

# Redefining the Gold Standard of Advanced Airway Management: Use of A Dual Camera Input Screen to Facilitate Video laryngoscope-Assisted Fibreoptic in tubating Videoendoscopic endotracheal Intubation

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## Abstract

Failed or difficult intubation is associated with complications, including increased risk of hypertension, desaturation, unexpected admissions to the intensive care unit and death. Whilst direct laryngoscopy (DL) is by far the most common technique used to guide endotracheal intubation, the associated incidence of failure is high. Alternatives to DL use advanced technology to transmit an image from the tip of the scope to a display screen. Whilst videolaryngoscopy improves the view of the larynx during laryngoscopy; failure of endotracheal intubation with VL is also well documented. Thus, VL is not a panacea. However the combined use of a fibreoptic intubating videoendoscope (FIVE) and a VL eliminates the limitations of each individual device. Whilst the foresight, preparation, equipment and space required to implement this airway management strategy are usually prohibitive; I describe a technique that streamlines this approach. The C-MAC videolaryngoscope (with any blade) and a 11302 BDX FIVE (Karl Storz, Germany), within a clear plastic scope holder, if connected to a dual input 8403 ZX Screen (Karl Storz, Germany) attached to the 8401 YA stand (Karl Storz, Germany) is compact and portable. The combination of the improved visualization of the airway provided by the VL with the ability to use the FIVE as a tracheal tube introducer with a controllable tip greatly increases the range of airway challenges that can be overcome. This emerging technique could therefore redefine airway management

**Keywords:** Videolaryngoscope; Endotracheal intubation; Direct laryngoscopy; Fibreoptic bronchoscope; Fibre optic intubating videoendoscope.

## INTRODUCTION

Tracheal intubation is used for airway management in 38.4% of cases performed under general anaesthesia, estimated at 1.1 million procedures per year in the United Kingdom (UK).[1] Failed or difficult intubation is associated with complications, including increased risk of hypertension, desaturation, unexpected admissions to the intensive care unit (ICU) and death.[2] The 4th National Audit Project of the Royal College of Anaesthetists, UK (NAP4) found that major complications of airway management were frequently preceded by either delayed or

failed tracheal intubation.[2] Difficulty with tracheal intubation may be due to restricted neck flexion, limited mouth opening, enlarged tongue, poor tissue mobility, or cervical instability.[2] Difficult intubation is unpredicted in up to 93% of cases.[3] The sensitivity and positive predictive value of pre-operative airway assessment (e.g. Mallampati or Wilson index test) are very low.[2-4]

## DIRECT LARYNGOSCOPY

Direct laryngoscopy is by far the most common technique used to guide endotracheal intubation worldwide. To perform tracheal intubation with

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direct laryngoscopy (DL), the lower cervical spine must be flexed and the upper cervical spine must be extended to create a 'line of sight.' A straight (e.g. Miller) or curved (e.g. Macintosh) laryngoscope blade is commonly used to retract the tongue and elevate the epiglottis to allow visualization of the glottis and passage of a tracheal tube.

Alternatives to DL use advanced technology (either fiberoptic or digital) to transmit an image from the tip of the scope. This image can be viewed through an eyepiece or on a monitor.

### video laryngoscope

Rigid video laryngoscopes (VL), use a blade to retract the soft tissues and transmit continuous, real-time video to a screen on the handle or to a monitor. Thus the larynx can be seen without a direct 'line of sight.' This may allow visualization of the larynx if this is challenging during DL or predicted to be problematic.

Videolaryngoscopy improves the view of the larynx during laryngoscopy.[5] The number of laryngoscopies in which the laryngeal inlet cannot be seen is therefore likely to be less with VL than with DL. However, VL is not a panacea for all challenges with tracheal intubation.[6,7] Failure of endotracheal intubation with VL is well documented.[6-9]

For example, a Cochrane systematic review comparing VL with DL in adult patients requiring tracheal intubation reported failure of endotracheal intubation with VL in 44 of 1782 patients (2.5%) and with DL in 167 of 1601 patients (10.4%).[8]

In order to improve outcomes in airway management is important to critically dissect the causes of failed tracheal intubation. The data reported by Kleine-Brueggeney et al. (2016)[9] provide great insights into failed tracheal intubation under VL. They studied the performance of six VLs in a simulated difficult airway.[9] The incidence of failed VL guided intubation (19.2%; 137/720) they reported[9] was substantially higher than that in the meta-analysis of earlier studies reported by Lewis et al., 2017. Reviewing the causes of these failures is highly enlightening for airway management with VL.

The incidence of technical failure was low (5/720; 0.7%).[9] However any difficult airway management strategy that includes videolaryngoscopy must include

a contingency plan for technical failure.[6,7] Prior to inducing anaesthesia it is mandatory to ensure that at least two working DL are immediately available.[6,7]

However, VLs are substantially more expensive than DLs so many departments of anaesthesia may only have one VL available. So, if 'plan A involves VL and only one VL is immediately available; in the event of technical failure of the VL, the team would have to swiftly implement the next plan for airway management. [6,7] It is therefore important to clearly predefine this 'plan B' and ensure that any equipment and personnel required to execute this plan is immediately available. [6,7]

Failure of tracheal tube placement is much more common than technical failure. The overall incidence of reports of failure of tracheal tube placement was 111/720 (15.4%) in the simulated difficult airway.[9] Failure to see (i.e. failure of VL to provide an adequate view) occurred in 7.4% (53/720).[9] To see failure (i.e. failure to successfully pass the tube despite an adequate view of the larynx) was slightly more common (56/720, 7.8%).[9]

There are no specific clinical predictors of failure to intubate with a VL.[6,7] Indeed, there are no good quality data on the utility, sensitivity or specificity of VL assessment of the airway prior to induction of anaesthesia.[6,7] However, I routinely perform this examination if airway management 'plan A' includes VL. In my experience this examination provides useful information on the view of the larynx that may be obtained but does not correlate with ease of tracheal tube placement.[6,7]

Kleine-Brueggeney et al. (2016) assessed the performance of three VL with hyperangulated blades and reported that the rate of failed tracheal tube placement was lower with the C-MACDörge(D) blade (Karl Storz, Germany) and the McGrath (Aircraft Medical Ltd, Scotland) than with the GlideScope (Verathon Inc., USA).[9] A stylet must be used to facilitate intubation with VL with a hyperangulated blade that does not have a guiding channel.

Interestingly the GlideScope (Verathon Inc., USA), with its specifically designed stylet, had the second highest rate of failed tube placement (1%; second only to the A.P. AdvanceVL) of all the VL studied by Kleine-Brueggeney et al.[9] However, neither the

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C-MAC Dörge (D) blade (Karl Storz, Germany) nor the McGrath (Aircraft Medical Ltd, Scotland) have specifically designed stylets. So, Kleine-Brueggene et al.[9] allowed the intubating anaesthetists to choose and shape the stylets used with the D-blade and the McGrath. This suggests that it may be better for experienced practitioners to shape a malleable stylet than to use one with a fixed predefined curve.[6,7]

The success of tracheal tube placement with hyperangulated VL blades is affected by the type of stylet used. Use of the Truflex articulating stylet (Truphatek International Ltd, Israel) with the C-MAC D-blade provides better first attempt success rates than the Portex intubation stylet (Smiths Medical, USA).[10] Video laryngoscope guided fiberoptic intubation is the natural evolution of the concept that use of a stylet with a controllable tip facilitates tracheal intubation with a VL.[6,7]

### VIDEO LARYNGOSCOPE GUIDED FIBEROPTIC INTUBATION

Video laryngoscope guided fiberoptic intubation can obviously be performed using a VL and a fiberoptic intubating video endoscope (FIVE) with a separate display screen for each device. For example Greif et al. (2007) described the use of a fiberoptic bronchoscope (FOB; Karl Storz, Germany) with the C-MAC Direct Couple Interface (DCI) VL (Karl Storz, Germany) but used a separate display screen for each device. [11] I have also used a FIVE with a dedicated display screen successfully in clinical practice to rescue failed intubation with the Airtraq (Prodol Meditec SA, Spain), C-MAC (Macintosh and D-blades) and the A.P. Advance (Macintosh and Difficult Airway blades) VLS.[7] I have used similar techniques successfully with the GlideScope, McGrath and KingVision (Kings systems, USA) blade 3 VLS in manikins with various FIVEs including the disposable aScope 3 (Ambu, Denmark).[7]

The combination of the improved visualization of the airway provided by the VL with the ability to use the FIVE as a tracheal tube introducer with a controllable tip greatly increases the range of airway challenges that can be overcome.[7] Furthermore directly visualizing the passage of the tracheal tube introducer reduces the risk of trauma from blind passage.[7] However this technique is too cumbersome to use regularly in

routine practice, even if a difficult airway is expected. Substantial foresight, preparation, equipment and space is required.[7] Whilst I have used this strategy in the event of an expected difficulty with airway management; I have never successfully been able to implement this plan in the event of unexpected difficulty.

I therefore refined and optimized the technique initially described by Grief et al. (2007)[11] to the minimum preparation, equipment and space required. To achieve this I connect a C-MACVL (with any blade) and a 11302 BDX FIVE (Karl Storz, Germany), within a clear plastic scope holder, to a dual input 8403 ZX Screen (Karl Storz, Germany) attached to the 8401 YA stand (Karl Storz, Germany).[7] I have successfully used this strategy for the management of expected and unexpected difficult airways.

My current experience with this configuration of devices consists of several successful C-MAC Macintosh or D Blade assisted fiberoptic tracheal intubations in anaesthetised patients.[7] I have also used this combination of devices in the ICU to facilitate airway management for percutaneous tracheostomy.[7]

This configuration has several advantages. Crucially, both the VL and FIVE can simultaneously remain connected to the 8403 ZX screen which has two camera inputs.[7] Although only one device input can be displayed on the screen, switching between devices takes less than four seconds.[7] Whilst the screen is blank when switching between the devices the C-MAC blade can still be used for direct laryngoscopy.[7] The 8401 YA stand holds the VL and FIVE together with the 8403 ZX screen.[7] As the 11302 BDX FIVE has an integrated tube holder an endotracheal tube can easily be preloaded.[7] This configuration of devices can be moved by a single person and is extremely compact.[7] If set-up and kept 'ready to go' it can be used to manage unexpected difficult airways almost anywhere in the hospital.[7]

Sukerniket al., 2016 have described an algorithm for airway management that combines the use of a FIVE with the GlideScope.[12] I have adapted this for use with a C-MAC VL and a 11302 BDX FIVE VL simultaneously connected to a dual input 8403 ZX screen.[7] The FIVE can be used as a stylet with a controllable flexible tip if Cormack-Lehane (CL) grades

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one or two views are seen with the C-MAC VL.[7] The FIVE is guided into the glottis solely under the view of the C-MAC. If only CL grades three or four views are obtained with the C-MAC, the VL should be used to guide the FIVE to the point at which the FIVE is most likely to be able to view the glottis.[7] The 8403 ZX screen can then be used to display the view from the FIVE whilst the C-MAC is used like a DL to retract the oropharyngeal tissues.[7] The FIVE should then be passed through the glottis to allow endotracheal intubation.[7] If the C-MAC pocket monitor (Karl Storz, Germany) is available then the C-MAC can continue to be used as a VL. This would better assist optimal positioning of the FIVE and identify any cause of resistance to passage of the tracheal tube.[7]

### CONCLUSION

Strategies for advanced airway management are still evolving. The airway management skills, strategies and failures of the future are defined by current practice.[6,7] Whilst the use of VLs is increasing they are associated with an alarmingly high rate of failure.[6,7] Using a FIVE and a VL together eliminates the limitations of each individual device. [7] Videolaryngoscope guided FIVE intubation is an emerging technique that could therefore redefine airway management.[7]

This technique has been greatly enhanced by the availability of a display screen that allows two camera inputs.[7] This minimizes the preparation, equipment, space and time required to use these devices simultaneously. Although further studies are required, it is likely that this configuration of airway equipment can improve the rate of successful endotracheal intubation.[7]

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