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One year of experience working with the aid of a robotic assistant (the voice-controlled optic holder AESOP*) in gynaecological endoscopic surgery

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The aim of the study was a comparison of robotic versus human laparoscopic camera control. Utilizing robotic technology a robot has been designed specifically for the purpose of holding and manoeuvring the laparoscope under the direct control of the surgeon. We tested AESOP (automated endoscopic system for optimal positioning) in 50 patients undergoing routine gynaecological endoscopic surgical procedures. The elimination of the camera holder allows two doctors to perform complex laparoscopic surgery faster than without the robotic arm. The timing of surgical procedures performed by surgeons using the voice control was compared to the timing of similar operations using the foot or hand control. The voice-controlled AESOP works more efficiently and faster than the hand or foot control.

Key words: gynaecological endoscopic surgery/robotic assistance

Introduction

Over the last two decades minimally invasive surgery has become increasingly popular and has been demanded by both surgeons and patients. Its benefits lie predominantly in reducing pain and providing a more rapid recovery for patients compared to traditional surgery. Today many advanced techniques are being performed in gynaecology, urology, cardiac surgery, brain surgery and orthopaedic surgery as well as in general surgery. To control the surgeon's visual field it is either necessary for the surgeon to hold the laparoscope and camera attachment or rely on assistance. At present and in the imminent future improvements in efficiency and safety in minimally invasive surgery will include the disciplines of robotics, computer assistance, 3-D optics and mechanics. The benefits of sophisticated technologies will be measured by factors such as shortened operating times, improved outcomes, lesser morbidity, diminished use of personnel and elimination of other instrumentation. Utilizing robotic technology offered by a company in Goleta, CA, USA, called Computer Motion, a robot has been designed for endoscopic surgeons specifically for the purpose of holding and manoeuvring the laparoscope under the direct control of the surgeon. AESOP (automated endoscopic system for optimal positioning) has been tested in a variety of laparoscopic procedures and has already performed at least as well as, if not better than, a human assistant in terms of camera holding with less erroneous camera motion and accidental contacts of the endoscopic lens with internal organs. Robotic control of the laparoscopic camera scope and visual field has improved efficiency and shortened operative procedures in minimally invasive surgery. About a year ago voice control of the robotic arm became clinically available and has been used successfully. AESOP offers the possibility of hand control, foot control and voice control. It was the aim of the present study to compare voice versus foot control in so-called solo surgery using the AESOP.

Materials and methods

AESOP (Computer Motion Inc.) holds and moves the laparoscope during surgery (Harding, 1994; Kavoussi *et al*., 1995; Garcia, 1996; Geis *et al*., 1996). The surgeon can direct the articulated metal arm by means of a foot pedal or hand control or by using the voice control. In addition, laparoscopic views can be keyed in for return visits by using the memory feature which is available for three positions. With smooth movements of foot or hand the surgeon can smoothly shift the laparoscope in any direction – left, right, up, down, forward or backward. The pressure applied by the surgeon controls the speed. At all times the vertical and horizontal orientation is maintained. It certainly eliminates unwanted movements of the laparoscope caused by the assistant's heartbeat, breathing or sudden sneezes. AESOP is controlled by computer with a read-only memory software. With the robotic arm as an assistant, laparoscopic procedures can be performed by a solo surgeon including hysterectomy, adnexectomy, ovarian cyst enucleation, ectopic pregnancy treatment, omenectomy and other types of surgery. Even telesurgery can be performed controlling an AESOP computer linked to a telephone line. Tele-robotic surgery with AESOP was pioneered in the USA by Dr Louis Kavoussi, Director of the Brady Institute of Urology at the Johns Hopkins University School of Medicine and also performed in Europe by the urologist Professor Janetschek in Innsbruck. Figure 1 gives a picture of the AESOP control arm hooked to a special storage carriage with which it can be easily adapted to the operating table. A voice-control card for the individual surgeon has to be established and inserted at the beginning of the procedure. Figure 2 shows the AESOP control arm attached to the operating table during an endoscopic gynaecological procedure at the Department of Obstetrics and Gynaecology, University of Kiel, Germany. It also demonstrates the use of the voice-activated headset used by the surgeon.

Voice control follows according to the following principles: (i) the surgeon carries a small voice receiver around the head; (ii) AESOP responds to short commands, such as: AESOP move in; move out; move back; move down; move up; move right; move left; left; right;

*Automated endoscopic system for optimal positioning

up; down; back; in; save 1; save 2; save 3; return 1; return 2; return 3 and quit.

During the procedure the computer also gives commands, such as press manual mode button. No noise in the operating theatre distracts the direct voice control of the surgeon.

Patients

As the control arm of the AESOP is used as a camera holder only, no patient consent for this robotic device had to be obtained. Twenty five patients were treated in gynaecological procedures using the foot and hand control and 25 patients using the voice control.

Results

No mishaps occurred in any of the surgical procedures. The number of personnel required during laparoscopic surgery using the robotic arm attached to the operating table dropped from three to two. The visual field was found to be rock steady. In our experience the foot and hand control favoured interactions by the first assistant and the voice control of the visual field was best directed by the operating surgeon. Voice control increased the surgeon's concentration and proved to be clearly superior to foot or hand control of the robotic arm.

Table I compares the length of the operating times of those procedures performed by foot/hand control, by voice control and with an assistant camera holder.

The elimination of the camera holder allows two gynaecologists or one gynaecologist and a nurse to perform complex laparoscopic gynaecological surgical procedures, such as ovarian cyst enucleation, myomectomies and hysterectomies using the classic intrafascial supracervical hysterectomy technique (Semm, 1991). In cases with three additional ports, in addition to the optic trocar, the assistant can help with a third arm adding to the surgeon's two arms in action. In Kiel a nurse always assists in all surgical procedures. The use of the robotic arm to hold the laparoscope and camera along with its ability to provide an absolutely steady visual field increases the concentration and efficiency of the surgeon. As the application of the handpiece limits the surgeon to using two arms for the laparoscopic procedure, foot control seems preferable; however, in our experience this procedure takes longer as we had first to control the foot piece by eye as the eye/foot coordination was not always optimal. The robot with the voice control enables us to ask the robotic arm to move up; down; left; right; in; out; to save one, two and three pictures and return to these pictures. It allows a safer and more secure movement of the scope. Data specified in Table I demonstrate the decrease in the operating time of the procedure. Certainly less fogging and smudging of the scope lens was observed. As a result the requirement to clean the optic in heated water (50°C) during the procedure was seldom given.

In the solo surgery model the surgeon performed both simple and complex tasks more rapidly and without error using voice control of the robotic arm (and visual field) when compared

Figure 1. AESOP 2000 – an acronym for automated endoscopic system for optimal positioning as a voice-controlled robotic assistant for endoscopic surgery in its mobile carriage.

Figure 2. Position of surgeons using AESOP 2000 as camera holder during a hysterectomy at the Department of Obstetrics and Gynaecology, University of Kiel, Germany.

Table I. Robotic arm used in 50 gynaecological endoscopic surgical procedures, a comparison between foot/hand and voice control and gynaecological endoscopic surgery with an assistant camera holder. Times are rounded up to the nearest 5 min and comprise the whole preoperative preparation time after the anaesthetized patient has been rolled into the operation theatre, including the time taken to fix and set up the robotic tool.

Surgical procedure	Number of cases	Length of operation time (min) without robotic arm	Length of operation time (min) with robotic arm	
			hand/foot	voice
Ovarian cyst enucleation	29	95	70	60
Myomectomy	17	70	50	40
Hysterectomy	4	60	50	40

to foot control or hand control of the visual field. The studies demonstrated clearly trends in favour of voice control of the visual field both in our human and previous porcine experiences during laparoscopic surgery.

Discussion

Industrial robots have displaced workers in many fields. Will surgeons be sidelined as robotic devices advance in operative capabilities? We think not. AESOP, for example, is a sophisticated tool to assist the surgeon in moving the optic. In no way does it replace the surgeon. It supports the surgeon in doing his best and enables him to give a more powerful approach than was possible in the past. Technology is developing and we as doctors need to be part of it. We need to identify the appropriate use of new technologies in our field of medicine. Patients' outcomes do of course take first place. Using the solo surgery model the surgeon can perform both simple and complex procedures as described here more rapidly and without error using voice control of the robotic arm (and visual field) when compared to foot control and hand control. Our studies demonstrated trends in favour of voice control of visual field both in human and in our previous porcine experiences during laparoscopic hysterectomy, ovarian cyst resection and myomectomy. It is definitely the conclusion of our working group that at the present time the fixation of the robotic tool to the operating table takes some time and the whole procedure requires more concentration from the surgeon; however, the possibility of working more steadily in a confined field is greatly appreciated. At the present time the limitations of the device are seen in the case of adhesions where movements of the robotic arm over larger distances are required. In such cases the robotic arm takes longer to respond to the voice control than performance by hand. A robotic assistant is seen to be a cost-effective device, taking the place of the traditional assistant if so wished by the surgeon. This type of surgery is best applied in smaller clinics where fewer personnel are available. In larger university hospitals where, for educational reasons, more personnel are available, these techniques are, however, used to support the technological development.

The cost of AESOP 2000, described here, and the newer version AESOP 3000, which has more joints and is easier to move, amounts to US$ 60 000. This is well within the price range of other tools, such as lasers, also used in endoscopic surgical procedures. In the long run the cost benefit is indeed more favourable as AESOP reduces the number of personnel required in the operating theatre and can be used for solo surgery. With regard to teaching possibilities, AESOP increases the input of an assistant who can be very helpful using this modern technology. For example, by moving the camera with the hand or foot control the assistant can help during the procedure to bring in or move away the camera while the surgeon is performing a suture. Teaching possibilities are increased. AESOP can be effectively used in telerobotic surgery where surgeons working at different places can communicate by voice over the video screen.

In conclusion, in the long run a robotic assistant is seen to be a cost effective device replacing the traditional assistant and providing the surgeon with a more stable operating field.

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