Macintosh laryngoscope, i-view™, and C-MAC® video laryngoscopes for tracheal intubation with an aerosol box: A randomized, crossover, manikin study

Toshiyuki Nakanishi (nakanishi.anest@gmail.com)
Nagoya City University Graduate School of Medical Sciences https://orcid.org/0000-0003-0328-0629
Yoshiki Sento
Nagoya City University Graduate School of Medical Sciences
Yuji Kamimura
Nagoya City University Graduate School of Medical Sciences
Kazuya Sobue
Nagoya City University Graduate School of Medical Sciences

Research Article

Keywords: Aerosol box, Airway management, COVID-19, Tracheal intubation, Video laryngoscope

Posted Date: October 12th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-90522/v1

Version of Record: A version of this preprint was published at JA Clinical Reports on June 26th, 2021. See the published version at https://doi.org/10.1186/s40981-021-00455-7.

Abstract

Background: The aerosol box was designed to prevent cough droplets from spreading, but it can impede tracheal intubation. We tested the hypothesis that the C-MAC® video laryngoscope (C-MAC) with an external display is more useful than the i-view™ video laryngoscope (i-view) with an integrated display, or a Macintosh direct laryngoscope (Macintosh) for tracheal intubation with an aerosol box.

Methods: This prospective, randomized, crossover simulation study was conducted at an operating room of the two hospitals (a university hospital and a tertiary teaching hospital). We recruited 37 medical personnel (36 anesthesiologists and 1 dental anesthesiologist) who were working in the fields of anesthesia and intensive care with > 2 years of dedicated anesthesia experience from five hospitals. We divided the participants into six groups to use the laryngoscope in a determined order. After the training using each laryngoscope without a box, the participants performed tracheal intubation thrice with each laryngoscope with at least two-hour intervals. The primary outcome was the intubation time. The secondary outcomes were the success rate, Cormack-Lehane grade, and subjective difficulty scale score (numeric rating scale 0–10, 0: no difficulty, 10: highest difficulty). We used the Friedman test and the Wilcoxon signed-rank test with Bonferroni adjustment. Data are shown as median [interquartile range].

Results: Thirty-seven personnel (11 women and 26 men) with 12 [5–19] (median [interquartile range]) years of anesthesia and intensive care experience were enrolled. There was no significant difference in the intubation time: 30 [26–32] s for Macintosh, 29 [26–32] s for i-view, and 29 [25–31] s for C-MAC (P=0.247). The success rate was 95%–100% without significant difference (P=0.135). The i-view and C-MAC video laryngoscopes exhibited superior Cormack-Lehane grades and lower subjective difficulty scale scores than the Macintosh laryngoscope; however, there were no differences between the i-view and C-MAC video laryngoscopes.

Conclusions: Rapid and highly successful tracheal intubation was possible with Macintosh laryngoscope, i-view, and C-MAC video laryngoscopes on a manikin with an aerosol box. Improved Cormack-Lehane grade and ease of procedure may support the use of video laryngoscopes.

Trial registration: UMIN Clinical Trials Registry, identifier UMIN000040269.

Introduction

The outbreak of Coronavirus disease 2019 (COVID-19) is an important concern for health care providers because the causative agent, respiratory syndrome-corona virus-2 (SARS-CoV-2), is highly contagious, primarily via direct contact or droplet transmission. Tracheal intubation is considered one of the highest-risk procedures because of possible aerosol generation and the need to be in close physical proximity with the patient [1–9].

The "aerosol box" was first conceived by a Taiwanese doctor and was reported effective in preventing widespread dispersion of cough droplets during tracheal intubation [10–12]. This box was also expected

to be useful in situations where higher-level personal protective equipment (PPE), such as the medical protective head hood and powered air-purifying respirators is unavailable [13, 14]. However, simulation studies with a relatively small sample size (1–12 personnel) and a report involving five patients have shown that tracheal intubation in the box can be challenging because it restricts hand movements [11, 14–16].

Video laryngoscopes are recommended for tracheal intubation in patients with COVID-19 [1–7]. Currently, several types of video laryngoscopes are commercially available; some have an integrated display on the body, while others have an external display. There are some recommendations for the use of video laryngoscopes with an external display for patients with COVID-19 because it allows the healthcare practitioner to maintain a reasonable distance from the patient's airway [3–5]. When using the aerosol box, the box's seam impairs the operator's visibility, and there is a considerable distance between the operator and the patient's glottis. Moreover, in our experience, we sometimes felt visual difficulties due to the fogging of the goggles when intubating a patient with COVID-19. Thus, an external display may also be useful during tracheal intubation with an aerosol box. Given the short supply of disposables for video laryngoscopes, and the possible reduced risk of infection, a Macintosh direct laryngoscope (Macintosh) might be considered for use with the aerosol box [5, 6]. Many patients with COVID-19 undergoing tracheal intubation are hypoxemic and require rapid, highly successful procedures; therefore, it is essential to identify the optimal device to use with the box [2, 7].

We designed this study to test the hypothesis that the C-MAC® video laryngoscope (C-MAC; KARL STORZ, Tuttlingen, Germany) with an external display is more useful than the disposable i-view™ video laryngoscope (i-view; Intersurgical, Wokingham, UK) with an integrated display, or a Macintosh, when used with an aerosol box.

Methods

This prospective, randomized, crossover manikin study was conducted at the Nagoya City University Hospital and the Nagoya City East Medical Centre from April 30, 2020 to May 11, 2020. The study protocol was reviewed and approved by the Nagoya City University Graduate School of Medical Sciences and Nagoya City University Hospital Institutional Review Board. After explaining the study flow to the participants by verbally and the video made for instruction, we obtained written consent for study participation. Patients were not involved in the study.

We recruited medical personnel who were working in the fields of anesthesia and intensive care without previous experience with aerosol boxes from five hospitals (Nagoya City University Hospital, Nagoya City East Medical Center, Kainan Hospital, Kariya Toyota General Hospital, and Aichi Children's Health and Medical Center) in Japan. Per standard recommendations, only experienced physicians will perform tracheal intubation for patients with COVID-19; therefore, our study only included personnel with > 2 years of dedicated anesthesia experience [1–8]. We designed and conducted this study not only as a research trial but also as a simulation training for clinical use in the operating room.

In this study, we compared the following three types of laryngoscopes: Macintosh direct laryngoscope (Macintosh), i-view, and C-MAC. The C-MAC is a video laryngoscope with an external display, while the i-view is a display-integrated, one-size-fits-all (equivalent to a size 4), single-use video laryngoscope. A reused size-3 blade was used for Macintosh, and a single-use size-3 Macintosh type blade was used for C-MAC. The AirSim Combo Bronchi X (TruCorp, Lurgan, Ireland) manikin was used for all procedures. A 7.0-mm tracheal tube with a stylet, angled by each participant, was used. Although some arrangements have been reported [16, 17], we created and used an acrylic box based on the original version of the report [10].

Before the main measurement using the box, participants were trained to familiarize themselves with the three laryngoscopes and the manikin used in the study. The training was conducted in the same manner as the main study, except in the following order (Macintosh, i-view, and C-MAC) without the box. All the training and main studies were conducted in an operating room at the two hospitals (Nagoya City University Hospital and Nagoya City East Medical Center). The manikin was placed on the operating table in the supine position under the box. Both the manikin and the box were fixed with tape on the table so that the top of the manikin's head was 10 cm away from the box. During training and the main test, the participating physician wore a long-sleeved gown, double gloves, a surgical mask, face shield or goggles and a surgical cap. The N95 mask was not used because they are in short supply and have limited influence on intubation procedures. Neither a covering hood nor a powered air-purifying respirator was used. The height of the operating table was adjusted per the participant. In the box, a laryngoscope was placed on the left side of the manikin, and a tray was placed on the right side, where a tracheal tube and a cuff syringe with 8 ml of air were prepared. Six l/min of oxygen was administered to the manikin with a facemask. The participants removed the mask, opened the manikin’s mouth and picked up the laryngoscope. Then the participants picked up a tracheal tube, performed tracheal intubation, removed the stylet and inflated air into the cuff of the tube by themselves, considering the minimal number of personnel in the operating room. The participants removed the outer glove on their right hand and grasped the reservoir bag for ventilation. The investigators (TN, YS) stood on the right side of the manikin, recording the intubation time with a stopwatch, and helped connect the anesthesia circuit to the tracheal tube. The intubation time was defined as the time between holding the laryngoscope and confirming the first expansion in both lungs. An intubation time > 60 s, esophageal intubation, or single-lung intubation were considered to indicate failure. After each procedure, the participant assessed the Cormack-Lehane grade and the subjective difficulty scale score of tracheal intubation (numeric rating scale 0–10, 0: no difficulty, 10: highest difficulty). In the training, participants performed tracheal intubation thrice using each laryngoscope, without the box. If the participants failed, an additional procedure was performed to achieve successful completion.

At least 2 h after the training, the participants began the main part of the study using the aerosol box. To compare the three laryngoscopes, we used a randomized crossover design by dividing the participants into six groups and testing them in the determined order (Figure 1). The investigator (TN) not participated in the study performed computer-generated randomization and allocated participants to the six groups. The allocation was blinded to the participant until immediately before preparing the determined

laryngoscope. The participants performed tracheal intubation on the manikin with the box three times using each assigned laryngoscope. A washout period of at least 2 h was required before the next laryngoscope was used. The primary outcome was the intubation time. The secondary outcome included the success rate, Cormack-Lehane grade and subjective difficulty scale score.

Statistical Analysis

Based on a preliminary analysis performed by investigators who did not participate in the study, we estimated an intubation time of 25 s for C-MAC and 35 s for i-view. With an α error of 1.67% (adjusted for Bonferroni method), power of 90%, SD of 7, and correlation coefficient of 0.5 for 2-tailed statistical analysis, we arrived at a minimum sample size of 10 participants. However, we recruited as many eligible physicians as possible in the study because it also aimed to provide simulation training and increase the secondary endpoint estimate accuracy (success rate).

To compare the intubation time, Cormack-Lehane grade, and subjective difficulty scale score of the three laryngoscopes, we used the median values of the three measurements, considering the learning effect. The intubation time of i-view showed a non-normal distribution (Shapiro-Wilk test $P<0.05$); the intubation times of the three laryngoscopes are presented as the median [interquartile range (IQR)] values. The Cormack-Lehane grade and subjective difficulty scale score are also presented as median [IQR] values. We used the Friedman test to compare the three devices' performances. If a significant difference was found, the Wilcoxon signed-rank test with Bonferroni adjustment was used for pairwise comparisons. We compared the proportion of participants who successfully performed all three procedures between the three different laryngoscopes using the Cochran Q test. We also compared outcomes with and without the aerosol box in each laryngoscope. All the statistical analyses were performed using R software (version 3.6.3, R Foundation for Statistical Computing, Vienna, Austria). A P value of <0.05 was considered statistically significant.

Results

We enrolled 37 personnel (11 women and 26 men) with 12 [5–19] years of anesthesia and intensive care experience; all their records were incorporated into the final analysis (Figure 1).

A summary of the results with the aerosol box is shown in Table 1, and the details are shown in Supplementary Table 1. The intubation time was 30 [26–32] s for Macintosh, 29 [26–32] s for i-view, and 29 [25–31] s for C-MAC, showing no significant difference (P=0.247). The success rate was 95%–100% without a significant difference; two failed attempts with the i-view (One took 66 s, and the other stopped the procedure when 60 s had passed). The Cormack-Lehane grade was lower in i-view and C-MAC than Macintosh. The subjective difficulty scale score was higher with Macintosh than with i-view or C-MAC (Figure 2). However, there were no differences in the Cormack-Lehane grade and the subjective difficulty scale score between i-view and C-MAC.

A summary of the training result is shown in Table 2, and the details are shown in Supplementary Table 2. Intubation time with C-MAC was increased by the aerosol box (P=0.01), but there was no significant difference with Macintosh (P=0.32) or i-view (P=0.25). The Cormack-Lehane grade was worsened by the use of the aerosol box in Macintosh (P=0.014) but was unchanged in i-view (P=0.78) and C-MAC (P=0.42). In all three laryngoscopes, subjective difficulty scale score was higher when using the box: Macintosh (P<0.001), i-view (P=0.0496), and C-MAC (P=0.032).

Discussion

In this simulation study comparing the performance of three types of laryngoscopes, Macintosh, i-view, and C-MAC, for tracheal intubation in a manikin with an aerosol box, we found no differences in the intubation time among the three types of laryngoscopes. All three laryngoscopes facilitated quick tracheal intubation with a 95%–100% success rate; however, Macintosh had a higher subjective difficulty scale score and worse Cormack-Lehane grade than i-view and C-MAC.

The present results did not support our hypothesis that the use of C-MAC that has an external display is more useful than i-view for tracheal intubation with an aerosol box. One possible explanation is that poor visibility, because of vapor condensation on the goggles or face shields that have been reported as a problem during tracheal intubation, did not occur in our setting [7]. The new box's high transparency might have contributed further to this finding. Recently, Madabhushi et al. enrolled 78 normal airway patients without COVID-19 and found non-inferior time in tracheal intubation with the aerosol box compared to without the box, using Glidescope (Verathon, Bothell, WA, USA) with an external display [18]. The results of Madabhushi's study may suggest the potential benefit of external display when performing tracheal intubation with an aerosol box in real patients. Although an external display might be useful in a clinical setting, where eye-protective PPE or aerosol boxes are cloudy or well worn, we could not confirm the advantage in this simulation study using a transparent acrylic box.

The subjective difficulty scale score for tracheal intubation was higher for Macintosh than for i-view and C-MAC. In situations where both a Macintosh laryngoscope and a video laryngoscope can be used, our results support using a video laryngoscope because it would facilitate tracheal intubation with the aerosol box. However, video laryngoscopes may not be available because of an insufficient supply of disposable healthcare products [8, 9]. The Macintosh facilitated quick tracheal intubation with a high success rate that was unexpectedly comparable to that for video laryngoscopes, despite the greater difficulty and lower Cormack-Lehane grade. For medical personnel skilled in using Macintosh laryngoscopes, the combined use of a Macintosh laryngoscope and an aerosol box might be an option if a difficult airway is not anticipated and there is limited availability of video laryngoscopes.

Tracheal intubations in the aerosol box were performed with the highly successful rate (95%–100%) and the median intubation time of 29–30 s. Intubation time did not differ with or without the box except for C-MAC. These results are similar to a recently reported two simulation studies [19, 20]. In a study by Saito et al. compairing five laryngoscopes, eight anesthesiologists intubated a manikin's trachea using an aerosol

box with a high success rate (86%–100%) and a short intubation time (median 19–29 s) [19]. In the other study by Wakabayashi et al. comparing three laryngoscopes, 18 anesthesiologists intubated a manikin's trachea using a box with a 100% success rate and a short intubation time (mean 14–17 s) [20]. On the other hand, our results contradict those from a recent study performed by 12 anesthesiologists, which reported an intubation time of 42.9 [32.9–46.9] s without the box, 82.1 [45.1–98.3] s with the original box, and 52.4 [43.1–70.3] s with the modified box [16]. The shorter intubation time in our study may be due to familiarity with the device and manikin through training. A high success rate and short intubation time observed in our study suggest that the aerosol box can be used safely after sufficient training.

Our study has several strengths. First, we enrolled a moderate number of physicians who had > 2 years of dedicated anesthesia experience and were engaged in airway management at multiple centers. Moreover, the participants in our study wore PPE and underwent tracheal intubation with minimal assistance, referring to recommendations for airway management in patients with COVID-19. Therefore, our data are practical and clinically valuable. Second, we measured the outcomes three times for each laryngoscope and used the median values for the comparisons. In unfamiliarity, one-time measurements may result in long intubation times being recorded, which is not clinically meaningful. When evaluating a novel device, such as the aerosol box, the learning effect should be considered. The use of the aerosol box is highly controversial [12–22]. We believe that the current simulation study results would be referred for the safe use of aerosol boxes in clinical practice.

Certain limitations of the present study need to be noted. First, this simulation study was performed using a manikin. It is necessary to examine the safety and efficacy of aerosol boxes in clinical practice. Evidence for the use of aerosol boxes in real patients is lacking and needs to be studied in the near future [22]. Second, differences in the participants' familiarity with the three laryngoscopes might have affected the results. However, we believe that these effects were minimized because we provided training to the participants before initiating the main study. Third, we did not evaluate physician safety in this study in terms of droplet splash, aerosol spread and PPE breakage, although the breakage of the long-sleeved gowns did not occur in our study. Fourth, we used the box with the original design; however, various modifications to the box, with regard to shape and draping, have been reported [10, 16, 17]. These might make it difficult to generalize our study results. Finally, we did not simulate a difficult airway setting in the present study. Further, the participants in our study placed airway management equipment in their optimal position. Our results are not applicable to situations such as difficult airways and emergency airway settings. In such situations, the box should be removed and the airway secured in the best possible manner [11, 12, 17].

Conclusions

In summary, tracheal intubation under an aerosol box can be performed using any of the following three types of laryngoscopes: Macintosh, i-view, and C-MAC, with an intubation time of 29–30 s and a success rate of 95%–100%. Improved Cormack-Lehane grade and ease of procedure may support using a video

laryngoscope when using the aerosol box. Future researches on the safety and efficacy of aerosol boxes in clinical settings are warranted.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Nagoya City University Graduate School of Medical Sciences and Nagoya City University Hospital Institutional Review Board (reference number, 60-20-0032). After explaining the study flow to the participants by verbally and the video made for instruction, we obtained written consent for study participation.

Consent for publication

We obtained written consent for publication. Patients were not involved in the study.

Availability of data and materials

Data are available upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

None declared.

Authors' contributions

TN designed and conducted the study, analyzed the data, and wrote the manuscript.

YS helped design and conduct the study, and revise the manuscript.

YK helped design and conduct the study, and revise the manuscript.

KS helped design and conduct the study, and revise the manuscript.

All authors read and approved the final manuscript.

Acknowledgements

The authors would like to thank Hiroya Hashimoto, Ph.D., Clinical Research Management Centre, Nagoya City University Hospital (Nagoya, Japan) for the statistical advice, Aiji Sato, D.D.S., Ph.D., Department of Anesthesiology, Aichi Gakuin University School of Dentistry (Nagoya, Japan) and Tatsuya Tsuji, M.D., Department of Anesthesiology and Intensive Care Medicine, Nagoya City University Graduate School of

Medical Sciences (Nagoya, Japan) for the advice on the manuscript, and all of the participants for their cooperation in the study.

Footnotes

None.

Abbreviations

COVID-19: Coronavirus disease 2019, SARS-CoV-2: respiratory syndrome-corona virus-2, PPE: personal protective equipment, IQR: interquartile range

References

1. Zuo MZ, Huang YG, Ma WH, Xue ZG, Zhang JQ, Gong YH, et al. Expert Recommendations for Tracheal Intubation in Critically ill Patients with Noval Coronavirus Disease 2019. Chin Med Sci J. 2020;35:105-9.
2. Meng L, Qiu H, Wan L, Ai Y, Xue Z, Guo Q, et al. Intubation and Ventilation amid the COVID-19 Outbreak: Wuhan's Experience. Anesthesiology. 2020;132:1317-32.
3. Wax RS, Christian MD. Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients. Can J Anaesth. 2020;67:568-76.
4. Sorbello M, El-Boghdadly K, Di Giacinto I, Cataldo R, Esposito C, Falcetta S, et al. The Italian coronavirus disease 2019 outbreak: recommendations from clinical practice. Anaesthesia. 2020;75:724-32.
5. Cook TM, El-Boghdadly K, McGuire B, McNarry AF, Patel A, Higgs A. Consensus guidelines for managing the airway in patients with COVID-19: Guidelines from the Difficult Airway Society, the Association of Anaesthetists the Intensive Care Society, the Faculty of Intensive Care Medicine and the Royal College of Anaesthetists. Anaesthesia. 2020;75:785-99.
6. Brewster DJ, Chrimes N, Do TB, Fraser K, Groombridge CJ, Higgs A, et al. Consensus statement: Safe Airway Society principles of airway management and tracheal intubation specific to the COVID-19 adult patient group. Med J Aust. 2020;212:472-81.
7. Yao W, Wang T, Jiang B, Gao F, Wang L, Zheng H, et al. Emergency tracheal intubation in 202 patients with COVID-19 in Wuhan, China: lessons learnt and international expert recommendations. Br J Anaesth. 2020;125:e28-37.
8. Chen X, Liu Y, Gong Y, Guo X, Zuo M, Li J, et al. Perioperative Management of Patients Infected with the Novel Coronavirus: Recommendation from the Joint Task Force of the Chinese Society of Anesthesiology and the Chinese Association of Anesthesiologists. Anesthesiology. 2020;132:1307-16.
9. Cook TM. Personal protective equipment during the coronavirus disease (COVID) 2019 pandemic - a narrative review. Anaesthesia. 2020;75:920-7.

10. Everington K. Taiwanese doctor invents device to protect US doctors against coronavirus. Taiwan news. https://www.taiwannews.com.tw/en/news/3902435. Accessed 18 May 2020.
11. Canelli R, Connor CW, Gonzalez M, Nozari A, Ortega R. Barrier Enclosure during Endotracheal Intubation. N Engl J Med. 2020;382:1957-8.
12. Yang SS, Zhang M, Chong JJR. Comparison of three tracheal intubation methods for reducing droplet spread for use in COVID-19 patients. Br J Anaesth. 2020;125:e190-1.
13. Tsai PB. Barrier Shields: Not Just for Intubations in Today's COVID-19 World? Anesth Analg. 2020; doi:10.1213/ANE.0000000000004902.
14. Leyva Moraga FA, Leyva Moraga E, Leyva Moraga F, Juanz González A, Ibarra Celaya JM, Ocejo Gallegos JA, et al. Aerosol box, An Operating Room Security Measure in COVID-19 Pandemic. World J Surg. 2020;44:2049-50.
15. Gould CL, Alexander PDG, Allen CN, McGrath BA, Shelton CL. Protecting staff and patients during airway management in the COVID-19 pandemic: are intubation boxes safe? Br J Anaesth. 2020;125:e292-3.
16. Begley JL, Lavery KE, Nickson CP, Brewster DJ. The aerosol box for intubation in coronavirus disease 2019 patients: an in-situ simulation crossover study. Anaesthesia. 2020;75:1014-21.
17. Malik JS, Jenner C, Ward PA. Maximising application of the aerosol box in protecting healthcare workers during the COVID-19 pandemic. Anaesthesia. 2020;75:974-5.
18. Madabhushi P, Kinthala S, Ankam A, Chopra N, Porter BR. Time to adapt in the pandemic era: a prospective randomized non -inferiority study comparing time to intubate with and without the barrier box. BMC Anesthesiol. 2020;20:232.
19. Saito T, Taguchi A, Asai T. Videolaryngoscopy for tracheal intubation in patients with COVID-19. Br J Anaesth. 2020;125:e284-6.
20. Wakabayashi R, Ishida T, Yamada T, Kawamata M. Effect of an aerosol box on tracheal intubation difficulty. J Anesth. 2020;34:790-3.
21. Kearsley R. Intubation boxes for managing the airway in patients with COVID-19. Anaesthesia. 2020;75:969.
22. Sorbello M, Rosenblatt W, Hofmeyr R, Greif R, Urdaneta F. Aerosol boxes and barrier enclosures for airway management in COVID-19 patients: a scoping review and narrative synthesis. Br J Anaesth. 2020; doi:10.1016/j.bja.2020.08.038.

Tables

Table 1

Outcomes using the Macintosh, i-view, and C-MAC laryngoscopes for tracheal intubation in the aerosol box.

	A	B	C	A vs. B	A vs. C	B vs. C	*P*
	Macintosh	i-view	C-MAC	*P*	*P*	*P*	
	(n =37)	(n = 37)	(n = 37)				
Intubation time (s)	30 [26–32]	29 [26–32]	29 [25–31]				0.247
Success	37 (100)	35 (95)	37 (100)				0.135
Cormack-Lehane grade	2 [2–2]	1 [1–1]	1 [1–1]	<0.001	<0.001	1	<0.001
Subjective difficulty scale	4 [3–5]	3 [2–3]	2 [1–3]	<0.001	<0.001	0.055	<0.001

Data are shown as median [interquartile range] or number (proportion). P values of multiple comparison were adjusted using the Bonferroni method.

Table 2

Results of the training with the Macintosh, i-view, and C-MAC laryngoscopes, where the box was not used.

	Macintosh	i-view	C-MAC
	(n = 37)	(n = 37)	(n = 37)
Intubation time (s)	29 [25–33]	29 [24–32]	26 [24–30]
Success	31 (84%)	36 (97%)	37 (100%)
Cormack-Lehane grade	2 [1–2]	1 [1–1]	1 [1–1]
Subjective difficulty scale	3 [2–4]	2 [1–3]	2 [1–2]

Data are shown as median [interquartile range] or number (proportion).

Figures

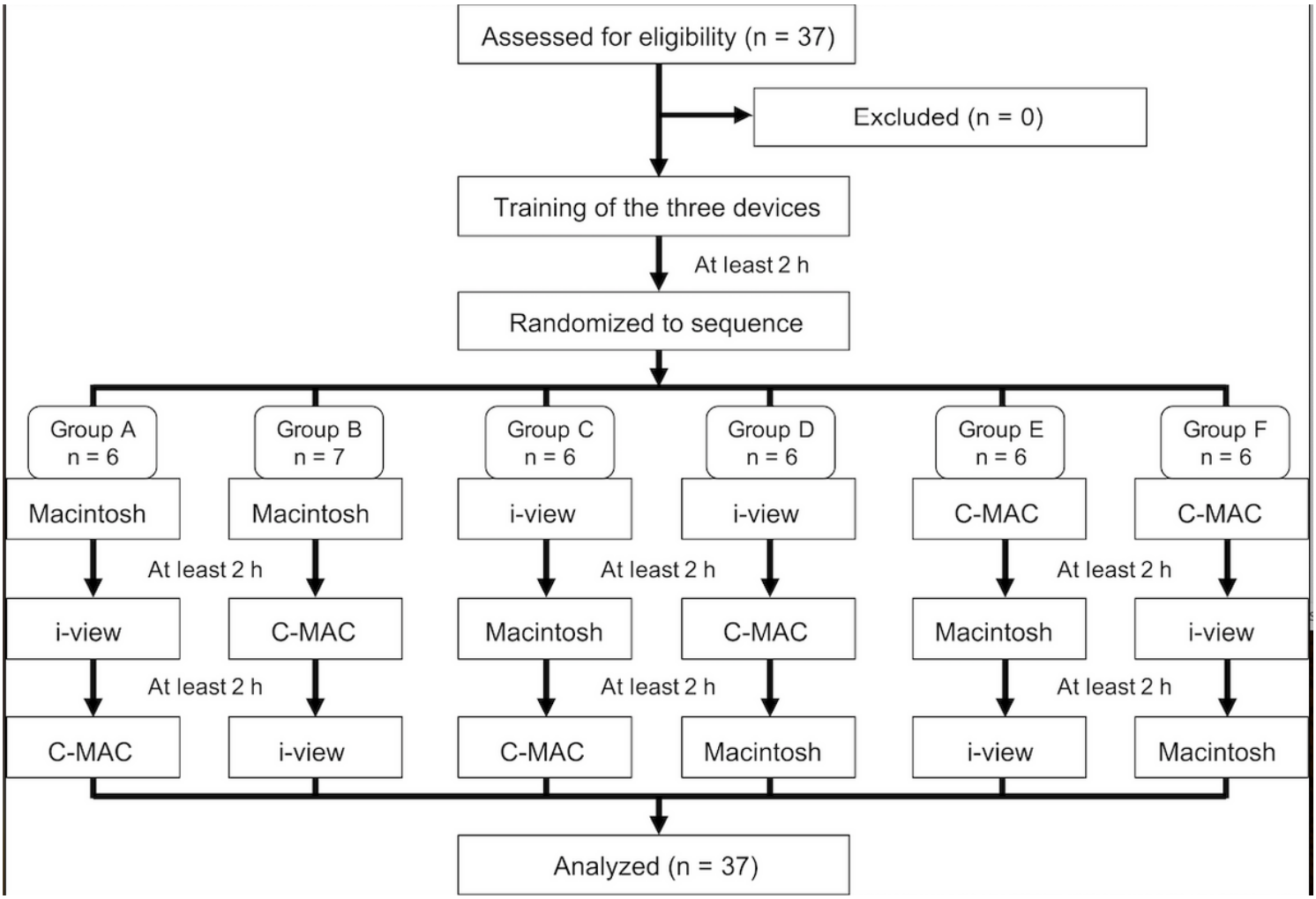

Figure 1

CONSORT diagram of the study participants.

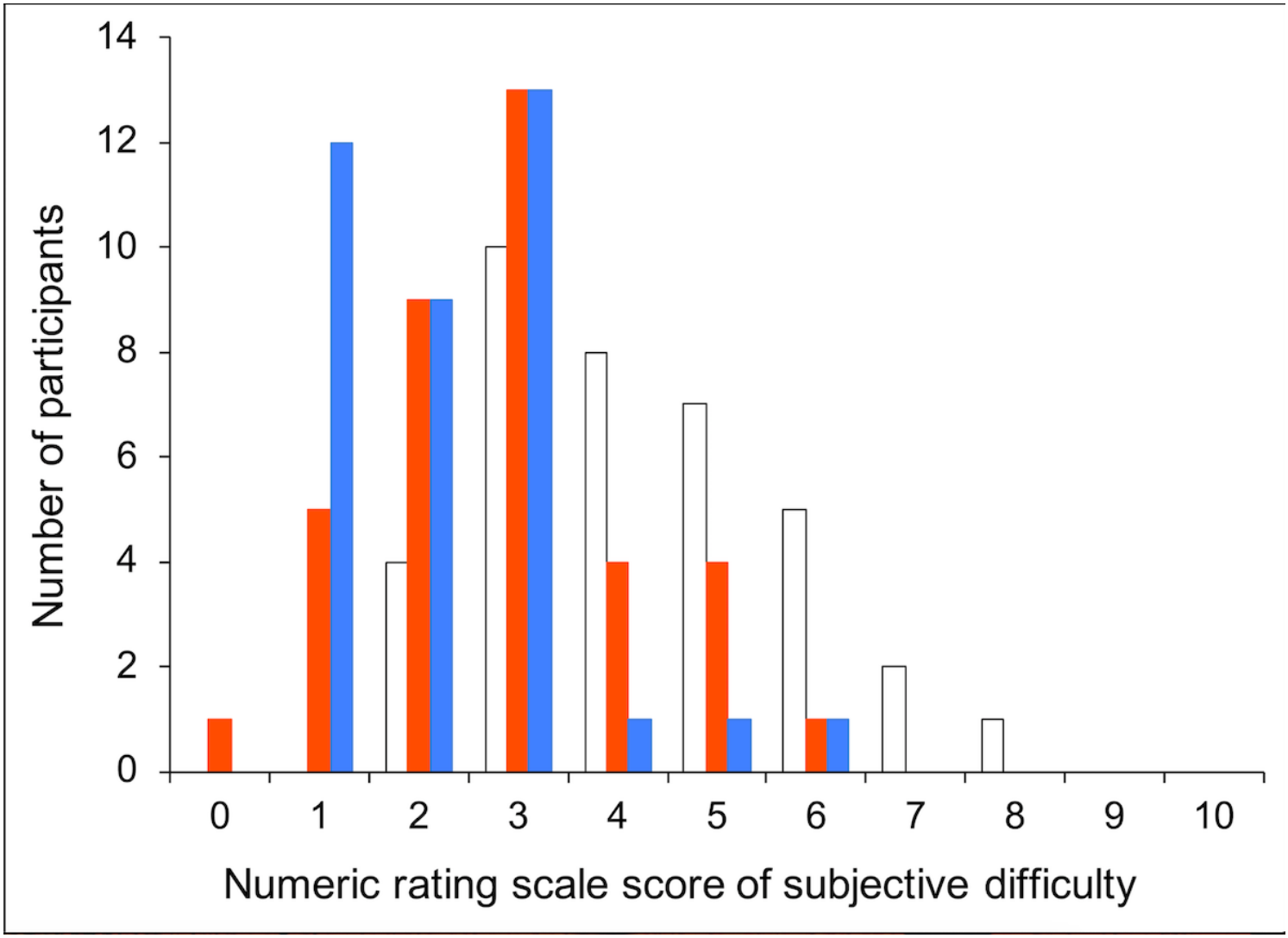

Figure 2

Distribution of the numeric rating scale score of subjective difficulty with the three laryngoscopes. The white, red, and blue bars show the number of participants for Macintosh, i-view, and C-MAC laryngoscopes, respectively.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupTable1.pdf
- SupTable2.pdf