Review Article

Videolaryngoscopes for placement of double lumen tubes: Is it time to say goodbye to direct view?

ABSTRACT

The advances in thoracic procedures require optimum lung separation to provide adequate room for surgical access. This can be achieved using either a double-lumen tube (DLT) or a bronchial blocker (BB). Most thoracic anesthesiologists prefer the use of DLT. However, lung separation in patients with potential difficult airway can be achieved using either BB through a single lumen tube or placement of a DLT over a tube exchanger or a fiberoptic bronchoscope. Numerous videolaryngoscopes (VL) have been introduced offering both optical and video options to visualize the glottis. Many studies reported improved glottis visualization and easier DLT intubation in patients with normal and potential difficult airway. However, these studies have a wide diversity of outcomes, which may be attributed to the differences in their designs and the prior experience of the operators in using the different devices. In the present review, we present the main outcomes of the available publications, which have addressed the use of VL-guided DLT intubation. Currently, there is enough evidence supporting using VL for DLT intubation in patients with predicted and unanticipated difficult airway. In conclusion, the use of VL could offer an effective method of DLT placement for lung separation in patients with the potential difficult airway.

Key words: Channeled videolaryngoscopes; double lumen tube; GlideScope®; McGrath®; videolaryngoscopes; video-stylets

Introduction

Several regional surveys among thoracic anesthesiologists showed that the double-lumen endobronchial tubes (DLT) is still the first choice for lung separation technique during thoracic procedures.[1-3]

Difficulty in tracheal intubation, mainly secondary to an insufficient laryngoscopic view is still a major problem that could be potentially associated with increased morbidity and mortality. The recent American Society of Anesthesiologists guidelines for the management of the difficult airway suggest the use of videolaryngoscopes (VL) as a choice for tracheal intubation in the nonemergent pathway where ventilation is adequate.[4] VL offer an effective tool for tracheal intubation in patients with predicted and unpredicted difficult airway.

Currently, several different classes of VL are available including traditional modifications of the angulated-blade conventional laryngoscopes, channeled VL, and video-stylets, but the efficacies are likely to be different between these devices.

Videolaryngoscope provides superior glottis view and easier tracheal intubation, despite that an improved view...
of the glottis does not always translate into easier tracheal intubation.

In addition, compared with direct laryngoscopy using the Macintosh laryngoscope, the use of VL took a longer time to tracheal intubation that can be explained by the variable learning curves of the practitioners.\[^5,6\]

Videolaryngoscope provides new merits for lung separation enabling the use of DLT particularly, in patients with potential difficult airway instead of using a bronchial blocker through a single lumen tracheal tube (SLT).\[^7,8\]

**Methods of Search Strategy**

In the present review, we screened published articles evaluating the use of various VL for placement of the DLT including the addressed outcomes, with the help of two independent expert librarians familiar with the literature search.

We searched the literature databases PubMed-MEDLINE (1950 to May 15, 2015). The search used the Medical Subject Heading keywords “VL,” “DLT,” “GlideScope\(^*\),” “McGrath,” “C-MAC,” “STORZ C-MAC,” “Channeled VL,” “Airtraq\(^*\),” “Pentax Airway Scope\(^*\),” “King Vision\(^*\),” “video-styles,” “OptiScope\(^*\),” “Trachway\(^*\),” and “outcomes.” A citation search by manual review of references from primary articles also was performed.

**Results**

Several studies and case reports have addressed the use of different types of the available VL for placement of the DLT.

We recruited 33 publications demonstrating the use of different VL for placement of DLT\[^5,7,9-41\].

Table 1-4 show the design, arms (when applicable), and prior operators experience in using the studied devices for placement of the DLT and end-points, as well as the main outcomes.

In this review, we presented the current practice in using each of the studied devices for placement of a DLT.

**Angulated blades videolaryngoscope**

GlideScope\(^*\)

John A. Pacey, a Canadian surgeon, has introduced the use of the embedded a miniature video chip into a modified Macintosh laryngoscope in 2001 “the GlideScope\(^*\)” (GVL, Verathon).\[^12\]

The GlideScope\(^*\) tended to be one of the most extensively studied VL for placement both of the SLT and DLT.

It has been designed for patients from preterm to morbidly obese through wide varieties of reusable and single-use blades such as the GlideScope\(^*\) titanium, GlideScope\(^*\) AVL, and GlideScope\(^*\) ranger. Whereas, the oldest GlideScope\(^*\) GVL has

| Table 1: Studies included the use of GlideScope\(^*\) for double lumen tube placement |
|-----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Reference                        | Study           | Arms            | Operators experience | End points                  | Outcomes                      |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Hsu et al. (2014)\[^9\]           | Randomized Prospective Blind? Powered | Tracheal orifice-covered \(n = 33\) Tracheal orifice-exposed \(n = 33\) Patients with normal airway | >300 times | Time to intubation Other outcomes Hemodynamic responses Sore throat Hoarseness of voice | Shorter time to intubation by 8 sec, \(p = 0.0001\) and less frequent sore throat and hoarseness with concealing the tracheal lumen |
| Gamez and Slinger (2014)\[^10\]    | Randomized Prospective Blind? Powered | Placement over an airway exchange catheter using a GlideScope\(^*\) Rusch Mallinckrodt Fuji-Phycon 17 participants Simulation study | 5-15 times or greater | Time to intubation Other outcomes Difficult intubation score Failure rate | Shortest time to intubation by approximately 20 sec, \(p < 0.01\) and easiest to use with using the Fuji-Phycon |
| Russell et al. (2013)\[^5\]       | Randomized Prospective Controlled Powered | Macintosh \(n = 35\) GlideScope\(^*\) \(n = 35\) Patients with normal airway | 3-6 times | Time to intubation Other outcomes Success rate Difficult intubation score Voice changes | Longer time to intubation by 38 sec, \(p = 0.0013\), more difficult to use and associated with more frequent voice changes with using the GlideScope\(^*\) Comparable rate of success at the first attempt |
| Hsu et al. (2012)\[^11\]          | Randomized Prospective Controlled Powered | Macintosh \(n = 30\) GlideScope\(^*\) \(n = 30\) Patients with normal airway | >300 times | Time to intubation Other outcomes Success of the 1st attempt Sore throat | Shorter time to intubation by 17 sec, \(p = 0.007\), and less frequent Sore throat with using the GlideScope\(^*\) Comparable the success of the first attempt |
only reusable blades [Figure 1a]. The GlideScope® has a color display monitor with the anti-reflective screen, high-resolution camera, anti-fog feature, and unique 60° blade angulation. In addition, the newly introduced the GlideScope® titanium has Mac-style blades size 3 and 4 for a traditional feel [Table 5].

The GlideScope® may be used to indirectly or directly elevate the epiglottis to expose the glottis exerting a lifting force of approximately 0.5-1.5 kg. Then tracheal intubation requires the use of either a GlideRite® rigid stylet (266 mm in length that is designed for use in SLT 6.0 mm and larger), a preshaped

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Table 2: Studies included the use of the McGrath® for double lumen tube placement

| Reference          | Study                  | Arms                                      | Operators experience | End points                                                                 | Outcomes                                                                 |
|--------------------|------------------------|-------------------------------------------|----------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Yao et al. (2015)  | Randomized Prospective | Macintosh (n = 48)                        | Experts              | Time to intubation                                                         | The use of the McGrath® was associated with a longer time to intubation by 15 sec, \( p < 0.05 \) more Cormack and Lehane grade-1 views by 37%, and a higher incidence of DLT malposition by + 12.5% Comparable rate of success at the first attempt, difficult intubation score, and complications |
|                    | Controlled Powered     | McGrath® (n = 48)                        |                      | Other outcomes                                                             |                                                                          |
|                    |                        | Patients with normal airway               |                      | Cormack and Lehane grade                                                  |                                                                          |
|                    |                        |                                           |                      | DLT malposition                                                           |                                                                          |
|                    |                        |                                           |                      | Success rate at the first attempt                                          |                                                                          |
|                    |                        |                                           |                      | Difficult intubation score                                                |                                                                          |
|                    |                        |                                           |                      | Hoarseness                                                                |                                                                          |
|                    |                        |                                           |                      | Oropharyngeal trauma                                                      |                                                                          |
|                    |                        |                                           |                      | Sore throat                                                               |                                                                          |
| Yao et al. (2014)  | Prospective Observational | McGrath® (n = 43)                  | N/A                  | Time to intubation                                                         | The McGrath® provided a high rate of grade-1 laryngeal views (88%), acceptable intubation time (54 sec), a high rate of successful intubation at the 1st attempt (95%), and was easy to intubate in 79% |
| Purugganan et al. (2012) | Retrospective Controlled | Macintosh (n = 40)                        | > 25 times            | Other outcomes                                                             |                                                                          |
|                    |                        | McGrath® (n = 44)                        |                      | Cormack and Lehane grade                                                  |                                                                          |
|                    |                        | STRÖRZ C-MAC® (n = 31)                    |                      | Number of intubation attempts                                              |                                                                          |
|                    |                        | Patients with normal and abnormal airway  |                      | Airway trauma                                                             |                                                                          |

N/A: Not available

Table 3: Studies included the use of the Airtraq® for double lumen tube placement

| Reference          | Study                  | Arms                                      | Operators experience | End points                                                                 | Outcomes                                                                 |
|--------------------|------------------------|-------------------------------------------|----------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Yi et al. (2015)   | Randomized Prospective | Airtraq® (n = 35)                         | >30 times            | Time to intubation                                                         | Shorter time to intubation by 18 sec, \( p = 0.002 \), and less hemodynamic changes with using the Airtraq® Comparable rate of success at the first attempt, difficult intubation score, and Sore throat |
|                    | Controlled Powered     | GlideScope® (n = 35)                      |                      | Other outcomes                                                             |                                                                          |
|                    |                        | Patients with normal airway               |                      | Cormack-Lehane grades;                                                   |                                                                          |
|                    |                        |                                           |                      | Success rate                                                              |                                                                          |
|                    |                        |                                           |                      | Difficult intubation score                                                |                                                                          |
|                    |                        |                                           |                      | Hemodynamic variables                                                     |                                                                          |
|                    |                        |                                           |                      | Sore throat                                                               |                                                                          |
|                    |                        |                                           |                      | Compared to the arms with using the Airtraq®                                |                                                                          |
|                    |                        |                                           |                      | Other outcomes                                                             |                                                                          |
|                    |                        |                                           |                      | Ectoletamine levels                                                       |                                                                          |
|                    |                        |                                           |                      | Bispectral index                                                          |                                                                          |
|                    |                        |                                           |                      | Time to intubition                                                        |                                                                          |
| Hamp et al. (2015) | Randomized Prospective | Macintosh (n = 20)                        | N/A                  | Hemodynamic variables                                                     | Higher epinephrine level and non-statistically shorter time to intubation by 18 sec, \( p = 0.26 \) with using the Airtraq® Comparable hemodynamic changes |
|                    | Controlled Powered     | Airtraq® (n = 20)                         |                      | Other outcomes                                                             |                                                                          |
|                    |                        | Patients with normal airway               |                      | C-MAC®                                                                    |                                                                          |
|                    |                        |                                           |                      | Success rate                                                              |                                                                          |
|                    |                        |                                           |                      | Other outcomes                                                             |                                                                          |
|                    |                        |                                           |                      | Glottis exposure                                                          |                                                                          |
|                    |                        |                                           |                      | Complications                                                             |                                                                          |
| Chastel et al. (2015) | Prospective Observational | Airtraq® (n = 37)                  | >20 times            | Time to intubition                                                         | only 33 (89%) were successfully intubated within 120s (mean time: 44 ± 27s) using the Airtraq® |
|                    |                        | Patients with normal and abnormal airway  |                      | Other outcomes                                                             |                                                                          |
| Wasem et al. (2013) | Randomized Prospective | Macintosh (n = 30)                        | N/A                  | Time to intubition                                                         | Comparable time to intubation , difficult intubation score, and Cormack and Lehane grade |
|                    | Controlled Powered     | Airtraq® (n = 30)                         |                      | Other outcomes                                                             |                                                                          |
|                    |                        | Patients with normal and abnormal airway  |                      | Cormack and Lehane grade                                                  |                                                                          |
|                    |                        |                                           |                      | Hemodynamic variables                                                     |                                                                          |
|                    |                        |                                           |                      | Hoarseness                                                                |                                                                          |
|                    |                        |                                           |                      | Oropharyngeal trauma                                                      |                                                                          |
|                    |                        |                                           |                      | Sore throat                                                               |                                                                          |
| Hirabayashi and Seo (2007) | Prospective Observational | Airtraq® (n = 10)                  | N/A                  | Time to intubition                                                         | Time to intubation was 49 ± 22 s Improved glottis view in 90% Correct placement of left DLT in 70% |
|                    |                        | Patients with normal and abnormal airway  |                      | Other outcomes                                                             |                                                                          |

Abbreviation: N/A; not available
malleable stylet with a 60-90° angle or an airway exchange catheter (AEC).

The manufacturer recommends inserting the GlideScope® down the midline of the tongue to the epiglottis, that could potentially narrowing the remaining room for the passage of the relatively large DLT, particularly in patients with restricted mouth opening. In addition, the GlideRite® rigid stylet is shorter than the commonly used DLT that precludes its use for placement of DLT.

**The GlideScope® and double lumen tube**

Shortly after introducing the GlideScope®, Hernandez and Wong[13] have described its successful use for placement of a DLT in a patient with potential difficult airway that was facilitated with bending the stylet of the DLT so that the distal 16-20 cm of the DLT curve follows the curve of the GlideScope®.[13]

Onrubia et al.[14] described a successful use of the GlideScope® for DLT insertion in an awake patient with difficult airway, despite this option could have potential risk of soft-tissue trauma for the patients when used in inexperienced hands.

Two powered randomized clinical trials compared the effects of using the Macintosh and GlideScope® laryngoscopes for the DLT insertions on the time to intubation in patients with the normal airway.[5,11] They reported contradictory results as shown in Table 1 that can be explained with the diversity of prior operator experience in using the GlideScope® for the DLT insertion.[5,11] The use of GlideScope®-guided DLT insertion was associated with a longer time to intubation by 38 s and more frequent voice changes when used by inexperienced users.[5] The noted prolonged intubation time may have clinical importance in patients with high-risk for hypoxemia who undergo thoracic procedures.

**Tips to facilitate GlideScope® double-lumen tube intubation**

Different tips can be used to facilitate the placement of the DLT using the GlideScope® which potentially may shorten the duration of intubation.

Bustamante et al.[15] described a successful use of sequential rotation of the DLT using the GlideScope® in 12 patients as follows:

(a) After engaging the tip of the bronchial lumen of the DLT into the glottis and removal of the stylet, an initial 180° counterclockwise rotation is performed to align the axis of the bronchial lumen with the patient’s tracheal axis. (b) Then, an additional 90° clockwise rotation is performed to align the DLT with the left main bronchus.

Chen et al.[13] have described the use of an AEC alongside the GlideScope® guidance for placement of a DLT in a patient with the unanticipated difficult airway. In this report, the GlideScope® did not permit passage of the DLT, despite improved glottis visualization.

In addition, the type of DLT design can play a role in facilitating the placement of DLT over an AEC using a GlideScope®,[10] The Fuji-Phycon DLT (Silbroncho®, Fuji Systems, Tokyo, Japan) was found to be easier to pass over an AEC compared with both the Rusch (Bronchopart®, Teleflex, Research Triangle Park, NC) and Mallinckrodt (Broncho-Cath®, Covidien, Mansfield, MA) DLT warrants consideration in patients with difficult airway [Table 1].[10] The flexibility and the 45° angulated distal bevel of the reinforced bronchial lumen of the Fuji-Phycon DLT can potentially facilitating passage of the DLT into the glottis. In contrast, the Rusch and Mallinckrodt DLTs have a bronchial end that is cut perpendicular to the axis of the tube (i.e., a square cut) or with a very short bevel, respectively.[10]

Another tip that can facilitate the placement of a DLT using the GlideScope® have been demonstrated by Hsu et al.[9] through the angulation of the tip of DLT to a hockey-stick shape with more acute angle concealing the tracheal orifice that resulted in 21% shorter time to intubation [Table 1].

**Table 4: Studies included the use of the rigid video-stylets for double lumen tube placement**

| Reference | Study                  | Arms                      | Operators experience | End points                  | Outcomes                                      |
|-----------|------------------------|---------------------------|----------------------|-----------------------------|-----------------------------------------------|
| Yang et al. (2013)[34] | Randomized Prospective Controlled Single blind Powered | Macintosh (n = 200) OptiScope® (n = 200) Patients with normal and abnormal airway | >30 times | Time to intubation Other outcomes | The use of the OptiScope® was associated with a shorter time to intubation by 5.5 sec, p < 0.01, higher success rate (+9%), P = 0.036, better Cormack and Lehane grade views, less need for external laryngeal manipulation, and fewer number of oral mucosal or dental injury |
| Hsu et al. (2013)[39] | Randomized Prospective Controlled Single blind Powered | Macintosh (n = 30) Trachway® (n = 30) Patients with normal and abnormal airway | >300 times | Time to intubation Other outcomes Need for external manipulation Hoarseness | The use of the Trachway® was associated with a shorter time to intubation by 20 sec, p < 0.001, and less incidence of hoarseness |

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The McGrath® (Covidien, Mansfield, MA) has a lightweight, durable 2.5” LCD color video screen with a complementary metal oxide semiconductor (CMOS) camera and high intensity LED light source. It has optical polymer 11.9 mm slim McGrath® MAC disposable blades (2, 3, and 4) [Figure 1b]. A recently added thinner McGrath® MAC EDL X blade™ combines the benefits of both direct laryngoscopy and VL. The use of a stylet with a bended tip with 60° is recommended to facilitate the tracheal intubation [Table 5].

### The McGrath® and double-lumen tube

Three clinical trials have described the successful use of the McGrath® VL for tracheal intubation with DLT [Table 2].

#### Table 5: Comparisons of the specifications of the GlideScope®, McGrath®, Berg CEL-100™, Airtraq®, Pentax AWS®, King Vision™, OptiScope®, and Trachway®

| Class Types | GlideScope® | McGrath® | Berg CEL-100™ | Airtraq® | Pentax AWS® | King Vision™ | OptiScope® | Trachway® |
|-------------|-------------|-----------|---------------|----------|-------------|--------------|------------|-----------|
| Blade sizes | 3, 4 available | 3, 4 available | DLT # 35 or 37 Fr | DLT # 28-41 Fr | DLT # 28-32 Fr | DLT # 32-37 Fr | DLT #35 Fr or larger | DLT #35 Fr or larger |
| Display     | 6.5” color Digital, DVD-quality monitor with anti-reflective screen | 2.5” LCD colour display | Direct view AWDR video system A-360 Wi-Fi camera Universal smart phone adapters Endo cam | 2.4” diagonal color LCD Direct-view type (0°) CCD color filter | 2.4” OLED color Screen 2.4” TFT LCD screen technology allowing crisp imaging of the airway with excellent color reproduction. | – | – | – |
| Camera      | Digital with high-resolution for real-time view | CMOS | CCD camera with high-resolution | CMOS | CMOS 640 x 480 VGA 30 frames/sec | – | – | – |
| Light       | LED light | High intensity LED | LED light | – | White LED, dual type | White LED | White LED illuminates the airway Additional red LED light trans illuminates through the skin | – | – |
| Field of view angle | 60° degree | – | 40° degree | 80° degree | 90° degree | 160° degree | – | – |
| Anti-fog feature | √ | – | CMF proprietary processing technique | √ | √ | Coating on distal lens | Through white LED light | – |
| Height      | GVL 4/GVL 3 14 mm/14 mm | 202 mm | Yellow | INTLOCK | Standard 13 mm | OptiScope 405 mm | Clarius Video System 317 mm | 380 mm |
| Width       | GVL 4/GVL 3 20 mm/16 mm | 170 mm | – | 28 mm | 49 mm | 26 mm | – | – |
| Thickness   | GVL 4/GVL 3 53 mm/37 mm | 38 mm | – | 19 mm | 96 mm | – | 5 mm | 5 mm |
| Use of stylet | GlideRite® Rigid Stylet | Stylet | Stylet | No | No | Video stylet | Video stylet | – |
| Use of AEC/Bougie | AEC mainly with a Fuji-Phycon DLT | Can be | ? | Can be | AEC, Bougie | ? | N/A | N/A |
| Cost $ US*a | ~US $27,000 | ~US $2,500 Disposable blade US $139.5 | ~US $90 | ~US $16,000 Disposable PBlade US $200 | ~US $1,500 Disposable $90 | – | – | – |

MAC; Macintosh, DLT; double lumen tube, DVD; digital versatile disc, LCD; liquid-crystal-display, TFT; thin-film transistor, HD; high-definition, OLED; organic light-emitting diode, CCD; charge-coupled device, COMS; complementary metal–oxide–semiconductor, LED; light-emitting diodes, CMF; chloromethyl furfural, AEC; airway exchange catheter.

*aThese are the available online average cost, that may differ from one country to another.
The use of the McGrath® VL for insertion of DLT improves the glottis visualization and allows easier intubation. However, one of these studies was observational and the other had the bias of retrospective analysis.

In a recent study, the placement of a DLT using a McGrath® VL in patients with a good glottic view took a longer time to intubation by 15 s and had 12.5% higher incidence of DLT malposition than with the Macintosh laryngoscope, despite improved glottis view.

**Tips to facilitate McGrath® double-lumen tube intubation**
Similar to the GlideScope®, the McGrath® VL has a hyper-angulated blade, which requires the operator to steer with a stylet during intubation.

Several techniques have been described to improve the efficacy of the McGrath® VL for placement of DLT.

The Parker Flex-It™ articulating stylet is designed to facilitate quick intubation through allowing changing the SLT curvature to follow the curvature of the airway, particularly for intubating difficult airways due to exaggerated airway curvatures and very anterior larynges. The combination of a Parker FlexIT™ stylet and the McGrath® VL can be a potential effective method for DLT intubation.

Imajo et al. described the successful use of a fiberoptic bronchoscope alongside a McGrath® VL for placement of a DLT in an elderly woman who had a predicted anatomically difficult airway after failed trials of combined use of the McGrath® and a gum elastic bougie.

**Berg CEL-100 videolaryngoscope™**
The CEL-100 VL™ (Connell Energy Technology Co. Ltd., Shanghai, China) has a blade that retains the same shape and curvature of the Macintosh blade with an additional slightly anterior curve (approximate 40° angle) at the distal tip. This blade design has the potential to provide the necessary space for inserting the DLT through displacing excess airway soft-tissue.

The distal 10 cm of the stylet of the DLT has to be reshaped to follow the curve of the CEL-100 blade. In similar to the GlideScope®, the CEL-100 VL™ blade has to be inserted along the midline of the tongue.

Lin et al. have reported the efficacy of the CEL-100™ for placement of DLT in 48 patients who had unanticipated high Cormack and Lehane grades when used by experienced anesthesiologists (>30 times) after prior two failed attempts for DLT intubation using the Macintosh laryngoscope.

Compared with the Macintosh laryngoscope, the use of the CEL-100 VL™ improved the glottis views and the success rate of DLT intubation at the first attempt (by 29% and 14%, respectively), and allowed easier intubation. In that study, all DLT intubations were performed by expert anesthesiologists.

**Channelled blades videolaryngoscope**
The use of channeled VL may offer additional benefits for DLT intubation in patients with limited mouth opening or restricted neck movement in whom the use of traditional VL such as the GlideScope® or McGrath® can be difficult because of the larger outer diameter, the distal curvature, and the increased rigidity of the DLT.

Airtraq®
A low-cost yellow Airtraq® (Prodol Meditec S.A., Vizcaya, Spain), a VL with guiding channel to deliver the DLT, offers both an optical and multiple options to visualize the glottis including a direct view, AWDR video system, A-360 WiFi camera, universal smart phone adapters, or Endo cam connection. The yellow Airtraq® has a unique, effective anti-fog system through warming up lens. The anatomically shaped yellow Airtraq® can be useful for placement of DLT sizes from 28 to 41 Fr in patients with a minimum mouth opening of 19 mm.

The operator has to load the left-DLT, after removal of the stylet, keeping the bronchial tip pointed toward the light of the Airtraq®, insert the Airtraq® into the midline of patient’s mouth to slide it over the tongue until identifying the glottis structures, place the tip of the blade in the vallecular or underneath the epiglottis, and advance the DLT slowly using rotatory, twisting, or corkscrewing movements of the blade as required. Then, remove the Airtraq® after detaching the DLT.
El-Tahan: Videolaryngoscopes for double lumen tubes

The right-DLT style, a less frequently used, has to be rotated 180° toward the light of the Airtraq®.

The Airtraq® and double-lumen tube
Hirabayashi and Seo have described the successful use of the yellow Airtraq® for DLT intubation in 10 patients.\[25\]

The use of Airtraq® had a success rate of 89% for placement of DLT during routine and difficult airway management situations [Table 3].\[26\]

Compared with the Macintosh laryngoscope, the Airtraq®-guided DLT was associated with either a comparable or a shorter time to intubation, higher release of epinephrine, and comparable difficult intubation score, Cormack and Lehane grade and hemodynamic responses [Table 3].\[24,27\]

Recently, Yi et al.\[28\] have reported a shorter time to DLT intubation with the use of the Airtraq® than with the GlideScope®, despite the associated comparable success rate at the first attempt and difficult intubation score [Table 3].

In addition, Salazar Herbozo et al.\[29\] described the successful use of the Airtraq® for awake DLT intubation in two patients with predicted difficult airway.

However, the channeled Airtraq® laryngoscopes has not gained widespread popularity because it requires a minimum mouth opening of 19 mm, provides only subtle enhancement of visualization, and has a higher incidence of hoarseness over the Macintosh laryngoscopes.\[24\]

Pentax-Airway Scope®
The Pentax-Airway Scope® (Pentax-AWS, Hoya Corp., Tokyo, Japan) incorporates advanced imaging technology utilizing high-resolution color images, and identification of anatomical structures can be easily obtained thanks to a wide viewing 90° angle. The Pentax-AWS has a single use P-Blade allowing the use of SLT with an inner diameter of 6.5-8.0 mm, which is compatible with a range of DLT sizes from 26 to 32 Fr [Figure 2b]. This limits the usefulness of Pentax-AWS for placement of DLT with larger external diameter [Table 5].\[30,31\]

Yamazaki and Ohsumi\[32\] described the efficacy of the Pentax-AWS in improving the glottis view during rapid-sequence induction for placement of a 35 Fr DLT in a patient presented for emergency surgery because of a hemothorax.

Tips to facilitate Pentax-AWS double-lumen tube intubation
Several techniques have been reported to address the limitation of using the Pentax AWS for placement of DLT larger than a size 32 Fr.

Some investigators\[33\] have suggested the use of either an AEC or a bougie to facilitate DLT intubation using the Pentax-AWS.

Suzuki et al.\[34\] described the successful use of an AWS with removed back plate of the tube channel to place a 39 Fr DLT in a patient with unpredicted difficult airway.

Furthermore, the INTLOCK, a specialized laryngoscope blade that encases the tip of the AWS to fit the oropharyngeal anatomy, allows placement of DLT. Unfortunately, it was associated with some minor complications such a mild hemorrhage, sore throat, and hoarseness of voice in 50% of the studied patients that case series, however, included only 10 patients.\[31\] These complications can be potentially minimized by using the Pentax AWS with an infant-size INTLOCK and a smaller 32-Fr DLT.\[30\]

King Vision™
The King Vision™ (King Systems, Indianapolis, IN, USA) has been designed with a durable, reusable video display with a disposable standard “nonchanneled” and channeled blade at an affordable price [Table 5 and Figure 2c].

Recently, El-Tahan et al.\[35\] demonstrated the successful use of the standard nonchanneled blade of the King Vision™ VL for placement of a 35 Fr DLT, as illustrated in the management of a morbidly obese patient with predicted difficult airway and severely restrictive pulmonary dysfunction. They described four necessary steps to insert a DLT using a nonchanneled blade of King Vision™ VL: First, bend the DLT stylet so that the distal 21 cm of the DLT curve follows the curve of the nonchanneled blade and the proximal curve of the DLT remains directed to the right side [Figure 3a and b]. Next, insert the DLT, exercising caution to avoid damage to the tracheal cuff by the upper teeth during its passage through...
the mouth opening. Then, after the bronchial cuff passes through the vocal cords, withdraw the stylet of the DLT. Finally, rotate the DLT 180° counterclockwise while advancing the DLT to the desired depth.[35]

Compared with the Airtraq® and the AWS, the nonchanneled blade King Vision™ VL has the thinnest and shortest stature (26 mm vs. 28 mm and 49 mm and 13 mm vs. 18 mm and 131 mm, respectively) and the widest field of view (160° vs. 80° and 90°, respectively) [Figure 2a-c], the dimensions of which may make it superior for those with limited mouth opening.[35]

**Video-stylets**

Video-stylets offers both an optical and video option to visualize the glottis, as well as to guide the DLT, particularly in patients with limited mouth opening and restricted neck movement.

**OptiScope®**

A video-stylet specifically designed for a DLT (OptiScope®, Pacific Medical, Seoul, Republic of Korea) has a malleable tip, a length of 40.5 cm and an outer diameter of 5 mm, accommodating a 35 Fr or larger DLT. This OptiScope® rigid video-stylet is derived from the Clarus Video System (Clarus Medical, Minneapolis, MN, USA) [Table 5].

Yang et al.[36] demonstrated a shorter time to intubation, a higher success rate for the first attempt at DLT intubation, a less frequent mucosal trauma, and a better vocal cord view with the use of the OptiScope® than with the Macintosh laryngoscope. That study was not blind, and the operators had diverse experience with both intubating devices.[36] Similarly, other investigators have reported successful OptiScope®-assisted DLT intubation in patients with a difficult airway.[37,38]

The OptiScope® has the potential to replace the use of awake DLT intubation over a fiberoptic flexible bronchoscope in patients with predicted difficult airway. Furthermore, the Clarus Video System has been successfully used for awake DLT intubation in a patient with a large epiglottis cyst.[38]

**Trachway®**

The Trachway® malleable video-stylet (Biotronic Instrument Enterprise Ltd., Tai-Chung, Taiwan) has an atraumatic tip and a rotatable monitor, potentially facilitating the insertion of DLT. Hsu et al.[39] have reported a shorter intubation duration by 20 s and less frequent hoarseness of voice with using the Trachway® video-stylet for placement of DLT than with the Macintosh laryngoscope.

**Lighted stylet**

The use of a lighted stylet-guided DLT intubation has been described in 34 patients as the only method to determine the depth of DLT insertion, thereby enhancing the chances of successful positioning on the first attempt without further manipulation of the DLT.[40]

**Bonfils retromolar intubating endoscope**

Bonfils retromolar intubating endoscope (10331B model) (Karl Storz GmbH, Tuttlingen, Germany) has an outer diameters of 5.0 mm, usable shaft length of 40 cm, distal deflection of 40°, movable eyepiece, 35 megapixel light bundle, and an adaptor for tube fixation and oxygen application.

Bonfils rigid fiberscope, one of the widely used airway assist devices for tracheal intubation in patients with limited neck movements, is increasingly used for DLT intubation to improve the laryngeal view, particularly in patients with unpredicted difficult airway. However, to accommodate the Bonfils rigid stylet into the DLT, the DLT has to be shortened by 1.5 cm, this can be possible in some types of DLT like bronchocath.[41]

**Video Laryngoscopes-Guided Double-Lumen Tube Intubation and Experience of the Operators**

Of note, the longer intubation durations with the use of different VL-assisted DLT insertion can be shortened with building up the operator’s experience [Tables 1-4]. Furthermore, familiarity and regular use of any VL device is a key to the effective clinical practice.

Sakles et al.[42] have reported significant improvement in the first pass success of tracheal intubation using the GlideScope® over a 7-year period. Thus, we expect that increasing the exposure of the operators to the use of VL for intubation with DLT would improve their performance and hence increasing
the first pass success in a comparable time to the use of direct laryngoscopy.

This can be achieved through conducting structured training courses to teach the practitioners of thoracic anesthesia how to use different VL for placement of DLT using the high-fidelity simulation of lung isolation. The latter becomes an important tool for teaching specific skills and evaluating performance during anesthesia training.\cite{43}

Further multicenter studies are needed to compare the performance of those 10 studied devices for placement of DLT by inexperienced anesthesiologists who are regularly insert DLT during the daily practice in the thoracic surgery particularly in a population at increased risk of a difficult airway.

Currently, there are two recruiting randomized, prospective, controlled studies comparing the efficacy of the GlideScope\textsuperscript{®}, Airtraq\textsuperscript{™}, and King Vision\textsuperscript{®} for DLT insertion by inexperienced anesthesiologists on manikins and in humans (www.clinicaltrials.gov identifier number NCT02305667).

**Conclusion**

Until that time, the author thinks that it is too early to say goodbye to the use of direct laryngoscopy or to recommend the routine use of any of the described VL devices for DLT intubation.

However, currently there is enough evidence supporting the use of VL for placement of DLT in patients with predicted and unanticipated difficult airway.

The use of VL could offer an effective method of DLT placement for lung separation in patients with the potential difficult airway.

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**Conflict of interest**

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**References**

1. Della Rocca G, Langiano N, Baroselli A, Granzotti S, Pravissani C. Survey of thoracic anesthetic practice in Italy. J Cardiothorac Vasc Anesth 2013;27:1321-9.
2. Eldawlatly A, Turkistani A, Shelley B, El-Tahan M, Macfie A, Kinsella J, et al. Anesthesia for thoracic surgery: A survey of middle eastern practice. Saudi J Anesth 2012;6:192-6.
3. Shelley B, Macfie A, Kinsella J. Anesthesia for thoracic surgery: A survey of UK practice. J Cardiothorac Vasc Anesth 2011;25:1014-7.
4. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt CD, Connis RT, Nickinovich DG, et al. Practice guidelines for management of the difficult airway: An updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 2013;118:251-70.
5. Russell T, Slinger P, Roscoe A, McRae K, Van Rensburg A. A randomised controlled trial comparing the GlideScope\textsuperscript{®} and the Macintosh laryngoscope for double-lumen endobronchial intubation. Anesthesia 2013;68:1253-8.
6. Kaki AM, Almarakbi WA, Fawzi HM, Boker AM. Use of Airtraq, C-Mac, and Glidescope laryngoscope is better than Macintosh in novice medical students’ hands: A manikin study. Saudi J Anesth 2011;5:376-81.
7. Chen A, Lai HY, Lin PC, Chen TY, Shyr MH. GlideScope-assisted double-lumen endobronchial tube placement in a patient with an unanticipated difficult airway. J Cardiothorac Vasc Anesth 2008;22:170-2.
8. Campos JH. Lung isolation techniques for patients with difficult airway. Curr Opin Anesthesiol 2010;23:12-7.
9. Hsu HT, Chou SH, Chou CY, Tseng KY, Kuo YW, Chen MC, et al. A modified technique to improve the outcome of intubation with a left-sided double-lumen endobronchial tube. BMC Anesthesiol 2014;14:72.
10. Gamez R, Slinger P. A simulator study of tube exchange with three different designs of double-lumen tubes. Anesth Analg 2014;119:449-53.
11. Hsu HT, Chou SH, Wu PJ, Tseng KY, Kuo YW, Chou CY, et al. Comparison of the GlideScope\textsuperscript{®} videolaryngoscope and the Macintosh laryngoscope for double-lumen tube intubation. Anesthesia 2012;67:411-5.
12. Cooper RM, Pacey JA, Bishop MJ, McCluskey SA. Early clinical experience with a new videolaryngoscope (GlideScope\textsuperscript{®}) in 728 patients. Can J Anesth 2005;52:191-8.
13. Hernandez AA, Wong DH. Using a GlideScope for intubation with a double lumen endotracheal tube. Can J Anesth 2005;52:658-9.
14. Onrubia X, Lluch-Oltra A, Armero R, Baldó J. Use of GlideScope for double lumen endotracheal tube insertion in an awake patient with difficult airway. Rev Esp Anestesiol Reanim 2014;61:346-8.
15. Bustamante S, Parra-Sánchez I, Apostolakis J. Sequential rotation to insert a left double-lumen endotracheal tube using the GlideScope. Can J Anesth 2010;57:282-3.
16. Yao WL, Wan L, Xu H, Qian W, Wang XR, Tian YK, et al. A comparison of the McGrath\textsuperscript{®} Series 5 videolaryngoscope and Macintosh laryngoscope for double-lumen tracheal tube placement in patients with a good glottic view at direct laryngoscopy. Anaesthesia 2015 Feb 27. doi: 10.1111/anae.13040. [Epub ahead of print].
17. Yao WL, Wang XR, Xu H, Zhang Y, Zhang CH. McGrath\textsuperscript{®} series 5 videolaryngoscope evaluation for double-lumen tube intubation. Anaesthesia 2014;69:646-7.
18. Purugganan RV, Jackson TA, Heir JS, Wang H, Catá JP. Video laryngoscopy versus direct laryngoscopy for double-lumen endotracheal tube intubation: A retrospective analysis. J Cardiothorac Vasc Anesth 2012;26:845-8.
19. Ueshima H, Kitamura A. Combination of Parker Flex-IT™ Stylet and McGrath MAC for effective double lumen tube intubation. Saudi J Anesth 2014;8:574.

20. Imajo Y, Komasawa N, Minami T. Efficacy of bronchofiberscope double-lumen tracheal tube intubation combined with McGrath MAC for difficult airway. J Clin Anesth 2015;27:362.

21. Lin WQ, Quan SB, Liu WJ, Zhang TH, Li HT, Zhong ZJ, et al. Evaluation of the CEL-100 videolaryngoscope™ for double-lumen tracheal tube insertion after failure using the Macintosh laryngoscope. Anesthesia 2012;67:1232-6.

22. Lin W, Li H, Liu W, Cao L, Tan H, Zhong Z. A randomised trial comparing the CEL-100 videolaryngoscope™ with the Macintosh laryngoscope blade for insertion of double-lumen tubes. Anesthesia 2012;67:771-6.

23. Liu WQ, Quan SB, Liu WJ, Zhang TH, Li HT, Zhong ZJ, et al. Evaluation of the CEL-100 videolaryngoscope™ for double-lumen tracheal tube insertion after failure using the Macintosh laryngoscope. Anesthesia 2012;67:1232-6.

24. Lin W, Li H, Liu W, Cao L, Tan H, Zhong Z. A randomised trial comparing the CEL-100 videolaryngoscope™ with the Macintosh laryngoscope blade for insertion of double-lumen tubes. Anesthesia 2012;67:771-6.

25. Rubin Y, Seo N. The Airtraq laryngoscope for placement of double-lumen endobronchial tube. Can J Anesth 2007;103:446-51.

26. Wasem S, Lazarus M, Hain J, Festl J, Kranke P, Roewer N, et al. Comparison of the Airtraq and the Macintosh laryngoscope for double-lumen tube intubation: A randomised controlled trial. Anesth Crit Care Pain Med 2015;34:89-93.

27. Hamp T, Stumpner T, Grubhofer G, Ruetzler K, Thell R, Hager H. Haemodynamic response at double lumen bronchial tube placement — Airtraq vs. Macintosh laryngoscope, a randomised controlled trial. Heart Lung Vessel 2015;7:54-63.

28. Yi J, Gong Y, Quan X, Huang Y. Comparison of the Airtraq laryngoscope and the GlideScope for double-lumen tube intubation in patients with predicted normal airways: A prospective randomized trial. BMC Anesthesiol 2015;15:58.

29. Salazar Herbozo E, Planas B, Ramasco F, Gómez Rice A, Catalán P. Double lumen tube insertion in awake patients through the Airtraq laryngoscope in 2 cases of expected difficult airway. Rev Esp Anestesiol Reanim 2011;58:315-7.

30. Ono N, Komasawa N, Nakano S, Kuwamura A, Tsutsumi S, Minami T. Successful double-lumen tube insertion using Pentax-AWS Airwayscope with an infant-sized intlock in a rheumatoid arthritis patient with restricted mouth opening and head tilting. Masui 2013;63:406-8.

31. Nakamura R, Kusunoki S, Kawamoto M. Usability of modified INTLOCK for double-lumen endobronchial tube insertion with airway scope. Masui 2007;56:817-9.

32. Yamazaki T, Osuami H. The airway scope is a practical intubation device for a double-lumen tube during rapid-sequence induction. J Cardiothorac Vasc Anesth 2009;23:926.

33. Poon KH, Liu EH. The Airway Scope for difficult double-lumen tube intubation. J Clin Anesth 2008;20:319.

34. Suzuki A, Kumasawa T, Iwasaki H. Double lumen tube placement with the Pentax-Airway Scope. Can J Anesth 2007;54:853-4.

35. El-Tahan M, Doyle DJ, Khidr AM, Hassibie AG. Case report: Double lumen tube insertion in a morbidly obese patient through the non-channelled blade of the King Vision (™) videolaryngoscope. F1000Res 2014;3:129.

36. Yang M, Kim JA, Ahn HJ, Choi JW, Kim DK, Cho EA. Double-lumen tube tracheal intubation using a rigid video-stylet: A randomized controlled comparison with the Macintosh laryngoscope. Br J Anesth 2013;111:990-5.

37. Kim YR, Jun BH, Kim JA. The use of the Clarus Video System for double-lumen endobronchial tube intubation in a patient with a difficult airway. Korean J Anesthesiol 2013;65:85-6.

38. Lee G, Ha SI, Song JG. An awake double lumen endotracheal tube intubation using the Clarus Video System in a patient with an epiglottic cyst: A case report. Korean J Anesthesiol 2014;66:157-9.

39. Hsu HT, Chou SH, Chen CL, Tseng KY, Kuo YW, Chen MK, et al. Left endobronchial intubation with a double-lumen tube using direct laryngoscopy or the Trachway® video stylet. Anesthesiology 2013;120:851-5.

40. Weng H, Wong DT, Deng SZ, Liu J. Positioning of double-lumen tubes by a lighted stylet. J Cardiothorac Vasc Anesth 2007;21:774-5.

41. Subramani S, Poopalalingam R. Bonfils assisted double lumen endobronchial tube placement in an anticipated difficult airway. J Anesthesiol Clin Pharmacol 2014;30:568-70.

42. Sakles JC, Mosier J, Patarwala AE, Dicken J. Improvement in GlideScope® Video Laryngoscopy performance over a seven-year period in an academic emergency department. Intern Emerg Med 2014;9:789-94.

43. Failor E, Bowdle A, Jelacic S, Togashi K. High-fidelity simulation of lung isolation with double-lumen endotracheal tubes and bronchial blockers in anesthesiology resident training. J Cardiothorac Vasc Anesth 2014;28:877-81.