Motorized scope positioner for solo thoracoscopic surgery

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Abstract: We report the benefit of a robotized endoscope positioner (Viky®, Endocontrol) during video-assisted thoracic surgery procedures. This system is in use in our department for 2 years. It provides a stable view of the operating field and eliminates camera shake. It helps make thoracoscopic procedures more ergonomic with less physical discomfort for the surgeon by saving movements, gaining fluidity and it results in enhanced precision.

Keywords: Scope holder; solo surgery; video-assisted thoracic surgery (VATS); thoracoscopy

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The complexity of closed chest procedures is increasing. We are currently performing thoracoscopic procedures that were not foreseeable until very recently. This complexity poses the surgeon a daily challenge in terms of technical skill, operating time and even mental load. The surgery we perform is mainly based on imaging. We no longer operate inside a chest cavity but on a screen. This means that the operator must be able to count on optimal image quality. Maintaining a clear image throughout the intervention relies on a number of methods and tools, sometimes sophisticated and sometimes very basic. We have described these in a recent publication (1). One of these means is to have a stable image that can be controlled by the surgeon himself, thanks to a scope-holder.

In this article, we will describe the system used for all major video-assisted thoracic surgery (VATS) procedures in our department, i.e., the Viky® robotized endoscope positioner (EndoControl, Grenoble, France). Although the term "telemanipulated" would be more appropriate than the term "robotized", the latter will be used for convenience.

With this system, the surgeon directly controls the position of the endoscope, without the help of an assistant. Through a voice-activated interface connected to a wireless microphone, the surgeon can speak to the system to move the thoracoscope to the desired positions. Control can also be achieved via a foot pedal. The control unit houses a software which analyses the surgeon's orders and activates the motors of the driver.

The key features of this system are the following:

- It provides stable view of the operating field;
- It eliminates camera shake and associated eye fatigue;
- It memorizes key positions of the endoscope for easy recall during procedure;
- It is easily fixed onto the operating table rail;
- It is cost-effective, with no disposable part.

The system is composed of the following components:

- A control unit which is installed within the video trolley;
- A driver consisting in a ring and a motor set;
- A passive arm that is fixed to the operating table rail thanks to a clamp. For most clinical applications in thoracic surgery, the clamp is placed at the patient's shoulders level. The clamp hole can rotate, thus allowing the arm to any angulation compared to the table;
- Control interfaces: foot pedal or wireless microphone.

The Control unit controls the driver (ring and motor set). It consists of a touch panel display, a connector for the driver, a connector for the foot pedal, an emergency button, a microphone and a USB dongle plug. The system software interprets user commands and controls motors accordingly.

Figure 1 The driver and motor set of the Viky® scope holder.

Figure 2 Setting up the Viky® scope holder (2).
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For security, it has several control loops.

The control unit allows the surgeon to control:

- The application;
- The driver models: it is possible to choose the model (small, medium or large, depending on the size and shape of the chest) at the beginning of the surgery and change the model during the use, if ever necessary. Actually, the medium size driver fits all our thoracic procedures;
- The recognition sensitivity (7 levels to determinate the selectivity of software voice recognition);
- The movements speed: 5 different levels of speed for each movement (left/right, up/down and back/in).

The Driver (*Figure 1*) is composed of a ring and 3 motors, each of them connected to the control unit by cables and attached to the ring. The latter is composed of two flat circles with a toothed circle system between them, allowing unlimited 360 degrees of rotation in both directions for lateral movements.

The inclination of the endoscope (up and down movements) is allowed by a toothed rod that can be inclined and declined compared to flat circles, with a range of 70°.

Finally, the translation movement (forward and backward movements) is allowed by a carriage (on which the endoscope is attached with an adapter) that slides along the toothed rod on a 20-cm distance. The driver is steam sterilizable (autoclavable).

The passive arm can be easily and rapidly fixed to the rail of the operating table with a clamp and enables to hold the ring just above patient's chest (*Figure 2*). It is also autoclavable.

The foot pedal allows the surgeon to easily move the driver by foot. It has a "joypad" system. A press on the joypad moves the driver accordingly in "left", "right", "up" and "down" directions. A press on "+" and "–" buttons will move the driver in "zoom-in" and "zoom-out" directions respectively (as long as the surgeon press these buttons). The driver can be deactivated with one-foot press to take back by hand endoscope. Another foot press re-enables driver back to its normal use.

A microphone allows for a voice control of the system. It is wireless and approved for use in operating room.

The movements allowed by the system are demonstrated on a phantom model (*Figure 3*) and in real situation.

Comments

The use of a mechanical or robotic scope holder was reported in laparoscopic surgery many years ago. It was part of a concept described in the 1990s under the name solo-surgery (4,5). Solo-surgery doesn't mean the surgeon is alone but that he is able to control most parts of the procedure without depending on a more or less experienced assistant. Surprisingly, this concept has made little inroads in thoracic surgery (6,7).

However, one of the benefits emphasized by the promoters of assisted robot surgery is the still nature of the image and its control by the surgeon (6). Some technological

Figure 3 Demonstration of the Viky® scope holder on a phantom model (3).
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innovations in robotic surgery are currently difficult to transpose into conventional thoracoscopic surgery, but the control of the scope movements is perfectly feasible—and in a simple way—in conventional thoracoscopy.

We have been operating this way since the very beginning of our thoracoscopic surgery program, using mechanical scope holders. The advantages are multiple:

- Image stability and tremor elimination;
- Control of the scope movements which depend only on the operator. When the movements of the optics are managed by the surgeon, without the dependence of an assistant, it is found that it is not necessary to frequently move the scope during surgery. It is also easier and more relaxing for the surgeon to control the image himself, especially if the assistant has little experience in thoracic surgery or thoracoscopy. The assistant can concentrate on other tasks;
- No crowding of the operating field and no conflict between the hands of the operator and those of a cameraman.

However, after many years of use, we have seen the limitations of a mechanical system. Most of the scope holders have been developed for laparoscopic surgery and are not well suited for a patient who is positioned in lateral decubitus. The length is often insufficient. In addition, they have to be manually unlocked, readjusted and then relocked for each change in endoscope position. The need for manual adjustment is not always compatible with the task performed and is often disturbing. This is why we have been looking at robotized scope holders, controlled either by voice (Aesop, Computer Motion), head movements (EndoAssist, Armstrong Healthcare, Bucks, UK) or by foot or hand (Lapman, Medsys). An extensive description of all available systems can be found in a book chapter from Bilhmaier (8).

We were not satisfied with any of these different systems, either because of a large footprint in the operating theatre or because of their complexity and cumbersome deployment (most of these devices need a dedicated trolley). Moreover, many of them have not been commercially successful and have disappeared from the market. For 2 years, we have been using the Viky® system described above for all complex procedures, especially for major pulmonary resections. Among the advantages of the system, there are:

- Rapid set-up;
- Lightness of the device, which is directly fixed on the operating table rail by a small arm diameter. Its position can be adjusted in such a way that it arrives from the thoracic apex, so that there is no conflict with the instruments (*Figure 4*);
- Possibility of control, either by voice or by foot pedal according to the preferences of the surgeon;
- No single-use part.

Use of the Viky® system has been reported for other major procedures (9,10) but, to our knowledge, not for major thoracoscopic procedures.

For many years, all complex operations have been performed with a deflectable scope (Olympus LTF) whose distal end can be tilted up to 110° in all positions. The benefits of this type of scope have been reported by our team (1) and others (11). The combined use of this optic and robotic scope positioner greatly enhances vision and provides a very accurate viewing angle. An efficient and easy-to-use scope positioner is one of the corner stones of the development of solo-surgery for VATS (12). The other component is the use of instruments that can be dropped into the thorax and held in a proper position, either by a mechanical (13) or magnetic system as recently reported (14,15). These developments will help make VATS more ergonomic with less physical discomfort for the surgeon (16-19) by saving movements, gaining fluidity and, in addition, resulting in enhanced precision. One of the major benefits of robotically assisted surgery is the better ergonomics due to seating position, direct control of the scope and degrees of freedom of instruments. During conventional thoracoscopic surgery, we can at least improve one of these points.

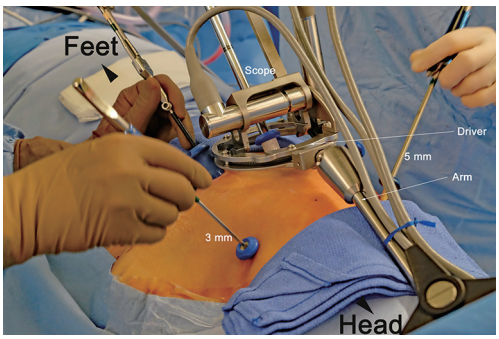

Figure 4 Use of the Viky® scope holder during a thoracoscopic lobectomy.

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