Direct and Video Laryngoscopy Using the McGrath MAC Enhanced Direct Laryngoscope

Direct laryngoscopy remains the most common technique for tracheal intubation, and has been considered the gold standard for decades. It creates a straight line of visualization from the mouth to the larynx by flexion of the neck and extension of the head. With the introduction of video laryngoscopy in 2002, clinicians are able to use a video camera along the laryngoscope blade that transmits images to an external monitor, allowing the clinician to intubate while visualizing the airway anatomy in real time on screen instead of looking directly into the mouth of a patient.

Among the video laryngoscopes currently available, the McGrath® MAC enhanced direct laryngoscope (EDL) offers clinicians a multipurpose device that can be used for both direct and video laryngoscopy, and can be employed for both routine cases and difficult airways. The McGrath MAC EDL provides enhanced direct laryngoscopy, eliminating the “tunnel vision” of direct laryngoscopes without requiring multiple devices. Its anterior camera angle facilitates an improved grade of view and provides a direct route for endotracheal tube (ETT) placement. This monograph provides an overview of clinical airway management with a focus on enhanced direct laryngoscopy using the McGrath MAC EDL.

Management of the Difficult Airway

The American Society of Anesthesiologists (ASA) released a practice guideline on the management of the difficult airway to not only provide direction on effective airway management, but also to reduce the potential for adverse events (AEs). Although there is no universally accepted standard definition, the ASA guideline defines a difficult airway as a “clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both.”

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The guideline emphasized the importance of airway evaluation before any intervention, when possible. This evaluation may assist clinicians in detecting medical, surgical, and/or anesthetic factors predictive of a difficult airway. If available, the assessment of previous anesthetic records also may be an effective tool for identifying prior airway management concerns. Conducting a physical examination also is recommended, with the purpose of detecting patient characteristics that may indicate a difficult airway. Table 1 summarizes potential findings on physical examination that may suggest the presence of a difficult airway.

ASA Recommendation Regarding Video Laryngoscopy

In February 2013, the ASA updated the guidelines recommending the use of non-invasive techniques when intubating a difficult airway. Most notably, the guideline recommendations included the use of video laryngoscopy for initial intubation in difficult airways as a measure to ensure a higher rate of successful intubations on the first attempt. The availability of a single device that allows the clinician to move from one technique to another may potentially be in line with the ASA recommendation.

The ASA guidelines featured a meta-analysis comparing video laryngoscopy with direct laryngoscopy using the view of the glottis, intubation time, and first-attempt intubation. The results showed that the use of video laryngoscopy led to improved glottic views and higher frequency of first-attempt intubations.

First-Attempt Success

Success on the first attempt often is promoted as a goal during intubation, even and perhaps especially among patients with a difficult airway. Repeated intubation attempts can be associated with an accelerated rate of AEs including hypoxemia, esophageal intubation, regurgitation, aspiration, bradycardia, and cardiac arrest (Figure 1). In a retrospective analysis of prospectively collected continuous quality improvement data involving orotracheal intubations over a 4-year period, Sakles and colleagues found an increase in the incidence of one or more AEs with repeated intubation attempts. An incidence of 14.2% was reported if the initial attempt to intubate was successful; this increased to 47.2% in cases requiring 2 attempts, 63.6% for 3 attempts, and 70.6% for 4 or more attempts. Similar results were observed in an analysis of a multicenter prospective registry of 11 Japanese emergency departments between April 2010 and September 2011. Hasegawa and colleagues reported an increased AE rate among patients who required at least 3 intubation attempts compared with those undergoing no more than 2 attempts (35% vs 9%). Major AEs that occurred more frequently in the group with 3 or more attempts included esophageal intubation with delayed recognition (17% vs 3%), regurgitation (5% vs 1%), and hypoxemia and cardiac arrest (2% vs <1%, respectively).

Although it remains the most common technique for intubation, the success rate of direct laryngoscopy declines with repeated intubation attempts. In a study conducted at

Table 1. Components of the Airway Physical Examination and Associated Potential Negative Findings

<table>
<thead>
<tr>
<th>Airway Examination Component</th>
<th>Potential Negative Finding</th>
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<tbody>
<tr>
<td>Upper incisor length</td>
<td>Relatively long</td>
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<tr>
<td>Relation of maxillary and mandibular incisors during normal jaw closure</td>
<td>Prominent overbite</td>
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<tr>
<td>Relation of maxillary and mandibular incisors during voluntary protrusion of mandible</td>
<td>Cannot bring mandibular incisors anterior to maxillary incisors</td>
</tr>
<tr>
<td>Interincisor distance</td>
<td>&lt;3 cm</td>
</tr>
<tr>
<td>Uvula visibility</td>
<td>Uvula is not visible when tongue is protruded and the patient is in a sitting position</td>
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<tr>
<td>Palate shape</td>
<td>Either extremely narrow or highly arched</td>
</tr>
<tr>
<td>Mandibular space compliance</td>
<td>Stiff, nonresilient, hardened, or occupied by mass</td>
</tr>
<tr>
<td>Thyromental distance</td>
<td>&lt;3 ordinary finger breadths</td>
</tr>
<tr>
<td>Neck length</td>
<td>Short</td>
</tr>
<tr>
<td>Neck thickness</td>
<td>Thick</td>
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<tr>
<td>Head and neck range of motion</td>
<td>Inability of the patient to touch the tip of the chin to the chest or inability to extend the neck</td>
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Hartford Hospital from September 1990 to July 2000, Mort reported an initial intubation success rate of 68% with conventional laryngoscopy; 10% of patients required 3 or more attempts for successful intubation.15

**Comparing Direct and Video Laryngoscopy**

The advent of video laryngoscopy offered several advantages over direct laryngoscopy, including not requiring a straight line of sight for intubation because the camera or viewing optics can be mounted distally on the laryngoscope and achieve a viewing angle superior to the direct line of sight. Also, the clinician can observe the procedure via an external monitor affording a more detailed view of airway structures for simultaneous viewing by others assisting in airway manipulation procedures.3 Additionally, the magnification and illumination of the airway allow the clinician to watch the ETT pass through the vocal cords in real time.3 Some video laryngoscopes have an exaggerated blade angulation that enables the clinician to view structures that normally would be difficult or impossible to see with direct laryngoscopy. Video laryngoscopy also enhances teamwork during intubation, thus offering opportunities to educate others not only in visualizing the anatomy, but also guiding and offering assistance during intubation.3

**Clinical Evidence**

Multiple studies have compared video laryngoscopy to direct laryngoscopy for tracheal intubation. In 2011, Su and colleagues published a meta-analysis involving 1,196 patients from 11 randomized trials to evaluate time to intubation, success rate of intubation, and quality of the view of the glottis.3,9,17-20,22-24 Of the 11 trials, 9 evaluated glottis view, and significantly improved views were observed with video laryngoscopy compared with direct laryngoscopy in 8 of the 9 trials.7,9,17-20,22-24 Although the definition of failed intubation varied across trials, an assessment of successful intubation rates revealed a nearly 100% success rate for both video and direct laryngoscopy—the pooled ratio was 1.0 (95% confidence interval [CI], 0.99-1.01; P=0.608).17 Similarly, time to intubation was comparable for both groups; pooled time to intubation using standardized mean difference was 0.26 (95% CI, -0.27 to 0.78; P=0.341).17 The results of a subgroup analysis revealed that difficult intubation was the only factor that significantly affected time to intubation.17 Video laryngoscopy was associated with a reduced time to intubation among those patients with a difficult airway.17 The authors concluded that video laryngoscopy was a good alternative to direct laryngoscopy and may provide added benefit in difficult intubation settings.17

Comparisons of video and direct laryngoscopy for intubation also have been conducted in specific patient populations, those with predicted difficult airway, in the operating room, and in the emergency department.5,13,25-27 In a pilot, parallel arm trial, Griesdale and colleagues randomized 40 critically ill patients requiring endotracheal intubation to either video (n=20) or direct laryngoscopy (n=20).25 The primary goal was to collect data for a larger randomized controlled trial (RCT) in the future; however, secondary goals included comparing both procedures with regard to the view of the glottis, time to intubation, and complications.25 Video laryngoscopy was associated with a significant improvement in glottic visualization compared with direct laryngoscopy (17 [85%] patients vs 6 [30%] patients with a Cormack-Lehane grade 1 view; P<0.001).25 The median time for successful intubation was comparable between groups; 221 seconds (range 103-291 seconds) for video

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**Figure 1.** Complications associated with intubation attempts.

laryngoscopy and 156 seconds (range 67-220 seconds) for direct laryngoscopy ($P=0.15$). The overall number of intubation attempts also was similar between groups with the number of patients successfully intubated after 2 attempts reported as 12 in the video laryngoscopy group versus 13 in the direct laryngoscopy group. Duration of intubation, the number of patients requiring a tracheostomy, and ICU and hospital mortality rates did not differ between the groups. The authors concluded that video laryngoscopy resulted in improved glottic visualization in this small population of critically ill patients; however, this did not translate into improvement in clinical outcomes.

In a 2-arm, single-blind, RCT involving 300 patients with predicted difficult airway, Aziz and colleagues compared the effectiveness of video (n=149) versus direct laryngoscopy (n=147). Enrolled patients had to have at least 1 of 4 predictors of difficult intubation. The primary outcome measure was successful intubation on the first attempt. Results revealed a significantly higher initial intubation attempt success rate for video laryngoscopy than for direct laryngoscopy (93% vs 84%; $P=0.026$). The investigators concluded that video laryngoscopy results in a significantly higher proportion of first-attempt intubation success among patients with factors predictive of difficult airway compared with direct laryngoscopy.

In a prospective, multicenter trial involving 867 adult patients undergoing elective surgery requiring general anesthesia and routine tracheal intubation, Kaplan and colleagues compared direct and video laryngoscopy. Results revealed an overall improvement in glottic visualization with video laryngoscopy compared with direct laryngoscopy using a modified Cormack-Lehane score ($P<0.001$). Additionally, the view of the glottis was classified as "easy" with direct laryngoscopy but "difficult" with video laryngoscopy in only 7 patients. In contrast, the view was considered "difficult" in 101 patients during direct laryngoscopy but "easy" with video laryngoscopy ($P<0.001$).

Similar results were seen in a prospective randomized trial involving 120 patients scheduled for elective minor surgery who required endotracheal intubation and presented with at least 1 difficult airway predictor. In this study, 2 different video laryngoscopes were found to result in significantly improved glottic visualization compared with direct laryngoscopy ($P<0.001$). The median time to achieve "best laryngeal view" was comparable among the 3 devices; however, intubation failure rate was higher with direct laryngoscopy (10%) compared with the 2 video laryngoscopes (2.5% for both).

Sakles and colleagues compared video to direct laryngoscopy through a retrospective analysis of prospectively obtained data involving 750 intubations (255 video; 495 direct) over a 28-month period. The primary outcome was successful intubation while secondary outcomes included first-attempt intubation and immediately recognized esophageal intubations. An increased proportion of patients experienced successful intubation with video laryngoscopy (97.3%; 95% CI, 94.4-98.9) compared with direct laryngoscopy (84.4%; 95% CI, 81-87.5). Video laryngoscopy was associated with first-attempt success in 79.2% (202/255) of patients (95% CI, 73.7-84) and direct laryngoscope intubations were successful on the first attempt in 73.1% (362/495) of patients (95% CI, 69-77). Among patients with one or more difficult airway characteristics, video laryngoscopy was associated with an improvement in successful intubation (98.4%; 95% CI, 92.3-98.7) compared with direct laryngoscopy (81.5%; 95% CI, 76.5-85.9). An increase in immediately recognized esophageal intubation was observed with direct laryngoscopy (4.8%; 95% CI, 3.1-7.1) versus video laryngoscopy (1.6%; 95% CI, 0.4-4.0). Overall, a greater proportion of successful intubations occurred with video laryngoscopy among patients needing urgent intubation.

Enhanced direct laryngoscopy combines the advantages of video laryngoscopy with the familiarity of direct laryngoscopy, and can be used for both routine and difficult airways. Clinicians would not need to switch from a conventional direct laryngoscope to a separate video laryngoscope, or vice versa, if needed when using the McGRATH MAC EDL (Figure 2).

The McGRATH MAC EDL is based on the original McGRATH Enhanced Direct Laryngoscopy

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The McGRATH MAC EDL is based on the original McGRATH
Unanticipated Difficult Intubation

Michael S. Higgins, MD, MPH

A 48-year-old woman presented for mastoidectomy and tympanoplasty of the right ear. The patient’s medical history was significant for obesity (BMI 34 kg/m²) and hypertension. Her only previous surgical procedure was the extraction of wisdom teeth 30 years before, which was uneventful. Her review of systems was unremarkable. Her airway exam was normal, revealing a good oral opening (>5 cm), oropharyngeal class II, approximately 3 cm thyromental distance, and adequate neck flexion and extension. The plan was for general endotracheal anesthesia with routine monitoring. Anesthesia was induced with fentanyl and propofol with lidocaine. After adequate mask ventilation was established, muscle relaxation was achieved with vecuronium bromide (0.8 mg/kg). Direct laryngoscopy was performed with a Macintosh #3 blade, but yielded visualization of the epiglottis (Figure 3). Repeat laryngoscopy using a Miller #3 blade with successful control of the epiglottis failed to allow visualization of any glottic structures. Attempted blind passage of a bougie was unsuccessful, during which the patient desaturated to 83% with improvement to only 92% with moderately difficult mask passage of a laryngoscope. A topical anesthetic was then administered, and after a prolonged amount of time for setup, direct laryngoscopy was attempted with the Macintosh #3 blade. Attempts at intubation resulted in poor visualization. The patient desaturated to 83% during one such attempt with the Macintosh #3 blade. When this proved unsuccessful, a Miller #3 blade and a Macintosh #3 blade were used with the same result. A Miller #2 blade and X blade™ were also unsuccessful, during which the patient desaturated to 83%. A Macintosh #4 blade was attempted without success during which the patient desaturated to 83%. A Miller #2 blade was then used, and with multiple attempts, a Miller #2 blade with the laryngoscope was used successfully. Anesthesia was maintained with sevoflurane, and the patient was successfully intubated. A review of the patient’s airway and oral cavity revealed a normal oral opening, with adequate neck extension and flexion, and no evidence of any glottic structures. The patient was transferred to the operating room for surgery. The surgery was uneventful, and the patient was transferred to the recovery room without complications. Her postoperative course was uneventful, and she was discharged home on postoperative day 1 without complications.

The McGRATH MAC EDL uses a standard curved Macintosh blade.3,28 Therefore, for most clinicians, no additional training may be required.28 This feature may provide an easier transition for clinicians due to its similarity to conventional direct laryngoscopy, and it would be especially valuable to operators who rarely use video laryngoscopy in practice. The combination of direct and video laryngoscopy capabilities also may be useful for educating novice intubators on both techniques. There is a potential for lower overall costs with the McGRATH MAC EDL.28

Recently, a new slimmer blade designed for particularly challenging airways was developed for the McGRATH MAC EDL.31 The X blade™ extends the blade range and clinical application of the device beyond routine and moderately difficult airways where clinicians may benefit having a more acute anterior curvature and slimmer blade profile.31

**Conclusion**

Enhanced direct laryngoscopy provides clinicians with a unique option for endotracheal intubation. Not only does the McGRATH MAC EDL allow for conventional direct laryngoscopy if desired, but the device has the capability to aid successful intubation via video laryngoscopy as well. This dual mechanism permits the operator to choose the most appropriate technique for both routine and difficult airways with a single device. Having this option may help improve first attempt success and reduce intubation-related complications.

**Figure 3.** The laryngoscopist’s view of the epiglottis during the first direct laryngoscopy attempt with the Macintosh #3 blade.
ventilation despite placement of an oral airway. The McGrath MAC video laryngoscope with #3 blade was used and revealed a grade II glottic view on the video screen with a small abrasion noted on the right arytenoid region. A stiletted 7.0 standard ETT was successfully placed with confirmation by end-tidal carbon dioxide detection and auscultation of breath sounds bilaterally (Figure 4). The anesthetic course was smooth and the patient was extubated uneventfully at the conclusion of the procedure. Postoperatively, the patient reported a moderate sore throat, but no hoarseness was observed.

**Conclusion**

At the present time, airway examination and prior laryngoscopy history are imperfect predictors of difficult direct laryngoscopy. For this reason, unanticipated difficult laryngoscopy is encountered relatively frequently in anesthesia practice and can be associated with significant morbidity. In the recently updated ASA Practice Guideline for Management of the Difficult Airway, a meta-analysis of studies comparing video-assisted laryngoscopy with direct laryngoscopy in patients with difficult airways reported a higher intubation success rate with video-assisted laryngoscopy. The risk for airway injury increases with the number of laryngoscopy attempts, so it stands to reason that video-assisted laryngoscopy will not only be associated with a higher success rate, but also a lower incidence of complications. For example, had the McGrath MAC EDL been used for the initial laryngoscopy attempt in this patient it may have been possible to avoid damage to the laryngeal soft tissues and the patient’s resulting sore throat. Finally, had the McGrath MAC EDL been used for the initial attempt, we could have avoided the additional expense associated with the use of the disposable Macintosh and Miller blades.

**Case Study 2**

**Anticipated Difficult Intubation**

*James DuCanto, MD*

A 79-year-old woman presented for left total hip arthroplasty under general anesthesia. The patient was classified as having ASA physical status 3, with a past medical history of stable atherosclerotic coronary artery disease, severe osteoarthritis, essential hypertension, and diabetes mellitus managed with oral hypoglycemic therapy.

The preoperative anesthetic interview revealed a thin, calm elderly woman in no acute distress, a normal heart rate and rhythm and without murmurs, and lung sounds clear to auscultation bilaterally. The following abnormalities were noted on her airway exam: Mallampatti class 3, interincisor gap 1.8 cm (full set of teeth upper and lower), head and neck flexion-extension 80 degrees, and thyromental distance 6.5 cm. Based on this preoperative evaluation, the patient was classified as a recognized difficult intubation, and specific preparations were made to ensure safe management of her airway.

The plan for the administration of the anesthetic coupled with airway management were to initially approach the patient...
with a period of thorough pre-induction preoxygenation and nitrogen washout, followed by rapid sequence induction and tracheal intubation with the McGRATH MAC EDL fitted with a size 3 disposable blade. Alternative plans for airway management included insertion of an intubating supraglottic airway in the event of failed video laryngoscopy, with intubation either through the supraglottic airway or oral fiberoptic intubation following emergence from the anesthetic.

Preoxygenation was performed with a resuscitator unit in the automatic mode (20 cm H2O pressure release) to provide a bilevel positive airway pressure-type ventilatory support, and accelerate nitrogen washout. After achieving an end-tidal oxygen concentration of 88% as indicated by the anesthesia gas analyzer, the patient was induced with propofol 1.5 mg/kg followed by succinylcholine 80 mg when loss of consciousness was confirmed.

Insertion of the McGRATH MAC EDL with size 3 blade was performed gently from the right corner of the mouth, sweeping the tongue leftward while tilting the laryngoscope cephalad, allowing the tip of the blade to be placed into the vallecula. Posterior pharyngeal structures were identified using the McGRATH MAC EDL as a direct line-of-sight laryngoscope (uvula, palatoglossal arches, and the tip of the epiglottis), revealing the patient’s airway to be a grade 3 visualization on the Cormack and Lehane scale by direct laryngoscopy.

On the video display, the McGRATH MAC EDL revealed a Cormack and Lehane grade 2B view of the larynx, which improved to a grade 2A with minor adjustments of the lifting angle on the laryngoscope (Figure 5). A 15 French bougie pre-loaded with a 7.0 ETT was inserted from the right corner of the mouth while visualizing its passage by direct laryngoscopy beyond the right palatoglossal arch and around the base of the tongue. A quick switch in visual reference by the endoscopist from direct to video laryngoscopy was performed to easily pass the bougie over the posterior commissure of the larynx and into the trachea on the first attempt. The ETT was advanced over the bougie and into the trachea with video guidance. Following capnographic confirmation of ETT position and bilateral equal breath sounds on auscultation, the ETT was secured at 21 cm with tape at the corner of the right lip (Figure 6).

Conclusion
Following airway management, the patient was positioned in the right lateral decubitus position for the procedure. The procedure was uncomplicated and the patient was awakened and extubated at the conclusion of the surgical procedure.

References


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