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EVALUATION OF THEEFFECT OF INTUBATION BOX USE ON TRACHEAL INTUBATION DIFFICULTY WITH KING VISION® AND TRUVIEW VIDEOLARYNGOSCOPE IN MANIKIN IN A TERTIARY CARE HOSPITAL

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Comparative study to evaluate the effect of intubation box on tracheal intubation difficulty with King Vision® and TRUVIEW video laryngoscope in manikin in a tertiary care hospita, India

Abstract

Background: ***The procedures of introducing an airway by intubation are associated with increased risk of aerosolisation of SARS-CoV-2 virus, posing a high risk to the personnel involved. Newer and novel methods such as the intubation box have been developed to increase the safety of healthcare workers during intubation.***
Methods (design): ***In this study, 33 anaesthesiologist and critical care specialists intubated the trachea of the airway manikin (US Laerdal Medical AS™) 4 times using a King Vision® videolaryngoscope and TRUVIEW PCD™ videolaryngoscope (with and without an intubation box as described by Lai). Intubation time was primary outcome. Secondary outcomes were first-pass intubation success rate, percentage of glottic opening (POGO) score and peak force to maxillary incisors.***
Results: ***Intubation time and the number of times a click was heard during tracheal intubation were considerably higher in both groups when an intubation box was used (Table 1). When comparing the two laryngoscopes, the King Vision® videolaryngoscope enabled much less time to intubate than did the TRUVIEW laryngoscope, both with and without the intubation box. (P<0.001) In both laryngoscope groups, first-pass successful intubation was higher without the intubation box, although the difference was statistically insignificant. POGO score was not affected by intubation box but a higher score was observed with King Vision® laryngoscope (Tables 1,2).***
Conclusion: ***This study indicates that use of an intubation box makes intubation difficult and increases the time needed to perform it. King Vision® videolaryngoscope results in lesser intubation time and better glottic view as compared to TRUVIEW laryngoscope.***

Keywords

Airway management • anaesthesiologist • intubation • SARS-CoV-2 pandemic • manikin • laryngoscope

Introduction

The severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) pandemic has put the lives of healthcare workers at great risk. Worldwide, infection in healthcare workers is increasing in many countries.[1] During the procedures of airway management, the odds of transmission of infection to healthcare workers is 6.6 times greater than in other interactions.[2] To combat the high risk of transmission of coronavirus disease amongst healthcare workers there have been efforts to develop ingenious devices and methods. One such device is the intubation box for use during tracheal intubation developed by Lai, Hsien Yung; Mennonite Christian Hospital, Hua Lian, 2020.[3]

However, there are concerns with the difficulties associated with the use of an intubation box during tracheal intubation. Hence, this study was conducted to determine the effect of an intubation box on tracheal intubation difficulty in a simulated normal airway environment using two different types of videolaryngoscopes.

Patients and Methods

The study was approved by the institutional ethics committee (GIMS/IEC/HR/EFR/2020/14) and written informed consent was obtained from all the participants.

Thirty-three anaesthesiologist and critical care specialists, having experience of more than 50 orotracheal intubations via videolaryngoscopes, were invited for the study. Three intubators were excluded due to denial of consent.

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The manikin used for our study is the Laerdal airway management simulator (US Laerdal Medical AS™).
Each participant intubated the trachea of the airway manikin 4 times as follows:

(1) using a King Vision® videolaryngoscope and a size #3 disposable videolaryngoscope channelled blade (KVLO3C) without an aerosol box;
(2) using a King Vision® videolaryngoscope and a size #3 disposable videolaryngoscope channelled blade (KVLO3C) with an aerosol box;
(3) using a TRUVIEW PCD™ – videolaryngoscope and an TRUVIEW PCD™ Optical blade size 3 without an intubation box; and
(4) using TRUVIEW PCD™ – videolaryngoscope and an TRUVIEW PCD™ Optical blade size 3 with an intubation box.

Our intubation box was made according to the standard reference, as described by Lai (length* height* width 40* 50 *50 cm; diameter of the circular opening for insertion of arms, 10 cm; position of the circular opening, 25 cm from base and 5 cm from the side of the box) [4].
A PVC tracheal tube with an internal diameter of 8.0 mm was used in all intubations. A malleable stylet (Intersurgical™ satin slip intubating stylet) was used for tracheal intubation with the King Vision® videolaryngoscope and a Truflex™ articulating stylet for the TRUVIEW PCD™ videolaryngoscope.
The table on which the manikin was placed was kept horizontal and a stiff headrest with a height of 7 cm was used under the manikin's head to maintain standard 'sniffing position'. The entire bed remained horizontal. Each participant was allowed three practice intubations in all the settings on the manikin to familiarise them with the process. The order of intubations was randomised for every intubator by computer-generated randomisation. All the participants donned personal protective equipment (PPE) in adherence to institutional guidelines. To conserve the valuable PPE expired N95 masks were used. The airway assistant for all tracheal intubations was a single experienced anaesthetist who was blinded to the order of scenarios.
The primary outcome was intubation time, defined as the time from initial insertion of the laryngoscope in the mouth to the first lung inflation with positive pressure breaths using an anaesthesia bag through the tracheal tube with an inflated cuff. Secondary outcomes were first-pass intubation success rate, percentage of glottic opening (POGO) score [5], peak force to maxillary incisors measured by force sensors attached to the manikin as default and heard as a click sound. Failed tracheal intubation was defined as intubation time of more than 60 s or oesophageal intubation. The time to successful tracheal intubation, attempt needed to intubate, and the peak force to maxillary incisors was recorded (measured by audible click) by a single assistant who was not involved in the study design. The POGO score was evaluated by each intubating anaesthetist.
Data was compiled in MS Excel and analysed using SPSS 23.0 software. Results are presented as numbers, frequencies, and proportions or as mean, standard deviation wherever appropriate. Testing for significant associations was done using chi square test or Fischer exact test or using student t test as required. P value was considered statistically significant if its value was below 0.05.

Result

The sample size was determined by using our pilot data ($n = 7$). In our pilot study, the mean (standard deviation) times to successful tracheal intubation were 18 and 20 sec with King Vision® videolaryngoscope and TRUVIEW videolaryngoscope, respectively, without the aerosol box. We assumed that the use of the intubation box prolonged the time for intubation by 12 s. With type I error of 5% and type II error of 20%, 27 participants were required for the study. To compensate for dropouts 33 participants were recruited.
Thirty anaesthetists randomly performed a total of 120 intubations, from which data was collected and subsequently analysed. Intubation time with the intubation box was significantly longer in both the laryngoscope groups when compared to the intubation time without the use of intubation box ($P<0.001$) (Table 1). Intubation time with King Vision® videolaryngoscope was significantly shorter when compared to the intubation time with TRUVIEW laryngoscope, both with and without use of an aerosol box ($P<0.001$) (Table 2).
Overall first-pass success was greater without the intubation box when compared to intubations with the use of aerosol box, in both the laryngoscope groups, but the difference was statistically insignificant (Tables 1,2). The number of times the click was heard during tracheal intubation was significantly higher when using an intubation box with both the laryngoscopes, as compared to without the use of an intubation box (Table 1).
Use of the intubation box did not affect the POGO score of the intubators (Table 1).
POGO score was significantly reduced with the use of TRUVIEW laryngoscope as compared to the use of King Vision® laryngoscope, both with and without intubation box (Table 2).
We found that use of the intubation box significantly increases both the intubation time needed and the force exerted on the upper incisors. Its use, however, did not significantly affect the POGO score and the first-pass success rate. In addition, intubation with King Vision® videolaryngoscope took less time

Table 1: Comparison of Coordinates of Tracheal Intubation Difficulty on Manikin Without And With Intubation Box.

Coordinates	TRUVIEW Laryngoscope (n=30)		P value†	King Vision® Laryngoscope (n=30)		P value†
	Without I.B.	With I.B.		Without I.B.	With I.B.	
Time to Successful Intubation (sec)	21.2±1.69	31.13±2.15	<0.001	15.80±1.13	23.37±1.17	<0.001
First Pass Intubation Success Rate*	29	24	0.103	30	26	0.112
Click	0	7	0.011	0	6	0.024
Pogo Score*	75-100	75-100	0.744	100	100	1.00

Values are presented as numbers or mean ± S.D.
I.B: intubation box, POGO: percentage of glottic opening.
*Values are presented as numbers (%)
†statistically significant difference (P<0.05)

Table 2: Comparison of Coordinates of Tracheal Intubation Difficulty Among the Two Laryngoscopes With And Without Use of Intubation Box.

Coordinates	With Intubation Box			Without Intubation Box		
	TRUVIEW video-laryngoscope (n=30)	King Vision® video-laryngoscope (n=30)	P value†	TRUVIEW video-laryngoscope (n=30)	King Vision® video-laryngoscope (n=30)	P value†
Intubation Time (sec)	31.13±2.15	23.37±1.17	<0.001	21.20±1.69	15.80±1.13	<0.001
First Pass Success*	24	26	0.729	29	30	1.00
Click	7	6	1.00	0	0	1.00
POGO Score*	75%(n=6)	100(N=30)	0.011	75%(n=5)	100(n=30)	0.021
	100%(n=24)			100%(n=25)		

Values are presented as numbers or mean ± S.D. POGO: percentage of glottic opening.
*Values are presented as numbers (%)
†statistically significant difference (P<0.05)

and provided better glottic view as compared to intubation with the use of TRUVIEW videolaryngoscope.

Discussion

Simulation is a well-established method for testing the safety and efficacy of medical innovations. [6] Many institutions have developed new protective barrier modalities for tracheal intubation of infected patients during the COVID19 pandemic.[3] Our aim was to test the utility of an intubation box in a simulated environment of a normal airway manikin.

To our knowledge this is the first formal study using these two videolaryngoscopes (TRUVIEW and King Vision® videolaryngoscopes) and the intubation box. In our study, we found that use of an intubation box during intubation significantly prolongs the intubation time and increases the force exerted on the upper incisors, hence making the procedure of intubation more complicated. Prolongation of intubation time in a COVID 19 patient requiring mechanical ventilation can be very critical, as it may lead to exaggerated hypoxia, increasing morbidity and mortality. Prolonged procedure time could result in greater aerosolization. Increased force exerted on upper incisors during intubation with the use of the aerosol box may indicate greater probability of dental trauma to patients. We also found the removal of assistive devices such as the stylet was more difficult with the use of an intubation box, which could be one of the factors in increased intubation time.

Our results are in agreement with another manikin-based pilot study, which concluded that the intubation times were higher when barrier devices such as an intubation box or plastic sheets were in place. The use of barrier devices resulted in ergonomic challenges such as difficult stylet removal and movement of hands under the barrier device. [7]

On the contrary, a study done by Wakabayashi R et al. [8] on the aerosol box concluded that 'the effect of an intubation box on tracheal intubation difficulty is clinically irrelevant when an experienced anaesthetist intubates the trachea in a normal airway condition.' Their difference in findings from ours could be due to the fact that we used real-time simulation by wearing PPE with goggles during all intubations.

In a letter to healthcare providers, the Food and Drug Administration (FDA) revoked the umbrella Emergency Use Authorization for passive protective barrier enclosures issued in May. [9] This was done as some studies pointed out that barrier enclosures used during COVID 19 may not decrease exposure of health care providers to airborne particles, and may add to the level of difficulty during airway management. They recommended use of negative pressure and full PPE cover while handling airways.

The King Vision® videolaryngoscope provides an indirect view of the glottis and has a provision of single-use blades,

which removes the concerns of contagious infections and is advantageous for use in COVID scenarios. Its distal lens has an anti-fog coating, which may be the cause for decreased intubation times when used with goggles. [10] The TVL (Truphatek Israel) is a Macintosh-type blade with an optical lens attached. [11]

Our research has a few drawbacks. To begin with, the intubation box was not assessed in a difficult airway scenario. Difficult airway conditions present a higher challenge and add to the time it takes to intubate. When used in these settings, it may result in a greater risk of damage and difficulty than when used in patients with a normal airway. Secondly, we could not use any parameter to evaluate the amount of protection from viral exposure achieved with use of an intubation box.

Our study analysed only laryngoscopy and endotracheal intubation as surrogate markers of airway management. However, airway management also involves other procedures such as mask ventilation, suctioning, laryngeal mask airway insertion, and tracheostomy, which were not analysed in our study. These procedures can also pose a challenge with the use of an intubation box.

In our study only experienced anaesthesiologists were recruited for testing the use of an intubation box. Healthcare providers with lesser experience in airway management could face additional challenges with the use of the intubation box.

Conclusion

In conclusion, the results of our study indicate that use of an intubation box makes tracheal intubation comparatively difficult and increases the intubation time. Of the two laryngoscopes used in our study, we conclude that the King Vision® videolaryngoscope takes less intubation time and gives a better glottic view as compared to the TRUVIEW videolaryngoscope. The ergonomic issues with the use of the intubation box are the trade-offs that must be made for the safety that the protective device claims to provide.

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