Review article

Learning Intubation with Video-Assisted Optical Devices or with Direct Laryngoscopy - Differences in the Success of Intubation and Learning Curves

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Abstract

Rapid laryngoscopy and intubation are essential for maintaining the airway in the management of patients with impaired consciousness, in patients during induction of anesthesia, and in intensive care units. By examining the patient in advance and using rating scales, it is possible to predict who will have difficulty with laryngoscopy and intubation. Special types of laryngoscopes are among the equipment necessary for difficult airway management. The choice of equipment contributes to successful intubations and fewer attempts. One of the most widely used devices is certainly the video laryngoscope, which comes in different variants. Studies on models in prehospital and hospital settings have shown that video laryngoscopy shortens the time to visualize the vocal cords and increases the success of intubation on the first attempt. This paper provides a brief overview of the most commonly used devices for video-assisted intubation and presents results from studies comparing intubation success with different devices. This paper aims to provide a useful review of commonly used video-assisted intubation devices and compare their effectiveness, for all the specialties performing intubation without prior experience in anesthesiology or intubation.

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Introduction

Breathing is a basic life function, and the respiratory system enables us to exchange oxygen and carbon dioxide, the gases of respiration, between the atmosphere and the blood and vice versa. The process of breathing is divided into four main functional parts for easier understanding: the regulation of breathing, pulmonary ventilation, the diffusion of oxygen and carbon dioxide between the alveoli and the blood, and the transport of oxygen and carbon dioxide by the blood to and from the cells (1). The respiratory tract is divided into the upper; nasal cavities, paranasal sinuses, oral cavity, naso-, oro- and hypopharynx, larynx and trachea, and the lower respiratory tract; right and left main bronchus, lobar and segmental bronchi, bronchioles and alveoli (2, 3). The alveoli serve exclusively for gas exchange. The volume of anatomical dead space in adults is about 2 ml/kg of body mass. In healthy, spontaneously breathing individuals, dead space is minimal, averaging approximately 150-200 ml (1, 3, 4).

Maintaining a patent airway is an essential task of resuscitation. Anesthesia also interferes with and disrupts the function of the respiratory system in many ways. It affects the mechanics of breathing, gas exchange in the lungs, control of breathing via central and peripheral receptors, affects metabolism, and alters the immune activity of cells in the lungs (3). Good airway management is essential for perioperative patient safety in resuscitation and anesthesia (2, 5).

Airway maintenance equipment

Several aids are used to maintain the airway. These are nasopharyngeal and oropharyngeal tubes (airway), supraglottic devices for ventilation such as classic laryngeal mask, flexible laryngeal mask, I-gel and different types of endotracheal tubes. Tubes are usually divided into orotracheal or nasotracheal, according to the type of material into silicone, reinforced, and according to the structure into single-lumen or double-lumen, uncuffed tube and Murphy's endotracheal tube. Various types of laryngoscopes are used to place the endotracheal tube and to visualize the vocal cords (2, 5).

Visualization of the airway

The most challenging part of intubation is visualization of the airway itself. In general anesthesia, this is done after the initial denitrogenation of the patient, in which the patient breathes spontaneuosly while receiving 100% oxygen before induction of anesthesia. The patient is then induced into anesthesia by administering sedatives, analgesics, and muscle relaxants intravenously, along with continuous ventilation of the patient, which together create the optimal conditions for an intubation attempt (3, 4). When the appropriate conditions are established, the patient's head is gently tilted back, the laryngoscope's oral part is introduced with one's left hand on the right side of the mouth, and the tongue is pushed to the left. The glottis is visualized by advancing and elevating the laryngoscope.

This creates the conditions for placing an endotracheal tube (3). The situation is somewhat different for patients who are intubated in the field. In these patients, there is often no time for preoxygenation, and the use of drugs for sedation, analgesia, and relaxation is often not possible. Therefore, in the field and in emergency settings, patients are often intubated without the use of drugs, which can result in reflex spasm of the muscles of the pharynx and airway (3). Bronchospasm, straining, vomiting, and episodes of desaturation are common in such emergency intubations.

Laryngoscopy

Laryngoscopes are a type of airway maintenance device that allow visualization of the laryngeal entry during endotracheal intubation. The blunt tip of the oral extension of the laryngoscope goes down the front of the tongue and reaches the depression between the base of the tongue and the epiglottis-vallecule (2, 3). They consist of a metal handle in which the batteries are inserted, and a mouthpiece on which the light source is located. The basic shape is represented by Miller straight extension and Macintosh curved extension. There are numerous modifications of traditional laryngoscopes on the market, which were designed precisely with the aim of adapting to the problems of difficult intubation (2, 3).

Intubation

Rapid and accurate intubation is essential for patient safety. It is performed to avoid complications such as hypotension and hypoxemia. The most common cause of complications during anesthesia is human error, often associated with poor supervision, faulty equipment, poor work organization, and the effects of medications.

Risk groups for anesthesia are most often assessed according to the American Society of Anesthesiologists (ASA) classification (4, 6). Complications due to the patient's condition are most often associated with emergencies, age over 70 years, and ASA classifications III, IV, and V. These are accompanied by complications that are the consequences of surgical disease and surgical procedure (4). The ASA classification helps in the preoperative assessment of the patient, and complications are expected in the perioperative period according to the patient's condition. It classifies patients into 6 risk categories, of which E (emergency) is a separate category, which is added after the ASA status assessment, and indicates an urgent surgical procedure (2, 3). In addition to the ASA classification, the expected difficulty of intubation is an important factor in effective preparation.

The modified Mallampati classification (MMC) is most used to assess intubation difficulty. It evaluates the size of the base of the tongue compared to the oropharyngeal opening, with the mouth maximally open. An important component of this test is maximum tongue protrusion without phonation (3, 6). The goal is to predict possible difficult endotracheal intubation. MMC is divided into the following four classes:

a. Class I. visualization of the soft palate, uvula, and palatal arches

b. Class II. visualization of the soft palate, uvula, and part of the palatal arches;

c. Class III. visualization of the soft palate and base of the uvula

d. Class IV. visualization of the hard palate only

Patients with grades three or four are at high risk of difficult intubation, which is important for the anesthesiologist to plan and predict interventions during intubation (3).

The Cormack-Lehane classification is based on the visualization of the anatomical structures of the glottis and the surrounding region. It is often used as another indicator of difficult laryngoscopy and intubation. The Cormack-Lehane classification classifies the visibility of the glottis into four grades:

a. Grade I. complete visualization of the glottis,

b. Grade II. partial visualization of the glottis or arytenoid cartilages,

c. Grade III. visualization of the epiglottis only, and

d. Grade IV. inability to visualize the glottis and epiglottis (3).

In general, the risk of difficult intubation is predicted by the inability to visualize the vocal cords. In the Cormack-Lehane classification, difficult intubation is expected in grades three and four, which is important for the eventual planning of possible interventions (2, 6).

In addition to these two most common tests for assessing difficult intubation, the Wilson score is also used, which includes the patient's weight, head and neck mobility, jaw mobility, chin retraction, and tooth size. Useful information that can help predict the risk of difficult intubation is provided by the thyromental distance between the chin and the upper edge of the thyroid cartilage of the larynx, the sternomental distance between the chin and the notch between the clavicles, the mouth opening test, and the upper lip bite test, as well as any combination of these tests (3, 4, 7).

Intubation complications

First-attempt intubation success is defined as the one that is performed within the first attempt of laryngoscopy, after which the patient is intubated with one tube. In that case (3, 6) the apnea time is the shortest. A successful intubation is also the one in which the tube has to be changed after the first laryngoscopy, or the tube must be placed over the bougie (4). In the study by Trent et al. the data of 1,863 critically ill adult patients who were intubated in the emergency department or intensive care unit (ICU) were analyzed. The time required for successful intubation was increased by 35 seconds when multiple intubation attempts were required after the first successful laryngoscopy (4).

The advantages of rapid and successful intubation on the first attempt are numerous, and the most important for the patient is the avoidance of hypoxemia. The most common complications of anesthesia are hypertension, hypotension, tachycardia, bradycardia, hypoxemia, and hypothermia. They are the main cause of anesthesia mortality. The complications that occur are most often described as respiratory problems (38%), cardiac problems (25%), and equipment problems (8%) (2, 3, 8). Respiratory complications during intubation include the following: oral and upper respiratory tract injuries, bleeding, soft tissue edema, dental injuries, tracheobronchial foreign bodies, esophageal intubation, possible aspiration of gastric contents, laryngospasm, bronchospasm, muscle spasms, and inability to open the mouth (3, 6, 7).

Difficult intubation

Difficult intubation is defined as the inability of an experienced physician to insert an endotracheal tube after 3 attempts. There are three possible situations of difficult intubation: difficult ventilation, difficult intubation, and difficult ventilation and intubation (5).

In case of difficult ventilation, ensuring oxygen delivery can be achieved by placing a laryngeal mask, I-gel mask, esophagophagotracheal combitube, or the patient must be intubated. If ventilation cannot be performed with a face mask, laryngeal mask, I-gel mask, or combitube, and difficult intubation is anticipated, a decision can be made to intubate a sedated patient or to try intubation after administration of general anesthetics. Alternative methods if intubation fails are blind orotracheal or nasotracheal intubation, intubation using a fiberoptic laryngoscope or fiberbronchoscope, retrograde endotracheal intubation, securing the airway surgically, or we can wake the patient up (2, 3, 5). In the case of anticipated or unexpected difficult intubation, assistance should be sought as early as possible.

In critical situations, when both ventilation and intubation are not possible, an emergency cricothyroidotomy or emergency tracheostomy can be performed (9). Rapid and successful intubation on the first attempt avoids all the above complications; if an expected difficult intubation is anticipated, additional equipment may be used. The most used will be reviewed and listed.

Auxiliary equipment for intubation

"Airtraq" is a fibreoptic intubation device used for indirect laryngoscopy that greatly simplifies orotracheal intubation. It is a light, portable, anatomically shaped, single-use device with two channels: an optical channel and an endotracheal tube channel. It enables a better visualization of the vocal cords and thus increases the success of intubation. It provides a visualization of the intubation procedure on the screen (3, 5, 10).

Fiberoptic laryngoscopes and bronchoscopes are optical instruments used for diagnostic purposes, airway lavage, and as an aid in difficult intubation (Figure 1). Both devices have two bundles of optical fibers: one transmits the image, and the other conducts and delivers light. The working channel through which airway contents can be aspirated allows for the collection of material for biochemical and bacteriological analysis and for the administration of drugs. A fiberoptic laryngoscope and bronchoscope should be an integral part of the airway maintenance kit (2, 3, 11).

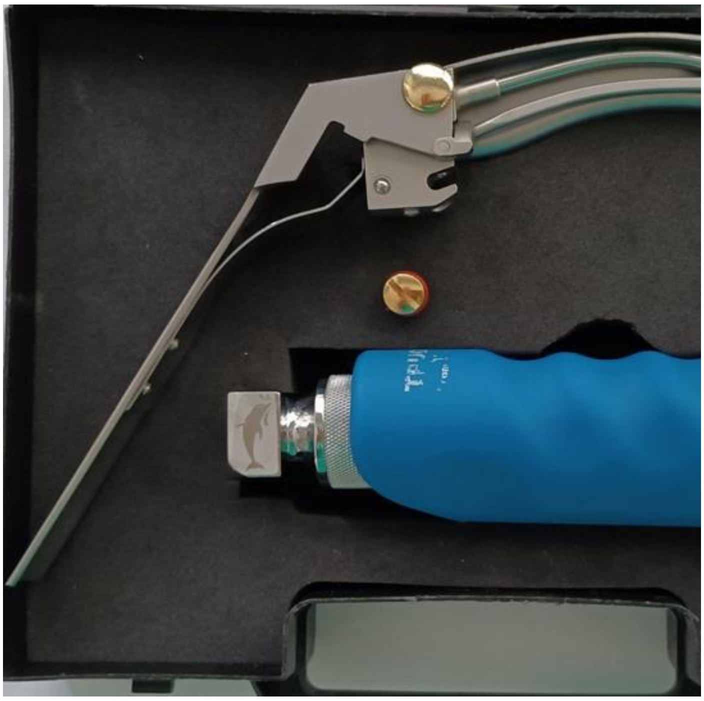

Figure 1. Fiberoptic laryngoscope with a movable tip attachment for easier visualization of the vocal cords in difficult intubation

Optical stylets contain an optical element and a light source in a single shaft, like a stylet. Typical such devices are the Shikani Seeing Stylet and the Bonfils Intubation Fiberscope. Both require less cervical spine movement than direct laryngoscopy (10).

The Bonfils Intubation Fiberscope (BIF) is a long, rigid, tubular instrument with conventional optics and light elements. The distal end is curved to 40 degrees, and the objective lens provides a 100-degree field of view. The proximal eyepiece can be used with the naked eye or the device can be connected to a standard endoscopic camera and displayed on a screen (Figure 2). A cable provides light from an external source, and suction can be performed through the working channel. The laryngoscopy technique uses a paraglossal approach and comes in three sizes: 2, 3.5, and 5 millimeters.

The Shikani optical stylet (SOS) has a configuration similar to the BIF, except that its distal end is flexible. The light source can be external, internal, or from the handle of the laryngoscope (3, 12) (4).

Unlike BIF, the SOS uses a midline approach. The SOS can be used as a stand-alone intubation tool or added to direct laryngoscopy when the patient has a high Cormack-Lehane score. Although the use of the SOS reduces the range of motion of the cervical spine, laryngoscopy was prolonged with the SOS (28 +/- 17 sec) compared with the Macintosh blade (17 +/- 7 sec), $P < 0.01$, with a higher number of unsuccessful laryngoscopies (12).

Figure 2. Learning intubation - facilitated visualization of the vocal cords in difficult intubation using the Bonfils optical stylet with image display on a freestanding screen.

The Levitan First Pass Success (LPFS) Scope is a shorter version of the SOS, 30 centimeters long, designed for direct laryngoscopy when good visibility cannot be achieved. Its length helps better positioning of the classic laryngoscope, as it is necessary to shorten the standard tracheal tubes so that the objective lens is inclined. The hypothetical advantage of using this device is reducing the percentage of unexpected difficult intubations and skills in using similar devices in daily practice. In clinical studies comparing the assurance of good glottis opening between this device and the Macintosh laryngoscope, a higher percentage of glottis opening with the Levitan FPS than with the Macintosh laryngoscope was observed (80% vs. 20%). This better visibility did not affect the success of intubation, the speed of intubation, nor did it reduce the side effects of intubation, such as sore throat, mucosal trauma or hemodynamic response (13).

The Clarus video system combines a flexible SOS distal end with complementary metal-oxide-semiconductor (CMOS) technology. It has a movable light-emitting diode (LED) screen on the handle and video input. This device also contains a transilluminator technique with a distal, anteriorly placed red diode that can be seen through the skin when the tip of the device is in the larynx (3, 5). The study by Moon and associates confirmed that the learning curve of intubation using the Clarus video system in untrained novice practitioners is satisfactory. The first intubation attempt lasted 106.8 ± 120.3 s. The next 5 intubation attempts were performed significantly faster, with an average time of 36.0 ± 26.8 s, without lip laceration, dental trauma, or mucosal bleeding (14, 15). When a trained practitioner uses the device, intubation time is even shorter. For urgent intubation, it was slightly faster with the Clarus video system (14.6 s [95% CI, 11.1 to 18.0]), and for intubation with direct laryngoscopy, an experienced practitioner needed 16.5 s [95% CI, 15.7 to 17.3](16).

Video laryngoscopes

Videolaryngoscope (VL) is a device that is placed like a classic laryngoscope, and the image is displayed from the top of the optical beam located at the distal end of the laryngoscope extension. The field of view moves away from the tongue, enabling intubation without direct visibility of the glottis (2). The image during videolaryngoscopy can be displayed on the screen above the laryngoscope handle or on a stand-alone screen. (Figure 3).

Although some anesthesiologists believe that starting to learn intubation with a video laryngoscope reduces the speed and skill of direct laryngoscopy, other authors consider it a good educational tool, which simultaneously facilitates learning, shortens the learning time, and reduces the risks of intubation (17).

Figure 3. A training of endotracheal intubation on a mannequin using a video laryngoscope. A small video monitor is attached to the laryngoscope handle, displaying a magnified view from a camera located near the tip of the blade, allowing a shared view and realistic medical training on a simulator.

The advantage of a video laryngoscope is reduced head and neck movement compared to a conventional laryngoscope. This is of particular importance in patients with cervical spine injuries who have cervical collars or in patients with cervical spine immobilization. The first video laryngoscope in widespread use was the Glidescope. Its mouthpiece had a light-emitting diode and a CMOS chip that was connected to a liquid crystal display (LCD) monitor by a cable. The distal part of the mouthpiece was curved at 60 degrees and was therefore called a sharp-angle video laryngoscope. Its design has several advantages. It can be used similarly to a conventional laryngoscope, since the camera is placed near the distal end of the mouthpiece, the user sees from a perspective deeper than the base of the tongue, and the tongue's position is not crucial for the view, as with a conventional laryngoscope. For a similar reason, tonsillar hypertrophy does not significantly affect visualization during intubation, as it does with a conventional laryngoscope. The camera eliminates fragile fiberoptic elements, and the image is available on the screen, enabling observation by other people (3, 5, 14). When used by inexperienced operators, the Glidescope provides better visualization of the glottis than the classical laryngoscope and can provide a Cormack-Lehane grade one or two visualization in 77 percent of patients in whom there was no visualization of the glottis with a classical laryngoscope (12). The success rate of intubation with a video laryngoscope is 97 to 98 percent (10).

Classic Glidescope placement follows a midline approach. Once the uvula is visualized, the extension is continued to the vallecula or posterior to the epiglottis. Complications of intubation are most often associated with blind manipulation of the endotracheal tube, without a video screen, and include traumatic injury to the soft palate, palatoglossal angle, and right tonsil. To avoid airway trauma, ensure that the stylet is within the slope of the endotracheal tube and maintain the tube in the midline as close to the oral appendage as possible. The user must focus on the patient's oral cavity and monitor how the videolaryngoscope and endotracheal tube advance in the mouth; avoid tilting the laryngoscope inward, as this increases the dead angle; avoid applying force to advance the tube; and practice reverse tube placement (3, 18). Reverse placement involves bending the distal part of the stylet in the opposite direction to the tube's normal inclination. This results in a more posterior placement of the tube and reduces the possibility of snagging on the anterior commissure or tracheal rings. A new version of the Glidescope, the Glidescope titanium, is available, functionally identical to its predecessor, made of titanium and featuring two standard curved lip tips. Disposable plastic versions are also available (12, 19).

A multicenter study by Aziz et al. involving 1755 patients confirmed that intubation was successful in 98% of patients in whom laryngoscopy was performed with Glidescope, while the success rate was 93.4% in the C-MAC group. There was no difference when laryngoscopy and intubation were performed by experienced anesthesiologists (20). Further analysis of these laryngoscopies showed that 301 were assessed as difficult. Factors associated with difficult laryngoscopy were difficult mobility and position of the head and neck, type of surgery, and provider level (21). Intubations performed by supervised residents had an Odds ratio of 1.83 to be identified as 'difficult videolaryngoscopy' than those performed by experienced providers (21).

The C-MAC system consists of an electronic handle with interchangeable metal mouthpieces. One of these, the D-piece, is a sharp-angled extension similar to the Glidescope mouthpiece when extremely difficult intubation is expected. The C-MAC also has mouthpieces identical to the classic Macintosh and Miller mouthpieces, but they are integrated with illumination and CMOS optics. This allows the device to be used both as a video laryngoscope and as a traditional laryngoscope. The image obtained with the C-MAC resembles that visible to the naked eye (Figure 4).

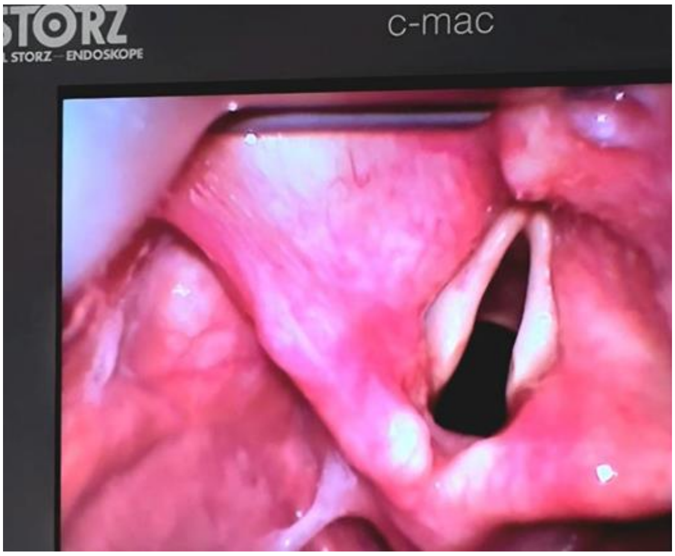

Figure 4. View of the vocal cords using the C-MAC laryngoscope with the vocal cords displayed on a freestanding display.

However, tube placement is facilitated because the need to maintain an unobstructed view of the glottis is reduced (Figure 5). The use is identical to that of the classic laryngoscope, which is of great importance when learning supervised intubation itself. It is believed that the use of the C-MAC has greatly improved the success of intubation (3, 5, 18).

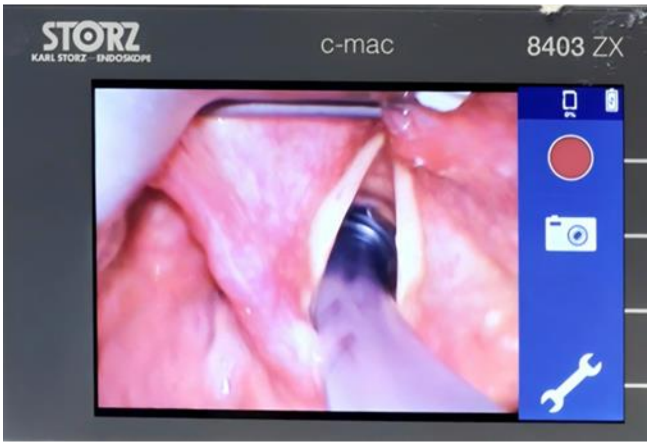

Figure 5. Display of the passage of the endotracheal tube through the vocal cords using C-MAC with display on a freestanding screen.

The McGrath Series 5 video laryngoscope consists of a mouthpiece, handle, power supply, and LCD display. It is unique in that it has a curved mouthpiece with a guard that can be adjusted in length to suit the patient. Similar to the Glidescope, the curved mouthpiece improves visibility of the larynx, but it has its drawbacks when placing the tube itself, so the use of a rigid tube or a tube with a stylet is recommended (3, 22). A study by Shipey et al. reported a 98% success rate for intubation with the McGrath in 143 patients. The authors measured that the average time required to achieve an optimal view of the larynx was 6.3 seconds, and for intubation was 24.7 seconds (22). The McGrath Mac is a newer generation of McGrath video laryngoscope with a reduced curvature and a narrower mouthpiece, compared to the McGrath Series 5. The reduced curvature makes it easier to use, and it has a screen that can be shared. Using this video laryngoscope reduces the blind spot compared to the classical laryngoscope and improves avoidance of soft-tissue trauma. The blind spot can be reduced due to the narrower design of the McGrath X mouthpiece and screen, which is used in anticipated difficult intubations (3, 18).

A new generation of video laryngoscopes, called channelled laryngoscopes, features a J-shaped channel that provides a view behind the tongue and produces a nearly 90-degree image of the oral cavity and pharynx, reducing the need for neck manipulation and tissue movement. The lubricated tube is placed on the channel before starting intubation and follows the same path as the video laryngoscope. Once a good view of the glottis is established, the tube is moved down the canal until it reaches the larynx. In theory, because the trachea is never at the death angle, this approach should reduce the soft-tissue trauma seen with the classic laryngoscope (3, 18).

The Airtraq optical laryngoscope is an anatomically shaped, channeled laryngoscope with a periscopic optic for single use. This device has a built-in anti-fog system and a cold light that improves the view of the larynx. The Airtraq has been shown to be successful in patients with failed intubation with a conventional laryngoscope. The force applied to the tongue is less than usual with this laryngoscope, but there is still some cervical spine movement in patients with axial immobilization (12). The Airtraq AVANT functions similarly, but the difference is in the multiple prismatic optics found in the disposable mouthpieces (3, 5). In a study by Hindman et al., comparing the forces and movements of the cervical spine during intubation with the Macintosh and the Airtraq laryngoscope, it was confirmed that the forces and movements of the cervical spine differed most at the best glottic view stage. Greater force was required for intubation with a Mackintosh laryngoscope (48.8 ± 15.8 versus 10.4 ± 2.8 N), while extension at the occiput-C5 level was 29.5 ± 8.5 vs. 19.1 ± 8.7 degrees (P = 0.0023) with Mackintosh compared to Airtraq laryngoscope, respectively (23).

In the study by Fras et al. from 2016, 47 paramedics performed intubation with Airtraq Avant devices and conventional Macintosh laryngoscopes in situations without chest compressions (CC) and in a simulation of resuscitation with CC on a mannequin (24). Paramedics successfully performed all intubations with both devices without CC. In the situation with CC intubation success rate was 82.9% vs. 91.5% (p=0.021) for MAC Laryngoscope vs. Airtraq Avant, respectively (24). These results confirm that Airtraq Avant provides benefits when used by paramedics in terms of glottic view, intubation success rate, and intubation time compared with conventional Macintosh during continuous chest compression (24).

The Airway Scope is a reusable device, channeled by a CMOS camera, which has a disposable mouthpiece. The handle contains an LCD monitor with an adjustable viewing angle. The mouthpiece channel accepts a tube with a diameter between six and a half and eight millimeters and can also be used to place smaller suction catheters, etc. It is recommended to lift the epiglottis with the mouthpiece before placing the tube (3, 25). A comparative analysis showed that novice healthcare providers in simulated tracheal intubation scenarios using a normal airway mannequin intubate on average 3 seconds faster using the Airway Scope compared to the McGrath MAC, and AceScope device intubation (11). Likewise, in the cervical spine immobilization model, the speed of intubation was significantly faster using the Airway Scope (4 to 6 seconds, $p < 0.05$). In intubation performed by novice healthcare providers using McGrath MAC in the cervical spine immobilization model, a significantly lower rate of dental injuries was recorded compared to AceScope use ($p < 0.05$) (11). In a study by Malik et al from 2008, Pentax AWS and Glideoscope were compared to Macintosh when used by experienced anesthetists. The authors have shown that the rate of successful tracheal intubation was again lower with the Macintosh (84%) compared with the Glidescope® (96%) or the AWS® (100%) (26).

The KingVision video laryngoscope includes a reusable, battery-powered LED screen and disposable channeled and non-channeled mouthpieces (Figure 6). Therefore, it can be used as a classic laryngoscope or as a video laryngoscope (3) (Figure 7).

In a 2019 study, authors Zhu et al examined the performance of nasotracheal intubation using King Vision, McGrath and Macintosh VL. The intubators were experienced with more than 100 successful nasotracheal intubations using each device. The times of laryngoscopy, intubation and success rate in expected difficult intubations were measured (11).

Figure 6. KingVision video laryngoscope for anticipated difficult intubation

Figure 7. View of the vocal cords and airway entrance prior to endotracheal tube placement in a patient with unexpected difficult intubation using the KingVision videolaryngoscope

Laryngoscopy time was the same when using the King Vision and McGrath video laryngoscopes (16.7 ± 5.5 s vs. 15.6 ± 6.3 s) and shorter than the Macintosh direct laryngoscope (22.8 ± 7.2 s, $p < 0.05$) (27). King Vision and McGrath intubation times were similar (37.6 ± 7.3 s vs. 35.4 ± 8.8 s), while both times were shorter than the time required for Macintosh intubation (46.8 ± 10.4 s, $p < 0.001$). The King Vision and McGrath groups had a first-attempt intubation success rate of 100%, significantly higher than the Macintosh group (85%, $p < 0.05$) (27). This study confirmed that the use of a video laryngoscope during difficult intubations significantly increases the success rate of the procedure.

To summarize studies on the effectiveness of videolaryngoscopy for intubation, Gunning et al. conducted a meta-analysis of 19 relevant studies in 2025. The success of intubation with a Macintosh video laryngoscope was compared with direct laryngoscopy when learning intubation (28). Unlike direct laryngoscopy, the video laryngoscope had a slightly higher success rate during intubation on the first attempt. The overall success of intubations with video and direct laryngoscopy did not differ significantly, nor did the intubation time. The heterogeneity of data, the variety of presentation of results, and the insufficient sample size make it difficult to compare individual studies (27).

The benefits of videolaryngoscopy in learning intubation are obvious, although only 15.7% of British anesthesiologists believe that videolaryngoscopy should be the standard of care (17). The reasons why anesthesiologists no longer use videolaryngoscopy are cost, risk of de-skilling in direct laryngoscopy, and no benefit from videolaryngoscopy (17). In contrast, in a large analysis of prehospital intubations in 1,279 patients, videolaryngoscopy was used in 64%. The success of the first intubation was 84% (n = 799) in the group that was directly intubated, and 92% (n = 443) in the VL group (28). These results, and results of several earlier studies, support the routine use of VL for use by inexperienced healthcare providers and in pre-hospital tracheal intubation.

Conclusion

With the advancement of all branches of medicine, especially surgical procedures, and the aging and obesity of the general population, there is an increasing trend toward patients with new and previously rare complications in the general population. Difficult intubation is also included in these complications. Despite all the studies mentioned, the most important conclusion from the above is that even the best equipment cannot replace clinial experience. Therefore, the greatest indicator of successful intubation on the first attempt remains the experience of the healthcare provider. No equipment will replace an experienced provider, so if we are not sure of a positive outcome, a call for help must not be delayed.

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Author contribution.

D.V. contributed to conception and design of the study, acquisition of data, analysis and interpretation of data, and drafting of the manuscript, and is guarantor of the study.
S.K. contributed to analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and final approval of the version to be published.
B.P. contributed to conception and design, administrative and logistical support, critical revision of the manuscript, and statistical expertise.
All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Podučavanje intubacije uz video-potpomognutu intubaciju ili direktnom laringoskopijom

Sažetak

Laringoskopija i brza intubacija ključne su za održavanje prohodnosti dišnih puteva kod pacijenata s oštećenom sviješću, kod pacijenata u anesteziji tijekom indukcije te u jedinicama intenzivnog liječenja. Prethodnim pregledom pacijenta i korištenjem ljestvica ocjenjivanja moguće je predvidjeti očekivane poteškoća s laringoskopijom i intubacijom. Postoje određene vrste laringoskopa koje spadaju među opremu za otežanu intubaciju. Pravilan izbor takve opreme doprinosi uspješnosti kod intubacija te manjem broju pokušaja. Jedan od najčešće korištenih uređaja svakako je videolaringoskop, koji dolazi u različitim varijantama. Studije na modelima u predbolničkim i bolničkim uvjetima pokazale su da videolaringoskopija skraćuje vrijeme vizualizacije glasnica i povećava uspjeh intubacije u prvom pokušaju. Ovaj rad ukratko opisuje najčešće korištene uređaje za video-potpomognutu intubaciju i osvrće se na rezultate studija koje uspoređuju uspjeh intubacije s različitim uređajima. S obzirom na sve veći broj specijalista koji izvode intubaciju bez prethodnog iskustva u anesteziologiji ili intubaciji, cilj ovog rada je služiti kao pregled različitih pomagala te njihove učinkovitosti.

Ključne riječi: laringoskopija, intubacija, intratraealna, krivulje učenja, video potpomognute tehnike i postupci