Video Laryngoscopy And the Pediatric Airway

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The use of video laryngoscopy by anesthesiologists for the pediatric patient has been possible for less than a decade. From the vantage point of a pediatric anesthesiologist who has managed numerous difficult airways, we have come a long way in a short time with the arrival of video laryngoscopy. That said, in the 1980s video technology made its appearance in the field of surgery.1 The use of this technology by our surgical colleagues has increased enormously over this period. More recently, anesthesia providers are learning what video technology can offer with regard to airway management.

Introduction

The introduction of video laryngoscopy technology has provided the laryngoscopist and others with an all-inclusive view of the airway. The result is a greater appreciation for the anatomy, for two reasons. First, video laryngoscopy offers an expanded view of the airway compared with that obtained through direct laryngoscopy2; second, the view provided by video laryngoscopy is of high resolution. These unique features demonstrate the overall appeal of video laryngoscopy and help explain why it has so rapidly become a part of the airway armamentarium.

This article will review the video laryngoscopes (VLs) that have application in the neonate, infant, and child under 8 years of age.
Implications of Pediatric Airway Anatomy For Airway Management

No matter the choice of device used to manage the airway, clinicians must understand the pediatric airway anatomy. There are several critical differences between the infant and child airway anatomy and that of an adult. Several of these developmental differences are summarized in Table 1.

The result is that the approach to airway management in these groups must be adapted to these differences.

Direct Versus Video Laryngoscopy

Anesthesia providers are knowledgeable and experienced in the techniques of direct laryngoscopy.

Compared with direct laryngoscopy, video laryngoscopy can provide an expanded view of the airway, from the oropharynx to the glottic opening. The technique of mouth opening is similar with direct laryngoscopy and video laryngoscopy. However, their subsequent steps diverge. The VL blade is inserted midline with the avoidance of a tongue sweep. The airway manager views the display monitor or other screen as the laryngoscope blade is gently lifted and advanced until the larynx becomes visible. As with direct laryngoscopy, external laryngeal manipulation may be necessary to improve the laryngeal view. Viewing the monitor while advancing the VL demands fine hand–eye coordination, a skill that may require practice to polish. In general, however, learning the nuances of using a VL device can be acquired over time.

Video Laryngoscopy in Pediatrics

Several studies, correspondence and case reports demonstrate the successful use of video laryngoscopy among pediatric patients. The evidence supporting the use of video laryngoscopy in the adult patient population is far more voluminous than that in pediatrics. Nor has any study to date in children compared the available VLs. However, in an adult mannequin study of difficult airway scenarios, Malik and colleagues compared the GlideScope (Verathon Medical), the Pentax AWS, and the Truview EVO2 (Truphatek) with the Macintosh laryngoscope. The investigators concluded that the Pentax AWS proved the most ideal alternative to the Macintosh.

Types of Video Laryngoscopes

Several VLs are available for use in the pediatric patient (Table 2). Some of these devices may be used in the smallest patients, including premature infants and neonates. Several of the devices listed in Table 2 are not in the strictest sense VLs. However, with the addition of a camera attachment and further connection to a monitor, these devices “cross over” and have similar function. Over the past few months, Verathon Medical developed a new line of blades with application even for the micrognathic pediatric patient. The need for this technology in the pediatric patient population is just as great as in adults.

Airtraq. The Airtraq (Figure 2) is a non-reusable optical laryngoscope that can accommodate a camera attachment and connect to a monitor to provide the quality of a VL. This device has application for the routine or difficult airway management of the infant, child, and adolescent. Its power source comes from alkaline batteries. The Airtraq consists of a light source, anti-fog system, and two channels. The optical channel contains the high-tech optical system; the guiding channel accommodates the endotracheal tube (ETT).

Use of the Airtraq begins with turning on the light source. Next, the ETT should be lubricated and placed within the guiding channel. The device is positioned midline into the opened mouth. At this point, the

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Table 1. Developmental Differences In the Pediatric Airway Compared To the Adult

<table>
<thead>
<tr>
<th>Component</th>
<th>Difference</th>
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<tbody>
<tr>
<td>Head (occiput)</td>
<td>Relatively large</td>
</tr>
<tr>
<td>Tongue</td>
<td>Large relative to the size of the mouth</td>
</tr>
<tr>
<td>Larynx</td>
<td>More cephalad in the infant (C2-C3) until it approaches that of the adult (C4-C5)</td>
</tr>
<tr>
<td>Epiglottis</td>
<td>Narrow, omega-shaped, and projects above the glottic opening</td>
</tr>
<tr>
<td>Vocal cords</td>
<td>Slant anteriorly and rostrally</td>
</tr>
<tr>
<td>Narrowest part of the larynx</td>
<td>Cricoid cartilage</td>
</tr>
</tbody>
</table>

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Figure 1. Use of video laryngoscopy in a 5-month-old infant.
The laryngoscopist will start looking through the eyepiece or at the monitor as the device is advanced through the oropharynx to identify the epiglottis. Similar to laryngoscopy with a Macintosh blade, the distal end of the Airtraq is inserted into the vallecula. The Airtraq is slightly lifted with motion from side to side to obtain a centered image of the vocal cords. It is at this point that the ETT is inserted through the vocal cords; a stylet is unnecessary. Once the ETT cuff has been inflated, the ETT should be removed from the guiding channel.

The infant (size 0) and pediatric (size 1) versions of the Airtraq for oral intubation, as well as an infant size for nasal intubation, were released in early 2009. These products became available in Europe in December 2008. There are several reports demonstrating the successful use of the Airtraq in the difficult pediatric airway.17-19

GlideScope Video Laryngoscope. The GlideScope (Figure 3) was introduced for pediatric use in 2005. Since its introduction, the neonatal and pediatric VL blades have evolved through several generations. Initially, this device provided black-and-white images, and now for several years the images have been in color. The GlideScope was developed for the management of the difficult airway, but now for many users of this device it has become part of routine airway management for all ages of pediatric patients and adults.

All three types of GlideScope currently on the market accommodate pediatric-size blades. The original GlideScope system has four blades, and three of these blades for the most part have application in pediatrics. The smallest blade can be used for infants of most sizes.

The GlideScope Cobalt is a newer system that consists of a camera and light source embedded in a baton. Non-reusable plastic blades slide over the baton.20 This system has the advantage over the original system of

Table 2. Video Laryngoscopes for Pediatricsa

<table>
<thead>
<tr>
<th>Device</th>
<th>Classification</th>
<th>Patient Size</th>
<th>Manufacturer/Distributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airtraq</td>
<td>Channeled device, crossoverb</td>
<td>Infant, child, adolescent</td>
<td>Prodol/King Systems</td>
</tr>
<tr>
<td>Angulated Video-Intubation Laryngoscopyc</td>
<td>VL</td>
<td>Child, adolescent</td>
<td>Volpi</td>
</tr>
<tr>
<td>Berci-Kaplan DCI</td>
<td>VL</td>
<td>Neonate, infant</td>
<td>Karl Storz Endoscopy</td>
</tr>
<tr>
<td>GlideScope GVL, Cobalt, Ranger</td>
<td>VL</td>
<td>Neonate, infant, child, adolescent</td>
<td>Verathon Medical</td>
</tr>
<tr>
<td>McGrath Series 5</td>
<td>VL</td>
<td>Adolescentd</td>
<td>Aircraft Medical/LMA North America</td>
</tr>
<tr>
<td>Pentax AWS</td>
<td>VL, channeled device</td>
<td>Adolescentd</td>
<td>Pentax/Ambu</td>
</tr>
<tr>
<td>Truview EVO2</td>
<td>Crossoverb</td>
<td>Infant</td>
<td>Truphatek International</td>
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</tbody>
</table>

VL, video laryngoscope

a Adult devices are manufactured. b Crossover = optical laryngoscope with video capability. c Not available in the United States. d No published reports of use in pediatric patients.
well-suited blades for the preterm or neonate patient. The third system, the GlideScope Ranger, is the most versatile. The Ranger has reusable blades as well as interfaces with non-reusable blades.

The basic construction of the GlideScope is the VL blade and display monitor. The VL blade consists of a camera and light source embedded along its inferior aspect. The blade has a 60-degree angle, and with its camera provides views of the supraglottic airway and adjacent structures. The airway image is captured on a display unit that accompanies this system or with other compatible designs.

After powering on the GlideScope and opening the patient’s mouth, the VL blade is inserted midline around the base of the tongue. The laryngoscopist then advances the blade toward the vallecula, observing the progress on the display monitor. Once the vocal cords appear on the monitor, a styletted ETT (mimicking the blade angle or likened to a “hockey stick”) is advanced through the opening. At the glottic opening, the stylet is removed while further advancing the ETT through the trachea. Following this action, the VL blade is removed.

To date, there are more cases in the literature citing use of the GlideScope in pediatric patients than any other VL. The largest study of the use of the GlideScope, by Kim et al, included 203 children. The investigators concluded that the device provided a view of the larynx that was equal or superior to that of conventional laryngoscopy. They also found that the time required for intubation was greater with the GlideScope. More recently, Redel et al compared the use of the GlideScope VL to the Macintosh laryngoscope in pediatric patients. The results of their study demonstrated no difference between these laryngoscope blades with regard to intubation time or incidence of injury to the larynx in this patient population.

Berci-Kaplan Digital Coupler Interface (DCI) and C-MAC Video Laryngoscopes. The Berci-Kaplan system provides a high-resolution image with a DCI camera and cable attachment to a control unit that combines image processing, a light source, and liquid crystal display (LCD) monitor. This system has application for pediatrics. The standard Miller size 0 and size 1 are available as low-profile VL blades.

A reported case documents the successful intubation of a neonate with dysmorphic facies using a Miller size 1 VL blade. The authors describe a Cormack-Lehane grade III view with direct laryngoscopy and a significantly improved grade I view with video laryngoscopy. In a prospective, randomized clinical trial of pediatric patients aged 2-16 years, Macnair et al compared the Berci-Kaplan VL with direct laryngoscopy. The conclusion of this investigation was that better views of the airway were obtained with video laryngoscopy. They also noted that the intubation time was greater with video than direct laryngoscopy. Similar findings have been reported in a study comparing the GlideScope with direct laryngoscopy.

The C-MAC (Figure 4) is a lightweight, compact system with a small monitor compared with the Berci-Kaplan system. Despite the smaller monitor, the images are of high resolution. Currently, there are no pediatric blades available with this latest system. A Miller size 1 and Macintosh size 2 blade are scheduled to be released by the end of 2009.

Truview Infant EVO2. The Truview EVO2 is a reusable optical laryngoscope with crossover capability through a camera attachment connected to a monitor or with the Premier display unit to provide video images (Figure 5). This device contains an optical system that offers a magnified laryngeal view. A sideport on the blade for the insufflation of oxygen ensures that secretions do not obstruct the view.
As with other devices described in this article, the mouth is opened and the Truview infant blade is inserted midline. The blade is advanced under visualization while moving the tongue to the left. Advancement of the blade continues until the epiglottis becomes visible (either through the optics or on the video monitor), whereupon the laryngoscopist gently lifts the device. A styletted ETT is positioned along the side of the blade. The ETT is advanced until the tip is visualized; further advancement slightly up and to the left, toward the direction of the distal end of the blade, can follow. The ETT is inserted through the vocal cords and the stylet is removed before advancement of the tube into the trachea.

A prospective clinical study performed by Singh et al examined whether the Truview EVO2 offered an improved laryngeal view at laryngoscopy compared with a Miller blade size 0.25 The time to intubation also was examined. The investigators found that the Truview infant EVO2 blade provided an improved laryngoscopic view compared with the Miller blade.25 The difference in intubation time was not clinically significant.25

**Angulated Video-Intubation Laryngoscope.** The angulated video-intubation laryngoscope (AVIL, Volpi AG) is not yet marketed in the United States. A prospective study of 100 pediatric patients demonstrated the advantages of the AVIL when manual in-line neck stabilization was applied over direct laryngoscopy without in-line neck stabilization.26 Case reports support the advantages of the AVIL in pediatric patients with cervical spine instability over the Miller blade size 2.27 Successful intubations were performed in these patients with the AVIL when the Miller blade failed.

**McGrath Series 5 Video Laryngoscope and Pentax AWS.** Both the McGrath Series 5 Video Laryngoscope and Pentax AWS have been used quite successfully in the adult airway. However, at the present time there are no published reports that document the use of these devices in pediatric airways.

**Conclusion**

It is quite evident from the medical literature that video laryngoscopy is gaining popularity as an airway device for the pediatric patient.819,22-27 Some anesthesiologists have incorporated the use of video laryngoscopy into their routine airway management of the pediatric patient. For others, video laryngoscopy may be reserved for the difficult pediatric airway. The impact of video laryngoscopy in airway management is significant and continues to grow.

**References**