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Should Video Laryngoscopy Replace Direct Laryngoscopy as a Primary Intubation Technique?

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Abstract

Purpose of Review While direct laryngoscopy has been the standard technique for tracheal intubation, the application of video laryngoscopy has grown over the past two decades. Early evidence established its beneficial role over direct laryngoscopy for difficult intubations.

Recent Findings Summative evidence indicates that video laryngoscopy is superior to direct laryngoscopy for more generalized populations in the operating room. Prior research has questioned the role of video laryngoscopy for tracheal intubation outside of the operating room in emergent situations. More recent evidence has now established video laryngoscopy to be superior for emergent tracheal intubation.

Summary Video laryngoscopy is superior to direct laryngoscopy across many clinical environments. However, video laryngoscopy has its limitations and should not be the only tool for airway management. As a result, concerns have been raised that widespread use of video laryngoscopy as a first-line technique may limit needed exposure and practice with direct laryngoscopy and awake tracheal intubation with a flexible scope.

Keywords Airway management · Video laryngoscopy · Direct laryngoscopy · Emergent airways · Difficult airway algorithm · Training in airway management

Introduction

Video laryngoscopy (VL) has been clinically available for decades, but made major advancements in 2001, with the introduction of modern video screens, digital technology, and alternate blade designs. Since then, much effort has been applied to determine the clinical efficacy of VL for intubation of adults and children both in the operating room and in emergency environments.

Early studies of VL focused on the novice performing laryngoscopy or the patient predicted to be difficult to intubate by direct laryngoscopy (DL). Those with predictors of difficult DL are easier to intubate with VL in terms of number of intubation attempts and other surrogates of difficulty [1–3]. While these studies were quite positive favoring VL, they focused on narrower populations. Many clinicians now reach for VL over DL for those at risk and when working with learners. However, it remained unclear for some time how to approach more routine airway management, as costly VL was often reserved only for patients predicted to be difficult to intubate by DL.

In this review, we explore the most recent evidence available to us, while comparing VL vs. DL in a multitude of settings. While the evidence demonstrates that VL outperforms DL in various clinical environments, we want to explore the implications of overreliance on VL becoming standard of care for trainees in acquiring a diverse skill set in airway management.

VL for Predicted Difficult Airway

Across environments, VL outperforms DL for those predicted to be difficult to intubate via direct laryngoscopy [4•]. A Cochrane review conducted in 2015 included 64 studies and 7044 participants comparing VL to DL in various

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settings. It demonstrated that video laryngoscopy was associated with multiple benefits, including improved laryngeal views, reduced'intubation difficulty' score, reduced failed intubations in all patients, reduced airway trauma, and reduced hoarseness. The review also found reduced intubation attempts in the hands of experienced operators but not with inexperienced users. This Cochrane review was updated in 2022 and now includes 222 studies and 26 149 participants [5••]. Compared to 2015 version, the 2022 version was better powered to detect differences in outcomes due to its significantly larger sample size. Furthermore, the most recent Cochrane review differentiated between different video laryngoscope designs such as hyperangulated blade, Macintosh-style blades, and channeled blades. Overall, the 2022 updated analysis provided more compelling evidence that VL outperforms DL across device designs and patient populations. Thus, recent evidence suggests that it is more judicious to use video laryngoscopy compared to direct laryngoscopy as the primary strategy for difficult airways.

VL for Generalized OR Population

Video laryngoscopy is traditionally reserved as a backup strategy for difficult DL. However, our ability to predict difficult DL is remarkably poor [6]. Our bedside tests come with poor predictive capacity, and consequently, most of our difficult DL encounters are unanticipated. In a large, prospective trial evaluating the efficacy of screening tools, Nørskov et al. observed that 89 to 91% of difficult tracheal intubations were not predicted [7]. Therefore, the traditional practice of applying VL only for those patients predicted to be difficult to intubate with DL fails to address our major source of challenge.

De Jong and colleagues described a valuable evaluation of "first-intention" video laryngoscopy [8]. The study took over 3 years, and included a transition period during which there was widespread education regarding video laryngoscopy and a "control hospital", in which no intervention took place. In the intervention hospital, the use of video laryngoscopy as a first attempt rose from 0.27 to 66%. Compared with both hospitals pre-intervention, the rate of reported easy airways (the absence of difficult laryngoscopy, intubation, or mask ventilation) significantly increased (94.3–98.7%). Use of airway rescue techniques or operator-reported difficulty decreased significantly (~threefold) from 5.3 to 1.9%. Rates of difficult laryngoscopy and airway rescue also both decreased significantly. In the comparator hospital during the same period, there was no discernible change in processes or outcomes.

Combined with the Cochrane review mentioned above, the evidence in anesthesia literature suggests that video laryngoscopy improves view at laryngoscopy, ease of laryngoscopy, and first-pass and overall success at tracheal intubation, without increasing complication rate, rather reducing it, especially in the generalized OR population.

VL for Emergency Tracheal Intubation

VL use outside the operating room, in locations such as the emergency department and intensive care unit settings, has been studied widely [9–11]. Baek et al. found that the overall success rate on the first attempt was significantly higher with VL than DL in the general ward [12]. However, the intubation-related complications between the two groups were largely the same, though the incidence of oxygen desaturation ($SpO2 < 80\%$) was higher with DL than VL, and in-hospital mortality was also higher in the DL group [12].

However, a study by Sakles found that DL had higher success rates when multiple attempts were required [13]. This finding is thought to be due to difficulty in passing the endotracheal tube despite an adequate view of the glottis with VL, or technical issues such as fogging or lens contamination. Conversely, Russotto et al. conducted a sub-analysis of a large international prospective cohort of critically ill patients (INTUBATE study) comparing video laryngoscopy to direct laryngoscopy for first-pass success rate [14]. They found that video laryngoscopy is associated with higher first-pass success rate. Also, VL was not significantly associated with major adverse events, such as hypoxemia, or major cardiovascular events [15].

Generally, randomized control trials performed on this topic are older, while observational studies are mostly supportive of VL. A study by Hypes et al. found an increased risk of complications in the intensive care unit when more than one attempt at VL was required [10], and Arulkumaran et al. found a higher incidence of hypotension when VL was used [11]. Moreover, several early studies have demonstrated that the time to successful tracheal intubation is longer with VL compared to DL [1, 15, 16]. While the time difference is minimal (10–20 s), in certain patient populations with poor pulmonary reserve, the time difference is meaningful. Yeatts et al. randomized trauma patients to either VL or DL and found that in patients with traumatic head injuries, the group randomized to VL demonstrated higher mortality rates and a higher incidence of hypoxemia [15].

Most clinical trials comparing DL to VL in the ICU were challenging to perform due inherent difficulties with emergency research. Those studies have resulted in mixed conclusions and were scrutinized for methodological limitations. More recently, a large-scale pragmatic trial was performed aimed at addressing these limitations. The DirECT versus VIdeo LaryngosCopE (DEVICE) trial is a multicenter, non-blinded randomized controlled trial that compared VL vs. DL for first attempt at tracheal intubation in non-OR settings

[17••]. It enrolled roughly 1400 patients and is the biggest RCT up to date on this subject. Results from this multicenter trial show that VL is superior to DL in out-of-OR settings, among critically ill adults, in securing the airway on first attempt. The rate of pulmonary complications surrounding intubation was similar between the two modalities for intubation.

VL Use in Obstetric Patient Population

Due to physiological changes associated with pregnancy, parturients are predisposed to having more difficult airways than the general population. A meta-analysis and mixed-methods systematic review published in 2021 found that video laryngoscopy was not superior to direct laryngoscopy for first-pass success rate for tracheal intubation [18] for elective C-sections, in simulated environments. The study also failed to find any statistically significant difference in time to tracheal intubation using either DL or VL as the primary airway management strategy in obstetrics. However, VL was found to be superior to DL in those with predicted difficult airways, with increased first-pass success rate. Furthermore, it was demonstrated to be a useful rescue tool for failed DL [18].

VL Use in Pediatric Patient Population

Infants have an inherently different airway when compared to adults. Unlike in adults, the pediatric airway is a funnel-shaped structure, and the narrowest point is at the cricoid cartilage. The larynx is also more superiorly located along the cervical spine, generally at the C3-4 level, compared to an adult larynx. Furthermore, the pediatric epiglottis is described as omega-shaped and floppy compared to an adult epiglottis. Given all of these factors, direct laryngoscopy in an infant can be intrinsically challenging.

Moreover, the first-pass success rate in an infant is more clinically relevant compared to a healthy adult due to life-threatening complications associated with multiple intubation attempts. One multicenter, randomized control trial found that using VL with a standard blade improves the first-attempt success rate and reduces complications when anesthesiologists carried out these intubations in the operating rooms [19]. Of note, one of the exclusion criterions of this study included neonates with a history of difficult airway or those with craniofacial abnormalities that would predispose them to a difficult airway [19]. Among neonates undergoing general anesthesia for non-cardiac routine surgeries, however, this multicenter international trial found that using a video laryngoscope was associated not only with a higher first-pass success rate, but also fewer complications surrounding intubations.

A Cochrane review conducted in 2018 found that video laryngoscopy is superior to direct laryngoscopy in the neonatal population in an emergent setting [20]. This review focused on studies conducted in the delivery room or neonatal intensive care units (NICU). They found that VL increases first-pass success rate when compared to DL, but may not reduce the time to successful intubation. They also reported lower incidence of airway trauma associated with video laryngoscopy when compared to DL in this age group.

A randomized control trial, composed of 48 first and second-year residents, found that teaching first and second year residents how to intubate using video laryngoscopy improved overall neonatal intubation success rates [21]. Another prospective, randomized cross-over study found that video-assisted verbal feedback to trainees during intubations resulted in higher success rate and lower peri-intubation complications [22]. Thus, video laryngoscopy may be superior to direct laryngoscopy not only with patient-related factors, but also as an educational device for novel learners in this high-risk population.

Overall, there is a paucity of research conclusively establishing VL as superior to DL in the neonatal pediatric population. However, novel studies done in this subfield demonstrate that VL may be superior to DL in regard to first-pass success rate and may reduce complications surrounding intubation. Furthermore, video laryngoscopy is also noted to be a helpful tool in teaching novice learners to intubate without exposing the neonate to devastating complications surrounding failed intubations.

Role of VL in Preventing Esophageal Intubations

The Project for Universal Management of Airways (PUMA) guidelines is the first to provide comprehensive recommendations for preventing unrecognized esophageal intubations [23]. Esophageal intubation is a common complication, with a reported incidence rate of 1 in 18 cases from an international study in emergent scenarios, despite user experience [24]. Per the PUMA guidelines, routine use of a video laryngoscope is now recommended to decrease the chance of esophageal intubation [23] by the proceduralist. Video laryngoscopes also enable a culture of safety since other personnel can view the intubation attempt and subsequently question correct placement if needed [23]. Together, these factors aid in creating a safe environment and reduction in rates of esophageal intubation.

Other studies have also found that using video laryngoscopy decreases the rate of esophageal intubation in various clinical environments, including emergency department

(ED) and medical intensive care units (MICU) [24, 25]. Bhattacharjee et al. found that though using VL was associated with lower rates of esophageal intubations, there was no benefit in overall success rate in the ED [25]. Mosier et al. found that in patients admitted to MICU, VL not only decreased rates of esophageal intubation but also increased the overall intubation success rate [26]. Thus, video laryngoscopy has shown to consistently decrease esophageal intubation rates across clinical environments, with varying degrees of overall success.

Limitations of VL/Predicting Failure

Failure Rates

No single intubation technique results in 100% success rate. While first attempt intubation success rate is improved with VL, there are some limitations present (Table 1). Some studies have demonstrated similar overall success rates and glottic views when comparing DL to VL [1, 27]. A recent meta-analysis by Hansel et al. found no difference in overall success rates with VL versus DL when > 1 attempt was required [7]. Another meta-analysis found no evidence that the use of VL reduced time to intubation [6]. A meta-analysis by Griesdale et al. found no difference in time to tracheal intubation or success rates when comparing the Glidescope and DL in expert hands [28].

A frequent source of VL failure using a hyperangulated blade is due to difficulty with endotracheal tube placement despite a good view of the glottis and vocal cords [27, 29]. The study by Michailidou et al. reported that 40% of failed intubations with VL were due to inability to pass the tube compared to a 21% failure rate when DL was performed [27]. Similarly, Aziz et al. found intubation failure in the setting of an adequate laryngeal view to occur more frequently with VL compared to DL (54 vs. 35%) [1].

Predictors of difficulty or failure with hyperangulated VL have been identified [30]. Aziz et al. identified four perioperative predictors, including neck anatomy, thyromental distance, cervical motion, and institution experience that were associated with failed intubation with Glidescope VL [29]. Specifically, patients with neck pathologies, such as previous radiation to the area, neck masses, and scar tissue, are at higher risk for failure, compared to those with normal neck anatomy. These patients are also more likely to fail facemask ventilation and direct laryngoscopy, so strong consideration should be made for awake tracheal intubation with a flexible intubation scope. This sub-population of patients may be prime candidates for an awake intubation with either fiberoptic scope or VL in certain clinical environments, as it would provide the safest and structured plan for securing the airway without excessive neck manipulation.

Risk of Injury

There have been case reports of injury to the palate and tonsillar pillars during advancement of the endotracheal tube during VL, predominantly with hyperangulated blades and styleted tubes [31–34]. Greer et al., who published a review of these types of injuries, suggest that they may occur due to the blind spot in the back of the mouth that cannot be visualized by VL, as well as the use of the rigid stylets that are provided with some VL systems [34]. These safety events continue to occur during hyperangulated VL despite widely disseminated caution regarding the risk and prevention. These risks are presumed to be smaller with airway devices that are placed under direct vision.

There is also risk of injury, such as lip laceration, gum laceration, or dental damage with VL, though these are also identified risks with DL as well. Furthermore, video laryngoscopy use in patients with cervical spine instability may impart some additional risk. In particular, there has been a case report that described a C5–C6 dislocation fracture while performing VL in a patient with ankylosing spondylitis [35]. The injury to the cervical spine was believed to be secondary to the hyperextension of the neck needed for intubation using video laryngoscopy. If a flexible intubation scope technique had been utilized instead of VL, it is feasible that this injury could have been prevented. Thus, even though less suspension pressure is required with VL compared to DL, the cervical spine still moves during VL, so

Table 1 Major benefits and barriers to video laryngoscopy, as summed up by current body of evidence

Benefits of video laryngoscopy	Barriers to video laryngoscopy
Improved laryngeal views	No difference in success rate when > 1 attempt
Improved first-pass success	No difference in time to tracheal intubation when compared to DL
Reduced failed intubations	Intubation failure in setting of adequate laryngeal view
Reduced dental trauma	Higher rates of failure when using hyperangulated blades in patients with neck pathology
Reduced hoarseness	Injury to airway structures including tonsillar pillars and soft palate
Reduced peri-intubation pulmonary complications	Cost

caution is warranted when utilizing VL for unstable cervical spine airway management.

Video laryngoscopy was chosen in the aforementioned case due to user familiarity and confidence with VL. This observation is relevant because it supports concerns regarding skill degradation with other airway management techniques. In the age of video laryngoscopy becoming the primary airway management tool, it is imperative to expose trainees to various airway management techniques to prevent overreliance on a singular technique.

Financial Considerations

Costs of VL systems are higher than DL systems. In a challenging financial climate, it may be difficult to secure funds for wide scale VL purchase. However, cost gaps are shrinking and the solidified evidence supporting VL should help to support the argument to overcome that gap.

Technical Considerations

VL carries risk for technical difficulties, as added technology increases source of potential technical failure. These barriers can include equipment failure, such as a frozen screen, or defective wiring that leads to no view on the camera. Obligate indirect laryngoscopy may also be impaired by contamination of the camera lens from secretions, vomit, or blood. These technical factors can make video laryngoscopy challenging, and can lead to either failed intubation attempt or conversion to a different technique.

Degrading Skills with Awake Flexible Approaches and DL

There has been concern that the overreliance on VL may negatively impact acquisition and competency of other tracheal intubation techniques, such as flexible scope intubation and even DL. Recent commentary identified that it is important to recognize the limitations of VL and to maintain as well as teach trainees alternate airway skills [36]. Fixating on any one airway device may lead to less exposure to alternate techniques. This may result in lower success rates and longer time to intubation if an alternate technique is required as a back-up plan. The American Society for Anesthesiologists (ASA) have created new infographics to guide decision making for difficult airway management in their 2022 updated practice guidelines. These guidelines emphasize the use of awake techniques for those predicted to be difficult laryngoscopy and the optimal application of either hyperangulated VL or standard geometry VL. The guidelines further emphasize awake flexible techniques, and the need to maintain a variety of skill sets for airway rescue [37].

Although VL is emerging as a popular tool in airway management due to its solid track record as a reliable tool, most guidelines stress the importance of having back up plans readily available, and the importance of being proficient in more than one technique. Moreover, being proficient in only a single airway device goes against the recommendations made by several airway algorithms, including ASA Difficult Airway Guidelines. This more routine practice of VL poses the risk of lower success rates with back-up devices that are no longer used and practiced regularly [38]. In the age of VL, it is imperative for training institutions to emphasize practice with alternative techniques so that future generations of anesthesiologists are experts in techniques used for primary airway management as well as rescue. It cannot be stressed enough that VL is not the only airway management solution and has its limitations.

Conclusion

Video laryngoscopy has become an important airway management tool in various clinical settings, including obstetric and pediatric populations. Novel research is increasingly proving its improved efficacy over direct laryngoscopy as the primary airway management tool in a myriad of clinical environments. This holds true not only for the generalized population in the operating room, but also for challenging airway management in other environments, such as the intensive care unit or the general ward. Despite the advantages of video laryngoscopy, it should not be taken as the universal approach and other techniques still need to be mastered to ensure safe airway management. Furthermore, VL is not always the best option for every patient in every environment, for any given user. Proficiency and practice with other techniques is necessary to produce a skillset to manage any airway encounter in an environment where difficulty is challenging to anticipate and no single technique is universally successful.

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Declarations

Competing interests MA has received meals and beverage from Karl Storz and Medtronic

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national research committee standards, and international/national/institutional guidelines).

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