Videolaryngoscopy for Intubation Training

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Education Gaps

1. The best way to train residents, fellows, and inexperienced laryngoscopy operators remains to be determined. Videolaryngoscopy provides an effective method for training inexperienced operators and improves the learning curve for safe endotracheal intubation in neonatal and pediatric patients. More frequent use of the videolaryngoscope in the early stages of training provides many advantages for short- and long-term clinical proficiency.

2. For a known or suspected difficult airway, one should ensure basic preparation such as identification of backup strategies for intubation, as well as preparing all potentially necessary equipment for managing the difficult airway. At a minimum, it is strongly recommended that a videolaryngoscope should be available in these scenarios.

Abstract

Intubation in the neonate can present unique challenges to an inexperienced clinician. The videolaryngoscope provides more easy visualization of the airway, as well as more reliable access to the airway. Since its inception, the videolaryngoscope has been modified from its original adult design for use in the pediatric patient population. Following its production, one of its main uses has been in the training of inexperienced operators, gaining widespread use in training hospitals. Before its introduction, instructors at these institutions relied solely on feedback from the trainee during intubation, rather than visual confirmation. Use of the videolaryngoscope to instruct trainees on the technique of intubation improves feedback given to the trainee as well as the first-attempt success rates, while lowering esophageal intubation rates. The available literature suggests that the use of videolaryngoscopy improves visualization of the glottis while sacrificing time to pass the endotracheal tube. Both methods (direct and videolaryngoscopy) proved to have similar times for intubation as well as intubation success rates for experienced practitioners. In the neonatal and pediatric populations specifically, another crucial use of videolaryngoscopy is its superiority in treating patients with a difficult airway. It enhances the operator’s ability to visualize the glottis in cases with no direct line of sight to the glottis.

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ABBREVIATIONS

DL direct laryngoscopy
LCD liquid crystal display
VL videolaryngoscopy
Objectives  After completing this article, readers should be able to:

1. Understand how the funnel-shaped infant airway presents unique challenges to endotracheal intubation in comparison to its adult counterpart. Difficulty achieving an adequate glottal view using traditional direct laryngoscopy blades may be as high as 37%.

2. Consider how the use of a videolaryngoscope improves the quality of feedback given to trainees, improves first-attempt success rates, and lowers the risk of esophageal intubation.

3. Describe how the 60-degree angle of the videolaryngoscope blade provides improved glottal visualization without requiring direct line of sight.

4. Consider that even for the experienced laryngoscope operator, the videolaryngoscope should always be available for a difficult airway.

INTRODUCTION

Tracheal intubation is a lifesaving procedure and is an essential step in elective general anesthesia and cardiopulmonary resuscitation. (1)(2) In pediatrics, intubation presents unique challenges for trainees because the airway is considerably different from the adult airway, and obstruction of the airway can lead to rapid cardiorespiratory decompensation in infants and children. (3)(4)(5) Specific to the neonate, a more cephalad larynx, a narrower epiglottis, a relatively larger tongue, larger occiput, and a more limited mouth opening contribute to increased difficulty for laryngoscopy and intubation. (1)(2)(3)(5)(6)(7)(8)

One study used video bronchoscopy in anesthetized and paralyzed children to measure the cross-sectional area of the airway at the level of the glottis and the cricoid. Their findings suggested that the glottis, rather than the cricoid, is the narrowest portion of the pediatric airway. (9) However, a more recent autopsy study confirms that the infant larynx is funnel-shaped with the narrowest portion found at the near-circular nondistensible cricoid cartilage. (10)

Before the development of videolaryngoscopy (VL), endotracheal intubation of the neonate was uniformly performed via direct laryngoscopy (DL). Typically, DL operators in the NICU use a Miller blade, sized 00 to 1, depending on the infant’s size, to visualize the airway and pass the endotracheal tube into the trachea. Although conventional DL is usually rapid and atraumatic in experienced hands, the difficulty in obtaining glottis exposure with traditional DL blades may occur in as many as 37% of cases. (11) In this review, the authors aim to assess the advantages of VL in the neonatal and pediatric populations, focusing on how this technique addresses 2 essential clinical issues in the neonate: the instruction of trainees and the management of the difficult airway.

THE UTILITY OF VL FOR INSTRUCTION OF TRAINEES

Before the advent of VL, instructors relied mainly on feedback from the trainee during intubation, rather than visual validation. (1)(2)(3) Because of the low pulmonary reserve and high oxygen consumption in small infants, instructors were often unable to correct trainees using real-time feedback when problems arose during DL for fear of the infant experiencing rapid decompensation. (8)(11) Instead, instructors found it necessary to perform endotracheal intubation themselves, delaying the achievement of trainees’ competence in endotracheal intubation. (8)

With this issue in mind, extensive research went into developing pediatric VL devices to better visualize the oral and pharyngeal axes, providing a better view than that available with DL visualization. (1)(3)(5) These VL devices provide high-resolution cameras and liquid crystal display (LCD) monitors to improve the view of the laryngeal inlet independent of the direct line of sight. (3)(4)(5)(8) Traditional DL relies on direct line of sight of the glottal channel. To achieve this direct line of sight, maneuvers including neck flexion, head extension, and laryngeal depression, all stimulating and sometimes dangerous maneuvers, may be required. In 2001, Dr Jack Pacey, a Canadian vascular surgeon, invented the adult GlideScope videolaryngoscope. It was designed to provide a more reliable
and more easily achieved visualization of and procedural access to the airway (Fig 1). Later, in 2005, a miniaturized pediatric GlideScope was introduced. Today, anesthesiologists, intensivists, emergency medical services, and military teams around the world use the GlideScope videolaryngoscope routinely.

The videolaryngoscope handle is similar to that of a standard laryngoscope. A wide-angling video camera, along with 2 light-emitting diodes placed on either side of the camera to provide illumination, is placed on the tip of the blade in combination with an antifogging device. (7) The image captured by the camera is displayed on an LCD monitor, resulting in improved glottic visualization. (1)(3)(4)(5)(7) In contrast to the standard laryngoscope, the blade is not detachable and has a 60-degree anterior curvature in the midline. (3)(5)(7) The 60-degree angle of the blade provides improved visualization without requiring alignment of the oral, pharyngeal, and tracheal axes. It also does so without requiring any additional lifting force. (5)(7)

Since their introduction, neonatal and pediatric videolaryngoscope blades have evolved through several generations. After the GlideScope, other videolaryngoscopes were developed, including the C-MAC® (Karl Storz, Tuttingen, Germany), a system offering the familiarity of the Macintosh standard laryngoscope blade; the TruView PCD (Teleflex, Wayne, PA), which offers a magnified laryngeal view; and the McGrath MAC (Medtronic, Minneapolis, MN), which gives the laryngoscope operator the option to use the device as a standard or videolaryngoscope. (6)(12)(13)(14) Figure 2 shows a comparison of these various laryngoscope blades. Bearing in mind the differences among pediatric videolaryngoscopes, this review will focus on the use of the pediatric GlideScope.

Research evaluating laryngoscopes and alternative intubation devices has historically focused on improving laryngeal exposure. As 1 of these “alternative devices,” the videolaryngoscope allows the operator to “look around the corner.” With the various angles provided, the individual intubating the airway can extend his or her line of sight beyond a large tongue, small mandible, retroflexed epiglottis, or hypopharyngeal soft tissue crowding. When a direct line of sight of the glottis is encumbered during DL, the view can be achieved with the videolaryngoscope, thus leading to successful intubation. This improvement results from the lighting and video technology at the tip of the laryngoscope capturing an image, which is then projected onto a screen that is easily viewed by the operator.

Several studies have compared the use of video-assisted laryngoscopy to traditional laryngoscopy in the pediatric population. Most have found no difference in time to intubate and intubation success rates for experienced operators; however, VL did improve the view of the glottis while sacrificing time to pass the tube. (1)(5)(15) Recently 2 Cochrane reviews examined VL versus traditional DL. The first study was conducted in neonates, and the second looked at the pediatric population excluding neonates. In the systematic review of the neonatal population, the

Figure 1. GlideScope videolaryngoscope. Left panel shows GlideScope liquid crystal display screen for monitoring the laryngeal inlet during endotracheal intubation. Right panel shows curved laryngoscope blade (clear cover) with internal light and video components.
researchers attempted to evaluate the efficacy and safety of VL compared with DL in decreasing the time and number of attempts at intubation while increasing success rate. Ultimately, they found that there is insufficient evidence in the literature to recommend the use of a videolaryngoscope in either the NICU or the delivery room. In contrast, in the Cochrane review of a pediatric population, Abdelgadir et al noted that, when excluding neonates, VL led to prolonged intubation times and an increase in the rate of intubation failure compared with traditional DL. (16) All of the aforementioned studies focused on children and neonates with normal anatomy in whom intubation was performed by an expert. (2)(16)

However, in contrast to these findings, VL appears to offer an advantage in specific cases in which airway visualization fails because of operator inexperience. Not only does the videolaryngoscope provide an enhanced view of the glottis to the laryngoscope operator (Fig 3), but it also provides the same view to observers in proximity to the operator, who may be supervising or providing additional expert opinion on the safe establishment of an endotracheal airway. The use of VL, therefore, presents the perfect opportunity to improve upon traditional methods of teaching the procedure of intubation (Fig 4).

A few studies have examined the use of VL in teaching residents to perform intubation in patients. Sakles et al investigated the use of VL for teaching trainees in the emergency department of an academic institution. (17) In 2014, they published a study evaluating emergency medicine residents’ (postgraduate years 1–3) intubation performance using VL or DL. They found that, across all trainee years, the residents had an increase in first-pass intubation success using VL compared with DL. In addition, they noted that, as the individual resident’s training progressed, he or she improved significantly using VL but not using traditional DL. (17) In 2015, Sakles et al published another emergency medicine study concluding that the use of VL in training emergency medicine residents to perform intubation significantly lowered their rate of esophageal intubation. (18) Both of these studies were conducted in an academic emergency department where the patient population predominantly comprised adults.

Figure 2. Laryngoscope blades. A and B depict the Macintosh and Miller blades for traditional direct laryngoscopy, respectively. C and D depict the videolaryngoscope blades of the C-MAC® and the GlideScope, respectively.

Figure 3. Videolaryngoscopic versus direct laryngoscopic views of the difficult airway, in a 16-month-old girl with a history of difficult intubation. A, view of the glottis using a Miller 1 laryngoscope. Note poor control and retroflexion of the epiglottis obscuring view into the glottal inlet. B, view of the glottis using the GlideScope videolaryngoscope. AE=aryepiglottic fold; BOT=base of tongue; EG=epiglottis; FV=false vocal fold; PC=postcricoid; PE=pharyngoepiglottic fold; T=palatine tonsil; *=true vocal fold.
So, how do these findings in adults translate to the pediatric population? Koele-Schmidt and Vasquez conducted a study teaching intubation to postgraduate year 1 residents rotating in the NICU at an academic hospital. (19) Trainees were taught intubation using 3 methods: traditional bedside DL, VL, and a computer-training module. During the exercise, the trainers found that the residents were faster at performing intubations using the direct laryngoscope. However, when surveyed after the training exercise, the residents endorsed that, although only 33% preferred using VL to DL, 76% thought that VL was a superior training method. (19) Other studies have shown similar feedback from trainees, and some have shown that proficiency at pediatric intubation using VL translates into improved aptitude in intubation using DL. As such, physicians early in their training, learning how to perform intubation in pediatric and/or neonatal patients, should routinely use VL when available. It is safer and improves their early successes, instilling the necessary skill set and confidence going forward.

THE UTILITY OF VL IN MANAGING DIFFICULT NEONATAL AIRWAYS

A few studies have examined intubation in children with a difficult airway or challenging anatomy. Figure 3A provides an example of more difficult airway anatomy with a large base of the tongue, crowded oropharynx, and a retroflexed epiglottis. Burjek et al compared the use of flexible fiberoptic intubation with VL-assisted intubation in the difficult pediatric airway and found that the flexible bronchoscope provided a superior view of the glottis compared with the videolaryngoscope. (20) They also found that the ability to ventilate during bronchoscopy led to a reduction in hypoxemic events during intubation. (20) Vlatten et al performed a randomized controlled trial assigning patients with difficult anatomy to either a VL or a DL group for intubation. (21) They found that, in children with abnormal anatomy, experienced anesthesiologists achieved a superior view of the glottis with VL, but it ultimately took them longer to pass the tube and intubate when compared with DL. (21) On the other hand, when evaluating inexperienced anesthetists, it has been shown that using VL improves their success rate and shortens their time to intubation. (22) Therefore VL is the preferred choice for intubation of a difficult airway by a less experienced operator. It may become the preferred choice for experienced operators also as its use becomes more widespread and routine.

CONCLUSION

Although the primary implementation of the videolaryngoscope was to provide a superior view of the larynx during intubation, it appears that the true power of this tool lies in its unrivaled mechanism of teaching trainees and novice operators the technique of endotracheal intubation. Along the same vein, the literature suggests that for inexperienced operators, VL may be helpful as the primary avenue for managing difficult neonatal airways. Every new device has a learning curve. VL has the capacity to steepen the learning curve for novice operators, and perhaps, once the
learning curve is passed by experienced operators, it may function as the intubation tool of choice for better laryngeal views in more difficult airways.

American Board of Pediatrics Neonatal-Perinatal Content Specification

- Know the proper approach to airway management in the delivery room.

References


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