Available online at www.sciencedirect.com

Resuscitation Plus

journal homepage: www.elsevier.com/locate/resuscitation-plus

Clinical paper

A comparative study of Video laryngoscope vs Macintosh laryngoscope for prehospital tracheal intubation in Hiroshima, Japan

N. Santou[a,*], *H. Ueta*[a], *K. Nakagawa*[b], *K. Hata*[b,e], *S. Kusunoki*[c], *T. Sadamori*[d], *H. Takyu*[b], *H. Tanaka*[a,b]

Abstract

Background: In Japan, there are no studies comparing endotracheal intubation performed by emergency medical technicians (EMTs) during out-of-hospital cardiac arrest (OHCA) using a Macintosh laryngoscope and a video laryngoscope.

Objective: The purpose of this study was to compare the success rate, complication rate, return of spontaneous circulation (ROSC), neurological prognosis (CPC1-2) and regional differences between Video laryngoscope (VL) and Macintosh laryngoscope (ML) for OHCA patients.

Method: This study is a retrospective cohort study using 10,067 OHCA data extracted from the national Utstein Form and emergency medical transport data. The primary endpoint was the success rate of tracheal intubation and the complication rate and the secondary endpoints were the incidence of ROSC and CPC1-2.

Results: A total of 885 tracheal Intubated OHCA patients were enrolled in this study. The success rate was 94.1% (490/521) in the VL group and 89.3% (325/364) in the ML group (RR, 1.05; 95%CI, 1.01–1.10, $P = 0.01$), the VL group shows significantly higher success rate than that of the ML group. In the complication rates, oesophageal intubation occurred in 0.2% (1/521) of in the VL group and in 6.0% (22/364) in the ML group, Indicating significantly higher complication rates in the ML group compared with the VL group (RR, 1.06; 95% CI, 1.03–1.09, $P < 0.001$). The ROSC rate and CPC1-2 rate are similar among the groups.

Conclusion: Our data suggest that using VL had a little advantage with a higher success rate and lower complication rate. Further discussion is necessary for the future development of Emergency Medical Services (EMS) intubation devices.

Keywords: Video laryngoscope, OHCA, Prehospital tracheal intubation, ROSC rate, CPC1-2, EMS, EMT, Medical Control

Introduction

In Japan, EMTs have been allowed tracheal intubation in out-of-hospital cardiac arrest (OHCA) patients since 2004. Yet, in recent years, its efficacy has been controversial.

Benoit et al.[2] reported that the odds ratio for ROSC was significantly higher in OHCA patients who received tracheal intubation than in OHCA patients received supraglottic airway devices, indicating the benefit of tracheal intubation. Hirasawa[3] also compared the survival rates of OHCA patients with supraglottic airway devices and intubated patients, and summarized that tracheal intubation worsening survival rate of OHCA and that there is no medical evidence that tracheal intubation contributes to improved survival in OHCA. Furthermore, some studies indicate better survival-discharge rates and neurological outcomes with mask ventilation than with tracheal intubation,[4] Hasegawa et al.[5]

In this context, CoSTR2020 proposes the use of supraglottic airway devices or tracheal intubation for advanced airway clearance in emergency systems with a high success rate of tracheal intubation in OHCA, and the use of supraglottic airway devices for advanced airway clearance in emergency systems with a low success rate of tracheal intubation.[1]

In Japan, a demonstration study was conducted in Hiroshima Prefecture in 2010, and the effectiveness and safety of VL use by

* Corresponding author at: Research Institute of Disaster Management and EMS, Kokushikan University, 7-3-1, Nagayama, Tama city, Tokyo 205-8515, Japan.

E-mail address: nobuos@kokushikan.ac.jp (N. Santou).

https://doi.org/10.1016/j.resplu.2022.100340

Received 29 September 2022; Received in revised form 16 November 2022; Accepted 28 November 2022

EMTs for patients scheduled for surgery were confirmed (success rate: 97%).[6]

Based on these results, tracheal intubation using a VL has been available since August 2011, and certified VL EMTs have been trained since 2012.[7] However, the status of training and tracheal intubation protocols differ among prefectural Medical control committees, which is reported to be related to regional disparities in hospital practice, medical resources, and operability compared to conventional laryngoscopes.[8]

Comparative studies of tracheal intubation with ML and VL include a study report by a physician at a medical institution[9] and a study report by a mannequin.[10] However, comp parative studies by prehospital EMTs have been reported in the United States[11] and Europe,[12] but not in Japan.

Therefore, we have been using a Video laryngoscope (Airway Scope®) as the first choice device for tracheal intubation since 2012, and analyzed data from Hiroshima Prefecture, which has a high rate of Video laryngoscope use, and in OHCA patients, we hypothesized that tracheal intubation with a Video laryngoscope would improve the prognosis of the injured patient.

Objective

The purpose of this study was to compare the success rate, complication rate, ROSC rate, CPC1-2, and regional differences between Video laryngoscope (VL) and Macintosh laryngoscope (ML) and to examine the usefulness of VL.

Method

Study design

In this retrospective cohort study, we extracted data on tracheal intubation in Hiroshima Prefecture from the Utstein style data nationwide from 2015 to 2019, and added emergency transport data and Hiroshima Prefecture tracheal intubation verification form data.

In conducting this study, we applied to the "Ethics Committee on Research Involving Human Subjects" of Kokushikan University and obtained their approval (receipt number 21005). The parties involved in the facilities providing the materials in Hiroshima Prefecture were fully informed and their consent was obtained in writing. The data used in this study did not contain any data that would identify the names of facilities or individuals, and we took sufficient care to protect the privacy of the data.

Target and extraction conditions

For the extraction of data used in this study, we combined 5 years of nationwide Utstein style data (627,982 cases) and emergency transport data (26,710,481 cases) collected from January 1, 2015 to December 31, 2019, from which we extracted cases of OHCA occurrence in Hiroshima Prefecture (10,067 cases). We combined the OHCA cases in Hiroshima Prefecture (10,067 cases) with data from the Hiroshima Prefecture tracheal intubation verification form (1062 cases), and extracted 979 cases, excluding 83 cases that were not combined. From the extracted 979 cases of tracheal intubation in Hiroshima Prefecture (979 cases), (1) cases with negative values for time factor (31 cases), (2) cases with outliers for time factor (58 cases), and (3) cases with multiple identical cases (5 cases) were excluded. The above items were excluded, and 885 cases were included in this study (Figure 1).

The Medical Control system in Hiroshima Prefecture, the target prefecture, as of April 1, 2019, consists of 7 regional medical control committees, 13 fire departments. There are 633 EMTs who are operational. There are 228 EMTs certified in tracheal intubation and 170 EMTs certified in Video laryngoscopy, and 405 EMTs (64% of the total) are not certified in tracheal intubation. Advanced airway securing devices include a supraglottic airway device (Laryngeal Mask, Laryngeal Tube) and a tracheal intubation tube. Paramedics without tracheal intubation certification (64%) use supraglottic airway devices, and EMTs certified in tracheal intubation (36%) use a tracheal intubation tube, attempt tracheal intubation, and use a supraglottic airway device if they find it difficult.

Study endpoint

Primary outcomes were success rate of tracheal intubation and complication rate (oesophageal intubation), and secondary outcomes were ROSC rate and CPC1-2. The good neurological prognosis rate at 1 month was defined as CPC1: good function and CPC2: moderate impairment in the Glasgow- Pittsburgh Cerebral Performance Category. The success rate of tracheal intubation and the number of tracheal intubations performed (per 1 million population) were compared in each region of Hiroshima Prefecture.

Statistical analysis

Numerical data were expressed as mean (standard deviation; SD). Student's t-test for comparison of continuous variables between each group. Qualitative data measures are presented in % (number of cases). Pearson's chi-square test and Fisher's exact test were used for comparison, with a significance level of 5%, and relative risk (RR) and 95% confidence interval (CI) were estimated. Microsoft Excel 2019 and JMP Pro15 were used for statistical analysis.

Results

Patients background

The background of the injured and ill patients studied is shown in Table 1.

Age, gender, bystander chest compressions, bystander AED, waveform type, electroshock, and medication administration were validated. There was a significant difference between groups in the presence or absence of bystander chest compressions ($P = 0.035$).

In terms of initial ECG waveform type, Asystole accounted for the highest percentage in both groups: 70.8% (369/521) in the Video group and 71.4% (260/364) in the ML group.

Results of success rates and complication rates and time to perform tracheal intubation.

A total of 885 tracheal intubated OHCA were enrolled in this study. The success rate was 94.1%(490/521) in the VL group and 89.3% (325/364) in the ML group(RR, 1.05;95%CI, 1.01–1.10, $P = 0.01$). The first time success rate was 87.7% (457/521) in the VL group and 81.6% (297/364) in the ML group (RR, 1.07; 95%CI, 1.01–1.14, $P = 0.01$), In the VL group shows significantly higher success rate than that of the ML group. In the complication rates, oesophageal intubation occurred in 0.2% (1/521) of in the VL group and in

Table1 – Patients background.

Laryngoscope used	Video laryngoscope (n = 521)	Macintosh laryngoscope (n = 364)	P-value
Age, mean (SD), years	77.9 (13.8)	78.2 (13.3)	0.79
Gender, No. (%)	290 (55.7)	200 (54.9)	0.83
Bystander CPR, No. (%)	253 (57.0)	167 (49.4)	0.0350
Bystander AED, No. (%)	8 (2.1)	3 (0.9)	0.24
Initial ECG, No. (%)			
VF	18 (3.5)	16 (4.4)	0.45
VT	4 (0.77)	0 (0)	
PEA	126 (24.2)	87 (23.9)	
Asystole	369 (70.8)	260 (71.4)	
Defibrillation, No. (%)	30 (7.7)	33 (9.7)	0.34
Epinephrine administration (%)	105 (25.5)	67 (19.9)	0.07

CPR: cardiopulmonary resuscitation, AED: Automated external defibrillator, ECG: electro cardiogram, VF: ventricular fibrillation, VT: ventricular tachycardia, PEA: pulseless electrical activity, SD: standard deviation.

6.0% (22/364) in the ML group, Indicating significantly higher complication rates in the ML group compared with the VL group (RR, 1.06; 95%CI, 1.03–1.09, $P < 0.001$). The mean time from contact with the injured person to completion of tracheal intubation was 13.4 (±5.4) minutes in the VL group and 14.0 (±6.0) minutes in the ML group, and the mean time from contact with the injured person to hospital admission was 28.2 (±8.6) minutes in the VL group and 28.6 (±9.1) minutes in the ML group, with no significant difference (Table 2).

Comparative results of where tracheal intubation was performed

Regarding the comparison of the location where tracheal intubation was performed, the cases where it was performed in the field were significantly higher in the VL group than in the ML group, 58.2% (303/521) in the VL group and 50.8% (185/364) in the ML group (RR, 1.14; 95%CI, 1.01–1.30, $P = 0.03$). The success rate in the field was 95.0% (288/303) in the VL group and 88.7% (164/185) in the ML group, which was significantly higher in the VL group than in the ML group (RR, 1.07; 95%CI, 1.01–1.13, $P = 0.01$). The success rate after field departure from the field was 92.7% (202/218) in the VL group and 89.9% (161/179) in the ML group (RR, 1.03; 95%CI, 0.97–1.10, $P = 0.34$). When we compared the percentage of ROSC cases in which tracheal intubation was performed in the field, 77.8% (21/27) in the VL group and 66.7% (12/18) in the ML group, with no significant difference between the groups (RR, 1.17; 95% CI, 0.79–1.71, $P = 0.41$). Among the CPC1-2 cases, the percentage of tracheal intubation performed in the field was 100% (8/8) in the VL group and 60.0% (3/5) in the ML group, with no significant difference between the groups (RR, 1.67; 95% CI, 0.84–3.41, $P = 0.13$) (Table 2).

ROSC rate and CPC1-2 results

The ROSC rate in all cases with tracheal intubation was 5.5% (27/490) in the VL group and 5.5% (18/325) in the ML group, with no significant difference between the groups (RR, 0.99; 95%CI, 0.57–1.78, $P = 0.99$). Similarly, CPC1-2 in tracheal intubation cases was 1.6% (8/490) in VL group and 1.5% (5/325) in ML group with no significant difference between the two groups (RR, 1.06; 95%CI, 0.35–3.22, $P = 0.91$) (Table 3).

Table 2 – Success rate and complication rate.

	Video laryngoscope	Macintosh laryngoscope	P-value	RR (95%CI)
Success rate	94.1% (490/521)	89.3% (325/364)	0.01	1.05 (1.01–1.10)
First time success rate	87.7% (457/521)	81.6% (297/364)	0.01	1.07 (1.01–1.14)
Time from casualty contact to completion of tracheal intubation. mean (SD).min	13.4 (5.4)	14.0 (6.0)	0.15	
Contact to completion of hospital Arrival Time. mean (SD).min	28.2 (8.6)	28.6 (9.1)	0.47	
Complication rate				
Incidence of oesophageal intubation	0.2% (1/521)	6.0% (22/364)	<0.001	1.06 (1.03–1.09)
Tooth damage	0.2% (1/521)	0.3% (1/364)		
Percentage of on-site implementation	58.2% (303/521)	50.8% (185/364)	0.03	1.14 (1.01–1.30)
Success rate	95.0% (288/303)	88.7% (164/185)	0.01	1.07 (1.01–1.13)
Success rate after field departure	92.7% (202/218)	89.9% (161/179)	0.34	1.03 (0.97–1.10)

• Successful tracheal intubation rate, tracheal intubation implementation rate, complication rate are expressed as % and (real numbers).
(): The left side is the number of successes • implementations / total number.
• Group comparisons were made using the Pearson's chi-square test and Fisher's exact test to estimate RR and 95% CI.
• Intubation time values are expressed as mean (standard deviation), and two-sample t-tests assuming equal variances were used to compare groups.

Successful intubation rate and number of intubations performed by each region

The success rate of tracheal intubation in Hiroshima Prefecture was 92.0% (815/885). Success rates were 100% (35/35) in HA, 97.2% (104/107) in HB, 93.1% (335/360) in HC, 92.1% (210/228) in HD, 87.7% (121/138) in HE and 58.8% (10/17) in HF, regional differences were found. The number of patients intubated per million population was 244 in the HA region, 1227 in the HB region, 1394 in the HC region, 153 in the HD region, 508 in the HE region, and 20 in the HF region, indicating a disparity in the number of tracheal intubations performed for OHCA in each MC region. As for the comparison of the success rates between the VL and ML groups, each area showed the same success rate between the groups or a higher success rate in the VL group (Table 4).

Discussion

Discussion of the main results of this study

In the present study, the success rate of tracheal intubation and the incidence of oesophageal intubation were examined using OHCA data from Hiroshima Prefecture, suggesting the usefulness of VL. At present, the process for obtaining VL certification in Japan is as follows the Medical control committees first grants ML certification to those who successfully complete 30 cases of tracheal intubation in hospital practice, and then grants VL certification to those who successfully complete 5 cases of VL. Thus, it cannot be denied that VL may have had a higher success rate than ML because the person who performed tracheal intubation in VL was a paramedic with sufficient experience in performing tracheal intubation in ML. On the other hand, the EMTs who performed the ML were inexperienced in tracheal intubation, which may have contributed to the lower success rate.

Previous studies on tracheal intubation in OHCA have reported similar or conflicting results to the present study. Risse et al.[11] reported on a study conducted on German paramedics and found that there was no significant difference in the success rate comparison between VL (Glidescope®) and direct viewing laryngoscope (75% and 68.1%, respectively) (P = 0.63). In addition, Huebinger et al.[12] reported a study conducted on paramedics in the United States and found that there was a significant difference in the success rate between VL (80.8%) and direct viewing laryngoscope (73.1%) (95% CI6.4%-9.0%, P < 0.001) and that the increased ROSC rate was not related to the use of VL (aOR 1.0, 95% CI 0.9–1.1).

In Hiroshima Prefecture, the Ministry of Health, Labor, and Welfare has notified the Ministry that five successful cases of hospital training are required as prior training for VL certification, and that after certification, re-training at a hospital is conducted every-two to three years. In addition, since the protocol specifies VL as the first choice device for tracheal intubation, many EMTs have experience in performing tracheal intubation with VL, which may be one of the reasons for the higher success rate compared to previous studies.

In addition, the Video laryngoscope makes it relatively easy to see the larynx and insert the tube even during chest compressions, and the monitor allows multiple people to check the tube, which is thought to be one reason for the low incidence of esophageal intubation and the high success rate. Esophageal intubation is fatal, and in this study, esophageal intubation was greatly reduced in the VL group compared to the ML group. Timmermann et al.[13] reported that emergency physicians performed tracheal intubation in 149 OHCA cases and esophageal intubation was observed in 10 cases (6.7%). Since esophageal intubation may occur with a certain frequency even if a physician performs tracheal intubation in OHCA, we would assume that the incidence of esophageal intubation is also higher when EMTs perform tracheal intubation in OHCA.

There are currently no precise values or definitions to distinguish between high and low success rates of tracheal intubation for OHCA; the studies by Wang et al.[14] and Benger et al.[15] considered the success rate of tracheal intubation to be low (51.6% and 69.8%, respectively), while the study by Jabre et al.[16] judged the success rate of tracheal intubation to be high (97.9%). The success rate of VL in this study was 94.0%, and that of ML was 89.8%. We believe that both can be judged as having a high success rate for tracheal intubation. The JRC (Japan Resuscitation Council) Resuscitation Guidelines 2020 also states that validation based on regional tracheal intubation success rates (and the need for uniform definitions) is necessary in order to recommend which advanced airway securing devices to use [1].

Consideration of the timing of tracheal intubation

The timing of tracheal intubation for OHCA has been much debated, and CoSTR2020 points out that in addition to the airway maneuver, the timing of the maneuver is also important, as observational studies have shown that advanced airway securement is associated with poor neurological outcomes and decreased survival if the timing is delayed.[1]

Kajino et al.[17] and Nakagawa et al.[18] reported that the later the paramedic tracheal intuba tion, the worse the prognosis, and early tracheal intubation correlated with a favorable neurological outcome, respectively.

In this study, approximately 60% of the VL group and 50% of the ML group were performed early on prior to ambulance admission,

Table 3 – ROSC rate, CPC1-2.

	Video laryngoscope	Macintosh laryngoscope	P-value	RR (95%CI)
Percentage of ROSC cases intubated in the field	77.8% (21/27)	66.7% (12/18)	0.41	1.17(0.79–1.71)
Percentage of CPC 1–2 cases intubated in the field	100% (8/8)	60.0% (3/5)	0.13	1.67(0.84–3.41)
ROSC rate	5.5% (27/490)	5.5% (18/325)	0.99	0.99(0.57–1.78)
CPC1-2	1.6% (8/490)	1.5% (5/325)	0.91	1.06(0.35–3.22)

•ROSC:return of spontaneous circulation. CPC:cerebral performance category.

•ROSC rate and CPC1-2 are expressed as % and (real numbers).

(): The left side is the number of successes • implementations / total number.

•Group comparisons were made using the Pearson's chi-square test and Fisher's exact test to estimate RR and 95% CI.

Table 4 – Success rate and number of implementations by region.

	Overall success rate	Video laryngoscope	Macintosh laryngoscope	P-value	RR (95%CI)	Number of implementation per million population
All of Hiroshima Prefecture	92.0% (815/885)	94.1% (490/521)	89.3% (325/364)	0.01	1.05 (1.01–1.10)	345
HA Region	100% (35/35)	100% (30/30)	100% (5/5)	0		244
HB Region	97.2% (104/107)	97.9% (95/97)	90.0% (9/10)	0.26	1.09 (0.88–1.34)	1,263
HC Region	93.1% (335/360)	95.0% (134/141)	91.8% (201/219)	0.24	1.03 (0.98–1.09)	1,498
HD Region	92.1% (210/228)	92.2% (130/141)	91.9% (80/87)	0.95	1.00 (0.93–1.08)	166
HE Region	87.7% (121/138)	91.3% (94/103)	77.1% (27/35)	0.03	1.18 (0.97–1.43)	580
HF Region	58.8% (10/17)	77.8% (7/9)	37.5% (3/8)	0.15	2.07 (0.79–5.42)	33

• HA∼HF: 6 areas in Hiroshima Prefecture.
•The success rate of each tracheal intubation is expressed as a % (real number).
(): The left side is the number of successes • Implementations / Total number.
• Group comparisons were made using the Pearson's chi-square test and Fisher's exact test to estimate RR and 95% CI.
• Based on the total population of each area, the number of people for whom tracheal intubation was attempted was converted to a number per million population.

and the ROSC rate for these early cases was 77.8% for the VL group and 100% for CPC1-2. It was found that performing tracheal intubation at the scene before in-vehicle housing increased both the ROSC rate and CPC1-2 rate. The reason for this was that after tracheal intubation, high quality chest compressions could be continued with minimal interruption of chest compressions.

Furthermore, a comparative of the results of tracheal intubation performed in the field showed that the success rate was 95.0% for the VL group and 88.7% for the ML group, with the VL group having a significantly higher success rate than the ML group. The ROSC rate,CPC1-2 relationship also suggested the usefulness of VL.

Successful intubation rate and number of intubations performed by each region

The success rates of the VL group and the ML group were 94.1% and 89.3%, respectively. However, when comparing the success rate and number of tracheal intubations performed in each region, the success rate of tracheal intubation varied from 58.8% to 100%. In terms of the number of tracheal intubations attempted per million population, there was a large disparity in the number of tracheal intubations performed for OHCA in each region, ranging from 33 to 1498. Success rates were also extremely low in areas where the number of intubations performed per million population was extremely low. One of the factors contributing to this significant difference is thought to be the influence of differences in physicians' orders and activity policies according to the tracheal intubation protocol in each area Medical control committees even within the same prefecture. Based on the results of tracheal intubation in each region, it is necessary for the Medical control committees to develop a protocol and discuss a course of action. As for the comparison between VL and ML in each area, the success rate of VL was higher than that of ML in all areas except for the area where the success rate was 100% in both groups, suggesting the usefulness of VL.

Limitations of the study

ROSC rates and CPC1-2 in this study were observational studies using Utstein style data and emergency transport data, and there may be confounding in the background of OHCA injuries. The study also has a number of limitations: it is a retrospective study limited to Hiroshima Prefecture; the skills of the EMTs who performed tracheal intubation were not evaluated; and the quality of chest compressions was not assessed.

Conclusion

Our data suggest that using VL had a little advantage with a higher success rate and lower complication rate. Further discussion is needed on the development of EMS intubation devices for rapid and safe endotracheal intubation in OHCA, based on clinical results on tracheal intubation in various regions.

Conflict of interest

All authors of this paper have no defined COI.

Acknowledgement

We would like to express my deepest gratitude and appreciation to the people involved in the Hiroshima Prefecture Medical Control committees, the Hiroshima Prefecture Fire Department, and Kokushikan University.

Author details

[a]*Research Institute of Disaster Management and EMS, Kokushikan University,Tokyo, Japan*[b]*Department of Emergency Medical System, Graduate School, Kokushikan University , Tokyo, Japan* [c]*Hiroshima Prefectural Hospital Emergency and Critical Care Medicine* [d]*Emergency and Intensive Care Medicine, Hiroshima University* [e]*Research Center for Mathematical Medicine, Tokyo, Japan*

REFERENCES

1. Japan Resuscitation Council. JRC Resuscitation Guidelines 2020. Tokyo: Igaku Shoin; 2021. p. 56–60.

2. Benoit JL, Gerecht RB, Steuerwald MT, et al. Endotracheal intubation versus supraglotti c airway placement in out-of-hospital cardiac arrest: A meta-analysis. Resustation 2015;9:20–2.
3. Hirasawa H. Ministry of Health, Labour, and Welfare Special Scientific Research Project: Research Group on Appropriate Airway Clearance by EMTs. FY 2001 Summary Research Report. Director Researcher Hirasawa, H, April 2002
4. Hanif MA, Kaji AH, Niemann JT, et al. Advanced airway management does not improve outcome of out-of-hospital cardiac arrest. Acad Emerg Med 2010;17:926–31.
5. Hasegawa K, Hiraide A, Chang Y, et al. Association of pre-hospital advanced airway m anagement with neurologic outcome and survival in patients with out-of-hospital cardiac arrest. JAMA 2013;309:257–66.
6. Kusunoki S, Tanigawa K. Video Laryngoscope-Expectations for Improving the Safety and Certainty of Prehospital Tracheal Intubation-emergency rescue. Crit Care 2012;27:20–3.
7. Fire and Disaster Management Agency: 2020 Edition Current Situation of Emergency Rescue: (Emergency). https://www.fdma.go.jp/publication/rescue/items/kkkg_r02_01_kyukyu.pdf (final data:2021.8.1).
8. Murakawa T, Tase C, Tanigawa K, et al. A Survey of the Use of Video Laryngoscopes for Rigid Intubation by EMTs – Report of the Medical Review Committee of the Japanese Resuscitation Society. Resuscitation 2016;35:77–83.
9. Uchida S, Hagino Y, Saito S, et al. Evaluation of Airway Scope® Proficiency and Its Usefulness as a Countermeasure for Difficult Intubation. J Jpn Soc Clin Anesthesiol 2011;31:678–84.
10. Nakao N, Tanaka H, Sone E, et al. Video Rigid Intubation for Tracheal Intubation Trainin g A Comparison and Study on the Usefulness of a Laryngoscope for. J Jpn Soc Clin Emerg Med 2020;23:539–45.
11. Risse J, Volberg C, Kratz T, et al. Comparison of Video laryngoscope and direct laryngoscopy by German EMTs during out-of-hospital cardiopulmonary resuscitation; an observational prospective study. BMC Emerg Med 2020;20:22.
12. Huebinger RM, Stilgenbauer H, Jarvis JL, et al. Video laryngoscope for out of hospital cardiac arrest. Resuscitation 2021;162:143–8.
13. Timmermann A, Russo SG, Eich C, et al. The out-of-hospital esophageal and endobronchial intubations performed by emergency physicians. Anesth Analg 2007;104:619–23.
14. Wang HE, Schmicker RH, Daya MR, et al. Effect of a Strategy of Intitial Laryngeal Tube Insertion vs Endotracheal Intubation on 72-Hour Survival in Adults With Out-of-Hospital Cardiac Arrest A Randomized Clinical Trial. Jama 2018;320:769–78.
15. Benger JR, Kirby K, Black S, et al. Effect of a Strategy of a Supraglottic Airway Device vs Tracheal Intubatio n During Out-of-Hospital Cardiac Arrest on Functional Outcome The AIRWAYS-2 Randomized Clinical Trial. Jama 2018;320:779–91.
16. Jabre P, Penaloza A, Pinero D, et al. Effect of Bag-Mask Ventilation vs Endotracheal Intubation During Card iopulmonary Resuscitation on Neurological Outcome After Out-of-Hospital Cardiorespiratory Arrest A Randomized Clinical Trial. Jama 2018;319:779–87.
17. Kajino K, Iwami T, Kitamura T, et al. Comparison of supraglottic airway versus endotracheal intubation for the pre-hospital treatment of out-of-hospital cardiac arrest. Crit Care 2011;15:R236.
18. Nakagawa K, Sagisaka R, Tanaka S, et al. Early endotracheal intubation improves neurol ogical outcome following witnessed out-of-hospital cardiac arrest in Japan: a population -based observational study. Acute Med Surg 2021;8:e650.