Comparison of C-MAC *vs.* McGrath video laryngoscopes on glottic exposure and endotracheal intubation success with stylet usage in obese patients

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Abstract. – OBJECTIVE: Cases of obesity are rising in parallel with the number of obese patients scheduled for anesthesia in which difficult airway is encountered. Video laryngoscopes (VL) have emerged as a popular device for the management of patients with difficult airway. The present study compares the success rate of intubation in obese patients using stylet in the ramped position using either a McGrath or C-MAC VLs.

PATIENTS AND METHODS: Class II/III obese patients who were intubated with either McGrath (Group M, n=50) or C-MAC (Group C, n=50) laryngoscopes were assessed for the presence of difficult airway using the Difficult Airway Assessment tool, the Airway Difficulty Score and the Total Airway Score. The intubation attempts were made after the best glottic view, direct and indirect Cormack-Lehane (CL) score, and intubation time were recorded. In the event of failure, a further intubation attempt was made using a styled, and the intubation time was again recorded. If the intubation failed again, a third attempt was made using a C-MAC D-Blade. The Intubation Difficulty Scale score was recorded after the intubation.

RESULTS: There was no statistically significant difference between groups in terms of demographic data, the number of patients with decreased CL score, the number of attempts required for intubation, or the first and second intubation time. The ADS Score, TAS Score, CL Score DL, and CL Score IN were found to be important risk factors for a second intubation requirement, and the cut-off value was found to be 8.50 for the ADS Score and 4.50 for the TAS Score in these patients. In the 38 patients who required a second intubation attempt, the procedure was successful in all, but one patient required a third attempt of intubation with C-MAC D-blade.

CONCLUSIONS: Both McGrath and C-MAC were effective and comparable for best glottic view with no failed intubation. It was concluded that regardless of the type of video laryngoscope used, the use of a stylet in the first intubation attempt increases the success of intubation.

Key Words:

Airway management, Obese patients, Video laryngoscopes, C-MAC, McGrath-MAC.

Introduction

The uncontrolled increase in overweight and obesity is a global health problem[1], and the increased prevalence of obese or overweight patients is also increasing the number of obese or overweight patients scheduled for anesthesia. Obesity can bring challenges to airway management, including difficulty in mask ventilation and, tracheal intubation. The use of video laryngoscopes (VLs) is the optimum approach in such scenarios, having been designed to provide a better laryngoscopic view on a brand-specific video monitor, thus easing intubation in many situations.

Systematic reviews and meta-analysis in recent decades[2,3] have shown that a VL provides a better glottic view than a direct laryngoscope, which makes VL the best choice for obese patients. Increased body mass index (BMI) is associated with increased difficulties in intubation, and studies have reported that morbid obesity increases the risk of difficult intubation from 1.42 times to 6 times when compared with non-obese patients[4]. In parallel to technological improvements, VLs have gained popularity in recent decades for the management of expected and unexpected difficult airway due to their ability to provide an excellent glottic view from a brand-specific monitor via a

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video camera positioned close to the tip of the VL blade that can be designed and modified based on the patient's anatomy.

The different video laryngoscope models available on the market each have advantages and disadvantages for use with obese patients based on the design of the handle and blade. Both the C-MAC® (Karl Storz GmbH, Tuttlingen, Germany) and McGrath (McGrath-MAC, Aircraft Medical Ltd., Edinburgh, UK) VLs are popular for use when difficult airway management is encountered[5]. The McGrath VL is a portable, lightweight unit with a single-use disposable angulated acrylic blade. It features its own flat-screen monitor mounted to the handle, and thus allows a neutral line-of-sight with the patient when in use. It requires the use of a pre-curved stylet tracheal tube and insertion along the midline of the oral cavity. The C-MAC VL, on the other hand, features a blade similar to a Macintosh steel blade with a camera at the tip. It does not require a pre-curved/curved stylet tracheal tube in routine usage, as it is inserted into the oral cavity using the standard direct laryngoscopic technique. Both VLs provide a magnified view of laryngeal structures and the glottic opening allowing the anesthesiologist to facilitate the manipulation of the airway device.

Although the use of VLs for intubation has been well established in studies focused on the management of difficult airway in literature, their use in routine elective obese patients has as yet not been studied in detail. In the present study, we hypothesize that the C-MAC VL would allow faster, easier and more successful tracheal intubation than the McGrath VL in adult obese patients with difficult airway. The present study compares the effect of stylet use on the success rate of intubation with a McGrath VL and a C-MAC VL in adult obese patients in the ramp position.

Patients and Methods

Following the granting of approval for the study by the Hospital Ethics Committee (Registry No: 18-925-16), 100 obese (Class II and III) adult ASA II patients undergoing several types of surgery under general anesthesia between December 2018 and September 2021 at a university hospital were included in this current prospective controlled clinical study. The study was registered to ClinicalTrials.gov with the NCT Number: NCT03402581.

All patients included in the study were informed about the study and written consent was obtained. The study did not benefit from any industrial or medical device company sponsorship. Obesity was defined as BMI 30 kg/m^2 and above, based on the WHO classification (Class I: 30-34.9 kg/m^2, Class II: 35-39.9 kg/m^2, Class III: >40 kg/m^2). Patients with risk factors for gastric aspiration, uncontrolled cardiovascular or cerebrovascular disease, or a history of drug allergy, and those undergoing emergent surgery, were excluded from the study.

A senior anesthesiologist carried out a preoperative airway assessment of each patient one day before surgery. All demographics, including age, gender, height, weight, BMI, ideal body weight (calculated), ASA physical status, and STOP-Bang score for assessing the risk of obstructive sleep apnea (OSA), were recorded.

Patients defined as Class II or III obese were assessed for difficult airway using the modified Mallampati grading (Mallampati Class III or IV), the measurement of thyromental distance (less than 6 cm), sternomental distance, interincisor distance (less than 4 cm), upper lip bite test (ULBT), and evaluation of neck mobility and neck circumference. The patients were also assessed in terms of "Airway Difficulty Score" (ADS) and "Total Airway Score" (TAS)[6,7].

The patients were randomly assigned to one of the two study groups, Group M, intubated using a McGrath VL, and Group C, intubated using a Storz C-MAC® VL.

On the day of surgery, the patients were taken to the operating room without premedication, and standard monitoring was carried out, including pulse oximeter, electrocardiogram (ECG), non-invasive blood pressure (NIBP) and neuromuscular monitoring (NMT) (Carescape® B650 Monitor, GE, USA).

Optimal patient positioning maximizes the success of laryngoscopy and tracheal intubation, and so all patients were positioned routinely in the "ramped" position after premedication with intravenous midazolam (0.05 mg/kg) to achieve the horizontal alignment of the external auditory meatus and the suprasternal notch, thus improving the view and exposure during direct/indirect laryngoscopy. Patients were preoxygenated for 3 minutes with 70% O_2. After the induction of anesthesia with thiopental (4-5 mg/kg), remifentanil (0.5-1 micgr/kg) and rocuronium (0.9 mg/kg), the patient was assessed for difficult mask ventilation[8]. After achieving profound block based on the lack of response to TOF stimulation (TOF=0), a direct laryngoscopy was performed, and a CL grading was given by one of the two anesthesiologists, both of whom had >5 years of clinical experience and had performed at least 50 successful intubations using both VLs.

A direct laryngoscopy was performed with VLs to assess the glottic view, and the CL and time to best glottic view (t_0) were recorded. After recording the direct CL score, the indirect CL score was also evaluated and recorded. The intubation was then performed, and if successful, the intubation time was recorded as t1. If the intubation failed, a further attempt was made with a styled endotracheal tube, with or without external laryngeal pressure, and the intubation time of the second attempt was recorded as t2 if successful. If this second attempt failed, a third attempt was made using a Storz C-MAC® VL with D blade, and if successful, the intubation time was recorded as t3. In the event of a failed third intubation attempt, a laryngeal mask airway (LMA), flexible fiberoptic bronchoscopy (FOB) or awakening the patient were planned as an alternative. In all of the intubation attempts, the visualization of $ETCO_2$ trace was accepted as successful intubation, and the time to successful intubation was recorded as the total intubation time. The "Intubation Difficulty Scale (IDS)" value was also recorded after successful intubation[9] (Figure 1).

Statistical Analysis

A statistical power analysis was performed for sample size estimation based on data from a published study (16) (N=50) comparing V-MAC to McGrath VLs for intubation success at the first attempt. With an alpha = .05 and power = 0.95, the projected sample size needed with this effect size (calculated by GPower 3.1.9.2 software) is approximately N = 49 for this between-group comparison. Considering the loss rates, it was planned to conduct the study with 50 patients in each group.

SPSS Version 11.5 (SPSS Inc, Chicaco, IL, USA) was used for statistical analysis. Numerical variables were expressed as mean±standard deviation and median (minimum-maximum); categorical variables were expressed as counts and percentages. Between-group differences were determined by an independent sample t-test for numerical variables with a normal distribution, and a Mann-Whitney U test for numerical variables without normal distribution. Chi-square and Fisher-exact tests were used to examine the relationship between two categorical variables. A receiver operating characteristic (ROC) analysis was performed, and the Youden Index value was used to calculate the cut-off value for the numerical variable. Univariate and multivariate logistic regression analyses were used to identify risk factors affecting the need for a second endotracheal intubation. Statistical significance was considered as p <0.05.

Results

The data of 100 Class II and III obese patients who underwent intubation either with the McGrath (Group M, n=50) or C-MAC (Group C, n=50) VLs were evaluated in the study. Descriptive statistics of numerical variables in the study, including age, BMI, STOP-Bang score, variables used to evaluate airway, scores used to predict difficult airway, time to best glottic view and durations of all intubation attempts are presented in Table I. There were no statistically significant differences between the groups in terms of age,

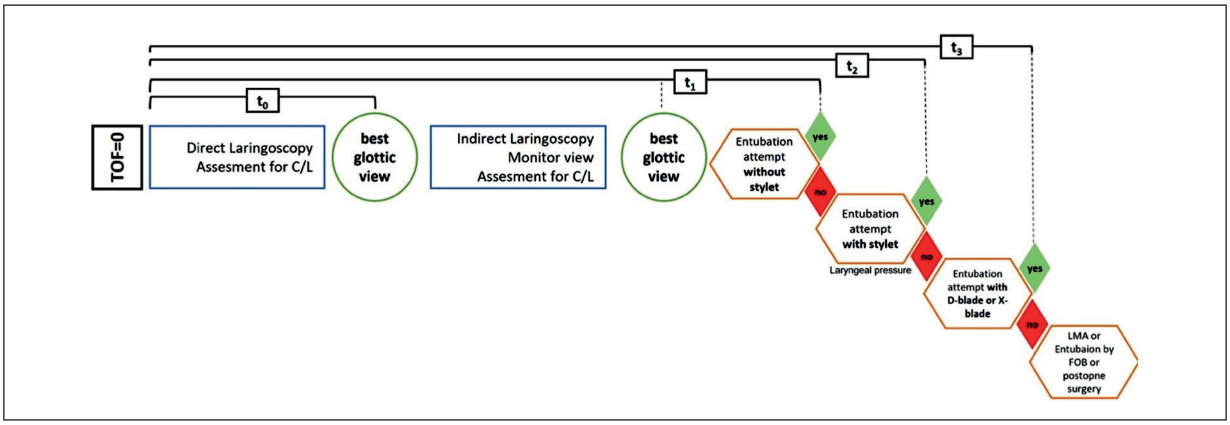

Figure 1. Intubation procedure and timings of recorded data.

Table I. Numerical variables related to demographic, preoperative airway assessment and endotracheal intubation.

Variables	C-MAC		McGrath MAC		Total		
	Mean ± SD	Med (min-max)	Mean ± SD	Med (min-max)	Mean ± SD	Med (min-max)	*p*
Age (years)	51.22 ± 10.69	53.00 (22.00-65.00)	49.48 ± 11.22	50.00 (22.00-65.00)	50.35 ± 10.94	53.00 (22.00-65.00)	0.488[b]
BMI (kg.m^{-2})	41.08 ± 4.81	40.00 (36.00-55.00)	40.22 ± 4.03	39.05 (36.00-54.00)	40.65 ± 4.43	39.30 (36.00-55.00)	0.524[b]
STOP-Bang Score	3.72 ± 1.31	4.00 (1.00-7.00)	3.42 ± 1.65	3.00 (1.00-7.00)	3.57 ± 1.49	3.50 (1.00-7.00)	0.294[b]
TMD (cm)	7.21 ± 1.04	7.30 (4.60-9.20)	7.42 ± 1.27	7.45 (4.60-10.30)	7.32 ± 1.16	7.40 (4.60-10.30)	0.357[a]
SMD (cm)	13.16 ± 1.58	13.10 (9.80-16.80)	13.25 ± 1.46	13.40 (10.00-16.50)	13.20 ± 1.52	13.20 (9.80-16.80)	0.763[a]
IIG (cm)	4.39 ± 0.57	4.40 (3.50-5.80)	4.21 ± 0.66	4.20 (2.50-6.30)	4.30 ± 0.62	4.20 (2.50-6.30)	0.139[a]
NC (cm)	40.88 ± 4.55	40.00 (31.00-55.20)	42.29 ± 4.72	41.80 (31.40-54.00)	41.58 ± 4.67	40.90 (31.00-55.20)	0.132[a]
ADS	8.38 ± 1.10	8.00 (5.00-10.00)	8.12 ± 1.26	8.00 (5.00-10.00)	8.25 ± 1.18	8.00 (5.00-10.00)	0.249[b]
TAS	5.02 ± 1.33	5.00 (2.00-8.00)	4.66 ± 1.52	5.00 (1.00-8.00)	4.84 ± 1.43	5.00 (1.00-8.00)	0.237[b]
IDS	2.04 ± 2.22	1.00 (0.00-8.00)	1.44 ± 1.54	1.00 (0.00-6.00)	1.74 ± 1.93	1.00 (0.00-8.00)	0.236[b]
Time to best glottic view (s)	10.54 ± 3.14	10.00 (6.00-16.00)	10.58 ± 3.04	10.00 (5.00-16.00)	10.56 ± 3.08	10.00 (5.00-16.00)	0.949[b]
Time to first intubation (s)	43.42 ± 9,.24	41.50 (29.00-68.00)	39.72 ± 9.97	39.00 (20.00-65.00)	41.57 ± 9.74	40.00 (20.00-68.00)	0.104[b]
Time to second intubation (s)	33.40 ± 13.07	28.00 (19.00-61.00)	29.39 ± 6.90	27.50 (18.00-48.00)	31.50 ± 10.67	27.50 (18.00-61.00)	0.781[b]
Time to total intubation (s)	62.86 ± 33.67	55.50 (32.00-219.00)	53.70 ± 19.08	47.50 (25.00-108.00)	58.28 ± 27.61	50.00 (25.00-219.00)	0.488[a]

[a]: Student-*t* test, [b]: Mann-Whitney U test, SD: Standard Deviation, Min: Minimum, Max: Maximum, BMI: Body Mass Index, TMD: Thyromental distance, SMD: Sternomental distance, IIG: Inter-incisor gap, NC: Neck circumference, ADS: Airway Difficulty Score, TAS: Total Airway Score, IDS: Intubation Difficulty Scale

BMI, STOP-Bang score, airway assessment parameters, Airway Difficulty Score (ADS), Total Airway Score (TAS) and Intubation Difficulty Scale (IDS). There were also no statistically significant differences between the groups in terms of the best glottic view time with direct laryngoscopy, first and second intubation time, and total intubation time.

Descriptive statistics of such categorical variables as gender, ASA score, OSA risk score calculated according to STOP-Bang score, Mallampati score, ULBT, direct and indirect CL score, number of patients who had better indirect CL scores than direct CL scores (improvement in CL score), difficult mask ventilation classification, the number of patients needing second intubation, the number of patients requiring the use of stylets, the number of patients who underwent laryngeal compression and the degree of intubation calculated according to the IDS are presented in Table II.

There was no difference between the groups in the numerical or categorical variables used to evaluate airway. In the preoperative evaluation, only five (5%) patients had a diagnosis of OSAS. The OSA risk score calculated according to the STOP-Bang score was found to be high in 11 (22%) patients in Group C and 13 (26%) in Group M.

When the distribution of the CL scores during direct laryngoscopy was compared, a statistically significant difference was noted between the groups (p=0.011). Although the distribution of CL scores during direct laryngoscopy was different, most of the patients had a CL score of 2 or 3 in both groups.

There was a statistically significant difference between the groups in terms of the distribution of CL scores during indirect laryngoscopy (p<0.001). Although the distribution of CL scores during indirect laryngoscopy was different, most patients had a CL score of 1 or 2 in both groups.

When indirect laryngoscopy was performed after direct laryngoscopy, an improvement in CL score was observed in 72% of the patients, and there was no statistically significant difference between the groups in terms of the number of patients (p=0.373).

There was no difference between the groups in terms of difficulty in mask ventilation, number of second intubation attempts, number of patients requiring stylet use and laryngeal compression. Stylets were used in 18 patients in Group M and 20 patients in Group C due to the difficulty in directing the endotracheal tube at the first intubation attempt (p=0.68). A second intubation attempt was made on 38 patients in the entire sample, and was successful in 37 patients, while the final patient, in Group C, was intubated at the third attempt. When the degree of intubation difficulty was evaluated according to the intubation difficulty scale (IDS) score, moderate to major difficulty was observed in three patients in Group C and in one patient in Group M.

When the ROC analysis results for the ADS and TAS scores were evaluated in patients who underwent a second intubation attempt, the areas under the curve were found to be significant for both variables. The cut-off value was found to be 8.50 for ADS score and 4.50 for TAS score (Table III, Figure 2).

When the univariate logistic regression analysis results were evaluated for patients who required a second intubation attempt, ADS score, TAS score, CL score DL, and CL score IN were found to be significant risk factors (Table IV). An increase in the ADS and TAS scores by one unit increases the risk of a second intubation requirement by 2.086 and 1.506 times, respectively.

In addition, a CL score in direct laryngoscopy of 3 or 4 rather than 1 or 2 increases the risk of a second intubation requirement 9.6 times, and a CL score on indirect laryngoscopy of 3 or 4 rather than 1 or 2 increases the risk of a second intubation requirement by 16.2 times. A multivariate logistic regression analysis revealed none of the variables to be significant when evaluated together.

Discussion

The use of both C-MAC® and McGrath VLs for difficult intubation has been well established and studied in literature, as VLs provide a better glottic view than direct laryngoscopes. In the present study we evaluate whether or not C-MAC® VL allows faster and easier tracheal intubation with a higher success rate than the McGrath VL in obese patients. No difference was identified in the number or duration of intubation attempts, or in the number of patients requiring a second intubation attempt. The ease of orientation and manipulation of the endotracheal tube when using a stylet during the second intubation attempt led us to consider that a stylet can increase the likelihood of successful intubation at

Table II. Categorical variables related to demographics, preoperative airway assessment, and endotracheal intubation.

Variables	C-MAC Count	C-MAC %	McGrath MAC Count	McGrath MAC %	Total Count	Total %	*p*-value
Gender							0.648[a]
Female	38	76.0	36	72.0	74	74.0	
Male	12	24.0	14	28.0	26	26.0	
ASA Score							0.577[a]
1	9	18.0	12	24.0	21	21.0	
2	35	70.0	30	60.0	65	65.0	
3	6	12.0	8	16.0	14	14.0	
Obstructive sleep apnea risk							0.337[a]
Low	9	18.0	14	28.0	23	23.0	
Intermediate	30	60.0	23	46.0	53	53.0	
Severe	11	22.0	13	26.0	24	24.0	
Mallampati class							0.469[a]
1	5	10.0	5	10.0	10	10.0	
2	6	12.0	12	24.0	18	18.0	
3	15	30.0	12	24.0	27	27.0	
4	24	48.0	21	42.0	45	45.0	
Upper lip bite test							0.495[b]
1	35	70.0	38	76.0	73	73.0	
2	15	30.0	11	22.0	26	26.0	
3	0	0.0	1	2.0	1	1.0	
Classification of difficult mask ventilation							0.556[b]
1	29	58.0	24	48.0	53	53.0	
2	18	36.0	24	48.0	42	42.0	
3	3	6.0	2	4.0	5	5.0	
Cormack-lehane score in direct laryngoscopy							0.011[a]
1	6	12.0	10	20.0	16	16.0	
2	15	30.0	27	54.0	42	42.0	
3	21	42.0	11	22.0	32	32.0	
4	8	16.0	2	4.0	10	10.0	
Cormack-lehane score in indirect laryngoscopy							< 0.001[b]
1	15	30.0	36	72.0	51	51.0	
2	28	56.0	13	26.0	41	41.0	
3	4	8.0	1	2.0	5	5.0	
4	3	6.0	0	0.0	3	3.0	
Improvement in cormack-lehane score							0.373[a]
-	16	32.0	12	24.0	28	28.0	
+	34	68.0	38	76.0	72	72.0	
Using Stylet							0.680[a]
-	30	60.0	32	64.0	62	62.0	
+	20	40.0	18	36.0	38	38.0	
External laryngeal manipulation							0.766[a]
-	43	86.0	44	88.0	87	87.0	
+	7	14.0	6	12.0	13	13.0	
Degree of difficulty							0.611[b]
Easy	17	34.0	20	40.0	37	37.0	
Slight	30	60.0	29	58.0	59	59.0	
Moderate-Major	3	6.0	1	2.0	4	4.0	

[a]: chi-square test, [b]: Fisher-exact test, ASA: American Society of Anesthesiology.

the first attempt during a VL, and to shorten the intubation time and cause less trauma to the airway in obese patients.

Although in recent years VLs have come to be widely used for the improvement of glottic imaging and to increase the success of intubation

Table III. ROC analysis results for ADS and TAS.

	Area	Std. Error	*p*-value	95% confidence interval		Sensitivity	Specificity	Cut-off value
				Lower bound	Upper bound			
ADS	0.698	0.053	0.001	0.593	0.803	0.632	0.677	8.50
TAS	0.648	0.056	0.013	0.538	0.758	0.737	0.484	4.50

ADS: Airway Difficulty Score, TAS: Total airway score.

in patients with expected difficult airway, their routine use during endotracheal intubation in specific patient groups, such as the obese, is a new issue that has yet to be evaluated in detail. Mask ventilation in obese patients may also be difficult due to upper airway obstruction and reduced pulmonary compliance, and the incidence of difficult mask ventilation is significantly higher in morbidly obese patients than in non-morbidly obese patients[10,11]. Rapid desaturation can be seen in obese patients after the induction of anesthesia, despite preoxygenation, as these patients have reduced functional residual capacity (FRC) and increased oxygen consumption. In such patients, it is important to extend the safe apnea time through ramp position and preoxygenation, which provides better gas exchange than the supine position prior to anesthesia induction. The external auditory meatus and suprasternal notch are aligned horizontally in the ramp position, improving exposure during video laryngoscopy[12,13]. As noted in a recent meta-analysis, the risk of difficult laryngoscopy and difficult airway is high during direct laryngoscopy in adult obese (BMI $\geq$ 30 kg/m^{-2}) patients[14]. Compared to direct laryngoscopy, video laryngoscopy provides better vocal cord exposure in both the ramp and supine positions in obese patients[15,16]. Video laryngoscopes improve glottic vision, and reduce the number of failed intubations and laryngeal/airway trauma[17,18]. In the present study, high CL scores recorded during direct laryngoscopy with either McGrath or C-MAC® VLs decreased when evaluated with indirect laryngoscopy. In addition, a CL score of 3 or 4 rather than 1 or 2 during both direct and indirect laryngoscopy was found to be a significant risk factor for a second intubation attempt requirement.

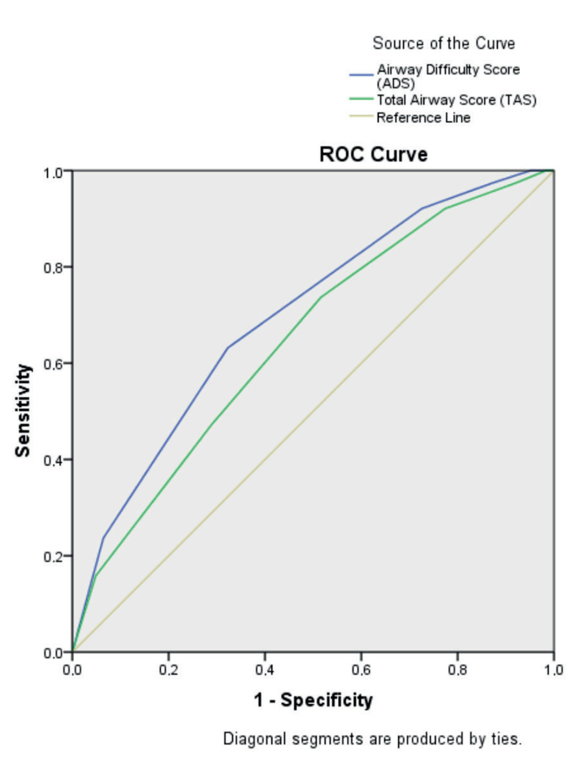

Figure 2. ROC curve for airway difficulty score and total airway score.

It is necessary to use shaped stylets to facilitate intubation during the use of non-channeled VLs fitted with angled blades, although stylets may not be used as routine during intubation with VLs that do not have an angled blade. During laryngoscopy with C-MAC® VL, using a stylet that angles the distal tracheal tube provides no benefit in an easy laryngoscopy scenario, but may be beneficial in more difficult laryngoscopy scenarios[19]. When intubation was carried out without stylets with GlideScope, C-MAC® and McGrath VLs in patients with normal airways, the successful intubation rate was found to be higher in the initial attempt with C-MAC®. A stylet was required in 7% of patients using C-MAC® and approximately 50% of patients in the other two VL groups[20]. In the study by Maasen et al[16], the authors tried to intubate obese patients using

Table IV. Univariate logistic regression results for second endotracheal intubation.

		β	SE	*p*-value	OR	95% CI of OR	
						Lower limit	Upper limit
McGrath MAC	C-MAC	0.170	0.412	0.680	1.185	0.528	2.660
Gender (Female)	Male	0.244	0.465	0.599	1.277	0.513	3.173
Sternomental distance		-0.066	0.137	0.628	0.936	0.715	1.224
Neck circumference		0.038	0.044	0.390	1.039	0.952	1.133
Risk of OSA (Low-Intermediate)	Severe	0.203	0.477	0.671	1.224	0.480	3.122
Airway Difficulty Score		0.735	0.229	0.001	2.086	1.330	3.270
Total airway score		0.409	0.162	0.012	1.506	1.096	2.068
CL score in DL (1 or 2)	(3 or 4)	2.262	0.477	< 0.001	9.600	3.766	24.473
CL score in IL (1 or 2)	(3 or 4)	2.789	1.084	0.010	16.267	1.944	136.104

β: Regression coefficient, SE: Standard error, 95% CI of OR: 95% confidence interval of odds ratio, OSA: Obstructive Sleep Apnea, CL: Cormack-Lehane, DL: Direct laryngoscopy, IL: Indirect laryngoscopy.

GlideScope, C-MAC® and McGrath VL without using a stylet, but failed despite two attempts. The patients were then successfully intubated using a stylet shaped like a hockey stick with a 90° angle at the third attempt. In this study by Maasen et al[16], 60% of patients in the GlideScope group, 76% of patients in the McGrath group and 10% of patients in the C-MAC® group were intubated using a stylet, while in the present study, 40% of patients in the C-MAC® group and 36% of patients in the McGrath group who could not be intubated at the first attempt were intubated using a stylet angled at 60° and shaped like a hockey stick. In the present study, there was no difference between the VLs in terms of the stylet use rate, and the number of patients requiring stylet use was low comparing to previous studies, which we believe was attributable to the fact that positioning the patients in ramp position provided better glottic exposure when compared with the supine position.

The parameters used for airway evaluation in obese patients and the scoring systems developed using these parameters were evaluated in several previous studies, and their efficacy in the prediction of difficult mask ventilation and difficult intubation were investigated. Morbid obesity, age>46, male sex, Mallampati class 3–4 and history of obstructive sleep apnea (OSA) were found to be risk factors for difficult mask ventilation[11]. In one study, male sex, Mallampati III-IV and obstructive sleep apnea were identified as other independent predictors of impossible mask ventilation[20]. In the present study, the difficult mask ventilation was identified in 5% of the obese patients. Although the rate of patients diagnosed as OSA was 5%, the rate of patients at high risk of OSA was found to be 24% with STOP-Bang questioning. In the present study, neither high risk of OSA or male sex increased the risk of a second intubation attempt requirement, although when the relationship between difficult mask ventilation and OSA is considered, it is better to carry out a routine STOP-Bang assessment of these patients during the preoperative period.

Different criteria, such as Cormack-Lehane degree, the number of tracheal intubation attempts or Intubation Difficulty Scale (IDS) score have been used to define difficult intubation in literature, and such differences in the definition of difficult intubation could lead to conflicting results in estimating the relationship between obesity and difficult tracheal intubation[21]. The Intubation Difficulty Scale assesses seven subjective and objective parameters associated with difficult intubation, and can serve as a uniform approach for the comparison of the findings of related studies[9]. The scale has been developed to define difficult intubation in patients undergoing intubation, and makes no discrimination between direct laryngoscopy or VLs. In the present study, the difficulty of endotracheal intubation with two different VLs was evaluated with the IDS, and a 4% moderate–high difficulty was identified. Mild difficulty was experienced in 59% of patients, and mostly in those with high CL scores who required stylet use during the second intubation attempt. Difficult or unsuccessful tracheal intubation is defined by ASA as a tracheal intubation requiring multiple attempts or tracheal intubations that fail after multiple attempts[22]. Based on this definition, 38% of the patients included in our study had difficult tracheal intubation. Since VLs improve glottic exposure and increase the success rate of intubation, the scales used to identify difficult intubation with these devices should be re-rated and reviewed.

Factors associated with difficult intubation include patient age > 46, male sex, Mallampati class 3–4, thyroid distance <6 cm, and the presence of intact teeth. In the present study, during the evaluation of risk factors for a second intubation attempt, we investigated whether or not difficult airway score and total airway score were predictive of difficult endotracheal intubation. The total airway score is a more accurate predictor of difficult intubation when compared to these parameters, and patients with a TAS core of >6 were found to be 13.57 times more likely to experience difficult endotracheal intubation[7]. Difficult airway scores greater than 8 indicate difficult intubation[6]. In the present study, the risk of a second intubation requirement was noted to increase with a one unit increase in the difficult airway score or TAS Score. Furthermore, a ROC analysis of the patients requiring intubation for the second time in the present study revealed a score of 8.50 for difficult airway score and 4.50 for TAS Score. In a systematic review comparing the results of video laryngoscopy and direct laryngoscopy in patients requiring tracheal intubation, no statistically significant difference was found between the devices in terms of the proportion of successful initial trials and the proportion of patients requiring multiple trials[17]. The effect of obesity on failed intubation rates, however, could not have been evaluated due to the lack of data in the review.

In a study comparing DL and VL in terms of their first-pass intubation success rates, the rate with VL was found to be 72.5% using such airway assisting devices as bougies, stylets, laryngeal manipulations or aspiration[23], although most of the patients in the study were non-obese, and their ADS scores were less than 8. In the present study, the success of the initial intubation attempt with a video laryngoscope was found to be 62%, although when a stylet was used (38%) and external laryngeal manipulation (13%) were applied together, the success rate reached 97% in the second attempt. We thus conclude that in obese patients with a difficult airway score of >8.5 and a TAS Score of >4.5, which poses a risk for second intubation requirement, the use of stylet could be a suitable and recommended initial approach.

It is not technically possible to blind the intubating anesthesiologist to the type of VL, and this may lead anesthetist bias if s/he has a preference for a particular device. This may be considered a limitation of the present study. That said, the design of the study and intubation steps, however, can be considered well-defined and objective.

Conclusions

Obese patients are always at serious risk during intubation, and the anesthesiologist is obliged to take the necessary measures to minimize this risk and to carry out the process without harming the patient. VLs in general may offer the best glottic exposure for the intubation of a difficult airway, especially in obese patients. Different VL blade designs may be compared in obese patients with different types of airway problems to assist anesthetists in their selection of the most appropriate device in each individual clinical scenario, although stylet usage should always be encouraged for the success of the first intubation. We found both McGrath and C-MAC® VLs to be efficient and to improve the glottic view, with no failed intubations and eased intubation with the use of a stylet. We thus concluded that regardless of the type or brand of VL used, the use of a stylet in the first intubation attempt should be recommended as it increases the success of the initial intubation.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Consent for Publication

All the authors checked and gave their approval for the publication of this version of the text.

Availability of Data and Materials

Data are available from the corresponding author upon reasonable request.

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Authors' Contribution

S.K.E., Ç.Y.G. and A.A.Y. designed the study. S.K.E., Ç.Y.G. and S.B. carried out the study. S.K.E., S.B. and F.D.E collected the data. S.K.E., Ç.Y.G. and O.B. contributed to the interpretation of the data and the analyses. S.K.E. and A.A.Y. wrote the manuscript. A.A.Y., Ç.Y.G. and S.K.E. supervised the review and editing of the manuscript. All authors read and approved the final manuscript.

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