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ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Comparison of C-MAC Video Laryngoscope with Macintosh Laryngoscope for Elective Tracheal Intubation in Patients with Diabetes Mellitus: Randomized Controlled Trial

Diabetes Mellitus Olan Hastalarda C-MAC Video Laringoskop ve Macintosh Laringoskopun Elektif Trakeal Entübasyon İçin Karşılaştırılması: Randomize Kontrollü Çalışma

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ABSTRACT Objective: C-MAC video laryngoscope and Macintosh direct laryngoscope were compared in terms of intubation conditions, during elective tracheal intubation in patients with diabetes mellitus (DM) who have a high risk for difficult airway. **Material and Methods:** One hundred and ten American Society of Anesthesiologist physical class II-III patients with DM undergoing elective surgery were randomized to be intubated using C-MAC video laryngoscope or Macintosh laryngoscope. Glottic view Cormack Lehane (CL) score, intubation time, intubation difficulty scale (IDS) score, and first attempt intubation success were compared. **Results:** Similar intubation times were detected [Macintosh laryngoscope: 39.6±30.1 seconds; C-MAC: 46.7±35.4 seconds (p=0.098). C-MAC provided significantly better CL scores]. Grade 1 CL laryngeal view was observed in 37 (68%) C-MAC vs. 26 (47.3%) Macintosh laryngoscope intubations (p=0.04). An IDS score of >5 was determined in 11 (20.4%) patients with C-MAC and in 10 (18.2%) with Macintosh laryngoscope (p=0.04), indicating an overall 20.1% moderate-to-severe intubation difficulty (p=0.536). The mean IDS score was 3.2±2.9 and 2.4±3.3 with C-MAC and Macintosh laryngoscopes, (p=0.04). First-attempt intubation success was 83.3% vs. 87.0% with C-MAC vs. Macintosh laryngoscope (p=0.786). **Conclusion:** In patients with DM, C-MAC provided improved glottis visualization, similar intubation time and first-attempt intubation success as a first-attempt intubation device compared with the Macintosh laryngoscope. However IDS scores were higher with the C-MAC. The incidence of actual intubation difficulty was found 20.1% in this diabetic study population.

Keywords: Airway management; intubation, difficult; video laryngoscope

ÖZET Amaç: C-MAC video laringoskop ve Macintosh direkt laringoskop, zor havayolu görülme riski yüksek bir hasta popülasyonu olan diabetes mellituslu (DM) hastaların, elektif trakeal entübasyonunda, entübasyon koşulları bakımından karşılaştırıldı. **Gereç ve Yöntemler:** Amerikan Anestezistler Derneği fizyolojik sınıfı II-III olan ve elektif cerrahi girişim geçiren 110 diyabetik hasta, C-MAC video laringoskop veya Macintosh laringoskop ile entübe edilmek üzere rastgele 2 gruba yarıldı. Glottik görüntü Cormack Lehane (CL) skoru, entübasyon süresi, entübasyon güçlüğü skalası skoru ve ilk denemede entübasyon başarısı oranı karşılaştırıldı. **Bulgular:** Grupların entübasyon süresi benzer bulundu [Macintosh laringoskop: 39,6±30,1 sn; C-MAC: 46,7±35,4 sn (p=0,098)]. CL skoru, C-MAC ile belirgin olarak daha iyiydi; Grade 1 CL laringeal görüntü, C-MAC ile 37 (%68) hastada ve Macintosh ile 26 (%47,3) hastada elde edildi (p=0,04). Entübasyon güçlüğü skoru >5, C-MAC ile 11 (%20,4), Macintosh ile 10 (%18,2) hastada saptandı (p=0,04); araştırma popülasyonda toplam %20,1 orta-ciddi derecede entübasyon güçlüğü saptandı (p=0,536). Ortalama zor entübasyon skalası skoru C-MAC ve Macintosh laringoskopla sırasıyla 3,2±2,9 ve 2,4±3,3 bulundu (p=0,04). İlk denemede entübasyon başarısı C-MAC ile %83,3; Macintosh ile %87,0 bulundu (p=0,786). **Sonuç:** Macintosh laringoskop ile karşılaştırıldığında DM'li hastalarda, C-MAC daha üstün laringeal görüntü kalitesi, benzer ilk deneme başarısı ve benzer entübasyon süresi sağlamasına rağmen C-MAC ile entübasyon güçlüğü skoru daha yüksek bulunmuştur. Bu diyabetik çalışma popülasyonunda zor entübasyon insidansı %20,1 bulundu.

Anahtar Kelimeler: Havayolu yönetimi; entübasyon, zor; video laringoskop

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Whether to use a video laryngoscope in the first tracheal intubation attempt in routine anesthesia practice is a matter of interest. Several studies have been conducted on this subject and reported inconclusive results.[1-3] A variety of video laryngoscopes have been compared with the conventional Macintosh laryngoscope in this regard.[4,5] The use of the C-MAC video laryngoscope (C-MAC, Karl Storz, Tuttlingen, Germany) provides comparable or better glottic views than direct laryngoscopy, however it was reported that, video laryngoscopy-guided intubation has the potential risk of increasing the number of intubation attempts and time, and the use of a tube-guide.[1] In another study, MacGrath video laryngoscope had fewer successful intubations, increased time to intubation and had a higher mean intubation difficulty scale (IDS) compared with the Macintosh group. More optimization maneuvers were required in the McGrath group.[2] One study concluded that the video laryngoscope should not routinely substituted for a conventional Macintosh laryngoscope because time to intubation was longer than direct laryngoscope in morbidly obese patients.[4] In contrast with the last study another study, reported that tracheal intubation was facilitated with significantly lower IDS scores when video laryngoscope was used, compared with the Macintosh laryngoscope.[5] These studies were subjected to meta-analyses that addressed the possible advantage of video laryngoscopes in patients with difficult airways.[6,7] However, these studies were performed in patients with simulated or predicted difficult airways, and the incidence of actual difficult intubation was not clear.[8,9]

Diabetes mellitus (DM) is a chronic disease with multisystem involvement, including the airway; the presence of DM increases the likelihood of difficult intubation.[10] Besides obesity and increased neck circumference, musculoskeletal system changes can lead to difficult intubation.[10] Metabolic disturbances such as glycolysation of tissue proteins and collagen accumulation in periarticular structures are possible causes of the musculoskeletal effects of DM.[11] As a consequence, joints become stiff and rigid; the involvement of the temporomandibular, atlanto-occipital and cervical joints may result in difficulty in the management of the airway. Besides this, patients with DM may have an exaggerated pressor response to tracheal intubation as a reflection of autonomic dysfunction; therefore, first-pass intubation success is even more important because as the number of intubation attempts and intubation time increases, the incidence of adverse events may also increase.[12]

The C-MAC features a Macintosh blade design with a camera close to the tip, the electronic unit and fiberoptic cable is attached to the handle, which connects to a separate monitor. Intubation with the Macintosh laryngoscope is accepted as the gold standard technique.[5] It was reported that C-MAC provides better glottis visualization and improved success rates compared with Macintosh laryngoscope.[6,7] Intubation conditions may be improved by using C-MAC for first attempt elective tracheal intubation instead of direct laryngoscopy in patients with DM.

It was hypothesized that the C-MAC would improve intubation conditions in patients with DM, which is a patient population with high risk of difficult airway, compared to the Macintosh laryngoscope. The aim of this study was to compare the C-MAC with Macintosh direct laryngoscope in terms of intubation conditions for elective tracheal intubation in patients with DM.

MATERIAL AND METHODS

This prospective randomized trial was conducted at an university affiliated training and research hospital, after being approved by the University of Health Sciences Dışkapı Yıldırım Beyazıt Training and Research Hospital Clinical Research Ethics Committee (date: January 29, 2018, no: 45/15) in accordance with the Declaration of Helsinki 1964, and its later amendments, and written informed consent was obtained from the patients. The trial was registered with Clinical Trials (NCT03336476).

One hundred ten adults with DM in American Society of Anesthesiologists (ASA) physical condition II-III, who were due to undergo elective surgery and required tracheal intubation, were enrolled in the study. Patients with a previous history of failed intubation, facial-oral and mentum deformities, and emergency surgery cases were excluded. Patient characteristics, the duration of DM, modified Mallampati score, thyromental distance, sternomental distance, inter-incisor gap (IIG) or intergingival distance in edentulous patients, neck circumference, head and neck movement, and the ability to bite the upper lip and presence of receding mandible were determined for each patient.[13] The airway screening tests were performed in the preoperative area.

Patients were randomized into 2 groups using a computer-generated random numbers list in the operating room by a study investigator (DÜY). Group C-MAC was intubated using the C-MAC® Macintosh blade, group Macintosh was intubated using the Macintosh laryngoscope (Macintosh Classic, Heine Optotechnik, Herrsching, Germany). Intubations were performed by the attending anesthesiologist in the operating room. Cuffed tracheal tubes (Chilecom, Boluo, China) were used; a semi-rigid stylet (Bıçakçılar, İstanbul, Türkiye) was placed in the tracheal tubes in the C-MAC group.[14] The choice of blade (3 or 4) and tracheal tube size was left to the discretion of the attending anesthesiologists. The experiences of the anesthesiologist in video laryngoscope intubations were recorded.

Standard ASA monitoring was applied. Baseline heart rate, mean arterial blood pressure, and peripheral oxygen saturation (SpO_2) were recorded.

Patients were placed in the supine position with a firm pillow providing a sniffing position during intubation, and were pre-oxygenated with 100% oxygen for 3-5 minutes via a face mask until SpO_2 ≥98% was achieved. The anesthesia protocol was standardized: 0.3 mg kg^{-1} midazolam intravenous was used for premedication; fentanyl 1 µg kg^{-1} and propofol 2 mg kg^{-1} were used for induction. After administering 0.6 mg kg^{-1} rocuronium and face mask ventilation for 3 minutes, patients were intubated according to their group allocation.

The C-MAC was used with a midline insertion technique without sweeping the tongue, the tip of the blade was advanced into the epiglottic vallecula under monitor vision; no lifting force was applied. The Macintosh laryngoscope was inserted into the right side of the mouth, the tongue was displaced laterally by the flange of the blade, the blade tip was advanced into the epiglottic valecula, and the epiglottis was elevated gently by raising the laryngoscope in a plane perpendicular to the mandible. The position of both laryngoscopes was adjusted to obtain the best laryngeal view and the trachea was intubated thereafter.

Heart rate, mean arterial blood pressure, and SpO_2 were recorded after intubation. Adverse events related to tracheal intubation: desaturation (SpO_2 <94%); $EtCO_2$ >35 mmHg; hypertension (mean arterial pressure >20% above baseline values); tachycardia (heart rate >20% above baseline values); laryngospasm; bronchospasm; airway trauma (blood stain on intubation device, laceration or trauma to lip or teeth) and sore throat in the post anesthesia care unit were also recorded.

The intubation time was the time elapsed from the insertion of the blade between the teeth to the time an $EtCO_2$ tracing was detected. The glottic view quality was evaluated using Cormack-Lehane (CL) grading as modified by Yentis and Lee (CL, Grade 1: full view of the vocal cords; Grade 2a: partial view of the glottis; 2b: posterior part of the vocal cord and arytenoids visible; Grade 3: only epiglottis visible; and Grade 4: neither epiglottis nor glottis visible) and the percentage of glottic opening (POGO): [0% when none of the glottis is seen to 100% when the entire glottis including the anterior commissure is seen].[15,16] Intubation success at first attempt was recorded. Intubation difficulty was assessed using the IDS score, which includes the numbers of attempts, operators, and alternative techniques used, the CL grade of laryngoscopic view, lifting force and external laryngeal manipulation required, and position of the vocal cords.[17] Every insertion of the laryngoscope and advancement of the tracheal tube towards the glottis counted as an attempt. A score of >5 indicates moderate-to-major difficulty. Intubation time exceeding 120 seconds was considered intubation failure with the allocated device, and an attempt with another device according to choice of the attending anesthesiologist was permitted. In the event that the trachea could not be intubated in 180 seconds, the institutional failed intubation algorithm would be followed. A propofol infusion was continued during intubation attempts. The position of the vocal cords and CL grade of the patients was scored by the anesthesiologist performing intubation; intubation time, intubation success at first attempt, number of intubation attempts, IDS score and adverse events were evaluated by a study investigator (DÜY). Blinding was not possible due to the obvious difference between the laryngoscopes used for intubation.

STATISTICAL ANALYSIS

All categorical variables were analyzed using the chi-square test, whereas normally-distributed variables were analyzed using the independent samples t-test for the mean differences between groups and variables not normally distributed were analyzed using the Mann-Whitney test. Results are presented as mean (standard deviation) or numbers (frequencies), and a Type-I error level of less than 5% was used to infer statistical significance. Sample size calculations were based on a pilot study, involving patients with DM, using the G*Power version 3.1.9.2 (©Faul, Erdfelder, Lang and Buchner, Kiel, Germany, 2009) [intubation time mean 68.5 (37.4) (n=10) vs. 52.0 (23.9) (n=10) seconds with Macintosh laryngoscope and C-MAC respectively]; 54 patients were required in each group to achieve 85% power with α=0.05 and 0.51 effect size; total 110 patients were recruited.[18] Outcome measures were intubation time, IDS score, intubation success at first attempt, intubation failure and glottic view quality. Outcome measures were compared both between main groups and according to the experience of anesthesiologist experience.

RESULTS

One patient in the C-MAC group was excluded due to postponement of surgery; the study was completed with 109 patients (Figure 1). Both

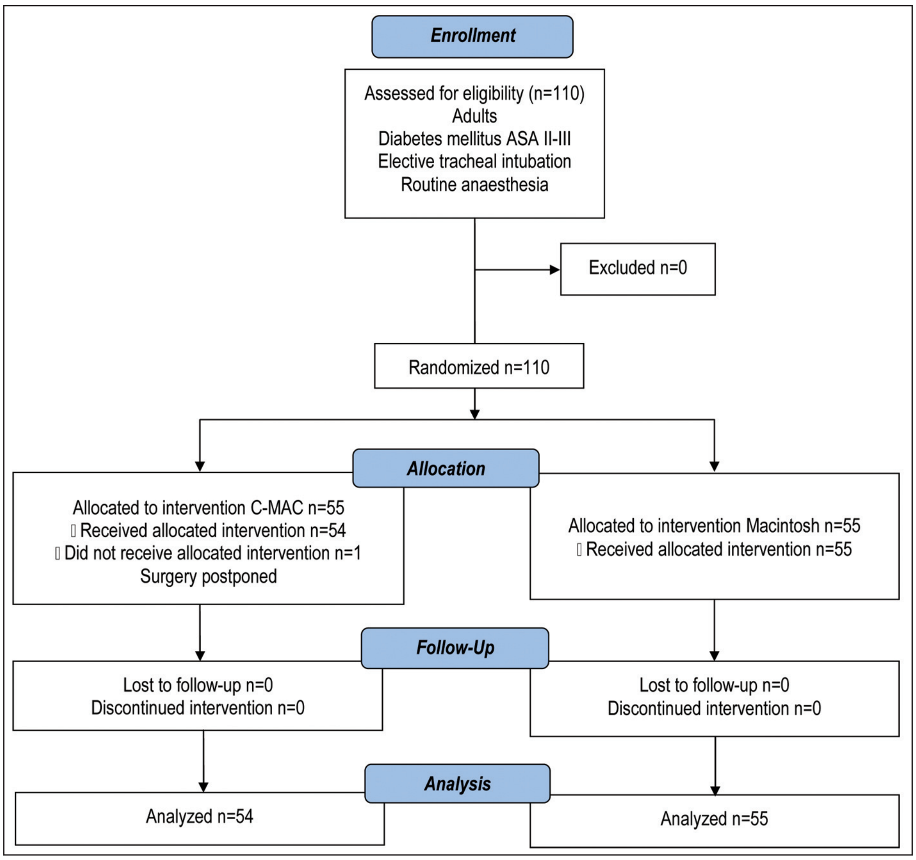

FIGURE 1: CONSORT flow diagram.

ASA: American Society of Anesthesiologists.

TABLE 1: Inter-group comparisons of the patient characteristics and airway screening tests of the study population.

n (%)	Overall (n=109)	C-MAC (n=54)	Macintosh (n=55)	p value
Age, mean±SD, years	56.9±9.9	57.46±10.4	56.54±9.4	0.660
Gender, female, n (%)	76 (69.2)	41 (74.5)	35 (64.8)	0.370
ASA II/III, n (%)	59 (54)/50(46)	31(57)/23(43)	28(50)/27(50)	0.296
Duration of diabetes, mean±SD, years	7.7±7.7	7.03±6.3	8.5±7.9	0.296
BMI, mean±SD, kg m^{-2}	31.1±5.7	31.0±5.8	31.2±5.8	0.829
BMI>30, n (%)	66 (60.5)	33 (60)	33 (61.1)	
Mallampati classification				
I	34 (31.1)	17 (30.9)	17 (31.4)	0.660
II	59 (54)	31 (56.3)	28 (51.8)	
III	15 (13.7)	7 (12.7)	8 (14.8)	
IV	1 (0.9)	-	1 (1.8)	
Total number of difficult airway predictors	2.0±1.4	2.0±1.4	2.0±1.3	0.535
Number of patients having at least 1 predictor	99 (90.8)	50 (92.6)	49 (89.1)	0.742
Number of patients having >2 predictors	33 (30.2)	16 (29.6)	17 (30.9)	1.000
TMD, mean±SD, cm		8.09±2.1	8.2±1.9	0.377
Patients with TMD <6.5 cm, n (%)	24 (22.0)	12 (2)	12 (22)	1.000
SMD, mean±SD, cm		13.8±2.3	14.1±2.1	0.230
Patients with SMD <12.5 cm, n (%)	29 (26.6)	16 (29)	13 (24)	0.707
IIG, mean±SD, cm		4.7±0.9	5.3±1.0	0.04
Patients with IIG <4 cm, n (%)	11 (10.0)	8 (15.1)	3 (5.7)	0.203
Neck circumference, mean±SD, cm		40.8±4.8	41.0±5.6	0.341
Patients with neck circumference >35 cm, n (%)	101 (92.6)	52 (94.5)	49 (96.1)	1.000
Head and neck extension, mean±SD, degree		81.6±22.3	88.9±22.9	0.148
Patients with limited neck movement <80°, n (%)	38 (34.8)	22 (40)	16 (29.6)	0.350
Unable to bite upper lip, n (%)	11 (10.0)	6 (10.9)	5 (9.6)	1.000
Receding mandible, n (%)	9 (8.2)	2 (4.2)	7 (13)	0.165

Values are numbers (frequencies) and mean±SD; C-MAC: C-MAC video laryngoscope; SD: Standard deviation; ASA: American Society of Anesthesiologists physical class; BMI: Body mass index; TMD: Thyromental distance; SMD: Sternomental distance; IIG: Inter-incisor gap; Head and neck extension was evaluated with a goniometer values are the sum of the degree of flexion and extension.

groups were comparable in terms of patient characteristics and duration of DM (Table 1). The groups were also comparable with regard to the presence of difficult airway indicators, except for mean IIG, which was 4.7±0.9 cm in group Macintosh vs. 5.3±1.0 cm in group C-MAC (p=0.04); the number of patients with IIG <4 cm was similar between the groups. Ninety-nine (90.8%) patients had at least 1 difficult airway predictor, and 33 (30.2%) patients had >2 predictors of difficult intubation (Table 1). Visualization of the vocal cords, represented with CL, was significantly better using the C-MAC (p=0.025). The CL laryngeal view was Graded 1 in 37/54 (68.5%) of C-MAC intubations and in 26/55 (47.3%) Macintosh laryngoscope intubations (p=0.04) (Figure 2). The POGO scores were similar (p=0.203).

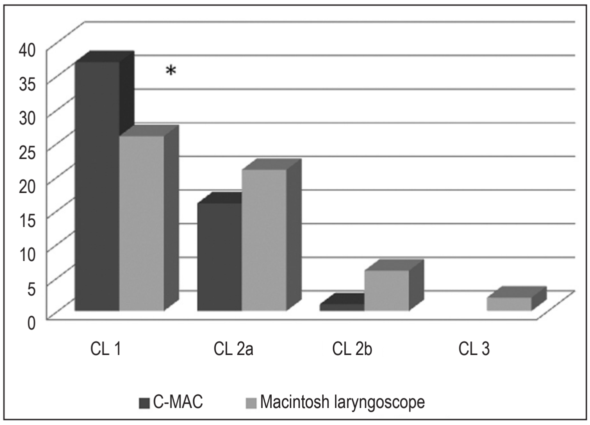

FIGURE 2: Cormack Lehane grades of both groups.
*p=0.025. CL: Cormack Lehane.

The mean intubation time was 39.6±30.1 seconds for the Macintosh laryngoscope and 46.7±35.4 seconds for the C-MAC (p=0.098). Successful intubation at the first attempt was achieved in 47 (87.0%) patients with the Macintosh laryngoscope and 45 (83.3%) patients with the C-MAC (p=0.786). Intubation failure with the allocated device was detected in 2 patients in both groups. The intubation device was changed from the Macintosh laryngoscope to C-MAC D blade in 2 patients; the glottic view improved from CL Grade 3 to CL Grade 1 in these patients. Failed intubations in the C-MAC group were also handled with the D blade according to the attending anesthesiologist's decision; the glottic view improved from 2a and 2b to a CL Grade 1 view. The mean IDS score was higher in C-MAC intubations 3.2±2.9 vs. 2.4±3.3 in Macintosh intubations (p=0.04). The C-MAC and Macintosh laryngoscopes performed similarly for both experienced and non-experienced anesthesiologists (Table 2).

Hypertension and tachycardia after intubation were detected in 1 (5.6%) patient in group C-MAC and in 1 (1.8%) patient in group Macintosh (p=0.363 and p=0.363, respectively). SpO_2 was maintained at >95% during intubation and after intubation, trauma

TABLE 2: Inter-group comparison of the intubation time and intubation conditions of the study population.

n (%)	C-MAC (n=54)	Macintosh (n=55)	p value
Intubation time, mean±SD, seconds	46.7±35.4	39.6±30.1	0.098
IDS score, mean±SD	3.2±2.9	2.4±3.3	0.04
Patients with IDS≤5	43 (79.6)	45 (81.8)	0.983
Patients with IDS>5	11 (20.4)	10 (18.2)	
Intubation success at first attempt	45 (83.3)	47 (87.0)	0.786
Intubation failure with allocated device	2 (3.7)	2 (3.8)	
Glottic view quality			
CL grading			
1	37 (68.5)	26 (47.3)	0.025
2a	16 (29.6)	21 (38.1)	
2b	1 (1.8)	6 (10.9)	
3	-	2 (3.6)	
4	-	-	
Patients with CL Grade 1	37 (68.5)	26 (47.3)	0.04
POGO, mean±SD	81.9±24.6	89.1±10.7	0.203
Adverse events	-	-	
Comparison by video laryngoscope experience (number of video laryngoscope intubations: <50 or ≥50)			
Intubation time, mean±SD, seconds			
<50	41.57±42.52	32.38±13.77	0.828
≥50	49.51±31.23	43.21±35.12	
Intubation success at first attempt			
<50	17 (89.5)	17 (94.4)	0.910
≥50	28 (80.0)	30 (83.3)	
IDS score, mean±SD			
<50	3.4±2.7	2.7±2.7	0.970
≥50	3.0±3.0	2.3±3.6	
Number of intubations pertaining at each experience group			
<50	19 (35.1)	18 (32.7)	0.945
≥50	35 (64.8)	37 (67.2)	

Values are numbers (frequencies) and mean±SD; C-MAC: C-MAC video laryngoscope; SD: Standard deviation; IDS: Intubation difficulty scale; CL: Cormack-Lehane; POGO: Percentage of glottic opening.

of the airway was not detected in any patients, and a sore throat was detected in 6 (11.1%) patients in group C-MAC and in 5 (9.09%) patients in group Macintosh (p=0.761).

DISCUSSION

The results did not confirm the study hypothesis, the C-MAC improved glottis visualization, but neither decreased intubation time nor improved first attempt intubation success, besides the IDS was higher with C-MAC when used as first-attempt intubation device compared with the Macintosh laryngoscope in this diabetic population with a documented 20% difficult intubation rate.

The World Health Organization's Global Report on Diabetes stated that the number of adults with diabetes was 422 million; 50% of these patients would undergo surgery at some time during their lives.[19,20] The metabolic consequences of DM including glycolisation of proteins, blood vessel and nerve damages, collagen accumulation changes the connective tissue.[20] The stiff joint syndrome (diabetic cheiroartropathy) is the most important result for the anesthesiologist.[20] The joint of the hands are the most frequently affected small joints. Often the patient cannot put both hands together in a praying position and press the palmar surfaces, which is called the prayer sign.[21] This feature is used as a preoperative screening test to predict difficult laryngoscopy in patients with DM. Also studies have shown that the presence of limited neck movements has a predictive value for difficult laryngoscopy.[21-25] An increase in the frequency of difficult laryngoscopy in patients with diabetes was previously confirmed.[10,22,23-25]

In this study we did not include patients according to the presence of difficult intubation predictors; instead, a patient population that can be regarded as an example of difficult airways was studied. Accordingly, over 90% of the study population had at least one difficult airway predictor and one-third had more than two difficult airway predictors. The most frequent difficult airway predictor was increased neck circumference, which was detected in half of the patients. The second most frequent predictor was decreased neck mobility, which was detected in one-quarter of the patients. The body mass index of the patients was high, indicating an obese study population. In consequence, over 20% moderate-to-major intubation difficulty was detected in this diabetic population.

Previous studies comparing the C-MAC with Macintosh laryngoscope were conducted in patients with difficult airway predictors. Aziz et al. reported that the C-MAC increased glottic visualization and the rate of successful intubations at first attempt compared with the Macintosh laryngoscope.[8] Although the authors presented data that represents a broad range of potential airway difficulties, intubation difficulty was not assessed and the incidence of difficult intubation in this study population was not reported. Noppens et al. evaluated these 2 devices in critical care setting. At least one predictor of potential difficult intubation was observed in 15% and 18% of patients intubated using the Macintosh laryngoscope and C-MAC.[26] The authors reported increased success rates at the first attempt with the introduction of the C-MAC in patients with a potentially difficult airway. In their study, intubation difficulty was not assessed with an index and was defined as at least 2 unsuccessful intubation attempts. According to this definition, a lesser actual difficult intubation rate was reported as compared with our study; 7% and 3% with the Macintosh laryngoscope and C-MAC. Meininger et al. compared direct larygoscopy and C-MAC laryngoscopy in unselected patients undergoing ear-nose-throat surgery, which were considered more susceptible to an unexpected difficult airway than the general population.[27] Difficult laryngoscopy was documented in 42% of the study population, however intubation difficulty was not assessed.

It is important that actual intubation difficulty is determined in our study because no single anatomic factor is able to predict a difficult airway or difficult intubation, and current screening tests are only of modest sensitivity and specificity in predicting difficult airways.[28] Therefore, previous studies performed on patients with predictors of difficult airway may not necessarily have been performed in difficult intubations.

A comparison of the Macintosh laryngoscope and the C-MAC in patients with known intubation difficulty does not exist; however, the Macintosh laryngoscope was compared with video laryngoscopes other than the C-MAC in patients with known conditions related with a high incidence of difficult intubation. Kim et al. compared the Macintosh laryngoscope with an acute-angle video laryngoscope in patients with obstructive sleep apnoea (OSA).[5] The main outcome was the IDS score, and scores indicating moderate-to-major intubation difficulty were observed in 10.8% of the study population. Video laryngoscopy improved the glottic view quality and ease of intubation, although the definition of "time to successful intubation" is not clear, it was 29 seconds for the Macintosh laryngoscope, which is shorter than our findings. The Macintosh laryngoscope was compared with diverse video laryngoscopes in patients with obesity. Abdallah et al. compared Macintosh laryngoscope with an acute angle video laryngoscope, however the airway evaluation data were not presented; only the Mallampati score was considered and intubation success with the Macintosh laryngoscope was 92% at the first attempt.[4] Yumul et al. compared three different video laryngoscopes with the Macintosh laryngoscope, and intubation difficulty was not assessed; however, results of airway screening tests were presented and these were comparable to our study; the authors reported improved intubation time only with the Video-Mac video laryngoscope.[18]

Improved glottis visualization is one of the most useful features of video laryngoscopes, especially in difficult airways. However, this feature does not always translate into easy intubation or intubation success. In a comparison of C-MAC and Macintosh laryngoscopy in the emergency department, the C-MAC provided better glottic visualization, but first-attempt intubation success was not improved.[29] Moreover, it was reported that video laryngoscopy may lead to worse viewing conditions, and in another study that compared the C-MAC with direct laryngoscopy in patients with both normal and difficult airways in routine anesthesia induction, the authors stated that video laryngoscopy-guided intubation had the potential risk of increasing the number of intubation attempts and the duration of intubation.[3]

In our study, visualization of the vocal cords, as represented using CL scores, was significantly better using the C-MAC. Interestingly, POGO scores were similar in both groups. Although the quality of glottic visualization was improved, worse IDS were encountered with the C-MAC. An explanation for this result may be that more maneuvers were needed to redirect the tracheal tube towards the trachea with the C-MAC. However, this did not affect the intubation times and intubation success rates. The intubation success at the first attempt with the C-MAC in our study was lower compared with previous studies in which 100% success was reported; we had 83.3% success with the C-MAC. We suggest this result is a consequence of the high incidence of actual difficult intubations in our study population.[1,12]

The association of DM and obesity or OSA is well known. There are comparative studies with different airway devices in patients with a diagnosis of obesity or OSA.[4,5,18] However the number of publications on different airway devices in patients with diabetes is limited and these publications did not directly compare airway devices.[30]

The experience of the operator performing the tracheal intubation can affect the results. There exists no validated tool to assess competency in video laryngoscope intubation. The tracheal intubation learning curve reaches a 90% success rate after 50 direct laryngoscope intubations and video laryngoscope improves the learning curve; therefore, we used a cut-off of 50 video laryngoscope intubations to define the experience of the operators.[31,32] The C-MAC performed similarly in the hands of anesthesiologists in both experience groups. This was considered important because it allows the extrapolation of the results to real-life situations where both experienced and less-experienced anesthesiologists perform intubations with video laryngoscope.

There are limitations of this study to be considered. First, neuromuscular function was not monitored. Second, a tube with a stylet was used in the C-MAC group; however, the removal of the stylet before detecting an $EtCO_2$ tracing might have increased the intubation time. The C-MAC may reduce the need for a stylet in normal airways;

however, in difficult airways, stylets improve intubation success, and reduce intubation time and the number of intubation attempts.[17] If we were to choose not to use tubes with stylets, this could lead to increased intubation difficulty and bias with the C-MAC. Another limitation is that the IDS score may not be ideal for evaluating video laryngoscope-assisted intubations because the score includes the CL grading, which was originally introduced for direct laryngoscopy and is a subjective score. Nonetheless, the IDS score is the only score that assesses intubation difficulty and is used in studies evaluating video laryngoscope.[33]

Since the duration of DM may have an effect on the changes related to the airway, it may be useful to conduct a study by grouping patients in terms of the duration of DM. Finally an analysis accounting for the severity of DM would be complimentary.

CONCLUSION

To conclude, in patients with DM, C-MAC provided improved glottis visualization, similar intubation time and first-attempt intubation success as a first-attempt intubation device compared with the Macintosh laryngoscope. However IDS scores were higher with the C-MAC. The incidence of actual intubation difficulty was found 20.1% in this diabetic study population.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Design:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Control/Supervision:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Data Collection and/or Processing:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Analysis and/or Interpretation:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Literature Review:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Writing the Article:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant;* ***Critical Review:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***References and Fundings:*** *Dilek Ünal Yazıcıoğlu, Emine Arık, Başak Gülel, Burak Nalbant, Melis Sumak Hazır;* ***Materials:*** *Dilek Ünal Yazıcıoğlu.*

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