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Original Contributions

TRACHEAL INTUBATION IN THE EMERGENCY DEPARTMENT: A COMPARISON OF GLIDESCOPE® VIDEO LARYNGOSCOPY TO DIRECT LARYNGOSCOPY IN 822 INTUBATIONS

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□ **Abstract—Background: Video laryngoscopy has, in recent years, become more available to emergency physicians. However, little research has been conducted to compare their success to conventional direct laryngoscopy. Objectives: To compare the success rates of GlideScope® (Verathon Inc., Bothell, WA) videolaryngoscopy (GVL) with direct laryngoscopy (DL) for emergency department (ED) intubations. Methods: This was a 24-month retrospective observational study of all patients intubated in a single academic ED with a level I trauma center. Structured data forms were completed after each intubation and entered into a continuous quality improvement database. All patients intubated in the ED with either the GlideScope® standard, Cobalt, Ranger, or traditional Macintosh or Miller laryngoscopes were included. All patients intubated before arrival were excluded. Primary analysis evaluated overall and first-attempt success rates, operator experience level, performance characteristics of GVL, complications, and reasons for failure. Results: There were 943 patients intubated during the study period; 120 were excluded due to alternative management strategies. DL was used in 583 (62%) patients, and GVL in 360 (38%). GVL had higher first-attempt success (75%, $p = 0.03$); DL had a higher success rate when more than one attempt was required (57%, $p = 0.003$). The devices had statistically equivalent overall success rates. GVL had fewer esophageal intubations (n = 1) than DL (n = 18); $p = 0.005$. Conclusion: The two techniques performed equivalently overall, however, GVL had a higher overall success rate, and lower number of esophageal complications. In the setting of ED intubations, GVL offers an excellent option to maximize first-attempt success for airway management.** © **2011 Elsevier Inc.**

□ **Keywords—intubation; video laryngoscopy; direct laryngoscopy; GlideScope®**

INTRODUCTION

Background

Since the invention of the Macintosh and Miller laryngoscope blades in the 1940s, direct laryngoscopy (DL) has been the mainstay of endotracheal intubation. The blades are designed to provide a direct line of sight by aligning the oral, pharyngeal, and tracheal axes to allow the intubator to visualize the glottic opening. Intubation is a life-saving procedure performed daily in emergency departments (EDs) across the country. On occasion, it is impossible to align the axes, making direct visualization of the laryngeal inlet difficult or impossible with direct laryngoscopy. These cases present a particularly challenging situation for emergency physicians.

Video laryngoscopy provides a potential solution when direct laryngoscopy fails to provide glottic visualization by attaching a video camera on the device blade. The camera brings the view of the glottis out of the patient's mouth to a video monitor, eliminating the need to align the three axes. Multiple video laryngoscopes have been developed with varying characteristics.

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Importance

The GlideScope® (Verathon Inc., Bothell, WA) video laryngoscope (GVL) was introduced in 2001. The first reported use was published in 2003 (1). Since that time, most of the literature has been reported in anesthesia settings with operating room patients and simulation laboratories (2–13). Little research evaluating the GlideScope's effectiveness in ED patients has been reported (14).

Goals of this Investigation

The primary outcome of this study was the first-attempt success rates of two methods of intubation in a real-practice setting of an academic ED. Secondary outcomes included overall success rates, key performance characteristics, and reasons for failures with the two devices.

METHODS

Study Design

This was a 24-month retrospective observational study of concurrently collected data of all ED patients intubated at a single academic ED between July 1, 2007 and June 30, 2009 utilizing an ED quality assurance database. A simple one-page data collection sheet was developed for the Continuous Quality Improvement database and is completed by the operator immediately after each intubation is performed. Structured data forms were cross-referenced to professional billing records to identify any missing data forms. If an intubation was identified without a completed form, the operator was sent a blank form for completion immediately.

Study Setting

The study was conducted at a tertiary urban university hospital with a Level I trauma center and annual ED census of approximately 60,000 patients. The ED is staffed full time with emergency medicine residents and attending physicians. Typical of academic EDs, airway management at the institution is the ultimate responsibility of the attending faculty emergency physician (EP), who determines which resident will perform the intubation and what technique/device is used on a case-by-case basis. If an initial intubation attempt was not successful, the supervising EP determined whether or not to switch to another device. Residents and attending EPs are familiarized with the devices as part of the residency curriculum and a simulation laboratory is available for independent practice. Most often, however, experience is gained in the ED during the use of a device. Intubations are typically performed by emergency medicine residents; however, attending EPs typically complete the intubation if a resident is not successful. Potential laryngoscope options included the GlideScope® standard with reusable blade, GlideScope® Cobalt with single-use disposable blade, portable GlideScope® Ranger with reusable blade, and traditional Macintosh/Miller laryngoscope (Welch Allyn Inc., Skaneateles Falls, NY).

Selection of Participants

All patients requiring intubation in the ED were entered into the database. Patients intubated before arrival by pre-hospital providers were excluded. All intubation cases entered in the database during the study period that used a GlideScope® video laryngoscope or traditional laryngoscopy were extracted for analysis.

Methods of Measurement

The registry data information forms were completed by the physician who performed the intubation. Collected data forms were cross-referenced to professional billing records to identify any missing intubation forms. If an intubation form was missing, a data collection form was submitted to the operator for completion. Information collected included intubation indication, technique, outcome, medications used, demographics, and performance characteristics.

An attempt at intubation was defined as insertion of the laryngoscope blade into the patient's mouth, regardless of whether an attempt to pass a tracheal tube took place. First-attempt success was defined as the placement of an endotracheal tube on the first attempt. Ultimate overall success was defined as tracheal intubation with the initial device selected regardless of the number of attempts.

Optical clarity was measured on a 10-cm visual analog scale. Gross lens contamination was measured as one of the following: none, mild, moderate, or severe. The data form included a list of potential factors that may make intubation more difficult. These factors included obesity, small mandible, large tongue, cervical immobility, short neck, blood or vomit in the airway, facial or head trauma, and airway edema.

Primary Data Analysis

Data were analyzed using Stata statistical software version 9.0 (Stata Corporation, College Station, TX). An alpha of 0.05 was used for global statistical comparisons. This study was reviewed and approved by the University of Arizona Institutional Review Board.

RESULTS

During the study period, 943 patients were intubated in the ED; 120 patients were excluded because DL or GVL was not used. In 583 (62%) patients, DL was used, and in 360 (38%) GVL was used. Of the 583 DL cases, it was the initial device in 533 (91%); in the remaining 50 cases, DL was a rescue device. Of the 360 GVL cases, it was the initial device in 278 (77%); in the remaining 82 cases GVL was a rescue device. These patients formed the study group and were included in the data analysis. The patients in the two groups were similar (Table 1). Methods of intubation included rapid sequence intubation, oral intubation with sedation only, and oral intubation without the use of any medications.

GVL had a higher first-attempt success rate than DL for all airways and in airways with two or more difficult airway predictors (Table 2). DL had a higher ultimate overall success rate when more than one attempt was required. First-attempt success was highest with senior (third-year Emergency Medicine) residents with all devices, compared to more junior residents (Table 3). Cormack-Lehane (CL) grade of view, lens contamination, and optical clarity are summarized in Table 4. Failed intubations with DL were typically reported as due to failure to visualize the airway, whereas failures with videolaryngoscopy were reported due to inability to direct the endotracheal tube into the airway. Videolaryngoscopy was associated with a statistically significant decrease in the esophageal intubation rate (Tables 5, 6). Overall success rate with GVL using the rigid proprietary Verathon stylet was 91.3%, whereas the overall success rate using a malleable stylet was 76.0%. For DL, the success rates were 61.5% and 90.0%, respectively ($p \leq 0.0001$).

Table 1. Demographics

	DL			GVL			
	#	Total	%	#	Total	%	p-Value
Male	387	583	66%	257	360	71%	0.1135
Female	196	583	34%	103	360	29%	0.1135
Trauma	252	583	43%	247	360	69%	0.0001
Medical	331	583	57%	113	360	31%	0.0001
RSI	505	583	87%	316	360	88%	0.6897
Sedation only	4	583	1%	5	360	1%	0.1649
No meds	71	583	12%	37	360	10%	0.3438
PGY-1*	108	583	19%	53	360	15%	0.1539
PGY-2*	215	583	37%	136	360	38%	0.782
PGY-3*	235	583	40%	162	360	45%	0.1745
Attending*	9	583	2%	3	360	1%	0.5513

DL = direct laryngoscopy; GVL = GlideScope® videolaryngoscopy; RSI = rapid sequence intubation; PGY = post-graduate year.
* Numbers are for first operator. Remaining intubations by non-Emergency Medicine personnel.

DISCUSSION

Videolaryngoscopy demonstrates a superior first-attempt success rate compared to DL in our analysis. Platts-Mills et al. (2009) report the only comparison analysis between

Table 2. Success Rates

	DL			GVL			
	#	Total	%	#	Total	%	p-Value
Overall							
Overall success rate	504	583	86%	304	360	84%	0.39
First-attempt success rate	398	583	68%	270	360	75%	0.03
Trauma							
Overall success rate	216	252	86%	209	247	85%	0.80
First-attempt success rate	173	252	69%	187	247	76%	0.09
Blunt trauma							
Overall success rate	177	209	85%	182	216	84%	1
First-attempt success rate	140	209	67%	161	216	75%	0.09
Penetrating trauma							
Overall success rate	37	41	90%	27	31	87%	0.72
First-attempt success rate	31	41	76%	26	31	84%	0.56
Medical							
Overall success rate	288	331	87%	95	113	84%	0.43
First-attempt success rate	225	331	68%	83	113	74%	0.29
0 or 1 Difficult airway predictor							
Overall success rate	335	372	90%	130	145	90%	0.87
First-attempt success rate	281	372	76%	119	145	82%	0.13
2 or More difficult airway predictors							
Overall success rate	169	211	80%	174	215	81%	0.90
First-attempt success rate	117	211	56%	151	215	70%	0.00
More than 1 attempt							
Overall success rate	106	185	57%	34	90	38%	0.003

DL = direct laryngoscopy; GVL = GlideScope® videolaryngoscopy.

Table 3. Success Rates by Level of Training

DL vs. GVL Analysis (PGY)	DL #	DL Total	DL %	GVL #	GVL Total	GVL %	p-Value
PGY-1							
Overall success rate	78	102	76.5%	38	48	79.2%	0.8353
First-attempt success rate	71	102	69.6%	36	48	75.0%	0.5645
PGY-2							
Overall success rate	169	215	78.6%	108	139	77.7%	0.8952
First-attempt success rate	142	215	66.0%	95	139	68.3%	0.7287
PGY-3							
Overall success rate	204	253	80.6%	141	168	83.9%	0.4385
First-attempt success rate	179	253	70.8%	135	168	80.4%	0.0299
Attending							
Overall success rate	36	42	85.7%	9	14	64.3%	0.1193
First-attempt success rate	31	42	73.8%	8	14	57.1%	0.3171

DL = direct laryngoscopy; GVL = GlideScope videolaryngoscopy; PGY = post-graduate year.

GVL and DL in the ED setting (14). They found no difference in success rates between the two devices, however, they have a fewer number of intubations and potentially are subject to a type II error. Our first-attempt success rate with DL is significantly lower than their reported rates, likely due to earlier abandonment for another device given the many rescue devices available at our institution. In the presence of two or more difficult airway predictors, GVL shows a significantly improved success rate on first attempt. DL, however, shows a higher success rate than GVL when more than one attempt is required. This is likely due to the reasons for failure for each device. GVL is likely to fail from either difficulty passing the endotracheal tube, or lens contamination. Both of these reasons for failure have little maneuvers that can improve the chances of success. In the face of lens contamination from fog or secretions, blood, or vomit, the device is usually rendered unusable. Failure to pass the tube is likely due to the 60-degree curvature in the GVL blade. Although it is almost certain to always give an adequate view, it adds the dimension of having to navigate the tube around the curvature as opposed to the straight line of view achieved when using DL.

Table 4. Lens Contamination, Fogging, CL View

	DL #	DL Total	DL Avg	GVL #	GVL Total	GVL Avg
CL view						
Overall	997	583	1.71	501	340	1.46
Fogging						
Fogging				421.1	359	1.17
Lens contamination						
None				285	348	82%
Mild				34	348	10%
Moderate				11	348	3%
Severe				19	348	5%

DL = direct laryngoscopy; GVL = GlideScope videolaryngoscopy; CL = Cormack-Lehane.

Additionally, laryngoscopists tend to abandon GVL after one failed attempt for another device. In contrast, failure with direct laryngoscopy is likely due to inability to obtain a view of the glottic opening. Blade adjustment, positioning, and maneuvers like the Backwards-upwards-rightwards-pressure maneuver tend to improve the view and improve intubating conditions for DL, but not GVL. Some physicians also tend to make several attempts with DL before abandoning to another device such as GVL or other adjunctive airway devices, likely due to their level of comfort with the device.

Most studies comparing GVL and DL have been performed in the operating room or simulation laboratory (3–13). Lim et al. (2005) showed that GVL provided faster time to intubation and better CL view compared to DL in patients with cervical immobility (6). Savoldelli et al. (2008) showed a higher success rate with GVL over DL in patients with cervical immobilization (7). However, other studies report either no difference, or better performance with DL in the same scenario (5,10,12). Several studies compare GVL to DL in simulated difficult airways with cervical immobility, pharyngeal obstruction, and large tongue. These studies showed either no difference or minimal difference between the devices (4,8,11,13).

Table 5. Reason for Failure

DL vs GVL Analysis (Reason for Failure)	DL #	DL Total	DL %	GVL #	GVL Total	GVL %
Reason for failure						
Can't see cords	94	150	62.7%	19	53	35.8%
Can't direct tube	36	150	24.0%	29	53	54.7%
Tube wouldn't pass	7	150	4.7%	2	53	3.8%
Esophageal intubation	6	150	4.0%	0	53	0.0%
Equipment failure	5	150	3.3%	3	53	5.7%
Other	1	150	0.7%	0	53	0.0%
Secretions	1	150	0.7%	0	53	0.0%

DL = direct laryngoscopy; GVL = GlideScope videolaryngoscopy.

Table 6. Complications

DL vs GVL Analysis (Complications - DL/GVL ONLY device used)	DL			GVL			p-Value
	#	Total	Avg	#	Total	Avg	
Complications							
Overall	98	450	0.22	60	234	0.26	0.29
Esophageal intubation	18	450	0.04	1	234	0.0043	0.005
Desaturation	54	450	0.12	41	234	0.18	0.06

DL = direct laryngoscopy; GVL = GlideScope videolaryngoscopy.

Our analysis is the first large-scale comparison of DL and GVL in the ED setting. Our results indicate that GVL is at least as good, and in certain situations better, than DL.

Limitations

This study has several limitations. Although registry data were collected immediately after intubations were performed, they are subject to self-report bias. This was a real-practice effectiveness study of the use of DL and GVL, and the patients were not randomized. The choice of laryngoscope in each case was therefore subject to bias. In addition, although we attempted to measure and account for several potential confounders (e.g., severity of case, training level of resident), we may have missed some important confounders. Finally, although the physicians received education regarding the registry form, inter-rater reliability has not been studied on the accuracy and precision of the subjective measures. Future research should investigate the impact of difficult airway situations individually on success with each device. Ideally, a prospective study could be conducted with video recordings of each intubation for independent review and assessment of the airway.

CONCLUSION

In this real-practice comparison, GVL showed a higher overall first-attempt success rate than direct laryngoscopy for ED intubations. The advantage of GVL decreased if more than one attempt was required. Secondarily, GVL provided an improved CL view and lower complication rate than DL.

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ARTICLE SUMMARY

1. Why is this topic important?

Airway management is the paramount procedure performed by emergency providers with the majority of their patients representing high-risk airways. Advances in airway management should be aggressively evaluated to improve patient outcomes and limit complications.

2. What does this study attempt to show?

This study compares video laryngoscopy using the Glidescope to direct laryngoscopy. It attempts to evaluate the first attempt, and overall success rates for each technique, as well as complication rates with each method of airway management.

3. What are the key findings?

Overall success rates remain the same, however first attempt success rates and complication rates are statistically significant favoring video laryngoscopy.

4. How is patient care impacted?

Fewer attempts at intubation and lower complication rates has the potential to greatly improve emergency airway management in our emergency departments.