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Digital technologies and quality improvement in cancer surgery

D. Mutter, G. Bouras, J. Marescaux*

European Institute of Telesurgery (IRCAD/EITS), University Hospital, Strasbourg, France

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Abstract Telecommunications, multimedia and computer technologies will introduce marked changes in the management of cancer. New modalities in the representation of patient's medical records using computer technology products and services allow unlimited cross-sharing of information. Education taught through multimedia methods, and through the Internet, is available anywhere and any time just like surgical simulation, robotics and virtual reality. Thanks to computer and IT technologies, surgeons will be able to acquire, assess and validate new surgical procedures or concepts from any geographical location. Live demonstrations shared via videoconferencing facilitate mental development through the acquisition of the cognitive aspects of surgical procedures. Virtual reality is a major improvement in the processing of medical imaging. As a result, the interpretation and the simulation of therapeutic approaches to patients with cancer are facilitated through transparency, navigation and manipulation. The Internet eventually offers uninterrupted communication links between healthcare providers (teaching, training or multidisciplinary telementoring included). Computer and IT technologies will undoubtedly contribute to standardized cancer treatment modalities and determined guidelines for good clinical practice worldwide.

Introduction

Many procedures across a board spectrum of clinical specialities have become amenable to treatment by the minimally invasive surgical (MIS) approach. Although this approach for the treatment of cancer was initially strongly criticised, it has become increasingly accepted by the surgical community following the evaluation of the supposed risks which can be minimized by accurate operative technique and efficient surgical practice. Substantial progress has been made in the field of minimally invasive cancer surgery with regard to the refinement of technique and improvements in the equipment as well as the understanding of the risks and benefits of this approach.

Surgical education and training is currently undergoing a revolution. Validation of a new

* Corresponding author. Address: European Institute of Telesurgery (IRCAD/EITS), 1 Place de l'Hôpital, 67091 Strasbourg Cedex, France. Tel.: +33 3 8811 9006; fax: +33 3 8811 9096.
E-mail address: jacques.marescaux@ircad.u-strasbg.fr (J. Marescaux).

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technique by a pioneering expert does not necessarily mean that it is comparable to existing surgical practice if the majority of surgeons are not trained in this technique. Despite the on-going debate about whether MIS training should be conducted outside or inside the operating room (OR), the MIS community has come to agreement that basic MIS training should begin by learning the fundamental concepts and skills of laparoscopic surgery. This training should ideally start during residency and it is increasingly accepted that the technical skills should be taught outside the OR. It has, therefore, become apparent that traditional surgical training methods may not be appropriate for MIS.

There is a clearly defined learning curve in basic MIS training which requires patience, hours of videotape-viewing and repeated practice, in particular, of suturing using simulator box trainers or animal models. However, it is imperative that the concept of a skillful surgeon being more than just an efficient performer of motor skills is maintained. As demonstrated by Rogers,[1] a surgical procedure is not simply a summation of basic surgical skills but a 'total surgical task which involves surgical decision making and the management of the surgical team and resources'. In order to achieve such a holistic attitude, new methods of education and training have to be established in MIS. In this respect, multimedia computer-aided learning will introduce important changes in surgical education.[2,3] Apprenticeship, which has traditionally been the basis of surgical teaching, is progressively being replaced by newer strategies from the 'information age'. This includes the application of computer technology such as multimedia programs, the internet, surgical simulation and robotics. There has also been an expansive availability of theoretical and practical information of high versatility. Using this technology, surgeons will soon be able to acquire, evaluate and validate new surgical concepts from any location.

To become competent in the various surgical techniques required in MIS, it is necessary to acquire a multitude of new skills. This acquisition can be divided into several phases. The first is the cognitive phase during which the trainee develops a mental picture of the task to be performed. The second phase of skill acquisition is the associative phase during which the student eliminates errors and enhances his or her performance. The last phase is the autonomous phase in which the skills are performed with little cognitive awareness. The requirement of a high level of skill and precision is particularly emphasized in cancer surgery due to the potential consequences of errors leading to miss-treatment of the patient. In our centre, we have made progress in the development of surgical multimedia and computer-aided learning including video-conferencing, virtual reality and computer-assisted simulation in order to optimize surgical education.

Video-conferencing

Acquisition of the cognitive aspect of a surgical procedure is enhanced by observing an expert perform the procedure. This enables the student to gain a mental picture of the perfectly executed procedure as well as the ability to recognise any pitfalls. The acquisition of skills is facilitated by better cognitive understanding of the nature of the task. Video-conferencing allows the viewing by trainees of high-quality real-time surgical images with interactive sound transmission from an expert operating surgeon.

Technical requirements

We developed a surgical training centre in which there are two auditoriums equipped with a live video-conferencing system directly connected to two surgical ORs. Three video images and one sound source can be simultaneously transmitted from each OR to a central editing system through high-speed fibre optic connections (4 Mb/s). One of the video images is the laparoscopic view used by the surgeon. The second is obtained from a camera located on the operative light continuously displaying the position of the instruments, ports, surgeons and their gestures. The third video may display images from a mobile camera showing the organization of the operation room, or images from other operative sources such as endoscopy, ultrasonography or fluoroscopy. The sound source is obtained through a microphone which is mounted on a helmet worn by the surgeon (Sennheiser®) allowing interactive communication between the trainees in the auditorium and the operating surgeon. The surgeon is able to explain the surgical procedure while receiving feedback from his audience in real-time.

The impact of video-conferencing

The images viewed by the trainees in the auditorium can display multiple images from the OR or images from other teaching sources. Such a system flawlessly fulfils one of the objectives of surgical training as proposed by Ballantyne 'the surgeon should observe an expert