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Review

Videolaryngoscopy – Theory and practice

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ABSTRACT

Videolaryngosopy involves the indirect visualisation of the laryngeal inlet using a laryngscope that contains a camera or other optical device, in order to enable endotracheal intubation. Videolaryngoscopy has revolutionised airway management by helping to overcome difficulties in achieving adequate glottic visualisation via direct laryngoscopy. In doing so, videolaryngoscopy has generated its own challenges, chiefly difficulty with tube advancement into the trachea despite a well visualised laryngeal inlet. This article addresses the uses of videolaryngoscopy, the range of available videolaryngoscopes, the technique of videolaryngoscopy, use of awake videolaryngoscopy and the documentation of videolaryngoscopic intubation.

Contents

1. Role of videolaryngoscopy

The classical theory of 'three-axis alignment' proposes that direct laryngoscopy is achieved by aligning oral, pharyngeal and laryngeal axes to obtain a direct line of vision to the laryngeal inlet [1]. A more recent 'two-curve theory' proposes that direct laryngoscopy requires the alignment of primary (oro-pharyngeal) and secondary (pharyngo-glotto-tracheal) curves, which exist in continuity at the laryngeal vestibule. The laryngoscope displaces upper airway tissues to flatten both curves along the line of vision, obtaining a direct view of the glottis [2].

Videolaryngoscopes can 'look around the corner', enabling intubation without the need to align the three axes or two curves. Videolaryngoscopy is therefore of greatest use in enabling glottic visualisation when axial/curve alignment is anticipated to be difficult (e.g. retrognathia, ankylosing spondylitis), when this difficulty has arisen on direct laryngoscopy (a possibility for all patients), or when attempting alignment risks injury (e.g. with cervical spine immobilisation). Videolaryngoscopy requires less movement of the head and neck and results in less application of force than direct laryngoscopy, and can therefore reduce the likelihood of haemodynamic alterations, dental injury and cervical spine instability [3].

A videolaryngoscope can also assist with double-lumen tube placement, safe tube withdrawal during percutaneous tracheostomy, visualisation of tracheal tube exchange over an airway exchange catheter, nasogastric tube placement under anaesthesia and foreign body removal from the laryngopharynx [4].

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The images obtained on videolaryngoscopy can be viewed simultaneously by multiple clinicians and the anaesthetic assistant, allowing for real-time collaborative management of the patient's airway rather than blindly awaiting feedback from a multi-tasking direct laryngoscopist who may be experiencing task fixation and declining much needed assistance. This may be particularly evident during rapid sequence induction of the critically ill patient, where both anatomical and physiological challenges in airway management commonly arise.

Videolaryngoscopes are only beneficial in the hands of those competent in their use. The Difficult Airway Society advocates that all anaesthesiologists should have immediate access to videolaryngoscopes and be skilled in their use through regular practice [5]. The society recommends that videolaryngoscopy be considered for the intubation of all critically ill patients and as a first-line approach for those patients with an anticipated difficult airway [6]. Furthermore, a switch to videolaryngoscopy is advised if a poor view is obtained on direct laryngoscopy. Other clinicians have advocated videolaryngoscopes as first-line devices for all intubations [7]. The availability of these devices may excessively reassure the clinician that airway management will not prove difficult and lead to a lack of preparation for circumstances of failure. However, videolaryngoscopy does fail and should not compromise the preparation of a thorough airway management plan.

2. Types of videolaryngoscope

A wide variety of videolaryngoscopes are now available, varying chiefly in blade angulation and whether tube placement occurs via a channel.

Blade angulation can mirror that of a conventional laryngoscope blade, as seen with standard C-Mac Macintosh and Miller blades. These blades allow for simultaneous use of the device as a direct laryngoscope, with greater elevation of the epiglottis and less frequent use of a stylet [8]. Blade variations exist to accommodate variances in patient anatomy. For example, the McGrath X-Blade and C-Mac D-blade obtain a more steeply angulated view of the laryngeal inlet.

The Airtraq laryngoscope is strictly an optical laryngoscope, but is regarded as a videolaryngoscope for the purpose of this article. This device exists in complete single-use form or with reusable optics and disposable blades. The optical channel consists of a series of prisms and lenses that enable a view of the glottis via an eyepiece or by attaching a wireless camera. A second channel guides passage of the tracheal tube. Along with lubrication, selection of a smaller tracheal tube diameter allows for easier advancement through the channel. An Airtraq designed to facilitate nasal intubation is also available, whereby the posterior wall of the channel has been removed to accommodate tube advancement, essentially acting as an unchanneled device. Other devices, such as the King Vision, have both channeled and unchanneled configurations.

Failure to intubate with one type of videolaryngoscope does not mean that failure will arise with another. For example, switching from an unchanneled to a channeled device, or vice versa, or selecting a different blade angulation, may prove beneficial. A key determinant of success is the experience of the clinician with the specific laryngoscope being used and their appreciation of the specific anatomical challenges offered by the patient's airway.

A videolaryngoscope may exist as a self-contained device, such as the Airtraq, Pentax and McGrath, or require connection to a separate monitor, such as the C-Mac and Glidescope.

No videolaryngoscope has demonstrated clear superiority over others. The optimal device likely varies based on the difficulty at hand. For example, failure to visualize the glottis with direct laryngoscopy may benefit from use of a videolaryngoscope with a hyperangulated blade, whilst a Macintosh-like blade may be more appropriate for training or routine use [9].

3. Videolaryngoscopy technique

Levitan divides tracheal intubation via videolaryngoscopy into three stages- 1. Laryngeal exposure; 2. Delivery of the tracheal tube to the glottic opening; and 3. Advancement of the tube into the trachea [10].

During direct laryngoscopy, the tongue is swept to the left and the tube is inserted from the right corner of the mouth so that the direct view of the glottis is not eliminated during its advancement. However, a videolaryngoscope is typically inserted in the midline to obtain a view in the median plane as there is no direct line of vision to conserve.

Occasionally, difficulty with device insertion is encountered because of patient anatomy. Limited mouth opening can render certain devices unsuitable or make videolaryngoscopy impossible. Challenging chest anatomy (obesity, large breasts, short neck) may be overcome by rotating the laryngoscope handle ninety degrees to the right for insertion, or for those devices with disposible blades, by inserting the laryngoscope blade into the mouth prior to attaching it to the handle [11].

Following insertion, the view can be obscured by failure of the light mechanism, secretions, vomitus or blood, which may require use of suction or removal of the laryngoscope for cleaning or exchange for another device. Whether the tip of the laryngoscope is placed in the vallecula or posterior to the epiglottis varies based on manufacturer guidance and clinician preference.

Once the larynx has been visualised, the tracheal tube must be advanced to the glottic aperture. With an unchanneled videolaryngoscope, the tracheal tube must be independently navigated past the upper airway structures. Occasionally, a crowded upper airway, such as tongue protrusion on the right side of the videolaryngoscope or patient pathology, can make passage through the pharynx difficult. Failure to inspect the pharynx during insertion of the videolaryngoscope, or to focus solely on the video monitor during tracheal tube advancement, creates blind spots in airway management. The likelihood of airway trauma, chiefly tonsillar pillar or palatal injury, is reduced by insertion of both the device and tracheal tube into the mouth under direct vision, though the tracheal tube will still disappear briefly from view before entering the visual field of the videolaryngoscope [12]. The mild pre-formed curvature of the tracheal tube can mean that the tip of the tube is not directed sufficiently anterior to enable passage towards the glottic aperture. Instead, it may collide on the arytenoid cartilages or pass towards the oesophagus. Therefore, the tube is commonly styletted to mirror the angulation of the laryngoscope blade, creating a 'hockey stick' appearance. Some videolaryngoscopes have dedicated stylets to aid sculpting of the tube, such as the GlideRite stylet for the Glidescope. Alternatively, any malleable stylet can be used. Other commonly used aids include a bougie and flexible fibre-optic scope.

Channelled laryngoscopes contain a conduit for the tracheal tube, which allows for easy bypass of upper airway structures and avoids the need for a stylet. However, bridging the gap between the end of the channel and the laryngeal inlet can prove challenging as the tube can still abut the arytenoid cartilages or the vocal folds. As the channel has a fixed course on the device, the entire device is manipulated in order to shift the image and re-align the trajectory of the tube with the target. Additional measures to aid intubation can include the advancement of a pre-loaded bougie through the tracheal tube or passage of a flexible fibre-optic scope through the

channel [13].

Further obstruction to tube passage can arise in the trachea. The anterior trajectory of the tracheal tube can lead to collision with the tracheal rings and anterior tracheal wall, which is passing in a posterior direction. This is most likely to arise with a steeply-angulated, and typically styletted, tracheal tube. Tube advancement is assisted by partial withdrawal of the stylet to soften the distal end, and clockwise tube rotation to disengage the tip from the tracheal rings [14]. 'Reverse loading' involves placing a tracheal tube on a stylet in the direction opposite to its pre-formed curve. The stylet is sculpted to direct the tube anteriorly as per usual, but the tube subsequently bends posteriorly down the trachea when offloaded from the stylet given its inherent memory [15]. Tracheal tubes with flexible, tapered distal tips that are less likely to meet resistance against tracheal rings are available for video-laryngoscopy, such as the Parker Flex-Tip tracheal tube [16].

An excessive depth of insertion of the videolaryngoscope, in an effort to obtain a complete view of the glottis, is a leading cause of failure to advance the tube. The laryngeal inlet is lifted anteriorly, the view obtained is less panoramic and the tube must be more steeply angulated. Partial withdrawal of the videolaryngoscope shifts the larynx to the upper half of the image and can result in an incomplete view but an overall more favourable path for intubation [17].

External laryngeal manipulation can also aid intubation success, and unlike direct laryngoscopy, the assistant themselves is able to visualize the effects of their intervention in real-time.

Finally, central to all aspects of airway management is patient oxygenation, which has historically involved intermittent bag-mask ventilation between laryngoscopy attempts. The use of apnoeic oxygenation with low-flow or high-flow nasal cannulae can extend the time to desaturation and allow for less hurried videolaryngoscopy, particularly when upper airway patency is confirmed by visualisation of the vocal cords but tube navigation is proving difficult.

4. Awake videolaryngoscopy

Awake videolaryngoscopy is a modern alternative approach to the use of a fibre-optic scope for awake intubation, and has been reported with both channeled and unchanneled devices [18].

Effective airway topicalisation and sedation are central to success. 'Spray-as-you-go' topicalisation with lidocaine is commonly performed with progressive advancement of the videolaryngoscope to suppress airway reflexes. Awake videolaryngoscopy that is only briefly tolerated may still attain a view of the laryngeal inlet that informs the anaesthesiologist's decision making, such as the necessity of an awake intubation based on observed pathology at the laryngeal inlet.

Awake videolaryngoscopy can be performed in the 'face-to-face' position, whereby the patient sits upright with the clinician in front of them, advancing the laryngoscope with the handle facing downwards. This is known as a tomahawk intubation, and is of greatest benefit for those patients that are intolerant of a supine position, such as a dynamic airway obstruction.

A videolaryngoscope may be more effective than a fibre-optic scope at displacing tissues and maintaining a view when there is a large secretion burden. It can also prove beneficial for a severely narrowed airway that risks occlusion with a fibre-optic scope or requires a smaller diameter tracheal tube [19]. However, awake videolaryngoscopy is reliant on a greater degree of mouth opening than awake fibre-optic intubation. Additionally, laryngoscope insertion may be impeded by chest wall anatomy, such as a fixed flexion deformity. Insertion of a videolaryngoscope can cause tissue trauma, particularly if airway anatomy is abnormal, which could further compromise an already jeopardised airway.

5. Documentation

The Cormac and Lehane grading system is universally understood amongst anaesthesiologists. Strictly speaking, it describes the view of the glottis obtained during direct laryngoscopy, which reflects the ease of intubation. This grading system is not an appropriate descriptor for videolaryngoscopy as axial alignment is not attempted, and the glottic view obtained is less reflective of the likelihood of successful intubation.

A number of approaches to documentation have been proposed, such as the percentage of glottic opening (POGO), Fremantle score and Intubation Difficulty Scale [20]. The anaesthesiologist should thoroughly document all aspects of videolaryngoscopic intubation, to include:

- Device type and size
- Tube type and size
- Extent to which laryngeal inlet was visualised e.g. approximated percentage of glottic opening, or full/partial/none (Fremantle score)
- Use of adjuncts such as stylet, bougie or fibre-optic scope
- Number of attempts
- Name of Operator(s)
- Subjective assessment following intubation – easy, moderate, difficult
- Additional relevant commentary e.g. subsequent view on direct laryngoscopy, complications

Some videolaryngoscopes have capacity to record the intubation, which can be saved for future review, and potentially linked with a patient's electronic record.

6. Conclusion

Videolaryngoscopy is a core skill for the anaesthesiologist and features prominently in airway management guidelines. The relevant skills need to be attained with a variety of devices in elective scenarios such that they can be optimally utilized during an airway crisis.

Areas for future research include the universal application of videolaryngoscopy, assessment of the combined benefit of apnoeic oxygenation with high-flow nasal cannulae and videolaryngoscopy, comparative studies on the use of awake videolaryngoscopy and awake fibreoptic intubation, and incorporation of video-laryngoscopy into an electronic patient record.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tacc.2019.05.001.

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