

Comparison of Effectiveness between Wycope Video Laryngoscope, C-MAC Video Laryngoscope, and Direct Laryngoscope in Intubation of Elective Surgery Patients

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Abstract

Objective. Airway management has undergone a dramatic transformation since the arrival of video laryngoscope (VL). VL has higher intubation success rate on first try and lower complications in comparison to direct laryngoscope (DL). The use of VL is recommended in intubating COVID-19 patients to speed up intubation time and reduce failure rate. A team from Airlangga University developed Wycope Video Laryngoscope (Wycope VL), a VL with Wi-Fi connection to smartphones for an easier VL with low cost. This study aimed to compare the effectiveness of Wycope VL, C-MAC Video Laryngoscope (C-MAC VL), and DL. **Materials and Methods.** This study was an analytic observational study with a cross sectional design, involving 63 patients who were divided into 3 groups based on the type of laryngoscope, namely Wycope VL, C-MAC VL, and DL. Intubation is carried out by 4th year anaesthesiology resident. Research subjects were patients who will undergo elective surgery at Dr. Soetomo General Hospital under general anaesthesia using orotracheal tube. Inclusion age of 19-64 years, PS ASA 1-2, no anatomical abnormalities of the airway, did not have difficult airway, and was willing to participate in the study. **Results.** All patients were successfully intubated without complications. C-MAC VL (5.33±1.42 seconds) and Wycope VL (5.95±0.74 seconds) was significantly faster in seeing vocal folds and glottis compared to DL (7.14±0.72 seconds) with P=0.000. DL was significantly faster in average time of intubation (15.52±5.90 seconds) compared to C-MAC VL (16.95±1.11 seconds) and Wycope VL (20.29±2.81 seconds) with P=0.000. **Conclusion.** DL was faster compared to VL in speed of intubation while C-MAC VL and Wycope VL was faster in viewing the vocal folds and glottis compared to DL.

Key Words: Laryngoscope ▪ Airway Management ▪ Intubation.

Introduction

The video laryngoscope (VL) is rapidly gaining popularity as an intubation device in a variety of scenarios and clinical settings among airway management specialists. In Sakles' study, the success of intubation using a C-MAC video laryngoscope (C-MAC VL) was higher than direct laryngoscope (DL) both in the first and second intubation attempt (1). Lewis' study showed that video laryngoscopy improved the ease of laryngeal visualization in patients without a predicted difficult airway (OR 6.77, 95% CI 4.17-10.98) and with a predicted difficult airway (OR 7.13, 95% CI 3.12-16.31) compared to DL (2). Difficult intubation is associated

with serious complications such as brain damage from hypoxia and hypercarbia. Other side effects include dental injury caused by repeated attempts at intubation, laryngeal spasm, and bronchial spasm (3). Based on data from the American Society of Anesthesiologists, the incidence of difficult airway and failed airway in the operating room is 1.2%-3.8% and 0.13-0.30% and can increase by 20% in other rooms such as the Intensive Care Unit (ICU) (4). Griesdale in his study found that the incidence of difficult intubation was 6.6% in the ICU of the Vancouver General Hospital (VGH) and 39% of patients experienced complications (5).

The act of intubation itself poses a risk of transmission of infectious diseases including COVID-19 from the patient's mouth to a specialist in Anesthesiology and Intensive Therapy. The use of a video laryngoscope is recommended as a strategy for intubating COVID-19 patients with the aim of speeding up intubation time and reducing intubation failure thus decreasing the possibility of complications and aerosol disease transmission (6).

Visualization using a video laryngoscope improves visualization of the glottis, including suspected or encountered difficult intubation, thereby reducing the rate of failed intubation, accelerating intubation time and complications of airway

trauma, thus increasing the effectiveness of intubation (2). However, successful visualization does not always result in successful endotracheal intubation, there were cases in which intubation attempt failed despite good visualization of the glottis.

The innovations made on the video laryngoscope itself are not new at Airlangga University. We hope to create better, cheaper, and superior video laryngoscopes as part of technological advances. Wycope video laryngoscope is one of the innovations developed by a team from Airlangga University. The use of Wycope video laryngoscope is expected to facilitate intubation with low production costs, so that this tool can be said to have good effectiveness.

The Wycope video laryngoscope consists of 2 main components, namely the frame of the laryngoscope and the laryngoscope camera cable. The Wycope laryngoscope frame is a combination of a handle and a blade. This blade from Wycope has a 60 degree angle similar to the Glidescope but with a different camera placement, design and material. The laryngoscope frame is made of PLA (Polylactic Acid) which is printed with a 3D printer. PLA itself has been widely used in the manufacture of medical equipment in handling COVID-19 patients due to its physical properties (7). The camera cable used here is a Wi-Fi endoscope camera which is commonly used for endoscopy. The choice of this camera is because the camera used is very good and clear and has sufficient lighting. The Wi-Fi connection used is easy to connect with cellphones from Android or IOS systems. The application used as a liaison is inskam. In using the application there is no delay from the



Figure 1. Wycope Video Laryngoscope.

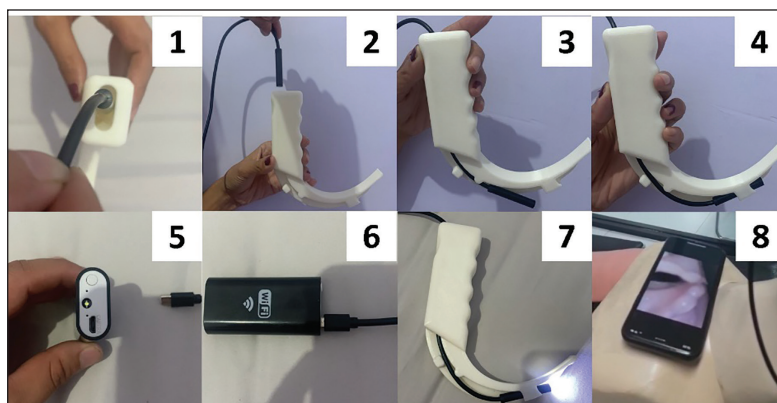


Figure 2. Setting up the Wycope Video Laryngoscope. The camera is connected to a cellphone via Wi-Fi connection. The cellphone can be placed on top of patient's chest or held by an assistant or placed anywhere else as convenient.

connection. The use of this Wi-Fi uses a battery attached to the cable and can be recharged. The price of this Wi-Fi endoscope is relatively affordable and can be replaced if it is damaged. The cost of a full set is around 75 USD. The frame is disposable, it cost around 25 USD. Sharing one frame for more than one patient is not recommended.

This study was conducted to find out whether there are significant differences in time required to see the vocal folds and glottis, intubation time, and use of BURP (back, upward, right lateral, pressure)

maneuver between Wycope VL, C-MAC VL, and DL. Aim of this study was to compare the effectiveness of using all three laryngoscopes for intubation

Materials and Methods

This research is an analytic observational study. This study involved 63 patients who were divided into 3 groups based on the type of laryngoscope, namely Wycope VL, C-MAC Video laryngoscope (C-MAC VL), and DL. The research subjects were

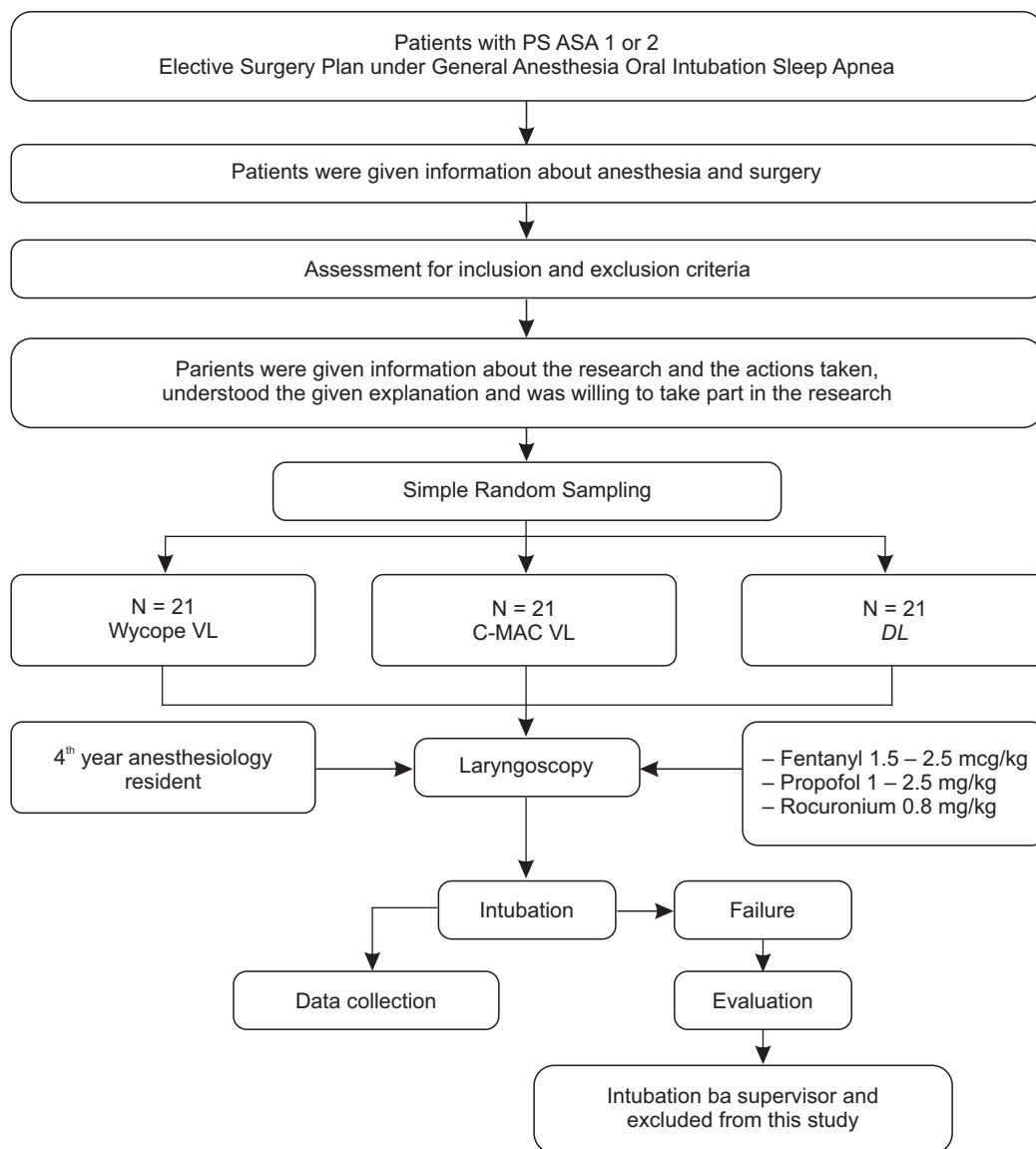


Figure 3. Study overview.

patients who would undergo elective surgery at Dr. Soetomo General Hospital under general anesthesia with oral intubation within April-June 2021. All patients met the inclusion criteria and none of them met the exclusion criteria. Intubation was carried out by three 4th year anesthesiology residents who had undergone residency in the same period of time and had attended the same trainings for each laryngoscopes.

Operator who would perform the intubation did the pre-surgery assessment the day before the surgery. Inclusion criteria were age of 19-64 years, PS ASA 1-2, normal airway anatomy, and was willing to participate in the study. Exclusion criteria for the study included difficult airway and failure of intubation by the resident and was replaced by the supervisor. The patients had predicted difficult airway if they had one or more of the followings: obesity, Mallampati score of 4, incisor distance less than 3 cm, mentohyoid distance less than 3 cm, hyothyroid distance less than 2 cm, limited neck range of motion, or history of difficult intubation.

Patients and their families were explained about the information on surgical and anesthetic procedures and the research carried out. Written informed consent was obtained from participants 1 day before the surgery. The process and protocol of this study were approved by the Ethics Committee of Dr. Soetomo General Hospital.

All patients who met the inclusion criteria and did not have difficult airway were numbered sequentially from number one. Among all of them 63 numbers/patients were chosen randomly. These chosen numbers represented chosen patients. Chosen numbers were arranged from the smallest to the biggest and then assigned to Wycupe VL group, C-MAC VL group, and DL group consecutively from the smallest number to the biggest one.

Patients were positioned supine and preoxygenation was given. Drugs administered were fentanyl 1.25-2.5 mcg/kg body weight, propofol 1-2.5 mg/kg bodyweight, and rocuronium 0.8 mg/kg bodyweight. Stylet and non-kink endotracheal tube was used in all intubation. Blades used were type C Macintosh blades for DL and C-MAC VL. For DL, blades used were blades with 60 degrees

arch similar to type D blade. Monitoring included blood pressure, peripheral oxygen saturation, electrocardiogram, and end-tidal carbon dioxide (ETCO₂). Assistant only assisted by doing BURP (back, upward, right lateral, pressure) maneuver when needed. All assistants had a minimum of 4 years of experience working in operating theatre or critical care unit.

Characteristics data of research subjects include gender, PS ASA, age, body mass index (BMI), height, weight, and Cormack-Lehane degree. Main outcomes of this study were: (1) time required to see the vocal folds and glottis counted from insertion of the laryngoscope tip through the patient's lips until operator could assess the Cormack-Lehane grade and said "seen", (2) intubation time counted from insertion of the laryngoscope tip through the patient's lips, insertion of the endotracheal tube, until the laryngoscope were completely taken out and its tip already passed through the patient's lips, and (3) number of patients whom BURP (back, upward, right lateral, pressure) maneuver was done during the intubation process.

Statistical Analysis

Data collected was processed using different tests. Normality of ratio scale data was tested with Shapiro-Wilk test. Then it was analyzed with Mann-Whitney test because the data was not normally distributed. For nominal scale data, it was processed using the Fisher's Exact test because of the small sample size. Data analysis was performed using SPSS ver.26.0. A value of $P < 0.05$ was considered significant.

Results

This study involved 63 subjects divided into 3 groups according to the type of laryngoscope. Subjects were homogeneous in terms of gender, PS ASA, age, body mass index (BMI), height, weight, and Cormack-Lehane degree as seen in Table 1.

Table 1. Characteristics of Research Subjects

Characteristics	Wycope VL	C-MAC VL	DL	P value
Gender				
Male (N; %)	8 (38.1)	8 (38.1)	10 (47.6)	0.77
Female (N; %)	13 (61.9)	13 (61.9)	11 (52.4)	
PS ASA				
1 (N; %)	5 (23.8)	6 (28.6)	8 (38.1)	0.589
2(N; %)	16 (76.2)	15 (71.4)	13 (61.9)	
Age (year)	42.29±11.42	40.81±11.90	33.90±13.07	0.054
BMI	23.33±2.67	22.80±2.81	22.73±3.26	0.843
Grade CL				
1 (N; %)	15 (71.4)	16 (76.2)	16 (76.2)	0.283
2 (N; %)	6 (28.6)	5 (23.8)	3 (14.3)	
3 (N; %)	0 (0.0)	0 (0.0)	2 (9.5)	
Weight (kg)	58.67±9.32	59.76±9.284	60.00±10.84	0.896
Height (cm)	158.38±7.304	161.29±9.93	161.81±8.19	0.381

Wycope VL=Wycope Video Laryngoscope; C-MAC VL=C-MAC Video Laryngoscope; DL=Direct Laryngoscope; PS ASA=Physical Status American Society of Anesthesiologists; BMI=Body Mass Index; CL=Cormack-Lehane Degree.

Table 2. Time Required to See the Vocal Folds and Glottis Using Wycope DL, C-MAC VL, and DL

Statistics	Wycope VL	C-MAC VL	DL
Mean+SD (seconds)	5.95±0.74	5.33±1.42	7.14±0.72
Median (seconds)	6	5	7
Min-max (seconds)	5-7	3-9	6-8

Wycope VL=Time required to see the vocal folds and glottis using the Wycope Video Laryngoscope; C-MAC VL=Time required to see the vocal folds and glottis using the C-MAC Video Laryngoscope; DL=Time required to see the vocal folds and glottis using the Direct Laryngoscope.

Observation of the difference in time required to see the vocal folds and glottis between DL and C-MAC VL, DL and Wycope VL, C-MAC and Wycope VL showed significant result with P value 0.000, 0.000, and 0.19 respectively. The average time in the DL group was 7.14±0.72 seconds with a range of 6-8 seconds and a median of 7 seconds. In the C-MAC VL group, the average time was 5.33±1.42 seconds with a range of 3-9 seconds and a median of 5 seconds. While in the Wycope VL group, the average time was 5.95±0.74 seconds with a range of 5-7 seconds and a median of 6 seconds (Table 2 and 5).

Data of intubation time was not normally distributed due to lack of variation. The median time in the DL group was 15 seconds, in the C-MAC

VL group was 17 seconds, and in the Wycope VL group was 19 seconds. In the Wycope VL group, the range of intubation time was 17-28 seconds with an average time of 20.29±2.81 seconds. In the C-MAC VL group, the range was 15-19 seconds with an average time of 16.95±1.11 seconds. Meanwhile, in the DL group, the range was 11-36 seconds with an average time of 15.52±4.90 seconds. Comparison analysis between DL and C-MAC VL, DL and Wycope VL, C-MAC and Wycope VL showed there was significant difference in the time required for intubation with P=0.000 (Table 3 and 5).

BURP maneuver was used in 1 patient (4.8%) in the Wycope VL group, 3 patients (14.3%) in the C-MAC VL group, and 9 patients (42.9%) in the

Table 3. Intubation Time Using Wycope VL, C-MAC VL, and DL

Statistics	Wycope VL	C-MAC VL	DL
Mean+SD (seconds)	20.29±2.81	16.95±1.11	15.5±4.90
Median (seconds)	19	17	15
Min-max (seconds)	17–28	15–19	11–36

Wycope VL=Intubation time using the Wycope Video Laryngoscope; C-MAC VL=Intubation time using the C-MAC Video Laryngoscope; DL=Intubation time using the Direct Laryngoscope.

Table 4. BURP Maneuver

BURP Maneuver	Wycope VL	C-MAC VL	DL
Used	1 (4.8%)	3 (14.3%)	9 (42.9%)
Not used	20 (95.2%)	18 (85.7%)	12 (57.1%)

BURP Maneuver=Back, upward, right lateral, pressure maneuver; Wycope VL=Wycope Video Laryngoscope; C-MAC VL=C-MAC Video Laryngoscope; DL=Direct Laryngoscope.

Table 5. Statistical analysis using Mann-Whitney test and Fisher's Exact test

Outcomes	P value	DL and C-MAC VL	DL and Wycope VL	C-MAC and Wycope VL
Time required to see the vocal folds and glottis	Test*	0.000	0.000	0.190
Intubation time	Test [†]	0.000	0.000	0.000
Use of BURP maneuver	Test [‡]	0.085	0.009	0.606

Wycope VL=Intubation using Wycope Video Laryngoscope; C-MAC VL=Intubation using C-MAC Video Laryngoscope; DL=Intubation using Direct Laryngoscope; BURP Maneuver=Back, upward, right lateral, pressure maneuver; *Analyzed using Mann-Whitney test; [†]Analyzed using Mann-Whitney test; [‡]Analyzed using Fisher's Exact test.

DL group. Statistical analysis showed significance between Wycope VL and DL with $P=0.009$, and no significance between C-MAC VL and DL also Wycope VL and C-MAC VL with $P=0.085$ and 0.606 respectively (Table 4 and 5).

drugs, operator and assistant, as well as the preparation of other intubation equipment (8).

Anatomy of the airway was made homogenous by excluding the patients who were predicted to have a difficult airway on physical examination. All

Discussion

This study aimed to compare the effectiveness of using all three laryngoscopes for intubation, therefore the factors which might affect the intubation process should be made as similar as possible. Those factors included anatomy of the airway, head position, preoperative anesthesia,

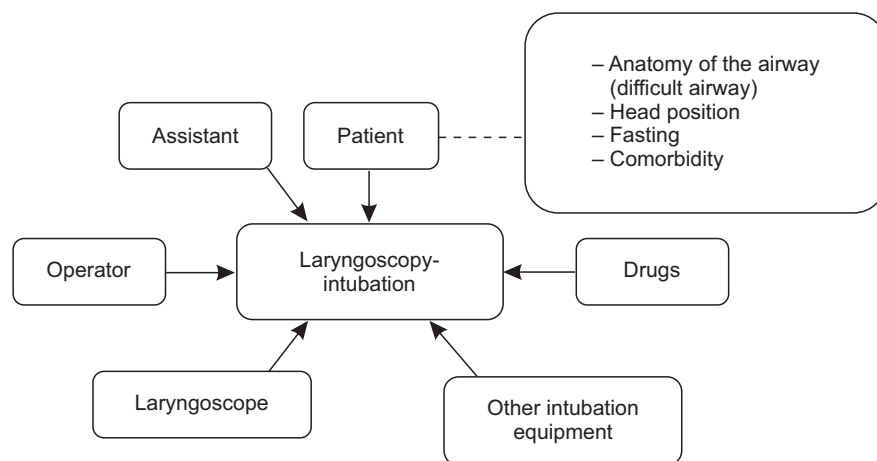


Figure 4. Factors affecting laryngoscopy and intubation.

patients in this study were given the same relaxant drug, dosage was adjusted according to body weight. The operators' skill was equalized before to maintain the homogeneity of this study (8).

All subjects were homogeneous in terms of gender, PS ASA, age, body mass index (BMI), height, weight, and Cormack-Lehane degree. Cormack-Lehane degree was used for assessment of possible complications during intubation (8).

Comparison of average laryngoscopy time using Wycope VL, C-MAC VL, and DL was statistically significant even though the difference was less than a second to two seconds. Both C-MAC VL and Wycope VL were significantly faster than DL. C-MAC VL was significantly faster than Wycope VL. These result was in accordance to the

theory that VL facilitates laryngoscopy compared to DL thus time efficiency could be achieved without having to do a sniffing position and BURP maneuver. Difference of time needed using Wycope VL and C-MAC VL matched the theory regarding the operator's experience or skill as use of C-MAC VL was more often than Wycope VL (2, 8-11).

In this study, we found that DL was significantly faster in intubation time compared to C-MAC VL and Wycope VL. C-MAC VL was significantly faster than Wycope VL. Data of intubation time was not normally distributed due to the lack of variation. The median time in the DL group was 15 seconds, in the C-MAC VL group it was 17 seconds. Meanwhile, in the Wycope VL group, the median time was 19 seconds. We concluded that

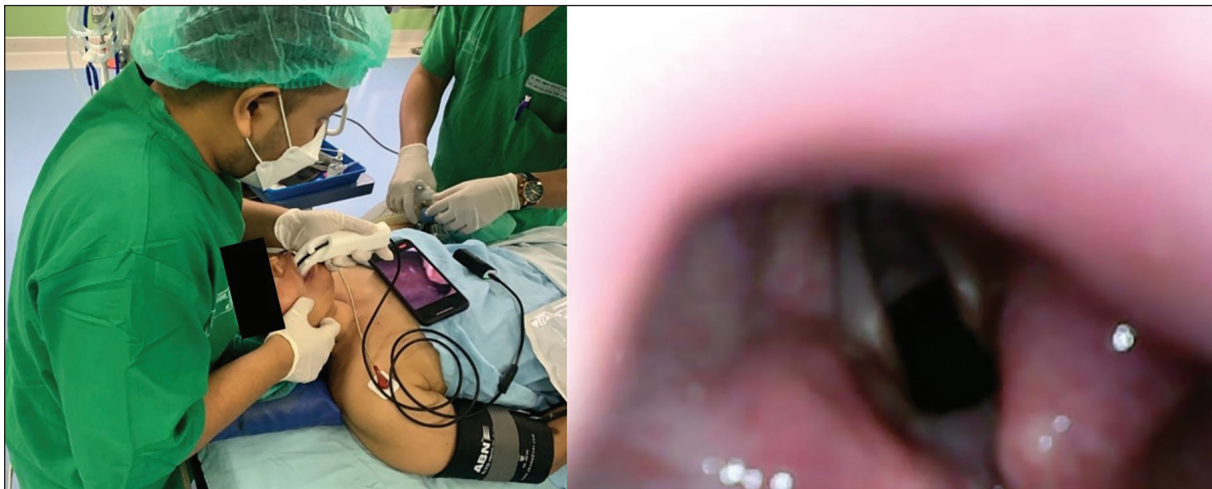


Figure 5. Intubation using Wycope Video Laryngoscope.



Figure 6. Intubation using C-MAC Video Laryngoscope.

in this study the use of DL for intubation was faster than VL. As to why intubation using Wycope VL took the longest time was because the operator had not used Wycope VL for a long time in comparison to DL and C-MAC VL. DL was most frequently used by 4th year residents, so the time required was shortest. The image quality of the camera also affected the intubation time. The use of VL requires experience/expertise from the operator especially in eye and hand coordination when inserting the endotracheal tube through the vocal fold opening. There was a difference in the field of view provided by the C-MAC VL and the Wycope VL due to different distance of the camera to the tip of the blade and blade curvature between the Wycope VL and C-MAC VL. Emergency conditions or elective surgeries also affected intubation procedure in terms of patient preparation and medication hence this study which was in elective surgery setting might not have the same results as studies carried out in emergency settings. Intubation time with DL was faster in this study because all of the patients did not have difficult airway whereas VL presented better laryngeal visualization and could aid intubation especially in patients with difficult airway. Wycope VL could aid intubation process by offering easier laryngeal visualization than DL with lower cost compared to C-MAC VL. The convenience offered by the VL might be significant if the operators had equal experiences on using both DL and VL (2, 8-11).

Observations on 63 subjects divided into three treatment groups showed that all subjects were successfully intubated and no complications of airway trauma were found in all three groups. This was due to several things, including: the homogeneity of the research subjects' characteristics, there was no patient with difficult airway, setting of the study which was elective surgery, and all operators were 4th year anesthesiology residents therefore they had sufficient skill and experience on all three laryngoscopes at the same level (2, 8, 11-13). The use of BURP maneuver between Wycope VL and DL showed significant difference. BURP maneuver was used less frequently in VL as VL provides better visualization. BURP maneuver was performed

to aid visualization of epiglottis and vocal chords (8, 10, 11).

Limitations of the Study

Limitation of this study was the small sample size as it might lead to a biased result. Other limitations were this study only conducted in elective surgery setting but not in emergency conditions and all patients who had difficult airway were excluded thus we could not analyze the success rate of each device. Assessment for difficult airway was done, however data of Mallampati score, incisor distance, mentohyoid distance, hyothyroid distance, neck range of motion, and history of difficult intubation were not collected despite being checked before enrolling patients to this study. Although all operators had sufficient skill and experience in using DL, C-MAC VL and Wycope VL, the use of DL was still more frequent so they were more experienced in using DL. They also had more experience and was more accustomed to using C-MAC VL as it was used more often compared to Wycope VL. Future study with larger sample size, in emergency setting, with operators who has equal experiences on using DL, C-MAC VL, and Wycope VL might show different result as bias will be minimized and subjects will be more heterogeneous.

Conclusion

This study showed that there were significant differences in the speed of laryngoscopy and intubation using the three laryngoscopes. The DL was faster than VL in speed of intubation while the C-MAC VL and Wycope VL was faster in viewing the vocal folds and glottis compared to DL.

What Is Already Known on This Topic:

Video laryngoscope is a rising device in airway management especially in intubation. Difficult intubation is related to serious complications one of which is brain damage from hypoxia and hypercarbia. Studies showed VL had better visualization and time required in laryngoscopy in comparison to DL.

What This Study Adds:

In this study we compare the effectiveness of Wycope VL, C-MAC VL, and DL in adult patients who did not have difficult airway and in

elective surgery setting. Wycope VL is a VL developed by a team from Airlangga University to aid laryngeal visualization in intubation with lower cost. C-MAC VL and Wycope VL was faster in viewing the vocal folds and glottis compared to DL although DL was faster in speed of intubation as all of the operators used DL more frequently compared to C-MAC VL and Wycope VL.

Authors' Contributions: All authors contributed equally to the article.

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

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