A New Video Laryngoscope - An Aid in Intubation and Teaching

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Original Article

Abstract

In recent decades, video techniques have been employed in the majority of endoscopic procedures because of several distinct advantages provided. These include the following: The displayed anatomy is magnified. Recognition of the anatomical structures and anomalies is easier, and manipulation of airway devices is facilitated. When assistance is required, the operator and assistant can coordinate their movements because each sees exactly the same image on the video monitor. As a result, video techniques have become the method of choice in teaching.

The Video Macintosh Intubating Laryngoscope System (VMS) was designed employing a standard Macintosh blade and laryngoscope handle. A camera was incorporated into the handle with a short image and light bundle. The magnified anatomy is displayed on an 8-inch monitor, which is attached to a swivel arm on a small cart. Observation and manipulation can be performed in one axis.

235 patients were studied and were divided into two groups: Group A (n=217) where intubation was thought unlikely to be difficult, and Group B (n=18) where difficulty with intubation was anticipated.

External laryngeal manipulation (ELM) was required in 22 of the 217 Group A patients (10%). All intubations but one in this group were successful. In the second group (B) of 18 patients who had anatomical conditions that suggested that direct laryngoscopy might be challenging, all 18 cases required ELM but all were successfully intubated using the VMS.

The improved coordination afforded by an image on a video monitor seen by both the assistant providing laryngeal manipulation and the anesthesiologist handling the laryngoscope results in a significant advantage over the conventional laryngoscope technique. As a consequence the learning curve is short. In our view, video laryngoscopy will become the method of choice in teaching.

Key words: Direct Laryngoscopy, Oral Intubation, Video Intubation.

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Introduction

The advantages of video techniques during endoscopic procedures have become obvious over the last three decades. In many disciplines *e.g.* gynecology, gastroenterology, head and neck surgery and general surgery, a TV monitor has replaced a small monocular eyepiece.[1,2,3,4] Three observations are critical in understanding this evolution: 1) the displayed anatomy is magnified, making recognition of anomalies and appropriate manipulation easier; 2) when assistance is required, the operator and assistant can coordinate their movements because they have exactly the same view on the video monitor; 3) video has become essential in teaching endoscopic procedures (general, thoracic, gynecological, and ENT surgery).

To facilitate laryngoscopy and tracheal intubation, Macintosh, Miller, and others modified the metal laryngoscope by adding a distal light bulb and a battery in the handle. [5, 6] These laryngoscopes have become the standard tools for practicing anesthesiologists despite certain shortcomings. One limitation of the use of the standard laryngoscopes is that they provide only a limited (keyhole) view through the mouth of the patient. A second limitation is that this view is available only to the laryngoscopist. Thus, in the event that laryngeal manipulation is required to optimize the view of the vocal cords, the assistant performs laryngeal manipulation because the intubator needs both hands to hold the laryngoscope and pass the endotracheal tube. The assistant cannot simultaneously see the effect of the movements performed in an attempt to improve the view of the vocal cords. This limitation of conventional laryngoscopy also surfaces when teaching intubation skills because there is no practical way for the instructor and student to have the same view of the airway.

To overcome these limitations a Video Macintosh System has been developed that includes the following components:

A. A television camera is incorporated into the handle of the laryngoscope. Thus, an enlarged image of laryngeal structures is provided. The “keyhole” view is eliminated because the image is displayed on a video monitor. (Fig. 1)

B. A modified Macintosh blade: The modified laryngoscope uses a Macintosh blade to accommodate the image light bundle. After introduction of the blade into the mouth, instead of looking alongside the blade, the anesthesiologist and the assistant observe the TV monitor. (Fig. 3 and 4)

C. A video monitor: Should ancillary movements be necessary, the assistant and the intubator can simultaneously see the effect of those manipulations which are required to bring the vocal cords into optimal position to achieve intubation. The video monitor (or a newer type of flat screen) allows an instructor to have the same view as a student laryngoscopist. (Fig. 5)

D. A universal cart: The cart accommodates all the components of the Video Macintosh System. The image of the larynx shown on the monitor can be recorded. (Fig. 2)

E. Flexible fiberoptic endoscopes with an MVM (Micro Video Module) incorporated into the handle can be plugged into the same camera control and light source as the Video Macintosh laryngoscope.

This report describes our initial experience with the Video Macintosh unit. The unit is now available commercially from the Karl Storz Company. (http://www.karlstorz.com/).

Materials and Methods

The Video Macintosh System (VMS) consists of a standard laryngoscope handle with the battery replaced by a small television camera (Micro Video Module = MVM) in the handle. A Macintosh blade is attached to the handle and a combined image/light bundle is threaded into a small metal guide in the blade. (Fig. 1) The camera cable is attached to a control unit and the light cable to the light source of the Video Macintosh unit. The illumination provided by the Video Macintosh Blade is 18.7 footcandles or 129 times greater than the standard battery powered Macintosh bulb illumination.[7] The system is installed on a small cart that is easily moved into position. The cart also supports an 8-inch monitor mounted on a swivel arm placed at the patient's left side. The monitor is positioned over the chest of the patient. This allows the intubator to work and observe in one axis. [Figs. 2-5]

The Intubating Laryngoscope is FDA approved (868.4450) and our application to the Institutional Review Board was granted. We used the Video Macintosh System (VMS) in 235 adults employing the same blade (Mac 4). No special preparation was required. A drop of antifog solution was placed on a small pad and the tip of the image/light bundle was treated with this material. All procedures were videotaped. Records were kept in a logbook.

Results

We reviewed the videotapes of 235 cases. There was one unsuccessful intubation in Group A. This was the first time the participating laryngoscopist used the Video Macintosh System (VMS).

Group A consists of 217 patients expected to be straightforward to intubate. In 22 of those patients (10%), external laryngeal manipulation (ELM) was required to improve the visualization of the vocal cords. All intubation attempts in this subgroup were successful. (Fig. C1 & C2)

In the second group (B) 18 patients had anatomical conditions (morbid obesity, short neck, short mandible, prognathism, etc.) that suggested that direct laryngoscopy might be more challenging.[8, 9] All 18 cases required ELM but were successfully intubated using the VMS. (Fig. C3)

Discussion

A significant improvement in the equipment used for direct laryngoscopy could benefit the many patients who undergo endotracheal intubation as part of the management of general anesthesia for surgery. This report describes the use of a new video system for endotracheal intubation in 235 cases performed during development of the instrument. In this series, endotracheal intubation was performed successfully in all but one patient. The series included patients with factors that predicted difficult intubation.

External laryngeal manipulation improved visualization of the vocal cords in several patients in the present series. These findings are consistent with other series.[10] The improved coordination afforded by an image on a TV screen that is seen by both the assistant providing laryngeal pressure and the anesthesiologist manipulating the laryngoscope may thus be a significant advantage of this system over conventional laryngoscopic techniques.

In a few cases (6 in group A), we found the video system useful during double lumen tube (DLT) placement. When using the Video Macintosh System, the bronchial limb is easily viewed as it passes through the cords. Once the double lumen tube is placed in the trachea, a compatible flexible intubating scope with an MVM in the handle can be used to confirm or reposition the bronchial portion of the tube using the same video system on the universal cart. It is a very quick switch over to pull out the VMS plug and insert the plug from the flexible intubating scope with MVM to continue the position process of the DLT. (Fig. C4)

Intubations were performed by 4 experienced anesthesiologists. Although it is possible that lack of familiarity with the equipment contributed to the single failed intubation reported – which was being performed by a first time user – the uniform success of all the other intubations performed by first time users suggests that learning curve is short. In our opinion, the average practitioner needs only a few cases to become comfortable with the view on the TV screen, necessary eye-hand coordination, and the handling characteristics of the instrument. The learning curve is very short because we are using a standard handle and a Macintosh blade.

From the physiology of vision we know that a darker image will result in a loss of visual acuity and color recognition. The brighter image facilitates improved perception.[11] This system provides a much brighter image compared with a battery operated unit and the TV camera produces increased brightness gain on the TV monitor.

Visual control of intubation is not a new concept. In 1979, one of us (GB) utilized a straight telescope with enhanced illumination armed with an ETT.[12] The patient was placed in a rigid bronchoscopy position. The telescope eyepiece had a teaching attachment through which the student or teacher could observe the passage of the ETT through the cords into the trachea. However, this intubating position was not well-accepted by anesthesiologists.

Several other attempts were made to convert the sometimes semi-blind laryngoscopic procedure to a visual one by inserting flexible fiber optics with an eyepiece into a laryngoscope that had a special configuration.[13, 14] Weiss et al. reported on a disposable laryngoscope with a long image light bundle that could be advanced into the blade. The camera control unit and the light source were placed beside or behind the anesthesiologist and there was a LCD screen for observation.[15, 16]

Throughout the 20th Century, numerous devices have been developed which attempt to improve visualization of the glottis and facilitate tracheal intubation. A few of these devices have made their way into clinical practice, but the majority that we have found are described only in patent applications and have not made a significant impact on clinical practice. Those that have been used in studies that were published in peer reviewed journals follow, including the Wu and Bullard instruments previously mentioned. These include a fiberoptic intubation scope with camera and light weight portable screen described by George [17], the Berall Laryngoscope[18], an optical stylet armed with an endotracheal tube and containing a flexible image bundle eyepiece described by Bashour [19] and Lee [20], and a similar device with an attached television camera by Berci [21]. Kitamura et al. Also described a fiberoptic stylet with an eyepiece and a flexible tip [22].

We selected a standard laryngoscope and autoclavable blade(s) and a TV system where the fiber moiré pattern is eliminated (US Patent 5,751,340). The gain and color are pre-programmed to yield a better image quality.

Our aim was a multi-purpose one:

a) To select instruments that are known to the practicing anesthesiologist built in a compact configuration, and which do not require an extended learning curve.

b) The improved video and illumination components provide an image of superior quality. The swivel arm with the monitor on the cart allows the intubator to manipulate and observe in the same axis.

c) The cart and accessories are designed to be a part of a Universal Intubating System. Flexible pediatric and flexible adult intubating scopes utilize the same Micro Video Module (MVM) integrated video camera in the handle as the videolaryngoscope. There is no need to attach and focus the camera. A built in electronic board eliminates the Moiré pattern of the fibers in every scope. We found it important to have a single system that serves many video intubation techniques by exchanging only a plug and a light fiber cable. We have found this feature to be timesaving and useful, for example, in thoracic cases, placing a double lumen tube (DLT) first with the Video Macintosh system and changing immediately to the flexible scope to check or position the DLT.

Teaching Value

In performing ELM, the nurse (or other assistant) immediately grasps the concept when looking at the video screen. The position of the glottic structures and movements necessary to optimize exposure are obvious. Intubation is rapid and precise using this coordinated maneuver.

With regard to the educational role of the video laryngoscope, we envision a significant role in teaching airway management skills. Because of the high-quality enlarged image, the anatomy of the upper airway can be demonstrated with heretofore unavailable clarity. In the classroom, recordings of intubation performed with the video laryngoscope can be used to introduce residents, nurse anesthetists, EMT students, or other novices, to the principles of laryngoscopy and intubation. In the clinical situation, the student will no longer have to peer over the shoulder of the instructor trying to see what the instructor sees as the laryngoscope is manipulated to expose the vocal cords and as the tube is introduced into the trachea. Many unnecessary attempts can be avoided.

With the enlarged image on the TV screen, the instructor can see precisely the effect of the resident's manipulations and offer direction on a real-time basis. Each attempt can be recorded on tape and reviewed at a convenient time. Should the external laryngeal manipulation be needed to improve visualization of the glottis, the instructor can do this while watching the monitor together with the resident to achieve ideal positioning.

This preliminary report of 235 patients describes experience gained during development of this Video Macintosh unit. Prospective multicenter studies are in progress to provide a more detailed analysis of its use.

Illustations

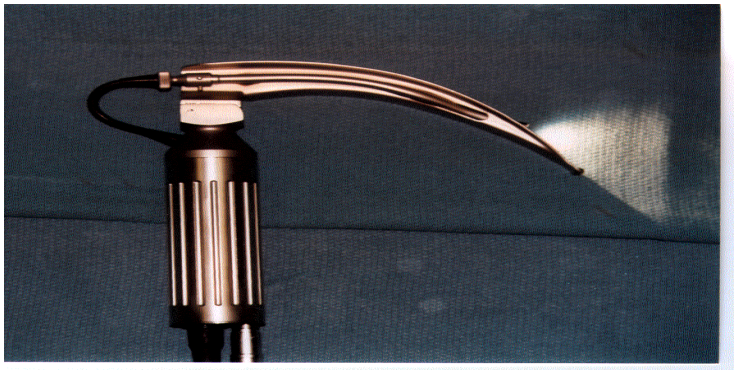


Fig. 1

Video Macintosh System (VMS). Standard handle with a camera incorporated. A small image-light bundle exiting from the handle is inserted into 2/3 of the ength of the standard blade. The interchangeable blade can be cleaned or autoclaved. The handle with the image light bundle can be cleaned, immersed (Steris, Cidex) or Gas sterilized.

Fig. 2

The Universal Video Cart: The swing arm with an 8-inch TV monitor is placed above the chest of the patient. Manipulation and observation are performed in one axis.

Top to bottom: Keyboard for data insertion.

Underneath: Camera control unit and light source with a fiber light cable, a digitized and standard S-VHS recorder. An adult flexible scope (3.7 mm with a 1.5 mm channel) and MVM can be attached to the same cart. (arrow) It is easy to wheel around and to position on the patient's left. (Manufacturer: K. Storz Endoscopy Co, Culver City, CA.)

Fig. 3

VMS is inserted into the mouth with a standard technique.

Fig. 4

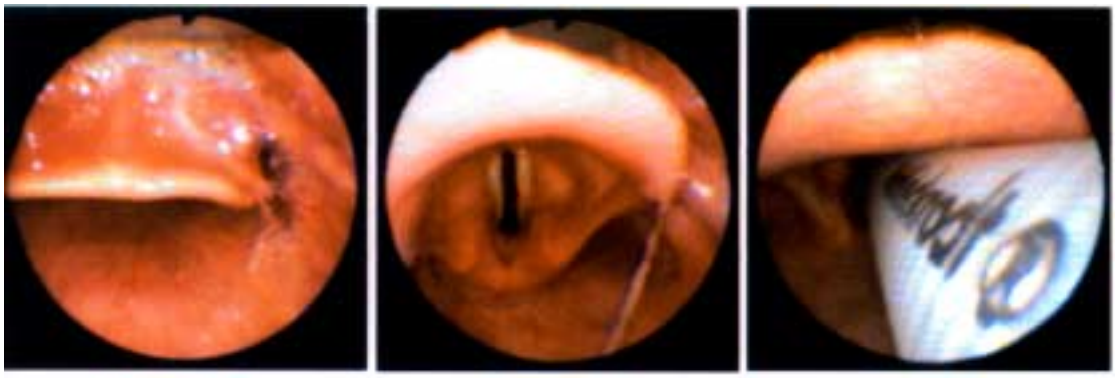
Further manipulations are observed and directed from the TV screen (eye-hand coordination). The stand-by nurse can see the procedure and if ELM is required, the nurse and the anesthesiologist can perform the manipulation in a coordinated and quick fashion.

Fig. 5

The possibility of seeing the enlarged anatomy from a convenient distance is of immense help in manipulating the ETT or if assistance (ELM) is required in difficult cases. During teaching, many unnecessary attempts can be avoided by being able to direct the "student driver."

INTUBATING VIDEO LARYNGOSCOPE
COLOR ILLUSTRATIONS

Legends of color illustrations: **C = Color Figures**



C= Fig. 1-A
Cords are not visible. The tip of the Macintosh blade seen in the Vallecula at the 12:00 o'clock position.

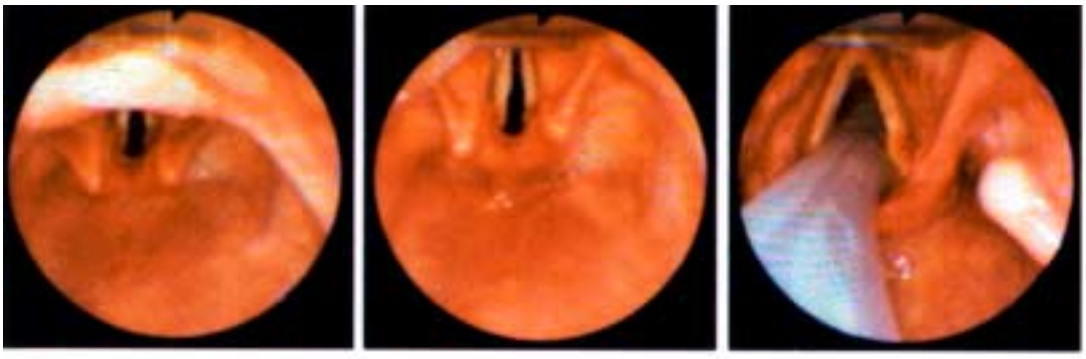
C= Fig. 1-B
External laryngeal manipulation (ELM) applied by the nurse and directed by the anesthesiologist, the vocal cords are brought into immediate view.

C= Fig. 1-C
The introduction of the endotracheal tube (ETT) is well seen.

C= Fig. 2-A
Vocal cords are not seen.

C= Figure 2/B.
ELM was provided by circulating nurses. The Video image allows rapid and efficient positioning of the laryngeal structures to aid intubation.

C= Fig. 2-C
Introduction of the ETT.



C= Fig. 3-A
The Macintosh blade is in the Vallecula but the cords cannot be well seen.

C= Fig. 3-B
The blade was withdrawn and repositioned to directly pick up the epiglottis (seen at 12:00 o'clock) and created a panoramic view.

C= Fig. 3-C
ETT is well seen during introduction.

C= Fig. 4-A
Vocal cords in appropriate position during intubation for a thoracic case.

C= Fig. 4-B
The endobronchial limb of the double lumen tube (DLT) is well seen in the glottic opening.

C= Fig. 4-C
During introduction, DLT is precisely rotated and passed at the posterior commissure avoiding increased pressure on the cords.

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