Original Article

Learning and performance of endotracheal intubation by paramedical students: Comparison of GlideScope® and intubating laryngeal mask airway with direct laryngoscopy in manikins

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ABSTRACT

Background and Aims: GlideScope video laryngoscope (GVL) and intubating laryngeal mask airway (I-LMA) may be used to facilitate intubation and secure the airway in patients with normal and abnormal airways. The aim of this study was to evaluate whether (GVL) and (I-LMA) facilitate and improve the tracheal intubation success rate and could be learned and performed easily by paramedic students when compared with Macintosh direct laryngoscopy (DL). **Methods:** This study was a prospective, randomised crossover trial that included 100 paramedic students. Macintosh DL, I-LMA and GVL were tested in both normal and difficult airway scenarios. Each participant was allowed up to three intubation attempts with each device, in each scenario. The time required to perform tracheal intubation, the success rate, number of intubation attempts and of optimisation manoeuvres and the severity of dental trauma were recorded. Statistical analysis was performed using Chi-square, one-way ANOVA, or Kruskal–Wallis test as appropriate, followed by *post hoc* test. **Results:** GVL and I-LMA required less time to successfully perform tracheal intubation, showed a greater success rate of intubation, reduced the number of intubation attempts and optimization manoeuvres required and reduced the severity of dental trauma compared to Macintosh DL in both normal and difficult airway scenarios. **Conclusion:** GVL and I-LMA provide better airway management than Macintosh DL in both normal and difficult airway scenarios.

Key words: Airway management, intratracheal, intubation, laryngeal mask, laryngoscopy

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INTRODUCTION

Paramedics are frequently required to perform tracheal intubation, a potentially life-saving manoeuvre in severely ill patients, in the prehospital setting.[1] It is a difficult skill to acquire and to maintain, especially with limited training opportunities.[2] Simulation training is an essential educational strategy for health care systems to improve patient safety; there is good evidence that procedural simulation improves actual operational performance in clinical settings.[3] The gold standard device used for intubation is the Macintosh direct laryngoscope (DL).[4] However, failures of tracheal intubation when using Macintosh laryngoscope have been reported in up to 30% of intubations by paramedics.[5] Recent studies have shown that novice medical students have low initial success when using a standard laryngoscope.[6] Several devices have been developed as alternatives to DL to aid difficult intubation such as GlideScope video laryngoscope (GVL) and intubating laryngeal mask airway (I-LMA).

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I-LMA is a supraglottic airway device that is inserted blindly. It may be used to facilitate intubation and secure the airway in patients with normal and abnormal airways or in emergency situations. It enables ventilation and provides a conduit for blind tracheal intubation.[7]

GVL provides a high-grade, indirect close-proximity view of the glottis on a monitor screen without alignment of the oral, pharyngeal and laryngeal axes.[8]

The efficacy of I-LMA and GVL, when used by paramedics, is not known, and the relative efficacies of these devices in comparison to the Macintosh DL have not been compared in a single study. We, therefore, wished to evaluate whether GVL and I-LMA facilitate and improve the intubation success rate and could be easily learned and performed by paramedic students when compared with Macintosh DL in easy and simulated difficult intubation (a manikin with immobilised cervical spine).

METHODS

Following local ethical committee approval, and written informed consent, a total of 100 paramedic students with no prior experience in performing tracheal intubation consented to participate in the study. All participants were given a 60 min lecture on the principles of airway management, including DL, I-LMA facilitated tracheal intubation and intubation with GVL. After the lecture, students received a standardised 10 min demonstration. Each participant was then allowed to practice one intubation with each device, before the commencement of the study.

The design of this study was a randomised crossover trial. For normal airway scenario using Laerdal Airway Management Trainer, each participant performed tracheal intubation with each device in random order while for simulated difficult airway scenario using SimMan manikin with cervical immobilisation, each participant performed tracheal intubation with each device in the same order used by him in normal airway scenario.

A number 3 Macintosh blade and 7 mm cuffed tracheal tube were used for DL. A 7 mm cuffed tracheal tube was used for GVL. A size 3 LMA Fastrach and its special 7 mm cuffed tracheal tube were used for I-LMA.

The primary outcome measure was the duration of successful tracheal intubation attempt which was defined as the time taken from the insertion of the device into the mouth until the endotracheal tube (ETT) was correctly positioned by each participant. Participants confirmed ETT position by visualising its tip passing through the vocal cords and inflating the manikin's lungs using an Ambu® bag attached to the tube. If the participant visualised the ETT tip passing through the vocal cords, the attempt was considered complete, but if he was unsure about ETT position, the attempt was considered complete after inflating the manikin's lungs. After each intubation attempt, an investigator verified the ETT position. An unsuccessful (failed) intubation attempt was defined as an attempt in which the trachea was not intubated, or when intubation of the trachea required >120 s to perform.

Other primary end points included the rate of successful endotracheal intubation with each device and the number of attempts required.

Secondary endpoints included severity of dental trauma, ease of intubation and the number of optimisation manoeuvres required.

The severity of dental trauma was calculated based on the number of audible teeth clicks (0, 1 or ≥2) with the Laerdal airway trainer, and based on a grading of pressure on the teeth (none = 0, mild = 1, moderate/severe ≥2) in the SimMan® manikin. Each participant was asked to report the laryngeal view obtained during laryngoscopy after each intubation attempt as the following: Most (>50%) of the vocal cords visible; some (<50%) of the vocal cords visible; the only epiglottis visible; or no epiglottis visible. These were converted into Grades 1–4 according to the Cormack and Lehane classification.[9] The ease of intubation was measured by asking every student to evaluate the ease of his intubation attempt for each device using a linear scale (0 = easy, 10 = difficult). The number of optimisation manoeuvres required (re-adjustment of head position, use of a bougie or stylet, external pressure, second assistant) to aid tracheal intubation were recorded with yes (used = 1) or no (not used = 0). At the end of the protocol, each participant scored his confidence with each device (from 0 = not at all confident to 10 = extremely confident). Finally, each paramedic student was asked to specify his preferred device.

Statistical analysis was carried out by the Statistical Package for the Social Sciences (SPSS) 15.0 for Windows Software (SPSS Inc., Chicago, USA).

Data for the success of tracheal intubation attempts were analysed using the Chi-square test. Data for the duration of the first and the successful intubation attempts, the number of intubation attempts, the number of optimisation manoeuvres, the severity of dental trauma, ease of intubation and device confidence scores, were analysed using one-way ANOVA or Kruskal–Wallis test followed by *post hoc* test. Parametric data were presented as mean (standard deviation) whereas non-parametric data were presented as median (interquartile range). The significance level for all analyses was set as $P < 0.05$.

RESULTS

The study was conducted by 100 paramedic students who consented to participate in the study. No participant had previously performed tracheal intubation and all participants completed the study.

In the normal airway scenario, the paramedic students performed successful endotracheal intubation in 80 out of 100 attempts (80%) by DL, in 95 out of 100 attempts (95%) by I-LMA, and in 94 out of 100 attempts (94%) by GVL ($P < 0.001$) [Table 1]. 14 attempts from the failed attempts were oesophageal in DL compared to 0 and 2 oesophageal attempts in I-LMA and GVL, respectively. The duration of both the first and the successful tracheal intubation attempts was longer with the DL (31.5 [14–49] s) compared to I-LMA, and GVL (20 [11–31], 22 [10–34] s, respectively) ($P < 0.001$) [Table 1]. Significantly more intubation attempts were required with the DL compared to I-LMA, and GVL ($P < 0.001$) [Table 1]. Glottis visualisation and Cormack and Lehane grades were significantly better with GVL than DL ($P < 0.001$) [Table 2]. The incidence and severity of dental trauma was significantly more with DL, compared to I-LMA, and GVL ($P < 0.001$) [Table 3]. Number of optimisation manoeuvres required to perform tracheal intubation using I-LMA, and GVL were fewer, compared to DL ($P < 0.001$) [Table 3].

In the difficult airway scenario, the paramedic students performed successful endotracheal intubation in 65 out of 100 attempts (65%) by DL, in 94 out of 100 attempts (94%) by I-LMA, and in 94 out of 100 attempts (94%) by GVL ($P < 0.001$) [Table 1]. 20 attempts from the failed attempts were oesophageal in DL compared to 0 and 1 oesophageal attempts in I-LMA and GVL, respectively. The duration of both the first and the successful tracheal intubation attempts was longer with the DL (40 [22–48] s) compared to I-LMA, and GVL (19 [12–28], 21 [15–35] s, respectively)

Table 1: Intubation time and rate of successful intubation with direct laryngoscopy, intubating laryngeal mask airway and GlideScope video laryngoscope in easy and simulated difficult airway in manikins

Type and grade of airway	DL (*n*=100) (%)	I-LMA (*n*=100) (%)	GVL (*n*=100) (%)
Easy airway			
First intubation attempt duration (s)	31.5 (14-49)*	20 (11-31)	22 (10-34)
Number of intubation attempts (%)			
1	68 (68)*	94 (94)	97 (97)
2	10 (10)	3 (3)	3 (3)
3	22 (22)	1 (1)	0
Successful intubation, *n* (%)	80 (80)*	95 (95)	94
Overall failure rate	20 (20)*	5 (5)	6 (6)
Oesophageal intubation	14 (14)*	0 (0)	2 (2)
Attempts abandoned	6 (6)	5 (5)	4 (4)
Difficult airway			
First intubation attempt duration (s)	40 (22-48)*	19 (12-28)	21 (15-35)
Number of intubation attempts (%)			
1	60 (60)*	90 (90)	94 (94)
2	15 (15)	7 (7)	4 (4)
3	25 (25)	3 (3)	2 (2)
Successful intubation, *n* (%)	65 (60)*	94 (94)	94 (94)
Overall failure rate	35 (35)*	6 ()	6 (6)
Oesophageal intubation	20 (20)	0 (0)	1 (1)
Attempts abandoned	15 (15)	6 (6)	5 (5)

*Range: Significantly different compared with the other two groups (P<0.05), Data are reported as median (IQR) or as number (%). DL – Direct laryngoscopy; I-LMA – Intubating laryngeal mask airway; GVL – GlideScope video laryngoscope; IQR – Interquartile range

Table 2: Laryngoscope views obtained when using direct laryngoscopy, intubating laryngeal mask airway and GlideScope video laryngoscope in easy and simulated difficult airway in manikins

Type and grade of airway	DL (%)	I-LMA	GVL (%)
Easy airway			
Laryngoscope view			
Grade 1	48 (48)*	NA	92 (92)
Grade 2	42 (42)*	NA	8 (8)
Grade 3	10 (10)	NA	0 (0)
Grade 4	0 (0)	NA	0 (0)
Difficult airway			
Laryngoscope view			
Grade 1	25 (25)*	NA	90 (90)
Grade 2	45 (45)*	NA	10 (10)
Grade 3	20 (20)*	NA	0 (0)
Grade 4	10 (10)	NA	0 (0)

*Significantly different compared with GVL (P<0.05); Data are number (proportion). NA – Not applied; DL – Direct laryngoscopy; I-LMA – Intubating laryngeal mask airway; GVL – GlideScope video laryngoscope

($P < 0.001$) [Table 1]. Significantly more intubation attempts were required with DL compared to I-LMA, and GVL ($P < 0.001$) [Table 1]. Glottis visualisation and Cormack and Lehane grades were significantly better with GVL than DL ($P < 0.001$) [Table 2]. The incidence and severity of dental trauma were significantly more with DL, compared to I-LMA, and GVL ($P < 0.001$) [Table 3]. Number of optimisation manoeuvres required to perform tracheal intubation using I-LMA and GVL were fewer, compared to DL ($P < 0.001$) [Table 3].

Paramedic students described DL as more difficult compared to the other devices ($P < 0.05$) [Table 4]. 12 paramedic students (12%) selected DL, 50 paramedic student (50%) selected I-LMA and 38 paramedic students (38%) selected GVL as their first preference [Table 4]. The paramedic students were significantly more confident in performing tracheal intubation using I-LMA, and GVL compared to DL ($P < 0.05$) [Table 4].

Table 3: Dental clicks and optimization manoeuvres incidence during intubation with direct laryngoscopy, intubating laryngeal mask airway and GlideScope video laryngoscope in easy and simulated difficult airway in manikins

Type and grade of airway	DL n (%)	I-LMA n (%)	GVL n (%)
Easy airway			
Dental clicks (%)			
0	6 (6)*	80 (80)	70 (70)
≥1	94 (94)*	20 (20)	30 (30)
Number of optimization manoeuvres (%)			
0	55 (55)*	87 (87)	85 (85)
1	30 (30)	13 (13)	13 (13)
>1	15 (15)*	0 (0)	2 (2)
Difficult airway			
Dental clicks (%)			
0	4 (4)*	80 (80)	70 (70)
≥1	96 (96)*	20 (20)	30 (30)
Number of optimization manoeuvres (%)			
0	45 (45)*	80 (80)	74 (74)
1	38 (38)	15 (15)	20 (20)
>1	17 (17)	5 (5)	6 (6)

*Significantly different compared with the other two groups (P<0.05); Data are reported as number (%). DL – Direct laryngoscopy; I-LMA – Intubating laryngeal mask airway; GVL – GlideScope video laryngoscope

Table 4: Overall paramedic student assessment of devices

Parameter assessed	DL	I-LMA	GVL
Ease of intubation	7*	1	3
First preference, n (%)	12 (12)	50 (50)	38 (38)
Confidence with the device	3±2.1*	7.2±1.9	6±3.1

*Significantly different compared with the other two groups (P<0.05); Data are expressed as mean (SD), number (proportion) and median (IQR). DL – Direct laryngoscopy; I-LMA – Intubating laryngeal mask airway; GVL – GlideScope video laryngoscope; SD – Standard deviation; IQR – Interquartile range

DISCUSSION

The Macintosh laryngoscope is the most popular device for tracheal intubation and considered by many as the gold standard.[4] However, failures of tracheal intubation when using Macintosh laryngoscope have been reported in up to 30% of intubations by paramedics.[5] Several devices have been developed as alternatives to DL to aid difficult intubation, GVL makes it easier to view the glottis, and facilitates the placement of the tracheal tube through the vocal cords into the trachea by means of a side channel.

I-LMA is a supraglottic airway device with unique advantages such as blind intubation and the possibility of ventilation between intubation attempts.

In our study, we found higher overall success rates and shorter intubation times with I-LMA and GVL compared to DL in both easy and simulated difficult airway scenarios. Specific advantages of I-LMA and GVL over DL include fewer intubation attempts, fewer optimization manoeuvres, less dental trauma, and they were less difficult to use. Overall, paramedic students described DL as more difficult. The participants were significantly more confident in performing tracheal intubation using I-LMA, and GVL compared to DL.

Studies comparing learning and performance of endotracheal intubation using DL, GVL and I-LMA have shown varying results.

Similar to our study, there are previous studies comparing GVL and I-LMA with Macintosh DL by paramedic students for endotracheal intubation in easy airway scenario[10] and by medical students who had no prior airway management experience in simulated easy and difficult laryngoscopy scenarios.[11] They found intubation with either GVL or I-LMA to be easier with better intubation success rates, reduced number of intubation attempts, and reduced number of optimisation manoeuvres required compared with DL.

Previous studies on the use of I-LMA in prehospital care compared with DL showed comparable or superior results.[12,13] The success rate of the first intubation attempt was higher and the time to ETT placement was shorter with the I-LMA, especially in the difficult-to-manage airway compared with DL.[14]

The GVL is recommended for improving the laryngoscopy view in paediatric patients with a difficult airway compared with DL.[15,16]

However in contrast to these results, the number of attempts to successful intubation with either GVL or DL did not differ but the time required for intubation with GVL was longer.[17]

In the previous study, using a simulation manikin in normal and difficult airway scenarios, the video laryngoscope compared with DL provided an enhanced view of the cords using less time, increased intubation success and decreased the time to intubation.[18]

Compared to DL, GlideScope® video laryngoscopy is associated with improved glottic visualisation, particularly in patients with potential or simulated difficult airways.[19]

In a manikin study comparing Force and pressure distribution using Macintosh and GlideScope laryngoscopes in normal and difficult airways, The GlideScope allowed the participants to obtain a successful intubation applying a lower force. A flatter and more uniform pressure distribution, a higher successful rate, and a better glottis view were observed with the GlideScope.[20]

In a retrospective observational study of all patients intubated in a single academic emergency department with a level I trauma centre, the GVL had a higher overall success rate, and lower number of oesophageal complications and offered an excellent option to maximise first-attempt success for airway management compared with DL.[21]

In a study comparing four different devices, including DL and GVL, the overall success rate for either device was not different.[22]

Another study found that the ease of intubation with GVLs was similar to conventional laryngoscopy when performed by novice anaesthesiologists. However, GVLs used were non-channelled. Hence, their results may not be applicable to other, especially channelled VLs like GVL, which was used in our study.[23]

In their study, Malik *et al*. compared five different methods, including I-LMA and GVL, with DL in the hands of experienced anaesthesiologists and found that the intubation success rate of I-LMA (100%) and GVL (96.7%) was superior to DL (90%).[24] Similarly, GVL and I-LMA provided higher success rates compared with DL in our study. However, they concluded that I-LMA had advantages over DL, but GVL did not in contrary to our results.

These studies suggest that intubation with GVL can be easily learned and performed with a higher success rate after a short period of training. In our study, GVL provided a higher success rate (91.7 vs. 78.5%) and a lower difficulty score (1.84 vs. 2.54) compared to DL, among our participants who had not used GVL before.

The other goal of our study was to compare I-LMA and GVL. We found that success rates and intubation times were similar for both devices. However, paramedic students defined I-LMA as easier than GVL, and they mostly preferred I-LMA. In their study, Malik *et al*. compared five different methods, including I-LMA and GVL, with DL and found that the intubation success rate of I-LMA (100%) and GVL (96.7%) was superior to DL, in the novice.[25]

CONCLUSION

GVL and I-LMA appear to possess advantages over Macintosh DL. They provide better airway management regarding rapidity, success rate and ease of intubation, with less dental trauma and optimisation manoeuvres compared to Macintosh DL in both normal and difficult airway scenarios. Similar comparative studies on humans are needed to further delineate the advantages of GVL and I-LMA.

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Conflicts of interest

There are no conflicts of interest.

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