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Comparison of the time to successful endotracheal intubation using the Macintosh laryngoscope or KingVision video laryngoscope in the emergency department: A prospective observational study

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Abstract:

OBJECTIVE: Intubation is a skill that must be mastered by the emergency physician (EP). Today, we have a host of video laryngoscopes which have been developed to make intubations easier and faster. It may seem that in a busy emergency department (ED), a video laryngoscope (VL) in the hands of an EP would help him intubate patients faster compared to the traditional direct laryngoscope (DL). Our goal was to compare the time taken to successfully intubate patients coming in ED using King Vision VL (KVVL) and DL.

MATERIALS AND METHODS: This was a prospective observational study on patients coming to the ED requiring emergent intubation. They were allocated one to one alternatively into two groups – KVVL and DL. Accordingly, KVVL or DL intubations were carried out by the EPs. Time taken to intubate, first-pass success, and crossover between laryngoscopes were recorded.

RESULTS: A total of 350 patients were enrolled in the study. Overall, mean time to intubate patients using the DL was 15.85 s (95% confidence interval [CI] 14.05–17.65), while the meantime with KVVL was 13.75 s (95% CI 12.32–15.18) (P = 0.084). The overall first-pass success rates with DL and KVVL were 89.94% and 85.16%, respectively (P = 0.076). A total of 7.43% (95% CI 5.12–10.66) patients had crossover between laryngoscopes.

CONCLUSION: We found the KVVL to have a similar performance to the DL in terms of time for intubations and ease in difficult airways. We consider the KVVL a useful device for EDs to equip themselves with.

Keywords:

Airway, direct laryngoscope, video laryngoscope

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Introduction

Endotracheal intubation is the first step in any resuscitation to maintain patency of airway, and if it is not secured well all the other lifesaving maneuvers can fail. Intubation is a skill which must be mastered by the emergency physician (EP). In a chaotic and busy environment, it is imperative for EPs to be swift and expeditious, especially when they are surrounded by patients

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requiring intubation. We all know that the environment of an emergency department (ED) is very different from that of an operation theater (OT) or intensive care unit (ICU) where the environment is much more controlled.

With new technologies come new gadgets. Today, we have a host of video laryngoscopes (VLs) which have been developed to make intubations easier and faster. It may seem that in a busy ED, a VL in the hands of an EP would help him intubate patients faster compared to the traditional direct laryngoscope (DL). On many occasions, the EP faces the challenging task to intubate difficult and not so difficult airways. EPs experience unsuccessful attempts in securing airways in 2%–10% of their patients.[1] Even though difficult airways can be managed safely by EPs, results of a failed airway can be disastrous – both for the patient and the physician. To prevent catastrophic events due to failed airways, new techniques and technologies have been developed. These include techniques such as rapid sequence intubation (RSI), delayed sequence intubation (DSI), awake intubation, and technologies such as the video and fiberoptic laryngoscopes.[2-6] The KingVision™ (AMBU, Denmark) VL (KVVL) is a new novel device developed to aid the EP in managing the difficult as well as routine airways quickly and safely.[7] Studies done in the ED setting by EM physicians comparing the VL with DL in all emergency airways are few.[8] If the KVVL proves to be more efficient in managing airways faster than DL using the macintosh blade, it would be prudent to equip the EDs with it. Our primary aim was to compare the time taken to successfully intubate patients coming into our ED using the KVVL and DL.

Materials and Methods

Study design

This was a prospective observational study comparing the KVVL and the Macintosh DL done for 1 year from July 2017 to June 2018. Patients coming to the ED requiring intubation were allocated one to one alternatively into two groups (VL and conventional Macintosh group). For this, a check sheet was kept and updated in the ED after every intubation so that every EP would know beforehand as to which group his/her patient would fall in. Accordingly, VL or DL intubations were carried out by the physicians. Consultants (trained in both VL and DL) as well as the 3rd-year postgraduate residents (under training) performed the intubations. The need for intubation was decided by the resident or consultant primarily in-charge of the patient. An observer was kept to check the time taken for intubation using a stopwatch. For our study, the time taken for intubation was defined as the time from inserting the tip of the laryngoscope blade into the oral cavity to confirmation of tracheal intubation through visualization. Other parameters such as Cormack–Lehane grading of airway, crossover between the laryngoscopes (violations), number of attempts, esophageal, or failed intubations, and complications were also recorded. This study was approved by the Institutional Ethics Review Board, and routine consent for intubations was deemed appropriate.

Setting

The study was conducted in the ED (20 bedded) of a 400-bedded urban tertiary care center.

Study population

All patients coming to the ED who required definitive emergency airway management were enrolled for the study. All enrolled patients were above the age of 18 years. Patients who required surgical airway were not included in the study.

Interventions

Consent for intubation was taken from the next of kin of all patients who required definitive emergency airway management. The check sheet for randomizing patients into VL or DL (Macintosh) group was checked and equipment prepared accordingly. Plan B equipment was also prepared in case of a failed attempt with the selected laryngoscope. Drugs as per department protocols were administered for RSI and DSI depending on the indication for each. An observer with a stopwatch would stand next to the physician. The physician would say "Start" when he inserted the tip of the blade into the oral cavity and "STOP" when the tube was passed. The physician would also note the Cormack–Lehane (CL) grade of the airway and document the same in the data collection sheet along with the time recorded by the observer. If the physician was not able to secure the airway using the selected laryngoscope, he would switch to the other laryngoscope (VL → DL; DL → VL). The same would be documented in the data collection sheet along with the reason for violation (malfunction, difficult, etc.). After every intubation, the laryngoscope used was crossed off the check sheet. All intubations were done by either consultants fully trained in emergency medicine or residents undergoing emergency medicine training. All data were collected in a data collection sheet. The time recorded by the observers using the stopwatch was final and binding. The primary investigator would check the data collection sheet and the check sheet daily.

Outcomes

The primary outcome of our study was the time taken to intubate the patient (as per our defined time) using the KVVL and DL. The predetermined secondary outcomes were the crossover of the laryngoscope and the reason for the same, first-pass success using each laryngoscope,[9] and the difference in the timings recorded between trained consultants and under training residents.[10]

Statistical analysis

Data analysis was conducted using IBM SPSS 22.0.0.0 and MS-Excel (New Delhi, India). Chi-square test with alpha = 5% was used for testing the relationship between categorical variables. It was used to evaluate tests of independence using a cross-tabulation (bivariate table). Pearson Chi-square was calculated, and *P* values presented for the variables. Kruskal–Wallis test with alpha = 5% was used for continuous variables. Tabulation for understanding the demography of the data has been done, and descriptive statistics were assessed with means, medians (p25, p75), standard deviation , and confidence interval (CI) with the above-mentioned tests.

Results

A total of 350 patients were enrolled in the study over a period of 1 year. The mean age of the patients was 59.7 years (95% CI 57.98–61.47). About 64.57% of patients were males, while 35.43% of patients enrolled were females [Table 1]. One hundred and seventy-six patients underwent intubations using the DL, while 174 patients underwent intubations using the VL. Emergency medicine residents intubated 212 patients, while consultants intubated 138 patients. Stroke (both ischemic and hemorrhagic) was the most common indication for intubation in 22% of the patients [Table 1].

Table 1a: Distribution of the patients according to their gender to the study groups

Gender	All patients, *n* (%) (*n*=350)	DL, *n* (%) (*n*=176)	VL *n* (%) (*n*=174)
Females	124 (35.43)	63 (35.80)	61 (35.06)
Males	226 (64.57)	113 (64.20)	113 (64.94)

DL: Direct laryngoscope, VL: Video laryngoscope

Table 1b: Characteristics of the underlying diseases

Intubation indication	All patients, *n* (%) (*n*=350)
Stroke	77 (22)
Pneumonia	68 (19.43)
Others	50 (14.29)
Shock	38 (10.86)
ACS	28 (8)
COPD	20 (5.71)
Kidney failure	16 (4.57)
Seizure	11 (3.14)
Cardiac arrest	10 (2.86)
Trauma	10 (2.86)
Poisoning	6 (1.71)
CHF	5 (1.43)
CLD	5 (1.43)
Carcinoma	3 (0.86)
UGI bleed	3 (0.86)

ACS: Acute Coronary Syndrome, CHF: Congestive Heart Failure, CLD: Chronic Liver Disease, COPD: Chronic Obstructive Pulmonary Disease, UGI: Upper Gastrointestinal.

A total of 58.86% patients had recorded CL grade 1, followed by 26.57% with grade 2, 12.86% with Grade 3 and 1.71% with grade 4 (only one intubation with DL while five intubations with VL).

Overall 86.29% patients (95% CI 82.29–89.50) underwent RSI, 9.14% (95% CI 6.55–12.62) underwent crash intubations and 4.57% (95% CI 2.83–7.30) had DSI performed on them. DL was used in 140 patients undergoing RSI, 10 patients undergoing DSI and 26 undergoing crash intubations while VL was used in 162 patients undergoing RSI, 6 undergoing DSI and 6 undergoing crash intubations.

Overall mean time to intubate patients using the Macintosh DL was 15.85 s (95% CI 14.05–17.65) while the meantime to intubate patients with VL was 13.75 s (95% CI 12.32–15.18) with a $P = 0.084$. In the DL group, consultants took an average time of 14.17 s (95% CI 11.80–16.53), while residents took a mean time of 17.16 s (95% CI 14.54–19.78). When VL was used, the average time to intubate patients by consultants was 12.3 s (95% CI 10.31–14.29), while residents took an average time of 14.53 s (95% CI 12.6–16.46) ($P = 0.042$) [Table 2]. Meantime to intubate patients with CL grade 1 airways was 14.99 s (95% CI 12.57–17.41) with DL and 11.8 s (95% CI 10.07–13.52) with VL; CL Grade 2 airways was 16.76 s (95% CI 13.33–20.18) with DL and 15.88 s (95% CI 12.93–18.81) with VL; CL Grade 3 airways was 19.24 s (95% CI 15.34–23.13) with DL and 17.38 s (95% CI 12.89–21.86) with VL; and CL Grade 4 airways was 5 s with DL and 10.6 s with VL [Table 1].

The overall first-pass success rates with DL and VL were 89.94% and 85.16%, respectively ($P = 0.076$). For

Table 1c: Comparison of the mean intubation time among DL and VL groups according to Cormack-Lehane Classification

Cormack-Lehane Classification	Mean Intubation Time (95% CI), s			P
	N (DL vs VL)	DL	VL	
Overall	176 vs 174	15.85 (14.05-17.65)	13.75 (12.32-15.18)	0.084
1	113 vs 93	14.99 (12.57-17.41)	11.80 (10.07-13.52)	**0.050**
2	41 vs 52	16.76 (13.33-20.18)	15.88 (12.93-18.81)	0.874
3	21 vs 24	19.24 (15.34-23.13)	17.38 (12.89-21.86)	0.299
4	1 vs 5	5	10.6	0.553

DL: Direct laryngoscope, VL: Video laryngoscope. Bold P values indicate statistical significance.

consultants using DL and VL, the first-pass success rate were 91.89% and 82.46%, respectively ($P = 0.272$), while for residents using DL and VL the first-pass success rate were 88.42% and 86.73%, respectively ($P = 0.218$) [Table 2].

A total of 7.43% (95% CI 5.12–10.66) patients (26 patients) had crossover between laryngoscopes. Of these, 26.92% (95% CI 13.70–46.08) patients, in which VL was to be attempted, crossover to Macintosh DL was done. 85.71% (95% CI 48.69–97.43) had technical issues with the VL while 14.29% (95% CI 2.57–51.31) patients had a forced to act intubation and the physician did not get time to setup the VL. In 73.08% (95% CI 53.92–86.30) of the crossover patients, physicians switched from DL to VL. 89.47% (95% CI 68.61–97.06) of these patients had difficult airway and could not be intubated using the Macintosh DL while in 10.53% (95% CI 2.94–31.39) of the patients the DL had technical issues.

Discussion

In this prospective study, we found that KVVL led to swifter intubations as compared to DL in patients presenting to the ED, but the difference was not statistically significant. The difference in the time taken to intubate by the residents under training with the DL and VL was significant statistically with faster intubations with the VL. It was also found that in difficult airways, it was easier to secure the airway with the KVVL as seen in the crossover data and in the time taken to secure airway for all the CL grades. Only one CL grade 4 airway was secured using the DL while five CL grade 4 airways were secured using VL. The fastest time to secure the airway using the VL was 4 s as compared to 5 s taken by the DL, but the data are not sufficient to be given much importance. The difference in the first-pass success of the two laryngoscopes was not statistically significant.

Table 2: Mean times to intubate, first pass success

Variable	Mean time(s)	95% CI	*P*
Overall			
DL	15.85	14.05-17.65	0.084
VL	13.75	12.32-15.18	
Consultant			
DL	14.17	11.80-16.53	0.419
VL	12.3	10.31-14.29	
Resident			
DL	17.16	14.54-19.78	0.042 (significant)
VL	14.53	12.6-16.46	
Variable	**First pass success, *n* (%)**		***P***
Overall			
DL	152 (89.94)		0.076
VL	132 (85.16)		
Consultants			
DL	68 (91.89)		0.272
VL	47 (82.46)		
Residents			
DL	84 (88.42)		0.218
VL	85 (86.73)		

DL=Direct laryngoscope, VL=Video laryngoscope, CI=Confidence interval

Since the 1940s, when the Miller and Macintosh blades were invented, conventional DL has become the standard of care in EDs, ICUs, and OTs.[11] Over the recent years, VLs have come into vogue. These are in DLs that have a small camera attached at the undersurface of the tip of the blade and an external screen. They have been used for many scenarios and especially in challenging airways.[9] Michailidou *et al*. reported higher success rates with the VL as compared to DL for intubating trauma patients.[10] Sakles *et al*. reported a higher first-pass success rate in patients with difficult airway characteristics presenting to the ED with VL as compared to DL. They had used Glidescope and C-Mac VLs in their study.[12]

Airway management in the ED usually occurs in unpredictable and uncontrollable environments. DL with the Macintosh blade has been accepted as a difficult skill to master.[13] In a busy ED, using the macintosh blade to secure a number of airways speedily for an EP can be quite challenging and complication prone. Recently, the use of video laryngoscopy has been widely accepted in the fields of emergency medicine and clinical anesthesia. Ease of handling, facilitation of visualization, shorter intubation times, and higher success rates in normal and difficult airways has been favorable toward the use of the wide variety of VLs available. These include the C-MAC, Glidescope, AirTraq, and KVVLs among others.[14]

Our study is unique as most of the studies that have been done have compared other VLs with the Macintosh blade[6,15-19] and have been mostly done on simulated airways or airways of trauma or gastrointestinal bleed patients.[11,20,21] Studies in the controlled setting of the OT on routine patients undergoing anesthesia have also been done on multiple occasions.[6,7,10,22] The KVVL has been previously compared to the Macintosh blade in novice users and EMS personnel,[23,24] in simulated or cadaver airways[25-27] or it has been compared to other VLs.[6,7,20,26-28]

Our study was done on all patients requiring emergent airway management in the ED by EPs which has not been done previously. Overall first-pass success rate although not statistically significant, was higher with Macintosh DLs which we felt was due to the paucity of training as the KVVL was a new addition to our department.

Limitations

This was a prospective observational study. Physicians were not blinded as to which laryngoscope to use for the enrolled patient, and hence, mental as well as physical preparation for the same would have occurred. This would

have led to faster intubation times compared to if they were blinded till the last. There could have also been some physician bias while starting and stopping the observer for recording the time taken to intubate. Furthermore, the KVVL was a new addition to our department, and the paucity of training for the same could have led to lower first-pass success rates but was not statistically significant. The training and experience difference between the consultants and residents could have affected the time taken to intubate and first-pass success.

Conclusions

In our study, we found that the overall performance of the KVVL was similar to the DL. We consider the KVVL a useful airway device to manage difficult and normal airways. Further training and experience in the use of VL would help in better first pass success and lower intubation times.

Author contribution statement

Mallick T was the primary investigator (first author) and designed the study. Verma A (corresponding author) contributed towards study design, data collection, analysis and manuscript writing. Mallick T and Verma A were the lead in writing the manuscript. The remaining authors provided critical feedback and helped shape the research, analysis and literature review of the manuscript.

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Conflicts of interest

The authors have no competing interests.

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