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Airway management during the COVID-19 pandemic: macintosh laryngoscopy *vs.* video laryngoscopy

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Abstract. – OBJECTIVE: Our study aimed to compare video laryngoscopy (VL) *vs.* direct laryngoscopy (DL) for tracheal intubation in adult patients receiving general anesthesia for elective surgery during the COVID-19 pandemic.

PATIENTS AND METHODS: The study included 150 patients 18-65 years old, ASA I-II (American Society of Anesthesiologists), and negative PCR tests before the operation was scheduled for elective surgery under general anesthesia. Patients were subdivided into two groups considering the intubation method: the video laryngoscopy group (Group VL, n=75) and the Macintosh laryngoscopy group (Group ML, n=75). Demographic data, operation type, intubation comfort, and field of view, intubation times, complications were recorded.

RESULTS: Both groups' demographic data, complications, and hemodynamic parameters were similar. In Group VL, Cormack-Lehane Scoring values were higher (*p*<0.001), the field of view was better (*p*<0.001), and the intubation was more comfortable (*p*<0.002). The duration for the vocal cord appearance was significantly shorter in the VL group than in the ML group (7.55±1.00 *vs.* 8.31±2.20 sec, *p*=0.008, respectively). The beginning of intubation to full ventilation of the lungs was significantly shorter in the VL group than the ML group (12.71±2.72 *vs.* 17.48±6.8, *p*<0.001, respectively).

CONCLUSIONS: Using VL in endotracheal intubation may be more reliable in reducing intervention times and the risk of suspected transmission during the COVID-19 pandemic.

Key Words:

COVID-19, General anesthesia, Video laryngoscopy, Direct laryngoscopy.

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes a highly contagious infection with the highest viral load in the upper respiratory secretions[1]. Despite using personal protective equipment, SARS-CoV-2 contamination is possible for the healthcare personnel during the airway management of infected patients[2]. Direct laryngoscopy (DL) remains the most common method for endotracheal intubation. It is recommended to use video laryngoscopy (VL) to minimize the risk of COVID-19 transmission from infected patients by increasing the physical distance between the anesthesiologist and the patient and for rapid passage through the trachea in the first attempt[3,4].

The design of VL, which aimed to shorten the time needed for successful intubation, has improved the glottis visualization and increased the rate of intubation success while decreasing the applied force and the procedure-related complications[5]. The C-MAC laryngoscope (C-MAC), in which a modified Macintosh blade is present, is a device used for VL[6]. Compared to the Macintosh laryngoscope (ML), the endotracheal intubation success rate of C-MAC is higher, besides providing a better glottis visualization with a shorter intubation time[7].

Our study aimed to compare VL *vs.* DL for tracheal intubation in adult patients scheduled for elective surgery *via* general anesthesia during the COVID-19 pandemic.

Patients and Methods

This study was carried out after ethical approval from the Health Science University Faculty of Medicine, Clinical Research Ethics Committee, Erzurum (BEAH KAEK 2020/20-200). Informed written and verbal consent was obtained from all patients. The study was prospectively enrolled and conducted by Consort guidelines. The study was in accordance with the 2008 Helsinki Declaration. The study was conducted between November 2021 and February 2022. The study was registered to clinicaltrials.gov. (NCT05121701).

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The study was designed to include 150 patients, aged between 18 and 65, scheduled for elective surgery performed under general anesthesia and classified as ASA I-II according to the ASA physiological classification. According to a computer-generated randomization list, the patients were assigned to a VL (VL Group, n=75) and ML (ML Group, n=75) group. The patients with intraoral surgery, gastroesophageal reflux, delayed gastric emptying, severe lung disease, kyphoscoliosis, and pregnant women were excluded from the study. The patients with negative COVID-19-PCR tests requested within 48 hours prior to the surgery were referred for pre-anesthetic evaluation. In the postoperative period, all patients were followed in isolated single rooms. PCR test was taken from patients who were symptomatic within five days after surgery.

In the pre-operative examination of the patients, ASA, surgeon type, and Mallampati scores were recorded. Before all the procedures were performed on the patients, the entire team that participated in the operation wore their protective equipment.

The patients taken to the operating room without premedication were monitored under standard conditions. After vascular access was provided, two milligrams of midazolam were intravenously administered to patients receiving Ringer's lactate infusion. The patients, pre-oxygenated using 100% oxygen *via* two-hand ventilation for one minute, were administered Propofol 2-3 mg/kg, Fentanyl 1-2 µg/kg, and Rocuronium 0.6 mg/kg. The doses for anesthesia induction were calculated considering the ideal weight of the patients. A mixture of 2% sevoflurane and 50%-50% O_2-N_2O was used to maintain anesthesia. After 90 seconds, endotracheal intubation was performed either with ML using a number four-blade (ML group) or C-MAC PM-Karl Storz VL (VL group). During laryngoscopy, the patients were classified according to the Cormack-Lehane classification: a complete vision of glottis as Grade 1, a partial view of the posterior glottic joint as Grade 2, visual of epiglottis without glottis as Grade 3, neither glottis nor epiglottis was visualized as Grade 4. The same two anesthesiologists did all intubations to exclude the influence of the interpersonal skill gap.

The visualization time of the vocal cords (T1), the time between the beginning of intubation to full ventilation of the lungs (T2), Cormack-Lehane class, intubation time (time-lapse between touching of the laryngoscope blade to the lips, and observation of the end-tidal carbon dioxide value on the monitor), laryngoscopy time (time-lapse between mouth insertion of the laryngoscope and the insertion of the endotracheal tube through the vocal cords) were recorded. In addition, the number of successful intubation attempts, the need for cricoid compression application, and complications were also recorded. Intubation comfort and field of view were evaluated by 4 points Likert scale (1: poor, 2: Average, 3: Good, 4: Excellent).

Sample Size

G* Power version 3.1.9.4 (University of Kiel, Kiel, Germany) software was used for sample size calculation. The power analysis using the time from intubation to the total ventilation of the lungs (T3) that showed an effect size of 92% and a significance level of power of 0.99 demonstrated the adequacy of the sample size.

Statistical Analysis

Descriptive statistics for quantitative and qualitative data were expressed as mean±standard deviation, frequency, and percentage, respectively. The comparison between both groups was performed using the *t*-test. The analysis of categorical data was done using the Chi-square tests. The significance was accepted when the *p*-value was below 0.05. SPSS 22.0 (Version 22.0., IBM Corp., Armonk, NY, USA) statistical package program was used for statistical analyses.

Results

The study was completed with a total of 150 patients. The flow diagram according to CONSORT guidelines[9] is provided in Figure 1. In demographic data, only the patients in the VL group had a significantly lower Cormack-Lehane grade than the ML group ($p<0.001$) (Table I), and there was no difference in other parameters.

The intubation conditions of the VL group were significantly more comfortable than the ML group ($p=0.002$) and the visual field observed in the VL group was significantly better than the ML group ($p<0.001$) (Table II).

The duration for the vocal cord appearance was significantly shorter in the VL group than in the ML group (7.55±1.00 *vs.* 8.31±2.20 sec, $p=0.008$, respectively). The beginning of intubation to full ventilation of the lungs was significantly shorter in the VL group than in the ML group (12.71±2.72 *vs.* 17.48±6.8, $p<0.001$, respectively) (Table III).

No statistically significant difference between the groups was present for the complications ($p>0.05$) (Table III).

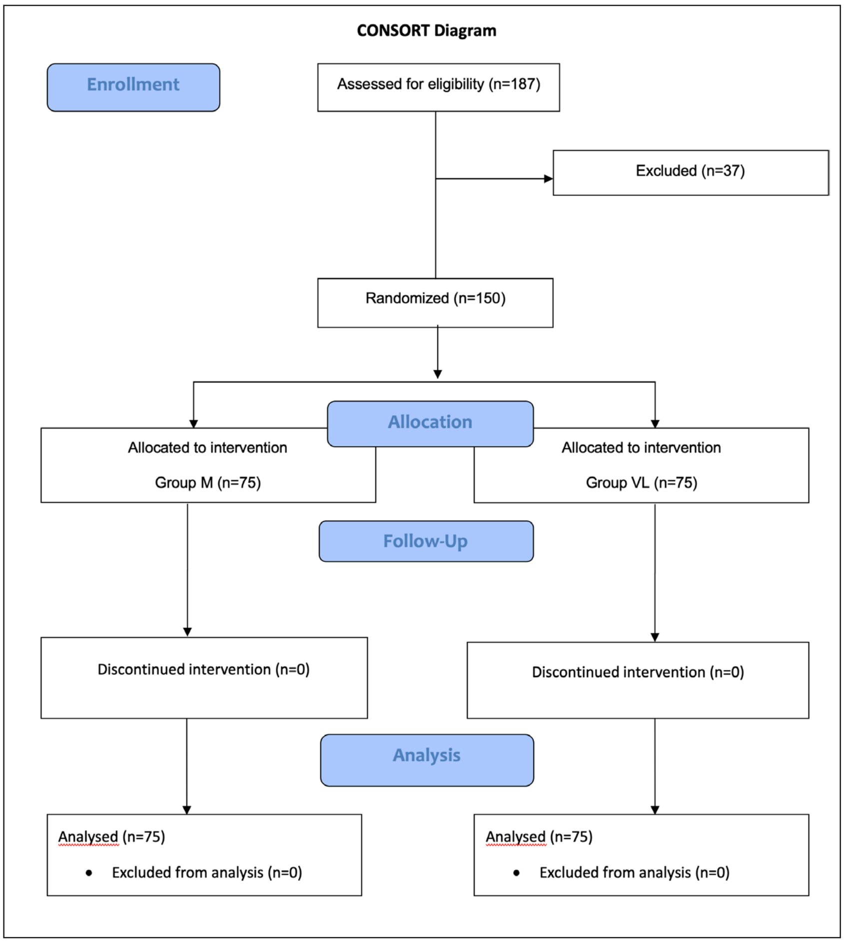

Figure 1. CONSORT Flow Diagram of the Study Groups.

Table I. Demographic data of patients.

	Group M (n=75)	Group VL (n=75)	*p*-value
ASA score (I/II)	38/37	44/31	0.206
Mallampati score			
I	21 (28%)	32 (42.7%)	
II	42 (56%)	32 (42.7%)	0.159
III	12 (16%)	11 (14.6%)	
IV	0 (0%)	0 (0%)	
Cormack lehane classification			
I	35 (46.7%)	66 (88%)	
II	27 (36%)	8 (10.7%)	**<0.001***
III	12 (16%)	1 (1.3%)	
IV	1 (1.3%)	0 (0%)	
Intubated case procedures			
Laparoscopic Cholecystectomy	54 (72%)	47 (62.7%)	
Lumbal Decompression	9 (12%)	16 (21.4%)	
Laparoscopic Ingunal hernia	3 (4%)	3 (4%)	
Thyroidectomy	3 (4%)	4 (5.4%)	0.573
Shoulder arthroscopy	1 (1.3%)	1 (1.3%)	
Appendectomy	4 (5.4%)	1 (1.3%)	
Upper extremity fractures	1 (1.3%)	2 (2.6%)	
Burn debridement	0 (%)	1 (1.3%)	

Values were expressed as number and frequency (%). *Chi-square test, ASA; American Society of Anesthesiologist.

Table II. Comparison of the field of view and intubation comfort during intubation between Group M and Group VL.

	Group M (n=75)	Group VL (n=75)	*p*-value
Intubation comfort			
Poor	1 (1.3%)	0 (0%)	**0.002***
Average	11 (14.6%)	3 (4%)	
Good	31 (41.4%)	18 (24%)	
Excellent	32 (42.7%)	54 (72%)	
Field of view			
Poor	2 (2.6%)	0 (0%)	**<0.001***
Average	11 (14.6%)	3 (4%)	
Good	34 (45.5%)	16 (21.4%)	
Excellent	28 (37.3%)	56 (74.6%)	

Values were expressed as number and frequency (%). *Chi-square test, ASA; American Society of Anesthesiologist.

Table III. Complications and comparison of pre-intubation preparation and times required for intubation between Group M and Group VL.

	Group M (n=75)	Group VL (n=75)	*p*-value
Need for cricoid compression (Y/N)	29/46	22/53	0.230[a]
Number of intubation attempts (I/II/III)	67/8/0	73/2/0	0.102[a]
Intubation longer than 30 Seconds (Y/N)	5/70	0/75	0.058[a]
Complication (Y/N)	4/71	1/74	0.367[a]
Oral injury (Y/N)	4/71	1/74	0.367[a]
Postoperative sore throat (Y/N)	11/64	10/65	1.000[a]
Postoperative dysphagia (Y/N)	4/71	4/71	1.000[a]
Postoperative hoarseness (Y/N)	2/73	0/75	0.497[a]
Postoperative cough (Y/N)	5/70	2/73	0.442[a]
T1 (sec.)	8.31 ± 2.20	7.55 ± 1.00	**0.008[b]**
T2 (sec.)	17.48 ± 6.8	12.71 ± 2.72	**<0.001[b]**

Values were expressed as number and mean ± standard deviation. [a]Chi-square test. [b]Student's *t*-test. sec.: second, T1: The Moment of Visualization of the Vocal Cords, T2: The Time from the Beginning of Intubation to Full Ventilation of the Lungs, Y: Yes, N: No.

Discussion

In this study, we found that VL compared with DL, provided shorter intubation time and faster ventilation in patients scheduled for elective surgery under general anesthesia during the COVID-19 pandemic.

COVID-19 is caused by a highly contagious, severe acute respiratory syndrome-corona virus-2 (SARS-CoV-2)[1]. The inhalation of infected material or exposure from contaminated surfaces that contain the live virus spread COVID-19. Healthcare workers attending the patients with COVID-19 are at risk of contracting the disease. Aerosol-generating procedures (coughing, sneezing, speaking, breathing, sputum production, tracheal intubation, non-invasive ventilation, mask ventilation) increase the risk of transmission of COVID-19 infection[1,8].

Endotracheal intubation should be considered a high-risk procedure for exposure and transmission to SARS-CoV-2. Virus particles can remain suspended in the air for three hours. A study comparing the VL to DL during the COVID-19 pandemic reported that VL increased the "mouth to mouth" distance between the anesthetist and the patient[9]. Rapid serial induction and intubation were found to be required to reduce aerosolization. In addition, it was recommended to use a VL instead of a DL for endotracheal intubation[10].

Due to the infection risk of healthcare workers, airway techniques are required to be reliable and efficient to increase success at the first attempt while manipulating airways multiple times. Besides the potential of a VL to contribute to the success of the first attempt, the indirect visualization of the larynx (video screen), while the position of the operator is upright with a straight elbow, increases the distance between the faces of the operator and the patient to a maximum. Hence, the transmission risk of the virus is expected to decrease[11]. The possibility of attaching a respiratory system filter to the tracheal tube prior to the intubation presents an additional advantage of the VL, while the spread of the virus and the need for the insertion of a tracheal tube stylet decrease to a minimum[12]. In a prospective randomized controlled study[13], in which six different VL were used in the tracheal intubation of 720 patients with limited neck motion and mouth opening were evaluated, and VL was found to be superior regarding the success rate in the first attempt, intubation time, laryngeal appearance, and the lowest rate of tissue damage. Several studies[12-16] in which various VL were compared to the conventional ML consistently agreed upon the higher success rate of VL to the ML.

The Cormack-Lehane classification system that describes laryngeal vision during laryngoscopy has a score range between one and four to indicate increasingly poor vision[17]. Studies[7,18,19] suggest improving visualization scores (a better Cormack-Lehane grade) using VL. Aggarwal et al[20] reported that using the C-MAC VL was related to a significant reduction in the Cormack-Lehane score compared with DL. Our study found that using VL was superior in terms of field of view, ease of intubation, and Cormack-Lehane scores.

A prospective randomized study by Macke et al[21] DL was evaluated with Cormack-Lehane in 152 patients who underwent intubation in the first intervention during the pre-hospital period. In that study, the success rate with VL was 95% on the first attempt, while it was 79% with DL. A higher success rate at the first attempt using VL is present for experienced airway managers. The use of a large screen during the procedure enables the sharing of the laryngoscope viewing by the airway team, thus, providing a greater distance between the team and the airway of the patient[9]. Our study found no difference in intubation trials and complications between the two groups. This is because we think that the experience of the anesthetist administering the anesthesia directly influences these results. However, it should not be overlooked that the visualization is significantly improved when VL is used.

It should be remembered that the VL may also affect the success of the first pass. Ruetzler et al[22] found varying success rates of five different VLs in a training circumstance where the performance of C-MAC in challenging airway situations proved significantly well[22]. In a study with 150 patients scheduled for elective surgery, 100% and 88% success rates were achieved using VL and DL, respectively[23]. Compared to ML, C-MAC has been shown to offer superior glottis visualization properties and require less external laryngeal manipulation[6].

Compared to the pre-pandemic period, it has been reported that in patients infected with infectious viral diseases, it should be done immediately by the most experienced team to protect the respiratory tract and reduce transmission, which has increased the preference for VL[24,25].

Limitations

The major limitation is that the study does not include the period when the pandemic was most infectious. The second limitation is the small sample size; only elective surgery and PCR-negative patients were included.

Conclusions

In conclusion, the key to airway management during the fight against the COVID-19 pandemic is a rapid response while minimizing the risk of complications and transmission. For this purpose, we suggest that using video laryngoscopy during endotracheal intubation is superior to direct laryngoscopy, considering the safety of both the patient and the anesthetist.

Conflict of Interest
The Authors declare that they have no conflict of interest.

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The current study received no financial support.

Ethics Approval
The Institutional Review Board at Health Science University Faculty of Medicine approved this study (BEAH KAEK 2020/20-200), which was conducted in compliance with the 2013 version of the 1975 Helsinki Declaration.

Authors' Contributions

I. Hakki Tör: Data curation, Investigation, Project administration, Formal Analysis, Methodology, Writing –original draft, and Writing – review & editing. S. Gulcin Ural: Data curation, Formal Analysis, Supervision, Methodology, and Writing – review & editing.

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Informed Consent

Informed written and verbal consent was obtained from all patients.

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