Brief Report on Thoracic Surgery

Technical means to improve image quality during thoracoscopic procedures

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Abstract: Although high definition imaging systems are now available in the operating room (OR), the displayed image quality during video-assisted procedures is often poor. This is due to several factors such as inappropriate angle of vision, instable endoscope, lens soiling and fogging. The aim of this article is to provide information about some technical and technological means that make it possible to keep a perfect picture all along a thoracoscopic procedure.

Keywords: Video-assisted thoracoscopic surgery (VATS); thoracoscopy; image quality; thoracoscope; scope holder

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Over the past 10 years, the picture quality displayed in the operating theatre has dramatically improved. We have moved from standard definition television (SDTV) with a 640×480 resolution to a high definition television (HDTV) signal that provides a much better resolution (1,920×1,080) and color rendition than in the past (*Figure 1*). In addition, modern camera chips are less sensitive to blooming or bleeding (that usually results in sudden darkness of the operative field). More recently, 4K technology, which has 4 times the resolution of full HD (4,096×2,160) has entered the operating room (OR) and makes it possible to use large screens. Eventually, for those of the surgeons who feel more comfortable with three-dimensional (3D) display, 3D technology is becoming mature and may be helpful for complex procedures or for some tasks like suturing.

Despite these outstanding technologies, it is striking how poor the general image quality remains in many OR. Several minor problems deteriorate the native picture, such as inappropriate choice of endoscope angle, instable image, lens soiling and fogging. As a result, surgeons sometimes operate with a picture quality they would not accept when watching TV at home. The main consequence is a loss of security for the patient.

The aim of this article is to provide information about some technical and technological tips that make it possible to keep a perfect picture all along a thoracoscopic procedure.

Operating with the optimal angle of vision

What is the viewing angle of the endoscope used for thoracoscopic major pulmonary resection (MPR) is a frequently asked question. Some surgeons prefer a straight viewing scope (0°) because it gives a more natural vision. Other favor oblique viewing scopes—usually 30°—to avoid tangential vision when the target is remote from the endoscope insertion port. It is however rare that one of these two choices is ideal all along the procedure, especially when moving from close-up to overall views. This is the reason why having the possibility to switch from a straight viewing angle to an oblique one with a single endoscope should be the best option. Two scopes are available on the market and have a different technology: the EndoCameleon (Storz) and the LTF (Olympus). The EndoCameleon is a rigid 10-mm scope housing a conventional rod-lens system. The distal lens can be tipped down so that its angle varies from 0° to 120°.

The LTF is based on a different technology. The endoscope is a 10-mm rigid one but has a flexible distal part

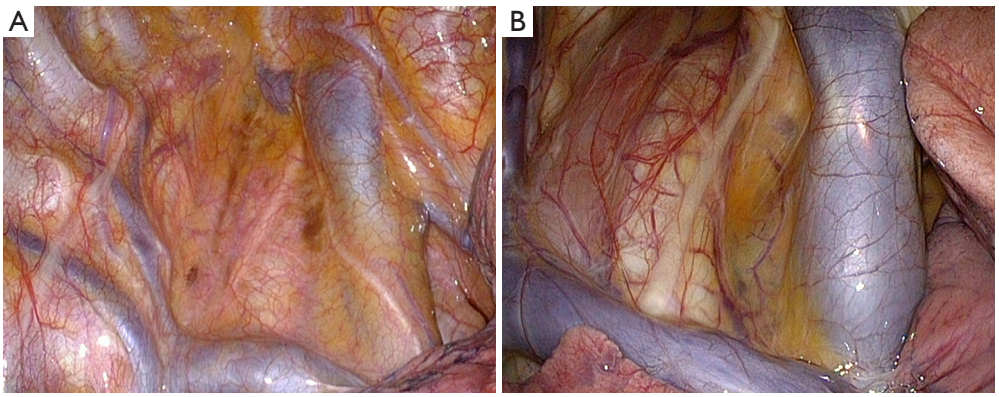

Figure 1 View from the right upper mediastinum with a standard definition television (SDTV) camera (A) and an high definition television (HDTV) camera (B).

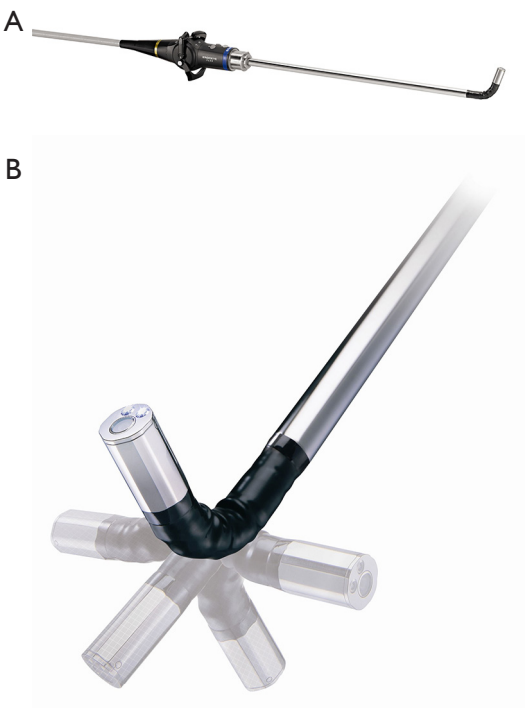

Figure 2 The 10-mm deflectable scope (Olympus LTF). (A) General view; (B) deflectable leading-end housing the CCD.

with the chip at the tip. The distal part can be deflected from 0° to 100° up-down and right-left or any combination of these movements thanks to two levers located on the handle (*Figure 2*). Once the appropriate angle has been chosen, it can be locked. It is possible to switch from a direct view to a bird-eye vision in just 1 action. We are using this scope during all our thoracoscopic MPRs for more than 10 years. It is especially helpful during lymph node dissection (*Figure 3*). Other authors have stressed the benefit of this type of endoscope for VATS surgery (1). Licht *et al.* not only found an advantage due to the better visualization but also a potential gain for the patient as it avoids torqueing of the intercostal space with its inherent postoperative pain (1). With the development of single-port surgery, it seems some surgeons are rediscovering the benefit of deflectable endoscopes (2,3).

Although very helpful, the LTF is not yet the ideal scope. It is indeed expensive and the sheath of its distal part is fragile. In addition, when used in small chest cavities, the distal part is too long to be maneuvered. However, despite these minor drawbacks, this endoscope is perfectly adapted to most MPR. A 5-mm version can be used for minor procedures (*Figure 4*).

Keeping a stable image

From the early beginning of our experience in thoracoscopic surgery, we have worked with a scope holder for three reasons: (I) it allows the surgeon to avoid a shaking picture; (II) the operative field remains hand-free, avoiding instruments conflicts and hands crowding over the patient's chest; (III) the assisting surgeon can concentrate on other tasks than holding the endoscope. However, few thoracic surgeons are familiar with this possibility. A PubMed search has not found any reference with the following items: "VATS-thoracoscope-holder", while ten references over the 3 past years are found with "laparoscope-holder". The interest of camera holders has even conceptualized as

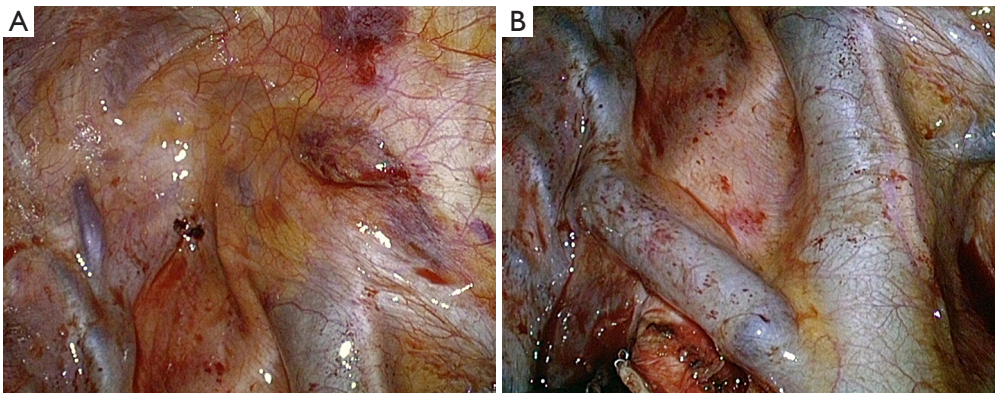

Figure 3 View from the right upper mediastinum, after completion of a right upper lobectomy with a direct vision (0°) and an oblique vision (90°) obtained from the Olympus LTF scope.

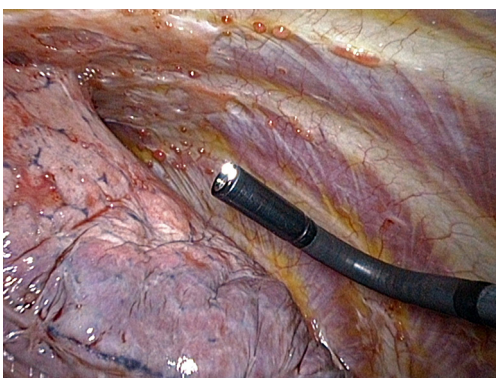

Figure 4 The 5-mm deflectable scope (Olympus LTF), used for minor procedures (in this case, pleural examination).

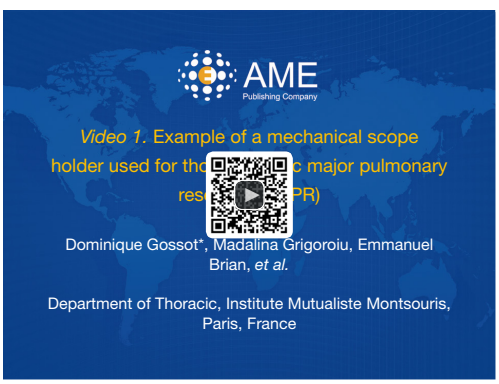

Figure 5 Example of a mechanical scope holder used for thoracoscopic major pulmonary resections (MPR) (6). Available online: http://www.asvide.com/articles/1450

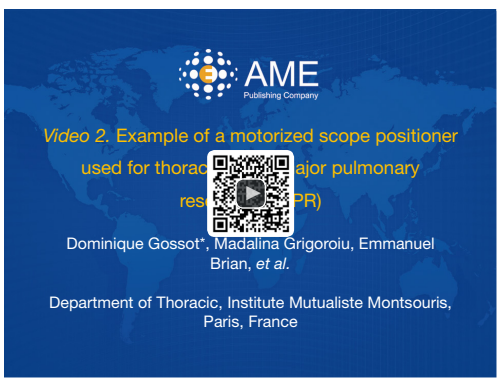

Figure 6 Example of a motorized scope positioner used for thoracoscopic major pulmonary resections (MPR) (7). Available online: http://www.asvide.com/articles/1451

"solo-surgery" (4) in laparoscopic surgery while there is only one reference in thoracic surgery (5).

The holder can be mechanical (*Figure 5*) or robotized (*Figure 6*). Unfortunately, few mechanical scope holders fit the thoracic surgeons' needs. Their arm is usually to short and not suited to patients who are positioned in lateral decubitus. After having used a mechanical scope holder during more than 10 years, we have switched to a robotic manipulator that can be controlled by foot pedal or by voice, depending on surgeon's preference. In the 2000, the most popular robotic scope holder was the Automated Endoscopic System for Optimal Positioning (AESOP®) (Computer Motion) system that is no more commercially available. It was efficient but was also cumbersome, heavy and expensive. Lighter and more intuitive systems are now on the market (Freehand®, Frehand Ltd, Eastleigh, UK or

Figure 7 The motorized Viky®-EP scope positioner.

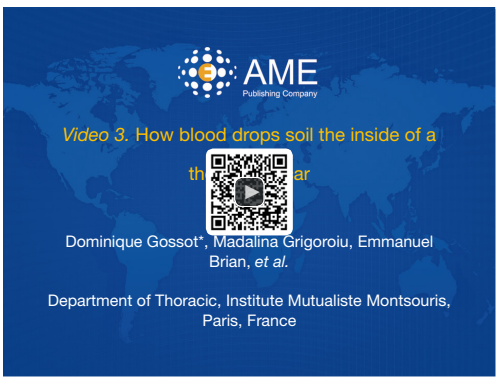

Figure 8 How blood drops soil the inside of a thoracic trocar (8).
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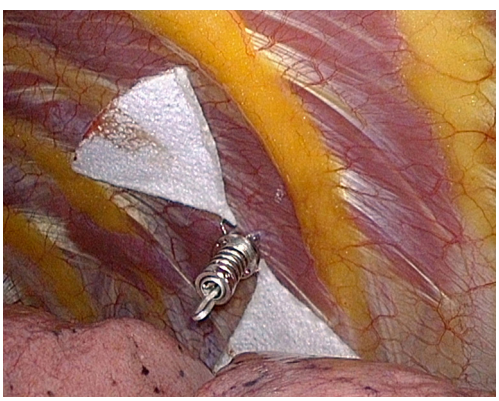

Figure 9 The EndoClear™ system anchored on the apical pleura.

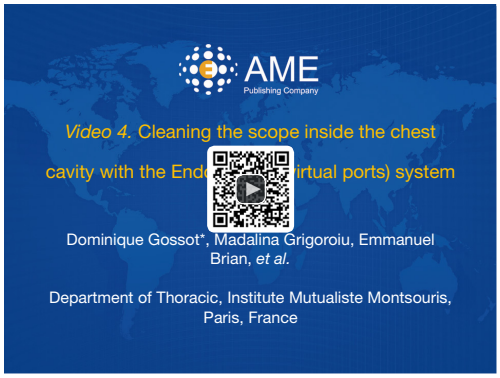

Figure 10 Cleaning the scope inside the chest cavity with the EndoClear™ (virtual ports) system (10).
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Viky®, EndoControl, Grenoble, France). We are using the VIKY®-EP endoscope positioner (*Figure 7*) that provides similar functions to old systems like AESOP® while being much lighter and easier to set up (*Figure 6*). It can be fixed onto the operating table rail. Its long and thin arm saves space around the patient's chest and avoids clashes with instruments. The system can move the endoscope forward and backward, up and down and laterally. The combination of the movements of this scope holder and of the view angles of the LTF thoracoscope, makes it possible to reach most targets without manipulating the scope. As it is autoclavable, there is no need to protect it with a sterile sheath, thus allowing a rapid set-up.

Operating with a clean lens

One of the more frequently encountered problems during thoracoscopic procedure is the soiling of the endoscope tip by blood dripping along the trocar sheath. As shown on *Figure 8*, blood sliding along the sheath goes back up by capillarity inside the trocar tube and soils the lens (*Figure 8*). This forces the surgeon to remove the scope for cleaning, what can be tedious and irritating when frequently done.

Rather than cleaning the scope outside, one solution can be wiping it inside with a lens cleaner system (EndoClear™, Virtual Ports) that can be released inside the chest cavity. A detailed description of this system has been given (9). In summary, it is a single use butterfly-shaped cleaner made of 2 non-woven materials mounted on two retractable triangles. The device is anchored to the parietal pleura (*Figures 9,10*). We evaluated this system in 43 patients and demonstrated its efficiency. It has however some drawbacks.

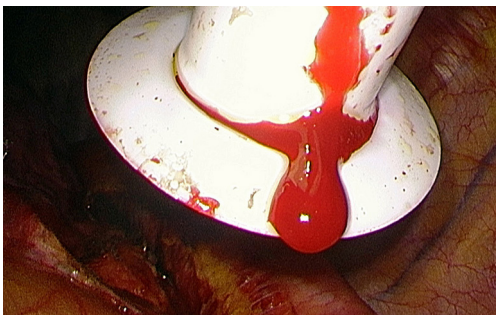

Figure 11 The blood-deflecting trocar.

Figure 12 The blood-deflecting trocar (Delacroix-Chevalier) (12). Available online: http://www.asvide.com/articles/1454

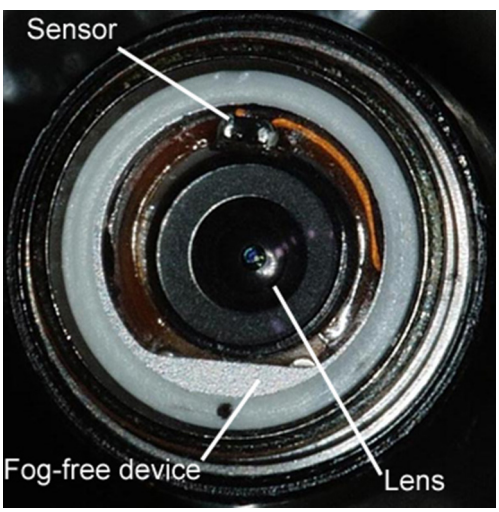

Figure 13 Distal lens equipped with a fog-free element (Olympus LTF).

The main one is that the cleaner is mounted on a rod that has a rigid loop at its basis for insertion and removal, thanks to a dedicated applier. This loop can be dangerous in case of unexpected reventilation of the lung during the procedure.

Out of the other technical solutions we suggested some years ago (11), we finally adopted the simplest one, i.e., a skirt mounted at the trocar tip, that deflects the blood drops (*Figures 11,12*). This simple tool is very efficient and is now used during all our thoracoscopic procedures.

Operating with a fog-less image

Lens fogging is a well-known concern and is a real impediment to a clear vision. It is caused by condensation due to temperature difference between the OR and the patient's thoracic cavity. The more the surgeon has to retrieve the scope for cleaning or any other reason, the more he/she gets in trouble with fogging. Numerous tricks have been proposed to overcome this issue, such as heating the scope into a sterile thermos flask filled with hot water (13), or using one of the commercially available antifogging solutions (14). As most surgeons know, none of these tips are totally efficient, as they don't treat the cause, i.e., the temperature difference.

Until now, the most efficient system we have used is the built-in warming system in Olympus endoscopes. A fog-free element is located at the back of the leading-end objective lens. It is combined with a sensor that constantly monitors the temperature (*Figure 13*). The fog-free element warms the lens and maintains it at the predetermined temperature, i.e., 39 ℃. Since we are using this system, we don't need any anti-fogging solution or any other heating system.

Conclusions

Thanks to the deflectable scope and to the various technical and technological refinements reported in this paper, it is possible to operate during long-lasting thoracoscopic procedures with the appropriate viewing angle and with a clear picture that remains stable, fog-free and blood-free. In combination with dedicated thoracoscopic instruments, the thoracic surgeon can concentrate on the procedure itself without being disturbed by frustrating issues and by useless and time-consuming manipulations.

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None.

Footnote

Conflict of Interest: One of the authors (D Gossot) is consultant for Delacroix-Chevalier Company. Other authors have no conflicts of interest to declare.

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