REVIEW ARTICLE

The difficult pediatric airway – a review of new devices for indirect laryngoscopy in children younger than two years of age

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Introduction

Managing a difficult airway in small children has always been a challenge. Fortunately, an unanticipated difficult airway is extremely rare in children; the history or appearance of the child almost always alerts the anesthetist to prepare for a possible difficult airway before inducing anesthesia. For years, fiber-optic-guided intubation has been the gold standard for managing difficult endotracheal intubations; however, during the last decade, several different look-around-corner or video airway devices have proven useful in clinical adult practice. Most of these devices are also useful in older children; yet, only four are available in sizes that may be used in children younger than 2 years of age: the AIRTRAQ® Disposable Optical Laryngoscope (Prodol Meditec, Vizcaya, Spain), the GlideScope® Video Laryngoscope (Verathon, Bothell, WA, USA), the Storz DCI® Video Laryngoscope (Karl Storz, Tuttlingen, Germany), and the Truview PCD™ Infant (Truphatek, Netanya, Israel). The purpose of this paper is to review these four new airway devices and their usefulness in children younger than 2 years of age. The size of the device and the mouth opening it requires determines its usefulness in the smallest infants. Training will be necessary in implementing and deciding when to use the new airway devices, although one of the big challenges of the future will be to maintain the teaching and training of fiber-optic-guided intubations, which remain the gold standard in difficult endotracheal intubations.

Keywords
infant; children; airway device; difficult airway; indirect laryngoscopy

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Summary

During the last decade, several new look-around-corner or video airway devices have proven useful in clinical adult practice. Only four of them are currently available in sizes that may be used in children younger than 2 years of age: the AIRTRAQ® Disposable Optical Laryngoscope (Prodol Meditec, Vizcaya, Spain), the GlideScope® Video Laryngoscope (Verathon, Bothell, WA, USA), the Storz DCI® Video Laryngoscope (Karl Storz, Tuttlingen, Germany), and the Truview PCD™ Infant (Truphatek, Netanya, Israel). Here, we review the literature and describe the clinical use of each device in this age-group. The four new laryngoscopes are generally effective and may solve many of the problems with difficult intubations in children younger than 2 years of age. The size of the device and the mouth opening it requires determines its usefulness in the smallest infants. Training will be necessary in implementing and deciding when to use the new airway devices, although one of the big challenges of the future will be to maintain the teaching and training of fiber-optic-guided intubations, which remain the gold standard in difficult endotracheal intubations.
which gives a 7-cm-wide picture on the 11.5-cm screen. The Airtraq comes in two pediatric sizes (Figure 1). ‘Infant’ (size 0) accommodates tube size 2.5–3.5 and ‘Pediatric’ (size 1) accommodates tube size 3.5–5.5. Both laryngoscopes need a mouth opening of 12–13 mm. The endotracheal tube may be lubricated to reduce resistance when it is advanced in the guide channel on the side of the Airtraq. During intubation, the Airtraq is gently inserted in the midline of the mouth while avoiding pressing the tongue toward the larynx. To expose the vocal cords, the tip of the Airtraq can be placed in the vallecula or, alternatively, it may be used to lift the epiglottis. When the glottis is located in the center of the view, the endotracheal tube is slowly advanced. If the endotracheal tube does not move in the right direction, the Airtraq should be repositioned, usually by lifting the device, as the tube most often will pass behind the glottis.

One case report described a Pierre Robin child, weighing 4.8 kg, who was successfully intubated using an Airtraq (1). Owing to the size of the device, its usefulness in small infants with limited space in the airway is questionable, and failures are seen in these infants when using the device (2). It has been suggested that the Airtraq be combined with a malleable stylet to direct the tube more anterior or a flexible bronchoscope to adjust the direction of the tube (3); yet, combining the Airtraq with a stylet will increase the risk of injuring the airway and is not recommended.

**Author’s experience**

We have successfully used the Airtraq in infants after failed intubation by direct laryngoscopy. It is important to lubricate the endotracheal tube, but despite this it may be difficult to determine whether resistance against advancement of the endotracheal tube is caused by the guide channel, an incorrect angle of the endotracheal tube, or a too large tube diameter. The Airtraq may be useful in infants, presuming the space required in the mouth and larynx is available. However, if the mouth opening is limited or the airway is narrow, as in infants with Pierre Robin sequence or Treacher Collins syndrome, another technique should be chosen. (2).

**The GlideScope® Video Laryngoscope, Cobalt (Verathon)**

The pediatric GlideScope is now in its third version, the GlideScope Cobalt. It has a reusable video baton and single-use laryngoscopy blades in two sizes (Figure 2). The laryngoscope provides a clear picture on the monitor screen, which is available with an optional built-in video recording unit. The most important improvement in the GlideScope Cobalt model is the availability of a 10-mm laryngoscope blade, compared to 14.5 mm in earlier models. This makes the early studies difficult to interpret, as the new design has increased its usability in infants.

The GlideScope is inserted into the mouth in the midline without displacing the tongue. Owing to the 70° angulation of the blade, it can be used only for indirect laryngoscopy. Two studies in children with normal airways found that the GlideScope provided a better view compared to direct laryngoscopy (4,5). In one of the studies, the GlideScope required longer intubation time (4). The difference in the shape of the stylet in the studies was a possible explanation for this (5). Two small case series have been published in neonates (6,7). In both series, there were two failures using the GlideScope. In the first series, the older model
(14.5-mm blade) of the Glidescope was used (6), while in the second series, the author attributed failures to insufficient experience with the device (7). So far, no case reports describing the successful use of the Glidescope in a child aged younger than 2 years with a difficult airway have been published.

**Author’s experience**

We have successfully used the Cobalt Glidescope in several infants with difficult airways. Compared to the other devices, the Glidescope Cobalt model provided a better overview of the glottis from a greater distance, which facilitated the orientating and directing of the endotracheal tube toward the glottis.

**The Storz DCI® Video Laryngoscope (Karl Storz)**

The Storz DCI Video Laryngoscope (SVL) is available with two slim Miller-like laryngoscope blades, size 0 and 1. The video laryngoscope gives a clear picture with a 14 cm diameter on the 24-cm-wide monitor screen (Tele pack; Karl Storz). The video lens is located with the light source, close to the tip of the blade, with an 80° view angle. An anti-fogging agent should be applied to the lens before use.

As the blade is straight, the view on the screen is similar to what is seen when looking directly into the mouth. The SVL may be used as a conventional Miller laryngoscope, which makes it useful in the training of direct laryngoscopy (8). It can be used in small infants with very limited mouth openings because of the small height of the blade (only 5 mm) and the distally located lens (Figure 3). The slim shape of the blade allows inserting it from the side of the mouth, like a ‘retromolar’ approach. The Miller-like shape of the blade allows the tip to be placed in the vallecula or used to lift the epiglottis during intubation. In children younger than 4 years with normal airways, the SVL provided a slightly better view compared to direct laryngoscopy (9). In a series of seven infants with difficult airways, the glottic view was improved to Cormack–Lehane grade 1–2 with the SVL and all infants were successfully intubated (10). The SVL was also successfully used after a failed intubation in a 2.1-kg pre-mature infant with micromelic dwarfism (11) and in a 9.3-kg infant with Pierre Robin sequence (12). Finally, the SVL has been tested in a series of 42 neonates weighing as little as 500 g; all were successfully intubated (8). As an interesting detail in this report, the Storz Video Laryngoscope was used without a stylet in the endotracheal tube. Instead, the endotracheal tube was coaxially inserted into the groove of the laryngo-

![Figure 3](image3.png)

**Figure 3** The Storz DCI Video Laryngoscope with laryngoscope blade size 0. The height of the blade is only 5 mm.

![Figure 4](image4.png)

**Figure 4** The Truview PCD Infant laryngoscope with the magnetic camera attached.

scope blade and advanced until it came into view on the monitor screen; it was then moved further into the trachea (8).

**Author’s experience**

We have had similar good experience with the SVL, but found it necessary to place the tip of the laryngoscope blade close to the glottis to obtain a good view. This can make it more difficult to position the endotracheal tube in front of the glottis. Inspired by the report by Vanderhal et al. (8), we applied their technique in a Pierre Robin child. After three unsuccessful attempts using a stylet in the endotracheal tube, we
removed the stylet and then slid the endotracheal tube coaxially into the groove of the laryngoscope. Thus, we were able to advance it into the trachea at the first attempt. This technique deserves further attention.

**Truview PCD™ Infant (Truphatek)**

The Truview PCD™ Infant is the latest version of a small handy laryngoscope with an eyepiece and optics providing a wide and magnified laryngeal view at a 46° anterior refracted angle (Figure 4). A small camera with a magnetic adapter can easily be attached to the eyepiece and provides a picture 7 cm in diameter on the 10-cm monitor screen (Truview PCD™ monitor; Truphatek). An adapter for oxygen insufflation serves as an anti-fogging mechanism and increases the oxygen fraction in the airway during intubation. The height of the laryngoscope blade is only 8 mm, which allows it to be used even in neonates. In a recent study, the device provided a slightly better laryngeal view compared with a standard Miller blade in 60 neonates and infants with normal airways (13). Unfortunately, no studies or case reports have yet been published showing the usefulness of this device in infants with difficult airways.

**Author’s experience**

We have used the Truview PCD Infant laryngoscope successfully a few times in our hospital in neonates with difficult airways. The option of insufflating oxygen both prevents fogging of the lens and significantly prolongs the time before desaturation occurs.

Attributes and field of view visuals of the four laryngoscopes are compared in Table 1 and Figure 5, respectively.

<table>
<thead>
<tr>
<th>Table 1 Attributes of the laryngoscopes</th>
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<tr>
<td>Airtraq</td>
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<td>Size (height) of laryngoscope blade (mm)</td>
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<tr>
<td>Field of vision when laryngoscope is in optimal position</td>
</tr>
<tr>
<td>Portability</td>
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<tr>
<td>Anti-fog mechanism</td>
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<tr>
<td>Laryngoscope can be used without a stylet in the endotracheal tube (ETT)</td>
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<tr>
<td>Can be used without camera/monitor</td>
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<tr>
<td>Disposability</td>
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<tr>
<td>Price without camera/monitor (DKK)</td>
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<tr>
<td>Price including camera/monitor (Euro)</td>
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<tr>
<td>Advantages</td>
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<tr>
<td>Disadvantages</td>
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</tbody>
</table>

aAnti-fogging is facilitated by the heat from the device’s lamp.
bAnti-fogging is facilitated by oxygen flow.
cThe device may be used without stylet, when sliding the ETT in the groove of the laryngoscope blade.
dOfficial 2010 list prices in Denmark translated into Euro (Currency rate: 100 Euro = 750 DKK).
eThe camera and monitor can be used with other equipment.
Indirect laryngoscopy

In conventional direct laryngoscopy, it may be difficult to obtain a good view of the vocal cords; it is usually easy to introduce the endotracheal tube when this view is possible. In contrast, indirect laryngoscopy often allows for a good view of the glottis, even in difficult airways. The difficult part is to direct the tube toward the glottis and between the vocal cords, which are not in the line of sight. If the endotracheal tube with the stylet is inserted ‘blind’, while looking at the screen or in the eyepiece, there is a risk of injury to the airway and even penetration of the palatal arch has been reported (14,15).

In most indirect laryngoscopy devices, it is necessary to have a malleable stylet in the endotracheal tube to shape and direct it into the correct position. Some manufacturers recommend shaping the stylet into the shape of the blade of the intubating device, but many anesthetists prefer to bend the most distal part of the stylet into a hockey stick shape with an angle of 60–80° (4,5,16) and insert it from the side of the mouth. This way, it is easier to position the endotracheal tube in front of the glottis. When the tip of the tube is positioned between the vocal cords, the stylet is retracted. This helps to advance the tube through the glottis and into the trachea.

Author’s experience

To minimize the risk of airway trauma during indirect laryngoscopy and intubation, the author proposes utilizing a four-step technique (Table 2). In narrow airways, it may be difficult or impossible to pass the endotracheal tube with the stylet to the glottis; when the endotracheal tube is advanced, it passes behind the larynx and toward the esophagus. This problem can usually be solved if the endotracheal tube with the

Table 2 The four steps in indirect laryngoscopy

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Looking in the mouth. The laryngoscope is inserted into the mouth and gently advanced toward the root of the tongue.</td>
</tr>
<tr>
<td>2</td>
<td>Looking at the screen. The position of the laryngoscope is optimized.</td>
</tr>
<tr>
<td>3</td>
<td>Looking in the mouth. The endotracheal tube with the stylet is inserted gently and placed as close to the tip of the laryngoscope as possible.</td>
</tr>
<tr>
<td>4</td>
<td>Looking at the screen. The endotracheal tube is directed toward glottis and between the vocal cords.</td>
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Figure 5 The best glottic view obtained by the four different laryngoscopes. From left to right: Airtraq, Glidescope Cobalt, Storz VL, Truvew.

Figure 6 (a) The endotracheal tube with the hockey stick-shaped stylet in position in front of the glottis. (b) Advancing it further will pass it behind the glottis. (c) If the stylet is stabilized pointing toward the glottis and the endotracheal tube advanced off the stylet, it will be directed into the glottis.
hockey stick–shaped stylet is placed in position in front of the glottis, pointed in the correct direction. With the stylet stabilized, the endotracheal tube is advanced off the stylet; it will then continue in the same direction and can be directed through the glottis and into the trachea (Figure 6). When using the SVL device, the earlier described technique, i.e. without a stylet in the endotracheal tube, should be considered.

Studies or case reports that evaluate the new airway devices in infants with difficult airways are still limited, although more will undoubtedly be published in the future. Most published reports used the Storz Video Laryngoscope in infants. In the future, more new adult airway devices will likely be marketed in versions suitable for use in infant airways.

Conclusion

The four new laryngoscopes described in this report are generally effective and will solve many problems with difficult intubations in children younger than 2 years of age. The size of the device and the mouth opening it requires determine its usefulness in the smallest infants. Nevertheless, there will still be situations in which only the flexible fiberscope will be appropriate. Although training will be needed in implementing and deciding when to use the new airway devices, teaching and training in fiber-optic-guided intubations must be maintained, as it remains the gold standard in difficult endotracheal intubations.

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Conflict of interest

The author declares no conflict of interest.

References