Review

Video Laryngoscopy vs. Direct Laryngoscopy in Adult Patients with Difficult Airways Who Require Emergency Intubation

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Abstract: This review compares the efficacy of video laryngoscopy (VL) with that of direct laryngoscopy (DL) in adult patients with difficult airways who require emergency intubation. Intubation and laryngoscopy are critical in emergency settings, and VL has emerged as an alternative to DL, particularly in difficult airway cases and when performed by non-experienced practitioners. VL demonstrates advantages such as a wider field of view, enhanced glottic visibility, and higher first-pass success rates, particularly in difficult airway scenarios. However, it also presents limitations, including potential view obstruction and technical complexity. While the evidence points to the advantages of VL, particularly in achieving higher first-pass success rates and minimizing adverse events in adult patients with difficult airways, the inconclusive findings from randomized trials emphasize the importance of future research in refining practices and improving patient outcomes.

Keywords: video laryngoscopy; direct laryngoscopy; emergency room; difficult airways

1. Introduction

Intubation and laryngoscopy play fundamental roles in emergency situations by ensuring a secure patent airway for patients who are unable to breathe adequately and independently. Laryngoscopy is a method that is used to visualize the airway and guide endotracheal tube placement, minimizing the risk of complications [1]. These procedures are vital in situations that include critically ill patients, emergent injuries, full stomach patients, respiratory and hemodynamic decompensation, decreased physiological reserve, and a lack of time for preparation [2]. The procedures ensure proper oxygenation and ventilation to support respiration until the underlying issue is addressed. Direct laryngoscopy (DL) has been the historical standard for airway management in emergency departments; however, the use of video laryngoscopy (VL) has remarkably risen during the past decade with the rising demand for finding alternate methods to deal with difficult airways [3], which is the main scope of this review.

The goal of emergency airway management is first-pass success without adverse events (FPS-AE). This goal has resulted in VL emerging as an alternative to standard DL. Several prospective, single-center observational studies have demonstrated that VL improves glottic exposure and intubation success in emergency rooms and intensive care unit patients [4–8]. Additionally, multiple studies have shown that the utilization of VL within emergency medicine residents was significantly associated with fewer adverse events, such as esophageal intubations [4–8]. Up until 2012, approximately 55% of emergency intubations were performed using DL, compared with 39% using VL [9]. This is in contrast to recent randomized trials in emergency and intensive care patients and one meta-analysis

of randomized trials with diverse patient categories, which showed no benefits of one intubation method over the other [1,10–12]. This literature review aims to discuss and define the relevance and significance of the choice of intubation method between DL and VL in adult patients with difficult airways who require emergency intubation, the factors that influence this choice in different scenarios, and their practical implications.

2. Definition and Prevalence of Difficult Airways

A difficult airway is a clinical situation in which a healthcare provider who is skilled at airway management encounters difficulty with one or more of the standard methods of such management. This definition is not standardized in the literature, and there are variations between national expert guidelines. The American Society of Anesthesiologists defines a difficult airway as "the clinical situation in which anticipated or unanticipated difficulty or failure is experienced by a physician trained in anesthesia care, including but not limited to one or more of the following: face-mask ventilation, laryngoscopy, ventilation using a supraglottic airway, tracheal intubation, extubation, or invasive airway" [13]. The Intubation Difficulty Scale (IDS) score is a function of seven parameters, which result in a progressive and quantitative determination of intubation complexity. This score is calculated by an operator immediately after intubation. An IDS score of 0 represents easy intubation; an IDS score of 1–5 represents slightly difficult intubation; an IDS score of >5 represents moderate to major difficult intubation; and an IDS score of ∞ denotes impossible intubation [14]. Difficult airways range in prevalence between 9% and 24% in the general population, with surgical populations exhibiting higher values. This may be caused by cervical spine rigidity, tongue swelling or enlargement, airway edema, limited mouth opening, obesity, the presence of liquid or semisolid foreign material, limited mandibular protrusion, a short neck, facial or neck trauma, a narrow dental arch, modified Mallampati class 3 or 4, and an increased neck circumference [15–17].

3. Video Laryngoscopy vs. Direct Laryngoscopy: Clinical Performance in Difficult Airways

3.1. Clinical Performance in Difficult Airways in Various Healthcare Settings

Video laryngoscopes provide a superior view of the glottic opening compared to direct laryngoscopes in cases of predicted difficult airways [18,19]. A randomized controlled trial by Jungbauer A. and colleagues [20] revealed that video laryngoscopes, in comparison to direct laryngoscopes, were associated with a shorter time for tracheal intubation (from mouth opening to cuff inflation), a higher success rate of intubations, and a reduced need for external manipulation or other maneuvers during expected difficult tracheal intubations [20]. Another study also found that the use of video laryngoscopes improved the overall success rate on the first attempt at intubation in patients with various difficult airway predictors [21].

Furthermore, video laryngoscopes have proven valuable in rescuing difficult or failed tracheal intubations when using a direct laryngoscope in unexpected difficult airway situations [22]. As reported by Asai and colleagues, video laryngoscopes achieved a 99% success rate in rescuing intubations when a Macintosh laryngoscope failed to provide an adequate laryngeal view [23]. In a study conducted in two medical centers, the success rate for VL after a failed DL was 94% [24]. Given that failed or multiple intubation attempts are associated with increased morbidity and mortality, these findings suggest that VL devices offer advantages over direct laryngoscopes for both predicted and unforeseen difficult airways. Therefore, these devices can serve as potential alternative rescue tools in clinical practice [25]. Another systematic review that compared VL with DL demonstrated the benefits of VL when it was performed by experienced anesthetists in patients with known difficult airways [26].

In a systematic review by Kim JG and colleagues [27], subgroup analyses were conducted on studies comparing the first-attempt intubation success of VL with DL in critically ill or emergency care patients. Significant heterogeneity was observed, attributed mainly to

the study designs and the proportion of difficult airways. The impact of the study designs on the heterogeneity was examined between single-center and multi-center studies. The pooled outcomes from multi-center randomized controlled trials exhibited greater consistency compared to single-center randomized controlled trials. The subsequent analysis of difficult airways revealed significant differences between studies with proportions below 50% and those equal to or above 50%. In studies with <50% difficult airways, the pooled results showed similar success rates for VL and DL [10–12,28–37], while studies with ≥50% difficult airways favored VL, indicating a higher success rate [38,39]. Other factors contributing to the heterogeneity included intubator experience, rapid sequence intubation, and the proportion of intubations during CPR. Notably, VL demonstrated a higher success rate than DL when utilized by inexperienced nonphysicians or in in-hospital settings.

3.2. Clinical Performance in Difficult Airways in an Emergency Department Setting Only

DL has traditionally been the go-to method for airway management in emergency departments, but VL has seen a consistent rise in use over the past decade. In 2012, DL was employed in most emergency department intubations compared to VL [9]. Prospective single-center observational studies have consistently highlighted the benefits of VL, showing improved glottic exposure and increased intubation success in both emergency department and intensive care unit patients. Additionally, numerous studies have linked the utilization of VL by emergency medicine residents with a decrease in adverse incidents, such as esophageal intubations [5–8]. Despite these positive outcomes, a randomized trial and a propensity-score-matched analysis have not conclusively favored any intubation method. It is important to note that these studies may not fully represent the diversity of emergency department populations, as many excluded cases involving difficult airways or involved primarily less experienced internal medicine trainees as the intubators [1,10].

Research that compares VL with DL in airway management within an emergency department setting has mainly been conducted with diverse patient populations, with a limited focus on difficult airways. To thoroughly investigate the comparative efficacy of VL in emergency departments airway management, we conducted a comprehensive literature search using Ovid MEDLINE by employing various combinations of keywords. Our search criteria were meticulously defined to include peer-reviewed original research articles and relevant reviews, without restrictions on the year of publication. In addition to the database search, we supplemented our findings by scrutinizing the reference lists of all the identified studies. Despite these efforts, the literature search yielded a limited pool of studies that explicitly address the use of VL in the context of difficult airways within an emergency department.

In a comprehensive analysis encompassing 2423 adult intubations performed by emergency physicians over a 6-year period (1 July 2007 to 30 June 2013) in a 61-bed tertiary care academic emergency department in the US [16], the efficacy of VL was compared with that of DL in achieving first-pass intubation success among patients that exhibited difficult airway characteristics (DACs). These DACs included cervical immobilization, obesity, facial or neck trauma, a short neck, a large tongue, a small mandible, airway edema, and/or the presence of blood or vomit in the airway. The emergency department, a Level 1 trauma center with approximately 70,000 annual visits, featured a 3-year emergency medicine residency training program and a 5-year combined pediatrics/emergency medicine residency training program. The results demonstrated that, in patients with DACs, VL using a GlideScope or a C-MAC yielded significantly higher first-pass success rates compared to DL. After adjusting for confounding factors in the multivariate regression analyses, VL maintained its superiority, with higher odds of first-pass success across all the DAC categories. These findings suggest that VL, specifically using a GlideScope or a C-MAC, may be a preferred and more effective option, particularly for patients at highest risk of intubation failure [16].

This study has several limitations. First, as an observational study, the absence of randomization introduces the potential for selection bias, as the choice of intubation device was based on operator preference or device availability. Despite efforts to mitigate this

bias, the groups appeared well matched demographically and across relevant variables. Moreover, adjustments for potential confounders were made in the multivariate analysis. Secondly, the reliance on operators to complete airway data collection forms introduces the possibility of self-report bias, even though the forms were completed shortly after the intubations. Real-time data recording on the part of an observer would ideally minimize any measurement bias but is not practical in our emergent clinical setting. Additionally, this was a single-institution study where emergency medicine residents predominantly performed the intubations, limiting the generalizability of results to other clinical settings where emergency intubations are carried out [16].

Another study undertook a secondary analysis by utilizing prospectively collected observational data from the National Emergency Airway Registry (NEAR) [3], a multi-center registry documenting emergency department intubations across 25 academic and community hospitals. Scrutinizing the intubation records from 1 January 2016 to 31 December 2018, a comprehensive examination of a total of 12,853 difficult airway intubations was conducted across 25 hospitals. This study demonstrated a consistently higher overall first-pass success rate with VL at 89.1% compared to DL at 77.7% in adult emergency department patients with anticipated or anatomically difficult airways. This advantage of VL appears to be additive, strengthening as airways become more challenging. Interestingly, the first-pass success rates between hyperangulated video laryngoscopy (HAVL) and standard geometry video laryngoscopy (SGVL) were similar for various difficult airway characteristics, with SGVL showing a slight advantage in cases involving blood or vomit in the airway. The overall adverse event rates, including cardiac arrest, hypoxia, dental trauma, direct airway injury, epistaxis, hypotension, iatrogenic bleeding, lip laceration, laryngoscope failure, laryngospasm, mainstem intubation, pharyngeal laceration, pneumothorax, and/or tracheal tube cuff failure, were comparable between VL and DL. However, VL showed significantly lower rates of esophageal intubation and vomiting. Esophageal intubations occurred in 0.4% of VL attempts versus 1.5% of DL attempts, and vomiting occurred in 0.6% of VL attempts versus 1.4% of DL attempts. Notably, no significant differences in the adverse event rates were observed between SGVL and HAVL. In conclusion, this study suggests that VL, whether hyperangulated or with standard geometry, should generally be considered the primary device for managing difficult airways in emergency departments [3].

This study has several notable limitations. First, the observational nature of the research prevents a causal relationship from being established between the use of VL and higher first-pass intubation success rates for difficult airways, introducing the risk of confounding bias. There may also be selection bias, as the rationale behind an operator's choice of laryngoscope for a specific patient remains unknown. Additionally, the predominance of data from academic emergency departments may limit the generalizability of the findings to diverse settings, especially more rural locations where VL might not be feasible due to resource constraints. This study did not examine the operator preferences between academic and rural settings, warranting further investigation in future studies. Although the results suggest improved first-pass success with VL in difficult airways, the accuracy of the clinician predictions regarding airway difficulty cannot be confirmed. Future research is needed to enhance the predictive abilities of physicians and guide optimal approach selection. The list of difficult airway characteristics considered in this study might not encompass all the relevant factors, and the subjective nature of their assessment introduces potential bias. Lastly, self-reporting bias and potential recall bias may influence the data accuracy [3].

4. Video Laryngoscopy: Evolution, Variants, Pros, and Cons

Endotracheal intubation typically involves DL, which can be challenging under specific circumstances. Video-assisted laryngoscopy serves as an alternative to DL and has seen a significant rise in use in recent years due to numerous advantages, which are elaborated upon in the following section [25].

The video laryngoscope was first introduced by Dr. John Pacey in 2001, representing a significant advancement in tracheal intubation, comparable to the invention of the Macintosh laryngoscope approximately 80 years earlier [40].

VL involves a laryngoscope that features a high-quality digital camera positioned a few centimeters from the blade's tip. This includes a method for transmitting images from this camera to a screen, improving larynx visibility by offering an anterior view of the glottis and a broader angle of vision [41,42]. During VL, a type of indirect laryngoscopy, the operator does not directly observe the larynx. Instead, they view it indirectly using a small imaging device such as a microminiature charge-coupled device (CCD) camera [43]. Video laryngoscopes come in various dimensions and blade shapes; they can be portable, disposable, or reusable; and they can be used with or without channels for different medical indications [41]. Typically, VLs fall into three categories:

1. Featuring standard Macintosh blades
2. Equipped with blades angled at the tip
3. Incorporating a channel to guide the tube

While no specific device has demonstrated superior advantages over the others, a particular design might be more suited to a particular clinical scenario [25] (Figure 1).

Macintosh-style	Hyperangulated	Channeled
• Storz V-MAC • C-MAC • McGrath MAC	• Glidescope • McGrath Series 5 • TruView Devices • Bullard laryngoscope • Storz D-blade • AP Venner scope	• Airtraq • Pentax-airwayscope

Figure 1. Types of video laryngoscopies and their examples.

Macintosh-style video laryngoscopes such as the Storz V-MAC, C-MAC, and McGrath MAC utilize the same shape as a standard laryngoscope blade with integrated video technology. They typically involve a similar insertion technique to a Macintosh laryngoscope. However, achieving a clear view of the glottis often requires the use of a tube introducer and laryngeal pressure [25,42,44].

Hyperangulated video laryngoscopes (HA-VLs) such as the GlideScope, the McGrath Series 5, TruView devices, a Bullard laryngoscope, the Storz D-BLADE, and the Venner AP scope, employ a blade shape with an extra curve (J-shaped) or hyperangulated blades to visualize the glottis without the need to manipulate the cervical spine or align the three axes (oral, pharyngeal, and laryngeal). They provide an indirect view of the glottis, necessitating the use of a pre-shaped stylet for intubation [25,42,44].

Channeled video laryngoscopes such as the Airtraq and the Pentax Airway Scope feature J-shaped or hyperangulated blades. These devices utilize a guiding channel with a preloaded endotracheal tube. Once the blade tip is positioned toward the glottis, the tube is inserted into the trachea through this channel [25,42,44].

4.1. Advantages of Video Laryngoscopy

A video laryngoscope presents numerous advantages when compared to a direct laryngoscope. First, VL significantly widens the field of view compared to DL, expanding the angle from a mere 10–15 degrees to approximately 60–80 degrees [42]. As reported by Asai et al. [23], when using the Pentax-AWS® VL, nearly all patients who were initially

graded as Cormack and Lehane (C/L) grade 3 or 4 with a Macintosh laryngoscope achieved either grade 1 or 2 visibility. This is explained by the video camera being situated beneath the surface of Macintosh-shaped or extra-curved blades, which enhances the laryngeal view, increasing both the field and angle of vision. This configuration benefits predicted and unexpected difficult airway situations. Enhanced visualization with suitable video laryngoscopes contributes to a generally high success rate in intubation procedures. Hence, VL is advantageous in scenarios with limited mouth opening or neck mobility [45]. Nevertheless, certain randomized controlled trials indicated that despite an enhanced glottic view, it might not always result in increased success rates [10,37,46]. Additionally, a Cochrane review highlighted that VLs of all designs likely reduce the rates of failed intubation and result in higher rates of successful intubation on the first attempt with improved glottic views and that VL likely provides a safer risk profile compared to DL for all adults undergoing tracheal intubation [47].

Patients with cervical spine immobilization find substantial benefit in the use of a video laryngoscope due to its camera technology, eliminating the need to align the eye with the oral, pharyngeal, and laryngeal axes. This feature provides an enhanced glottic view while minimizing the strain on and manipulation of the cervical spine and reducing the pressure on the teeth and soft tissues in the mouth and pharynx. Consequently, this decreases dental damage and mitigates throat injuries [41,48–50].

Ultimately, the video laryngoscope provides a shared airway perspective, offering clear, recordable images that benefit education, research, teamwork, and communication during intubation processes. This significantly enhances the safety measures in airway management [41]. Moreover, its real-time video function enables medical teams to share live information while performing intubations. Simultaneous visualization of the larynx by both the trainee and trainer enhances the trainee's chances of successful intubation and potentially reduces the learning curve. Studies have highlighted the increased effectiveness of novices in intubation training when utilizing a video laryngoscope rather than a traditional Macintosh laryngoscope [50,51].

4.2. Disadvantages of Video Laryngoscopy

Although VL presents the advantages discussed earlier, it is accompanied by a set of limitations. Even though the display system of a video laryngoscope allows for direct image viewing on a video screen, issues such as fogging or camera obscuration due to secretions can still impede the view [25,41]. However, a recent study highlighted that airway contamination, such as with blood or vomit, resulted in decreased first-pass success rates for both a video laryngoscope and a direct laryngoscope [52].

Another important limitation is that even with a clear view of the throat (Cormack and Lehane grade 1), there is still some uncertainty regarding the successful insertion of the tube into the trachea [53]. This situation is mainly associated with the use of HA-VLs due to inadequate insertion techniques [54]. Additionally, factors such as airway issues, a history of airway surgeries or neck radiotherapy, the use of a cervical collar, and limited neck movement have all been connected to unsuccessful VL [21].

Moreover, the need for effective hand–eye coordination while using video laryngoscopes might pose a challenge for certain users. Due to its more complex nature compared to conventional laryngoscopes, users must learn how to accurately manipulate the endotracheal tube while viewing the screen instead of directly observing the larynx. Consequently, additional training is necessary to acquire this skill, and inexperienced users might take longer to perform intubations [25].

Furthermore, video laryngoscopies do not provide the best depth perception because of the 2D images they display. Therefore, the blade or endotracheal tube might be difficult for the user to precisely locate, potentially resulting in patient injury [55]. Hence, injuries such as perforations or lacerations in the palatopharyngeal wall, tonsillar pillar, and soft palate have been linked to VLs [56–58], often attributed to inadequate training or techniques.

Additionally, technical problems such as low battery power, monitor malfunction, or issues related to fogging or solar glare can affect the performance of video laryngoscopes [41]. Finally, parts of the video laryngoscope such as the LED (light-emitting diode), CMOS (complementary metal–oxide–semiconductor), and battery could result in higher expenses for their acquisition and maintenance [25]. Table 1 provides a comparison summary between VL and DL.

Table 1. Comparison between direct and video laryngoscopy.

Aspect	Direct Laryngoscopy	Video Laryngoscopy
Introduction Year	Around 80 years before 2001	Introduced by Dr. John Pacey in 2001
Visualization	Direct line of sight	Indirect view through a camera on a screen
Blade Types	Macintosh blades	Standard Macintosh, hyperangulated, channeled blades
Field of View	10–15 degrees	Approximately 60–80 degrees
Advantages	DL could be advantageous over VL when performed by experienced clinicians [59]	Wider field of view and improved glottic visualization
	DL holds an advantage in scenarios where airway soiling obscures the camera lens, requiring the device to be removed and cleaned before repeated use [59]	Enhanced success rates in difficult airway scenarios
	More availability	Suitable for patients with cervical spine immobilization
	Less cost	Shared airway perspective for education and training
Disadvantages	Limited view; requires alignment of axes	Potential for fogging or camera obscuration
	Manipulations of the airway have adverse implications, such as significant hemodynamic disturbance, cervical instability, injury to the oral and pharyngeal tissues, and dental damage [60]	Does not always result in successful tube insertion
		Requires effective hand–eye coordination
		Limited depth perception; potential for patient injury
		Technical problems (low battery, monitor malfunction)
		Higher expenses for acquisition and maintenance

5. Conclusions

In conclusion, this literature review underscores the evolving landscape of airway management in emergency situations, with a notable shift toward the utilization of VL over DL. VL exhibited a superior success rate compared to DL in difficult airways, backed by moderate-quality evidence, particularly when employed by nonphysicians with limited experience. While the evidence points to the advantages of VL, particularly in achieving higher first-pass success rates and minimizing adverse events in adult patients with difficult airways, inconclusive findings remain from recent randomized trials. Future research should prioritize well-designed trials within emergency departments, considering diverse patient populations, operator preferences, and decision-making criteria. The generalizability of the benefits of VL to various clinical settings, including resource-constrained environments, warrants further exploration. Additionally, efforts to enhance the predictive abilities in identifying difficult airways and comparative analyses of different VL devices

are crucial for informed clinical decision-making. Long-term outcome, cost-effectiveness, and collaborative multi-center studies will contribute to a comprehensive understanding of the role of VL in emergency airway management, guiding optimal practices for improved patient outcomes.

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