mouth opening offered poor to moderate sensitivity (20-62%) and moderate to fair specificity (82-97%). The rate of difficult laryngoscopy in the obese population has been well documented to be much higher than the non-obese, ranging from 12-15.8%,[4,5,8] although multiple studies[5,8,9] have demonstrated that BMI *per se* does

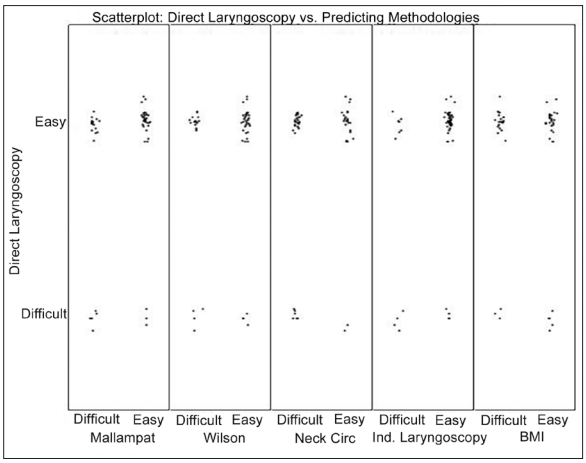

Figure 1: Scatterplot: Direct laryngoscopy vs. predicting methodologies

Table 2: Patient characteristics–mean (Standard Deviation) or median (Range) by laryngoscopy difficulty using the cormack lehane scale

Patient characteristics	All (n=52)	"Easy" (n=44) grade 1, 2 view	"Difficult" (n=8) grade 3, 4 view
Weight	115.5 kg (27.0)	114.5 kg (27.4)	121.1 kg (25.4)
Height	170.2 cm (10.4)	168.8 cm (10.2)	178.0 cm (9.4)
BMI	39.4 kg/m^2 (8.2)	39.8 kg/m^2 (8.7)	37.2 kg/m^2 (5.0)
Neck circumference	43.5 cm (5.0)	43.1 cm (5.0)	45.8 cm (4.5)
Wilson risk score	2 (0,5)	2 (0,5)	2.5 (1,5)
Mallampati score	2 (1,4)	2 (1,4)	3 (2,3)
Mirror laryngoscopy view	2 (1,4)	2 (1,4)	2.5 (1,4)

BMI=Body mass index

Table 3: Relationship between methodology and laryngoscopic view by wilcoxon ranks sum test (Chi^2 approximation)

Source	Chi^2	*P* Value	AUC	95% CI
BMI	0.3565	0.5504	0.51	0.37, 0.66
Wilson	2.7555	0.0969	0.59	0.45, 0.72
Neck	2.7752	0.0957	0.64	0.49, 0.76
Mallampati	2.7837	0.0952	0.64	0.50, 0.77
Indirect Laryngoscopy	3.8324	0.0503	0.67	0.53, 0.79

AUC= Area Under the Curve; CI= Confidence Interval

Table 4: Comparison between AUC. Differences with respect to indirect laryngoscopy

Method	Difference	95% CI Difference	Z Value	*P* Value
BMI	0.15	-0.18, 0.44	1.92	0.055
Wilson	0.08	-0.23, 0.39	0.57	0.570
Neck	0.03	-0.28, 0.34	0.21	0.837
Mallampati	0.03	-0.28, 0.34	0.19	0.852

CI= Confidence interval

not offer any predictive value for difficult intubation. High Mallampati score and large neck circumference have probably been the best single risk factor for difficult intubation in the obese.,[5,7,8] Ezri *et al.*[15] used ultrasound to quantify neck soft tissue at the level of the vocal cords and suprasternal notch and demonstrated that, in an obese population, the best predictor of difficult intubation was distribution of fat in these areas. While clearly a useful technique, the availability and time required performing this examination may be prohibitive to many anesthesiologists. Rosenblatt *et al.* performed pre-operative endoscopic airway examination (PEAE) with a fiberoptic bronchoscope in patients with potentially difficult airways due to anatomical abnormalities.[10] PEAE resulted in change of a previously established airway management plan in 26% of the study patients. While a change in plan in one of four patients is an impressive result, PEAE is a relatively complex and costly method requiring the utilization of a fiberoptic bronchoscope for every patient. Indirect laryngoscopy is a simple technique used frequently in otolaryngology to assess the larynx and upper airway. Yamamoto *et al.* demonstrated the applicability of this technique in the pre-operative airway assessment.[11] Our experience is that the technique can be learned rather quickly, and comfort with the device was obtained after approximately 10-15 uses of the device. The examination takes less than 30 seconds, and the device can be quickly cleaned in the same way as the laryngoscope blades. In the current study, mirror indirect laryngoscopy was the only method that had a tendency towards predicting whether an airway will be difficult or not. As had been reported previously, BMI had the poorest correlation with difficult intubation and when compared with indirect laryngoscopy, had a tendency towards being significantly worse. We experienced a 13.3% rate of excessive gag reflex, which is consistent with the 15% reported by Yamamoto *et al.*[11] The use of local anesthesia may have reduced this rate.

This study was designed as a pilot study to determine if indirect laryngoscopy might prove useful in the obese population. Our results are consistent with previous studies, which have demonstrated that no one of the commonly performed tests alone has proven to be adequate in predicting difficult intubation in the obese population. Indirect mirror laryngoscopy is a relatively simple method of assessing airway anatomy with a tendency towards statistical significance in predicting difficult laryngoscopy. A larger sample size will be required in further investigations to proof our hypothesis that mirror indirect laryngoscopy can be a useful test for pre-operative airway assessment of obese patients.

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