TELESURGERY

THE WAY OF THE FUTURE?

BY JENNIFER CLARA TANG

Introduction

You're sitting in a doctor's office on a cold blustery day in the Yukon territory, waiting for the prognosis. Surgery? When? Will I have to travel back and forth to the city for the procedure? You breathe a sigh of relief when you discover that thanks to modern robotic technology, surgery has become more accessible and convenient for rural areas like the one you live in...

Telesurgery: a term evocative of Star Trek futuristic technology combines the advances from the world of telecommunications with robotics. The marriage of these two technologies has made it possible to perform "remote surgery", advanced telementoring and other procedures that will advance the "telehealth" movement. It is important to understand the various terminologies used in telehealth. The term "telerobotic surgery" is used to describe "remote manipulation wherein the slave manipulator has an 'intelligence' and actions of its own and the master acts in a supervisory role" (Sheridan, 1992). "Telesurgery" is a term used to describe an operation in which the surgeon is separated by great distance from the patient and uses remote manipulation to perform the surgery. "Telementoring" or "telepresence" describes a situation where a senior surgeon can remotely observe, mentor or even physically assist a fellow surgeon in an operation.

Telehealth, which is the application of "information technology to offer treatments and procedures over long distances" (Behran, 47) promises to revolutionize the face of international healthcare. Telehealth is of specific interest to Canada, as there are many remote rural areas which suffer due to the shortage of specialists. Dr. Mehran Anvari of McMaster University is spearheading research into use of telerobotic surgery to service remote rural areas. Dr. Anvari, is the director of the CMAS (Centre for Minimal Access Surgery) which was formed in 1999.

The concept of using robots to assist surgeons in the operating room is not new. In 1988, minimally invasive surgery was performed using small cameras inserted through small incisions. On July 11, 2000, the FDA approved use of the first robotic system used in American operating rooms: the da Vinci surgical system. Since then, other robotic systems like the Zeus ™and AESOP have been developed. These will be discussed in further detail. Telesurgery is an exciting new medical technology which may prove useful as humans expand their exploration of space. In the case of emergency, a surgeon on Earth could treat an astronaut using telesurgery. With further research and development, telesurgery may one day be incorporated into the space program.

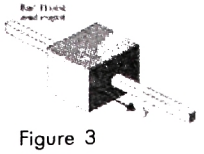

Figure 3

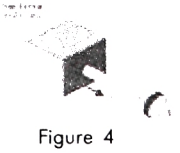

Figure 4

http://www.mech.uwa.edu.au/bjs/Vibration/OneDOF/DOF.html

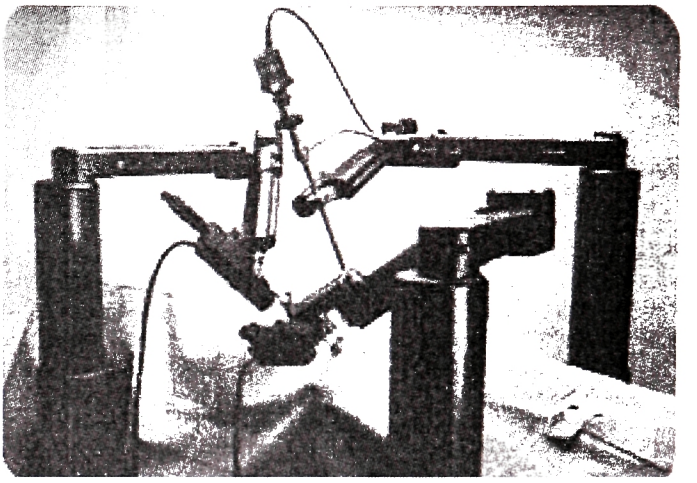

Figure 1 The Zeus™ Robot www.computermotion.com

Transatlantic Telesurgery: Strasbourg, France – New York, USA

On September 7, 2001 a milestone in surgery was reached. Stationed in New York, Dr. Marescaux and Dr. Gagner performed the first transatlantic telesurgery using the Zeus™ robotic system. To ensure a smooth operation, connections had to be flawless with delays of no more than 200 milliseconds. Five elements had to be simultaneously coordinated (Figure 1): surgeon's actions (via robot and data transmission, voice commands (AESOP), images from the endoscope, videoconference link, and continuous control data exchanged between the computers on each continent. The patient, a 68 year old woman, was stationed 7 000 km away from the surgeons in Strasbourg, France. The 45 minute surgery, a laparoscopic cholecystectomy (removal of the gall bladder) was performed successfully without any complications. This landmark surgery has set an important precedent for international healthcare. Under the direction of Dr. Anvari, Canada is planning a long distance surgery between a remote rural area and Hamilton, ON. The success of the transatlantic surgery demonstrates the potential of this new technology.

Zeus™ daVinci and AESOP

Zeus™ (Figure 2), the robotic system responsible for the success of the transatlantic telesurgery, was recently approved for use in Canada. Developed by Computer Motion, Zeus™ is a master-slave system consisting of three robotic arms; two arms manipulate the surgical instruments, the other arm is a voice or foot-pedal controlled endoscope. Newer models of Zeu™ are very flexible as they have five degrees of freedom (DOF). DOF may be defined as "the number of coordinates that it takes to uniquely specify the position of a system" (Stone). For example, in Figure 4, the block has only one DOF since it can only move along the y axis. In Figure 3, the block can rotate and move along the y-axis, thus it has two DOF. The endoscope

technology is called AESOP (Automated Endoscope System for Optimal Positioning). Not only does AESOP help to maintain a steady image of the surgical area, it also eliminates the need for surgical assistants. AESOP is flexible, with six DOF (degrees of freedom). The surgeon manipulates the Zeus™using joysticks (called the Microwrist ™ grasped in each hand while observing the surgery on a television screen. The joysticks are form-fitted to ensure that the surgeon's hand movements are correctly interpreted by Zeus™ The surgeon also has the option of viewing the surgery in 2D or 3D. Although the surgeon and patient in the transatlantic surgery discussed were separated by great distance, the Zeus™is also used in conventional operating rooms where the doctor and patient are separated by a few metres.

The da Vinci surgical system (figure 2) is quite similar to the Zeus™model; however, it lacks the AESOP voice recognition function. Unlike the Zeus™ da Vinci instruments have a limited lifespan. With six DOF, the da Vinci is more flexible than the Zeus ™ The da Vinci system provides a 3D view of the area (fig 5). Both systems operate in a similar fashion. For example, in a given operation, the system would begin by making 3 incisions, roughly the diameter of a pencil. The three arms of the robot would then insert themselves into the incisions and begin the minimally invasive surgery (MIS).

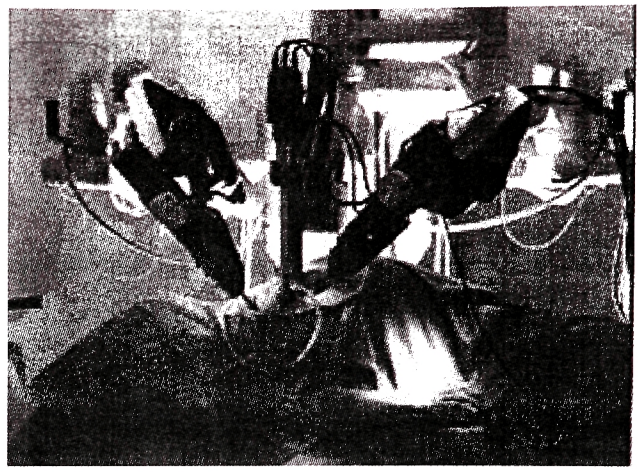

Figure 2 The da Vinci robot
http://robosapiens.mit.edu/05/imgs/davinci_lyr_r2_c1.jpg

Conclusion

Telerobotic surgery promises to revolutionize healthcare and speed post-operation recovery. Yet, the technology requires a great deal of further development. One of the main drawbacks of existing surgical robots is the lack of tactile feedback. Surgeons using the joysticks do not actually "feel" the patient; they must rely on visual cues to judge tension. Haptics, defined as the ability to sense touch, will likely be a quality achieved by the next generation of surgical robots. Another challenge that telesurgery faces is maintaining a secure, continuous connection with little or no delay in transmission. Major advances in technology are required before these connections can be implemented. The coming of telesurgery does not mean that surgeons can abandon traditional methods. In the words of Dr. Hollenberg, (Assoc. Professor Dept. Surgery, McMaster University), "If I were to be performing a robotic procedure on a patient at a distance, there would need to be an individual at the scene who was competent to convert to an open procedure should things go wrong.". As well, the economics of telesurgery must be further analyzed. Institutions must ensure that the cost of telesurgery does not exceed the traditional expenses involved with transporting patients and surgeons.

Many questions exist about the future applications of telesurgery. Will robotic surgery units become a standard in space stations, battlefields and Arctic bases? As telesurgery is a relatively young medical technology, further long-term study with regards to patient advantages, cost effectiveness, safety and clinical applicability (Getman, 2002) is required before the technology can be integrated into the healthcare system.■

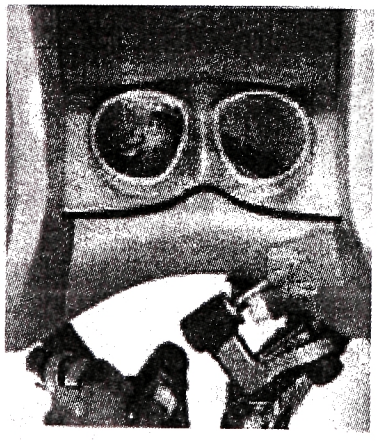

Figure 5

Surgeon's View: daVinci robot console.

http://www.devicelink.com/mx/archive/01/03/0103mx24a.jpg

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