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SPECIAL ARTICLE

Why go blind if you can see the airway?

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Abstract Airway management is a critical aspect of anesthesiology, essential for ensuring patient safety during various medical interventions, including surgery, emergency care, and critical care settings. Despite advancements, difficult laryngoscopy and tracheal intubation remain significant challenges, particularly in emergency scenarios, posing risks of hypoxia, brain damage, and death. This article examines the efficacy of videolaryngoscopy (VLS) and video laryngeal mask airways (VLMA) in improving airway management outcomes compared to traditional techniques across diverse clinical environments.

We conducted a comprehensive review of literature and current practices, analyzing the advantages and limitations of VLS and VLMA. The paper highlights the importance of visualization in airway management and evaluates the effectiveness of these devices in various settings. VLS and VLMA offer several benefits over traditional direct laryngoscopy, including enhanced glottic visualization, higher first-attempt success rates, reduced rates of oxygen desaturation, and fewer adverse events. These devices provide a larger angle of view and allow for real-time monitoring, improving overall patient safety. Additionally, they serve as excellent educational tools for training anesthesiologists and other healthcare providers involved in airway management.

In emergency and critical care scenarios, the rapid and accurate placement of airway devices is crucial. VLS and VLMA facilitate quicker and more reliable intubation, reducing the likelihood of complications such as esophageal intubation or airway trauma. These technologies also allow for better teamwork and coordination as the airway view can be shared with the entire medical team.

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The adoption of VLS and VLMA as standard practice in airway management can significantly enhance visualization and success rates, reducing the risk of complications. These devices should be integrated into routine clinical use to improve patient outcomes. Further research is warranted to optimize their application and explore advancements such as artificial intelligence in airway management.

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PALABRAS CLAVE

Manejo de la vía aérea;
Vía aérea difícil;
Videolaringoscopia;
Dispositivos supraglóticos de la vía aérea;
Video máscara laríngea;
Anestesia;
Seguridad del paciente;
Técnicas de intubación

¿Por qué ir a ciegas, si se puede visualizar la vía aérea?

Resumen El manejo de la vía aérea es un aspecto crítico de la anestesiología, que es esencial para garantizar la seguridad del paciente durante intervenciones médicas que incluyen cirugía, atención urgente y ámbitos de cuidados críticos. A pesar de los avances, la laringoscopia difícil y la intubación traqueal siguen siendo desafíos significativos, particularmente en escenarios urgentes, planteando riesgos de hipoxia, daño cerebral y muerte. Este artículo examina la eficacia del videolaringoscopio (VLS) y la video máscara laríngea (VLM) para mejorar los resultados del manejo de la vía aérea, en comparación con las técnicas tradicionales, en diversos entornos clínicos.

Realizamos una revisión amplia de la literatura y las prácticas actuales, analizando las ventajas y limitaciones de VLS y VLM. El artículo destaca la importancia de la visualización en el manejo de la vía aérea, y evalúa la efectividad de dichos dispositivos en diversos ámbitos. VLS y VLM ofrecen diversos beneficios con respecto a la laringoscopia directa tradicional, incluyendo mejora de la visualización glótica, tasas más altas de éxito al primer intento, reducción de las tasas de desaturación de oxígeno, y menos episodios adversos. Dichos dispositivos aportan un mayor ángulo de visión y permiten la monitorización a tiempo real, mejorando la seguridad global del paciente. Además, actúan como herramientas educativas excelentes para la formación de anestesiólogos y otros profesionales sanitarios implicados en el manejo de la vía aérea.

En escenarios de atención urgente y crítica, la colocación rápida y precisa de dispositivos para la vía aérea es esencial. VLS y VLM facilitan la intubación rápida y fiable, reduciendo la probabilidad de complicaciones tales como intubación esofágica o traumatismo en la vía aérea. Dichas tecnologías permiten también una mejor coordinación del equipo de trabajo, ya que la visión de la vía aérea puede ser compartida por el equipo médico al completo.

La adopción de VLS y VLM como práctica estándar para el manejo de la vía aérea puede mejorar considerablemente la visualización y las tasas de éxito, reduciendo el riesgo de complicaciones. Dichos dispositivos deberán integrarse en el uso clínico rutinario, para mejorar los resultados del paciente. Debe garantizarse más investigación para optimizar su aplicación y explorar avances tales como la inteligencia artificial en el manejo de la vía aérea.

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Airway management is complex and risky but paramount for patients' safety

Airway management is a highly complex and vital part of anesthesiology due to its critical role in ensuring an open airway, efficient gas exchange and patient safety during surgical interventions. Unpredicted difficult laryngoscopy and difficult tracheal intubation, especially in emergency cases, still present a potentially life-threatening challenge in our daily practice as the airway is critical for adequate oxygen delivery.¹

It is well-known that airway management carries a significant risk of complications due to the variability in patient anatomy and physiology, the dynamic and sometimes unpredictable nature of airway conditions, patient-specific factors, the critical need for accurate preoperative assessment, the technical challenges of using various airway devices and techniques, the necessity of using advanced skills and experience, and the importance of effective preparation and teamwork.¹

Rapid desaturation and hypoxia can cause brain damage or death. Airway-related morbidity is still reported in closed

legal claims and practice audits.²⁻⁵ The ASA Closed Claims² and NAP4⁴ studies describe 'airway management delay' in the recognition of an evolving 'can't ventilate, can't oxygenate' scenario as a major contribution to brain damage and death. Up to one-third of anesthesia-related deaths are due to failure to intubate, ventilate and oxygenate the patient, while 75% of these closed-claims cases involved judgment failures resulting in severe complications.^{4,6}

The incidence of difficult and failed airway management reported in the literature substantially differs according to various contexts, with the lowest incidence in the operating room (up to 8%) and the highest incidence (up to 30%) in obstetric and pediatric anesthesia, the prehospital, emergency department and critical care setting.⁷ Failures are due to difficulties adequately holding a facemask, correct insertion of an endotracheal tube (ETT) or a supraglottic airway device (SAD), and the hazards of multiple attempts with perseveration of the consistent application of any airway technique or tool more than twice without deviation or change of technique.⁸ Ideally, airway attempts should only be performed as long as the patient remains well-oxygenated.

Optimal management of airway problems is a multifaceted approach that involves careful airway assessment, identifying potential risk factors, selecting optimal airway devices, checking equipment readiness and developing alternative backup strategies in case of failed initial attempts. This includes plans for difficult tracheal intubation and emergency surgical airway access, e.g., eFONA, which is an emergency front-of-neck access cricothyrotomy using a scalpel-bougie technique, in case of a 'cannot ventilate, cannot oxygenate' emergency.⁹ All difficult airway guidelines now recommend established algorithms for difficult airway management and endorse using exit strategy options to be considered in case of failed ETT insertion.^{1,7-11} These strategies include declaring a failed tracheal intubation while extra help is summoned, awakening of the patient, temporizing with a SAD, proceeding with one further controlled attempt by a senior anesthesiologist using a different technique, or proceeding to an emergency front-of-neck access to the airway.^{7-9,11,12}

Why is airway management complicated in certain circumstances?

There are numerous reasons why airway management is particularly complicated during induction of anesthesia as each patient's anatomy is unique whereas some patients have specific conditions, e.g., obesity, a large tongue, a small or retracted jaw, congenital anomalies, intraoral trauma, edema, bleeding, infections and tumors. Unexpected events compromising the airway may occur due to e.g., gastric aspiration, airway obstruction or equipment failure. Furthermore, managing the airway in the extremes of age patients can present additional challenges due to differences in anatomy, physiology and pathology.¹³ However, poor or no visibility of the oropharynx and larynx is often related to 'blind' insertion of the airway tool with consequences such as esophageal intubation or malfunctioning of a supraglottic airway device (SAD).

Are preoperative assessment tests accurately predicting a patient with a difficult airway?

There are multiple tests available for both prediction and management of a difficult airway, e.g., Mallampati test, thyromental, hyomental and sternomental distances, upper lip bite test, mouth opening test, neck circumference, Wilson risk sum score, and the El-Ganzouri multivariate risk index.^{6,14} However, all these parameters and scores used during bedside tests for predicting a difficult airway show a low sensitivity and a high variability.¹⁵ In fact, despite huge efforts, there are no effective convenient and accurate recommended measurements available which adequately predict a difficult airway given the unpredictable nature of airway conditions. Point-of-care ultrasound of the airway has emerged as a more useful and reliable non-invasive tool to anticipate possible challenges and optimise airway management strategies, although more research is warranted.^{6,16-21}

Furthermore, the root cause analysis in case of an airway incident may be difficult to sort out when things go awry, while the intubator is under time pressure to understand the problem and to make quick accurate decisions regarding the best approach to manage the airway.

Optimal management of airway problems requires a multifaceted approach that involves preparation, assessment, technical proficiency and the use of appropriate tools and strategies.

Successful airway management requires proficiency in various techniques, including face mask ventilation, the use of supraglottic airway devices, endotracheal intubation and cricothyrotomy. Effective airway management requires extensive knowledge, skills, experience, and continuous training as the manufacturing industry continuously provides us with extensive new technological airway devices. However, even despite good glottic views with both direct and indirect views, ETT placement can be difficult in one in 20 patients.²² Once the airway device (ETT/SAD) is in place, confirmation of adequate placement is warranted. Use of subjective tests (auscultation, palpation, inspection, tube misting, esophageal detector device, caloric capnography) lack a high sensitivity and specificity, leading to false positive/negative results. Even the gold standard, using continuous waveform capnography, does not always guarantee confirmation of the exact position of the airway during tracheal intubation.

What is the potential of videolaryngoscopy and video laryngeal mask airways?

New techniques to visualise the insertion, position and function of the airway device have emerged to help the anesthesiologist to manage the airway, using a videolaryngoscope (VLS) or videolaryngeal mask airway (VLMA), incorporating a videoscope. The question raises whether this new equipment can adequately identify the anatomical structures during insertion of an ETT or SAD?

Videolaryngoscopy

Videolaryngoscopy is an advanced technique in airway management that offers several advantages over traditional direct laryngoscopy thanks to the ability to the enhanced view of the glottis and the display of the airway view on the monitor screen due to:²³ (a) its improved glottic visualization and surrounding structures, which is especially beneficial in cases where direct laryngoscopy might fail; (b) its ability to view the airway structures in real-time on a screen for the whole team, allowing shared visualization, better monitoring and adjustment during intubation, potentially increasing patient safety; (c) its higher first-attempt intubation success rates, even in patients with difficult airways; (d) its association with lower rates of oxygen desaturation during intubation, which is critical in maintaining patient stability during the procedure; (e) its excellent educational tool for training and education of new practitioners and its shorter learning curve compared to traditional methods; (f) its fewer adverse events during intubation as it requires less forceful manipulation causing less likely trauma to airway structures; (g) its versatility of the device in various clinical scenarios, including emergency settings, operating rooms and intensive care units, highlighting its effectiveness across different clinical environments; and (h) its recording and capturing image options, which is useful for clinical documentation, future reference and can help analyzing intubation techniques and outcomes.^{24–40}

Given that the digital camera and light source are mounted very close (2–3 cm) to the tip of the laryngoscope and close to the larynx, a VLS consistently offers a better and four times larger angle of view of the oropharynx and larynx (60 °) than with classic (direct) laryngoscopy (15 °). With classic laryngoscopy, the distance between the laryngoscope's eye and the vocal cords is about 30–40 cm, reducing the angle of view.³⁰ However, there are still blind spots when using a VLS, leaving the intubator unaware of the location of the tip of the ETT till it appears on the monitor screen, potentially leading to unrecognized airway trauma, especially when rigid stylets or forceful insertions are used.^{31,32} It has been shown that the space between the right side of the flange of the laryngoscope blade and the palatopharyngeal wall substantially differs across various VLSs, reducing the available space for insertion of the ETT, making the tracheal intubation prone to mucosal trauma of the oropharynx.^{31–33} Therefore, ETT insertion and advancement should be visually controlled and gently advanced beyond the uvula and palatopharyngeal fold using direct vision of the oropharynx to ensure that tissue planes are not violated, potentially causing trauma.^{31–33} Subsequently, the intubator's attention needs to be focused on the monitor screen to further navigate the ETT into the correct tracheal position by observing its passage on the monitor screen of the VLS.

Furthermore, despite good illumination and visibility of the mouth using superior light sources resulting in adequate vision, tracheal intubation may still be difficult or even impossible using a VLS. This may require additional devices, i.e., gum elastic bougie, stylet, or an angulated blade as the anatomy may differ in patients. And yet, oropharyngeal injuries still occur after instrumentation of the mouth in patients with morbid obesity, a massive tongue, or prominent canine teeth, and using e.g., blind insertion of an ETT,

a rigid stylet, double-lumen or orogastric tube, and insertion of a stiff temperature or transesophageal echocardiography probe.

Not all VLSs produce the same oropharyngeal and laryngeal view. It is therefore crucial for anesthesiologists to understand the differences between the different existing brands of VLSs, both channelled and non-channelled devices and the design and size of the blades used.^{34–40} Even when labelled a Macintosh blade, there are subtle differences between the different VLS brands, similar to the design of the difficult VLS using an acute angled blade. Each manufacturer of VLS has its specific blade length, width and curvature. Familiarity with the different VLSs is important. The authors advise to try out a new VLS first on manikins and make an informed decision on which VLS suits them best to practice on patients. Although obviously cost is an important factor, videolaryngoscopy is the way forward.^{23,40}

Videolaryngeal mask airways

SADs are frequently used devices as the intended primary airway technique in many surgical interventions. In addition, they also have a definite place in case of a difficult or failed tracheal intubation and in emergency situations.^{7–9,11} Their vital rescue role is clearly demonstrated as they can serve as a conduit to facilitate flexible bronchoscopy and visually guide an ETT in position. However, blindly inserted SADs often sit suboptimally. Various techniques have demonstrated that SAD insertion results in suboptimal positioning in 50–80% of cases, although that does not automatically mean that all will result in a failed airway.^{41,42} SADs are very forgiving devices and even when suboptimally positioned, they still can function more or less to satisfaction. But as not all SADs sit well, adequate gas exchange may be compromised.

However, if one opts for the best possible position and functioning of the airway device, a vision-guided insertion technique is the preferred method, as it allows maneuvers to optimise its position in the airway.⁴² Initially, direct or indirect laryngoscopy was used to insert an SAD. However, that resulted in a cramped situation of several airway devices in the limited space of an oropharynx. Adjusting the VLS blade by making it thinner, may help to create more room to improve placing the SAD in the correct position.

A further step is the introduction of a third-generation SAD, i.e., a videolaryngeal mask airway (VLMA), whereby a reusable videoscope is inserted in a blind-ending canal of the SAD, allowing to see the insertion process and its positioning in the hypopharynx. Van Zundert et al.^{43–45} made a case for a 3rd generation SAD facilitating direct vision placement and described features, characteristics, advantages and disadvantages of some of the new vision incorporated third-generation VLMA.

Indeed, several manufacturers produced various VLMA.^{46–55} The Totaltrack™ (Medcomflow S.A., Barcelona, Spain) VLMA combines a laryngeal mask with a VLS designed for simultaneous supraglottic ventilation and tracheal intubation under continuous visualisation in patients with anticipated and unanticipated difficult airway without the need for adjuvants, in contrast to fiberoptic tracheal intubation through a supraglottic airway.⁵¹ Other VLMA

include the Safe Comfortable Video Laryngeal Mask, SaCoVLM™ (Zhejiang UE Medical Corp, Hangzhou, China); and the SAFELM™ Video Laryngeal Mask System, with an adjustable view angle (Changsha Magill Medical Technology Co. Ltd, Changsha, Hunan, China).⁴⁴ These VLMA include a ventilation and intubation channel, a gastric tube channel, a separate dead-end visual channel for the videoscope, connecting the camera to the monitor screen. The reusable flexible electronic camera (focal length 7 mm, angle 90°) is connected with a wire to a remote screen (8 inch, SaCoVLM™) or sits on top of the device (3 inch, SAFELM™).⁴⁴

Initial tests performed on clinical patients by several researchers show promising results. VLMA combine the benefits of a 2nd generation SAD with continuous visual guidance during its insertion on the monitor. As such, VLMA can be considered a new monitor in airway management.⁵⁶ This visual placement helps ensure confirming correct positioning, reduce the risk of misplacement and allows maneuvers to correct them if necessary. Furthermore, if an ETT needs to be placed in the trachea, the VLMA allows its visual insertion. These studies show an increased first-attempt successful insertion rate of ETTs using these devices.

What brings the future?

Preoperative endoscopic airway examination can help anesthesiologists to understand any existing airway problem and help them to directly view the airway anatomy, avoiding imaging examinations (X-ray, CT-scan, MRI).

Both VLSs and VLMA allow recording of images taken during the insertion of the devices. These images should go into the (electronic) patient file, to better inform future anesthesiologist about any problem with the airway.

Artificial intelligence (AI) is a powerful tool which can accurately detect anatomical airway structures during insertion of an ETT or SAD and perform insertion time-sequence analysis involving the deconstruction of VLS-recorded images into several phases, using an AI model trained YOLO (You Only Look Once) algorithm.^{57,58} Using AI-based approach to detect tracheal intubation-related anatomical structures in the airway tract by analyzing VLS images and an automatic AI-based detection model to shorten the total tracheal intubation time.⁵⁸ Applications (Apps) available for predicting difficult airways are designed to help anesthesiologists in avoiding serious anesthetic complications, although undoubtedly will raise new questions.⁵⁷

If airway management would be in the 'cockpit of an airplane', modern airway devices like a VLSs or VLMA would be the standard equipment to visualize which way to go. Indeed, what we can see, we can do better. It is time to forget using 'blind' or outdated equipment and substandard technology. Blind intubation through an SAD is no longer an acceptable technique. All anesthesiologists should stand up for their patients and colleagues and do their utmost best to convince hospital administrators to provide them with essential equipment, not only for unique difficult cases but for standard optimal use in every patient, as a difficult airway may arise out of the blue.

Nevertheless, besides adequately evaluating and critically judging, comprehensive planning and correct prepa-

ration of any airway situation, up-to-date knowledge and regular appropriate training is part of a successful anesthesiologist keeping up with the advanced skills and experience, which is paramount in taking care of the patient's airway.

Limitations

We still need to determine what is an ideal VLS and we still need more cameras attached to VLMA to see all aspects of the positioning of the SAD, showing the 1st and 2nd seal of the airway, and to check whether the size of the device in situ, is the correct one to obtain an optimal functioning airway device. We need to be aware that despite all these technical advantages, there still will be situations where neither the VLS or VLMA will lead to an adequately functioning device. Therefore, we still need to adhere to the airway guidelines to minimize risks and be prepared to use exit strategies options.

Visual checks using VLSs and VLMA significantly enhance airway management by improving visualization, increasing success rates, and serving as valuable educational tools. These devices are more expensive which may limit their availability. However, despite the direct cost involved and some technical challenges (the camera lens can fog up or become obscured by secretions), the benefits they provide in both routine and difficult airway management scenarios, can make them cost-effective and highly valuable in modern anesthesia practice. Regular training and practice with these devices are essential to fully leverage their advantages.

Conclusions

Difficult airway management is challenging to reliably predict. As the literature on airway management evolves, anesthesiologists need to update guidelines, recommendations and accepted principles of optimal management in case of airway problems and use optimal equipment. Video-laryngoscopes (VLSs) have emerged as a safety net offering several advantages over direct laryngoscopy (DL), including offering a four-time larger angle of view of the oral cavity. However, we plea for standard VLS use, not incidental use, as the success of intubation will increase when VLS is used routinely in all situations. VLMA are very promising devices. Blind insertion of SADs or blind insertion of an ETT through a SAD is no longer an acceptable technique, while valid alternatives are available, avoiding complications and a high failure rate. Therefore, vision-guided insertion of ETTs or SADs is the way forward in all circumstances of airway management.

Both VLSs and VLMA are excellent teaching and research tools, allowing instructors, supervisors and researchers to verify exactly what the (trainee) intubator sees allowing real-time guidance. For novices in airway management, the learning curve is much shorter compared to traditional methods, i.e., using classic direct laryngoscopy and blind insertion of an SAD. But it is not the end. Artificial Intelligence and other technologies may bring further changes to the non-stop search for ideal tools to maximize correctly positioned and optimally functioning airway devices. However, we should consider VLS equipment and VLMA as the new gold standard in airway management.

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Declaration of competing interest

None.

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