Original Article

Comparison of the C-MAC D-Blade Video Laryngoscope and the McCoy Laryngoscope in Difficult Airway Patients According to Arne Multivariate Risk Classification: A Randomised Prospective Trial

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ABSTRACT

Background: Difficult intubation is an important cause of morbidity and mortality during anaesthesia. Detection of patient with difficult airway is very important. Arne multivariate risk classification score is one of the tests that is used to detect this difficult airway patients. McCoy direct laryngoscope and the C-MAC videolaryngoscope are parts of among the tools that are currently used for these patients. **Aim:** This study aimed to compare the intubation success and access the quality of difficult airway using the McCoy direct laryngoscope and the C-MAC video laryngoscope. **Methods:** Included in this study were 100 patients scheduled for elective surgery, ASA I–III, who had the Arne multivariate risk classification score >11. The patients were randomly divided into the C-MAC D-Blade video laryngoscope (n = 50) and the McCoy laryngoscope (n = 50). The Mallampati score, Arne multivariate score, intubation success, required time for intubation, number of intubation attempts, required time to visualize the glottis, need for auxiliary equipment, and complications were recorded. **Results:** No differences in the demographic data were observed between the two groups ($P > 0.05$). In addition, no differences were observed between the groups in the required time to visualize the glottis ($P = 0.801$) or the Arne score ($P = 0.619$). The rate of use of gum elastic bougies in Grup C-MAC was lower ($P = 0.014$), and the intubation success rate was higher during the first attempt ($P = 0.016$). The intubation time was longer in the McCoy group ($P = 0.017$). **Conclusion:** The C-MAC D-Blade video laryngoscope was superior to the McCoy direct laryngoscope for difficult-to-intubate patients due to the shorter required time for intubation, higher intubation success rate, and lesser need for auxiliary equipment.

Keywords: *C-MAC D-blade video laryngoscope, difficult airway, McCoy laryngoscope*

Introduction

Difficult intubation is an important cause of morbidity and mortality during anaesthesia. The frequency of difficult intubation is reported to be 5.1%,[1] and the rate of unsuccessful intubation as 0.06 in 1,000 patients.[2] Unsuccessful intubation associated with airway trauma, esophageal intubation, aspiration, cardiac arrest, hemodynamic instability, hypoxemia and hypoxic brain damage. Brain damage and brain death are rare consequences of difficult airway management. Brain damage or death occurs in 1 out of every 180,000 general anaesthesia procedures.[3]

The detection of difficult airway in patient and preparation of difficult airway equipments before

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intubation procedure could be lifesaving. Various models have been developed by Wilson *et al*.,[4] Arné *et al*.,[5] and Naguib *et al*.[6] to predict difficult intubations. The Arne multivariate risk index has 93% sensitivity and 94% specificity for predicting difficult airway cases.[7] A high score (>11), according to Arne multivariate risk score, requires the preparation for a difficult airway.

Many advanced airway devices have been used in anesthesia practice.[8] Difficult and unsuccessful tracheal intubation rates decreased four-fold between 2002 and 2015 with the introduction of these airway devices.[2] The McCoy laryngoscope (ML) and the C-MAC D-Blade video laryngoscope (CMDB) have been used successfully for orotracheal intubation in various anticipated difficult airway scenarios.[9]

This study aims to compare the intubation success and quality of the intubation, using the ML and CMDB devices in patients who were expected to have a difficult intubation according to the Arne multivariate risk index.

Methods

Approval was obtained from the Biomedical Research Clinical Ethics Committee of Adıyaman University Faculty of Medicine (01/24/2017/1-15) before starting the study. This study was carried out in the operating room of the Adıyaman University Training and Research Hospital. The operating room has 17 operating tables and approximately 100 patients are operated daily. The patients with anticipated difficult intubation according to the Arne multivariate classification were identified among patients who were evaluated in the anesthesia outpatient clinic over two years. All patients were informed about the study and the necessary written consent was obtained.

Study groups and randomization

Patients were randomly divided into two groups. The randomization was accomplished with a computer-generated table (www.randomizer.org). The randomization protocol was conducted by an anesthetist who was not involved in the data analysis or the airway management. The group distribution and the type of laryngoscope to be used were determined just before the laryngoscopy was performed. Patients who received the ML (Heineflex type, Germany) were placed in the M group (n = 50), and patients who received the CMDB device (Videoscope-KarlStorz, Tuttligen, Germany) were placed in the C group (n = 50). Patients were blinded to their assignment. All intubations were performed by consultant anesthetists who had performed at least 20 successful intubations with the CMDB. The Difficult Airway Association (DAS) guidelines were used for failed intubation cases.

Inclusion criteria: This study included 100 adult patients aged 18–75 years, who were undergoing elective abdominal surgery, ASA I–III class, scored 11 or above on the Arne multivariate classification [Table 1], and were expected to be difficult to intubate.

Exclusion criteria: Pregnant and pediatric patients, patients in the ASA physical classification IV and above, severe organ failure, severe diseases of the respiratory system, cardiovascular system, and central nervous system, bleeding diathesis, morbid obesity, consent refusal, patients with maxillofacial deformity or documented previously failed intubation, difficulty establishing cooperation, and patients with allergies to the drugs used were not included into this study.

Study design

The first patient was admitted in March 2017, and the study was completed in July 2019. A detailed preoperative evaluation was conducted for each patient, including an assessment of previous surgical and intubation experiences. Demographic data such as age, sex, height, weight, and body mass index (BMI) were collected. Airway assessment was performed using the Mallampati classification to determine the Mallampati score. In addition, measurements of neck circumference, mouth opening, thyromental distance, and sternomental distance were recorded. The Arne multivariate score, which predicts difficult intubation, and the American Society of Anesthesiologists (ASA) physical status classification were calculated for each patient. All collected data were systematically documented in a standardized form. Endotracheal intubation for the patients was planned using either an ML or a CMDB. Standard monitoring was achieved in the operation room. The D Blade compatible C-MAC stylet was used in the C group, and a conventional stylet was used in the McCoy group. A semi-rigid gum elastic bougies was used in both groups according to the intubation needs. In the event of a failed intubation, the DAS guidelines were followed. Supraglottic airway devices, a fiberoptic bronchoscope, and surgical airway equipment (tracheostomy) were kept available for use in the operating room.

Before induction, all patients were preoxygenated with 100% oxygen for three minutes. During induction, 2 μg/kg fentanyl, 2–3 mg/kg propofol, and 0.6 mg/kg rocuronium bromide were intravenously administered. The patients were ventilated with 100% oxygen using a balloon mask until endotracheal intubation. The upper time limit for a tracheal intubation attempt was planned to be 60 seconds. If the intubation attempt was unsuccessful within 60 sec, the patient was ventilated for another 30 seconds with a mask, thereafter a new

intubation attempt was initiated. Patients who could not be intubated during either attempt were recorded as unsuccessful intubation, and a different method which was specified according to the DAS intubation guidelines was used. In cases where patients could be ventilated but direct intubation failed, the plan involved the use of supraglottic airway devices, such as laryngeal mask airways, and fiberoptic bronchoscopy to facilitate intubation. These devices provide alternative airway access and improve visualization of the airway. For patients who could not be ventilated or intubated using these methods, immediate escalation to surgical airway management, including procedures such as cricothyroidotomy or tracheostomy, was planned.

Intubation success, time for the intubation, number of attempts at intubation (trials), time to see the glottis, use of semi-rigid bougies, and complications due to intubation (hypoxia, hypotension, hypertension, bradycardia, tachycardia, and oral bleeding) were recorded for both groups. After mask ventilation was terminated for a patient, the time until the end-tidal CO_2 was seen from the beginning of the intubation attempt was accepted as the intubation time. The standard wake-up and extubation procedures were applied to all patients at the end of the surgery.

Sample size

A power analysis was performed using G* Power 3.1 to calculate the sample size. The sample size was calculated based on the times required for intubation (group C: 39.56 ± 15.65 seconds – group M: 50.34 ± 15.65 seconds) reported in a previous similar study.[10,11] With a 0.8 effect size calculated at the 95% confidence level and power of 80%, 48 patients were needed for each group. The total sample size was increased to 50 patients per group to compensate for patient dropout.

Statistical analysis

Quantitative variables were presented as mean, standard deviation (SD), median, minimum, and maximum values, while categorical variables were expressed as frequencies (number of cases) and percentages. Group comparisons for normally distributed quantitative data were conducted using the unpaired *t*-test, whereas the Mann–Whitney U test was applied for non-normally distributed data. For categorical variables, the Chi-square (χ^2) test was employed, with Fisher's exact test being utilized when the expected cell count was below 5. A *P* value of less than 0.05 was considered statistically significant. All statistical analyses were carried out with SPPS 25 software (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY, USA).

Results

The flow of the participants during the study is shown by the CONSORT diagram [Figure 1]. The sample consisted of 67 males and 33 females, aged 22–75 years. No participant dropped out of the study. The CMDB was used in 50 patients and the ML was used in 50 patients too, who scored 11 or above according to the Arne multivariate risk score and were evaluated as a difficult intubation. One patient in group C and five patients in group M could not be intubated after two attempts and

Table 1: Simplified score model described by Arne *et al*.[5] For prediction of difficult intubation

Risk factors	Score
Previous knowledge of difficult intubation	
No	0
Yes	10
Pathologies associated with difficult intubation	
No	0
Yes	5
Clinicalsymptoms of airway pathology	
No	0
Yes	3
Inter-incisorgap (IG) and mandibleluxation (ML)	
IG ≥ 5 cm or ML > 0	0
3.5 < IG < 5 and ML = 0	3
IG < 3.5 cm and ML < 0	13
Maximum range of head and neck movement	
Above 100°	0
About 90° (90° 10°)	2
Below 80	5
Mallampati'smodified test	
Class 1	0
Class 2	2
Class 3	6
Class 4	8
Total possible	48

Table 2: The sociodemographic characteristics and preoperative examination between the groups

	Group C (*n*=50)	Group ML (*n*=50)	*P*
Age (year)	52.72±11.98	52.14±11.44	0.808
Gender			
F (*n*/%)	16 (32%)	17 (34%)	0.832
M (*n*/%)	34 (68%)	33 (66%)	
Total	50 (100%)	50 (100%)	
BMI (kg/m^2)	31.80±5.60	32.34±5.58	0.631
ASA			
1	31 (62%)	36 (72%)	0.385
2	18 (36%)	12 (24%)	
3	1 (2%)	2 (4%)	
Total	50 (100%)	50 (100%)	
Arne multivariate risk indeks	15.00±3.60	15.38±3.99	0.619

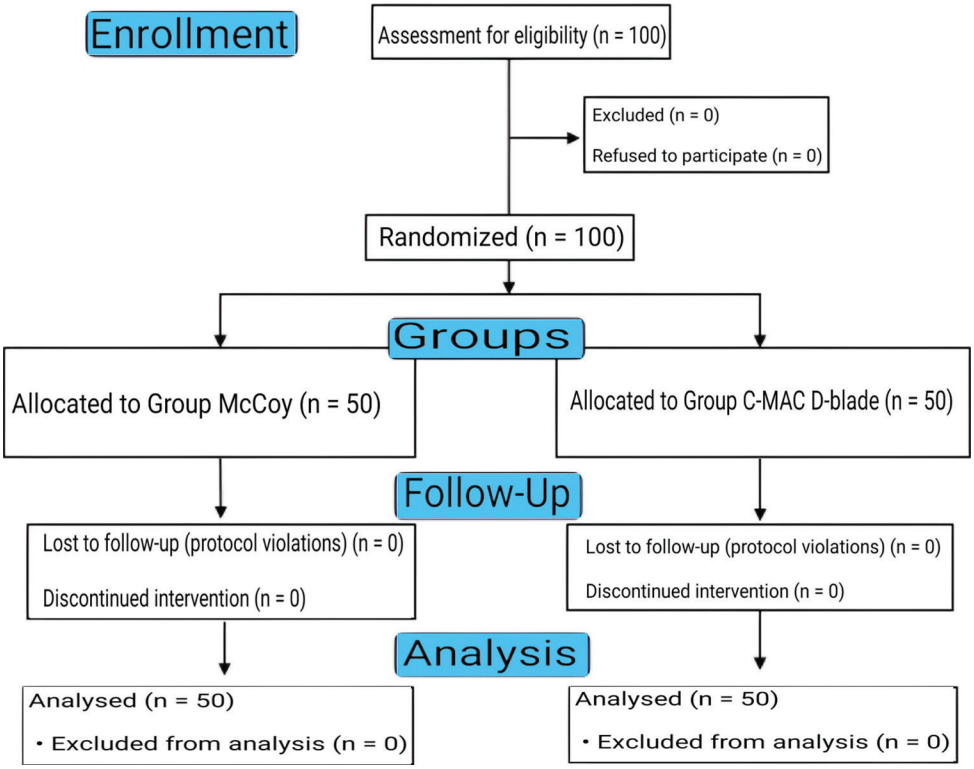

Figure 1: The CONSORT diagram showing the flow of participants in the trial

Table 3: Comparison of the data obtained during intubation between the groups

Parameters	Intubation outcomes of the groups	Group C	Group ML	*P*
The time required to visualize the glottis (sec)*	*n*	49	45	0.801
	Mean±Std	11.47±5.08	11.73±5.05	
Required time for Intubation (sec)*	*n*	49	45	0.017
	Mean±Std	27.76±14.79	35.96±17.82	
Complications	Yes	2 (4.1%)	4 (%8.9)	0.349
	No	47 (95.9%)	41 (%91.1)	
	Total	49 (100%)	45 (%100)	
Number of intubation attempts	First try	44 (88%)	34 (68%)	0.016
	Second try	5 (10%)	11 (22%)	
	Unsuccessful	1 (2%)	5 (10%)	
Gum elastic bougies usage rates*	Yes	4 (8.1%)	13 (28.9%)	0.014
	No	45 (91.9%)	32 (61.1%)	
	Total	49 (100%)	45 (100%)	

*While performing the statistical analysis, 6 patients who were considered unsuccessful intubations according to the study protocol were excluded from the evaluation

were accepted as unsuccessful intubations according to the study protocol.

As a result, no differences in gender (P = 0.832), ASA (P = 0.385), age (P = 0.808), BMI (P = 0.631), or Arne multivariate score (P = 0.619). Complication rates (P = 0.349) were found between the groups. Moreover, the gum elastic bougies usage rate was higher in group M (P = 0.014), and the first trial success rate was higher in group C (P = 0.016) [Table 2].

There were no significant differences in the time required to visualize the glottis (P = 0.801) and complication rates (P = 0.349). Moreover, the gum elastic bougies usage rate was higher in the M group (P = 0.014), and the first trial success rate was higher in the group C (P = 0.016) [Table 2]. However, the required time for intubation was longer in the group M (P = 0.017) [Table 3].

Discussion

In this study, CMDB and ML were compared in terms of

intubation success and quality in patients who received difficult intubations. CMDB blade had higher intubation success, shorter intubation times, less gum elastic bougie use, and fewer trials. These findings show that CMDB is superior to ML for difficult intubations.

Problems that develop due to airway management under general anesthesia are important causes of anesthesia-related mortality and morbidity.[12] In addition, intubations performed using blind techniques have been associated with brain damage.[13] Therefore, direct visual intubation of the larynx and verification with an end-tidal CO_2 capnograph is the gold standard for confirming tracheal intubation.

The sensitivity and specificity of the Arne multivariate risk index were high for determining difficult intubation. These have been confirmed in a prospective study of 1,090 consecutive ear, nose, and throat (ENT) and general surgery patients. The sensitivity and specificity were 94% and 96% in general surgeries, 90% and 93% in non-cancer ENT surgeries, and 92% and 66% in ENT cancer surgeries, respectively.[5] Therefore, this test was used in the current study.

Due to recent advances in technology, many airway devices have been developed for successful airway management. Video laryngoscopes developed by combining the advantages of the laryngoscope, fiberoptic bronchoscope, and C-MAC have come into use. This portable video laryngoscope is used with the original Macintosh blade, an angled D blade in combination with a CMOS digital camera, and a strong light-emitting diode. In this study, the D-blade version of the C-MAC video laryngoscope was used.[14]

Unlike the standard laryngoscope blade, ML is hinged at the tip, to improve the visualization of laryngeal structures. The lifting tip provides a better field of view by elevating the epiglottis during intubation. This helps to improve the view in intubated patients according to the Cormack-Lehane (CL) score, by 1 degree compared to the Macintosh blade.[14-16]

Video laryngoscopes have played an increasingly important role in unexpectedly difficult or unsuccessful endotracheal intubations. Videolaryngoscopes are endotracheal intubation tools that contain miniature video cameras allowing indirect visualisation of the glottis. Video laryngoscopes improve the CL score of difficult airway management cases and provide higher endotracheal intubation success rates compared to direct laryngoscopes.[17] The CMDB device is a video laryngoscope with a prominently upward distal end and a pronounced elliptical curvature. Although this curvature provides better imaging, it may be difficult to direct the endotracheal tube into the mouth for successful intubation.[18] To solve this problem, a properly shaped stylet must be used inside the intubation tube with the CMDB.[19] The CMDB has been successfully used for orotracheal intubation in expected difficult airway scenarios, such as morbid obesity[18,20] and cervical trauma.[21] Most anesthetists believe that the video laryngoscope should be used for rapid serial intubation, especially in patients who are expected to have a difficult airway.[22]

Aggarwal *et al*.[23] reported that the glottis was seen more frequently in the CMDB group than ML. However, the time taken to perform the endotracheal intubation was longer in the CMDB group. In this study, the duration of visualizing the glottis was not different between the groups. However, the intubation time was longer in the ML group. The reason was the number of second intubation attempts was higher in the McCoy group, and the intubation time was longer for this group. Similarly, Hazarika *et al*.[11] reported shorter intubation times for patients who were nasally intubated with the CMDB.

Similarly, Jain *et al*.[24] stated that the intubation time was 22 seconds with the CMDB and 26 seconds with the ML. They determined that the glottic visualization time was 5 seconds with the CMDB and 14 seconds with the ML. They noted that the CMDB reduces the difficulty of endotracheal intubation and improves visualization of the glottis in patients with their necks stabilized in a rigid cervical collar compared to the ML. In the present study, intubation time was 27.76 ± 14.79 seconds with the CMDB, which was shorter than ML. Also, the glottic visualization time was 11.47 ± 5.08 sec for the CMDB scope and 11.73 ± 5.05 sec for ML. Despite this similarity, the difference in intubation time may be due to the differences in the appearance and need for auxiliary equipment. The rate of using additional equipment (gum elastic bougies) for the CMDB was 8.1% and for the ML it was 28.9%.

In another study, the success rates of intubation during the first or second trials were 86.7% and 13.3%, respectively. For the ML it was obtained as 93.3% and for the CMDB it was 6.7%.[24] In the present study, the success of the first and second intubation trials was 88% and 10%, respectively, for group C, and for group M it was acquired at 68% and 22%, respectively. In a similar study, Hegazy *et al*.[25] compared the CMDB and fiberoptic bronchoscope in obese patients who were expected to undergo difficult intubation. The success rate of the CMDB was 86.7% during the first attempt and 13.3% during the second attempt. Consequently, the results of the current study are compatible with the literature.

It is occasionally necessary to use auxiliary airway devices for intubation attempts performed by conventional methods. One of these tools is the elastic gum elastic bougies. Elastic gum elastic bougies have been used successfully for decades as an aid to endotracheal intubation.[26] Although it is rare, some complications such as rupture of the trachea, may occur due to the use of the gum elastic bougies.[27,28] In this study, the use of gum elastic bougies was required at a rate of 28.9% in group M and 8.1% in group C. The reason for the lower rate of use of gum elastic bougies with the CMDB may be because it provides better glottic visualization during a difficult intubation. In the current study, no complications were observed due to the use of gum elastic bougies.

The rate of difficult or unsuccessful intubation is more common in obese patients than in non-obese patients.[20,25,29] In this study, the BMI of the patients was 31.8 kg/m^2 in the group C and 32.3 kg/m^2 in the group M. Thus, the cases in both groups were within the limits of obesity.

Previous studies have reported a few instances of lip injuries and bleeding on the laryngoscope in some cases, but no hypoxia or significant hemodynamic disturbances were observed.[25,30] Similarly, in our study, although no hemodynamic instability was noted, minimal airway bleeding was observed in a total of six patients. However, this bleeding did not require any intervention.

Some limitations of our study should be discussed. Firstly, the Arne multivariate score was used to determine the difficulty level of the intubation. Although the sensitivity and specificity of this score are sufficient, it is not a perfect score for detecting difficult intubations. Also, one of the most important tests to predict difficult intubation is the Cormak-Lehane difficulty score. The Cormack–Lehane difficulty score is assessed based on the visibility of the vocal cords, glottis, and surrounding tissues during conventional indirect laryngoscopy. However, modern airway equipment, such as the ML and the CMDB, may facilitate a clearer view of the airway during laryngoscopy. Consequently, the use of these advanced devices could potentially lead to an inaccurate assessment of the Cormack–Lehane difficulty score. Therefore, it is not appropriate to compare them.

Finally, devices such as the fiberoptic bronchoscope and glidescope, which are used for difficult intubations, could be added to the study. Also, the study could be expanded to a multi-centre. This may be the subject for further studies.

Conclusion

We demonstrated the CMDB was superior to the ML. This is because it provided a shorter intubation time and higher intubation success rates during the first attempt, and also required less auxiliary equipment. Based on the information obtained, we recommend that the CMDB be used as the primary airway management choice for patients considered to have a difficult airway. This approach is proposed to help avoid potential harms associated with prolonged duration and increased number of airway interventions.

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Conflicts of interest

There are no conflicts of interest.

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