Laparoscopic Skills Simulator: A Gradual Structured Training Program for Acquiring Laparoscopic Abilities

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ABSTRACT

The aim of this study is to investigate the importance of acquiring basic and advanced laparoscopic skills using a virtual reality low cost simulator in laparoscopic surgery. The authors have considered six basic and five advanced skills. The training exercises are related to the acquisition of tasks which allow students to reach basic gestures competences. In the second phase the students will perform complex drills to acquire a correct gesture. The authors have developed a standardized, graduated and evidence-based training course. A software able to handle the training task has been created through a virtual interface based on the concept “student - exercise – evaluation”. The results are expected because data analysis will be possible only after a period of simulator testing on different samples of students. Referring to the experience reported by other authors, they expect significant results in terms of: reduction of learning time, better dexterity, ability to recognize and correct procedural errors, positive economic impact in term of better patients outcome, analyzed by codified clinical indicators.

Keywords: Economic Performance, Laparoscopic Surgery, Low Cost System, Mastery, Simulator, Skills, Training

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INTRODUCTION

One of the most significant developments in surgery over the past 30 years has been the advent of minimally invasive laparoscopic surgery. While assisting their supervisor, residents are typically encouraged to observe the surgeon performing procedures on patients under general anaesthesia in the operating room. Because the ultimate goal of simulation training is to improve the surgeon's performance in operative room, transferability and retention studies are extremely important. Several studies evaluate the effectiveness of simulation training over time and have shown that it is not solely the simulator characteristics, but also the manner of training on the simulator, that determines the degree of transfer of skill to the operative setting.

The problems in conventional medical training have led to the development of multimodal virtual surgical systems (Lim et al 2007).

The potential advantage of these systems is a more efficiency compared to the traditional trainings on real patients (Issenberg et al., 1999; Wong, 2004; Hammond 2004).

These systems can be used to objectively evaluate and measure technical competence, and they are less expensive and less controversial than training on animal models.

The real technical challenge in developing effective multimodal virtual environments for medical applications, such as laparoscopic surgical simulation, is to develop realistic algorithms that can deliver accurate interaction forces to the user, as well as visually display the deformation fields in real time (Lim et al 2007).

Purely computer graphics-based technologies do not capture the physics of the problem. Mass-spring elastic models (Cover et al.,1993) and the finite element technique (Cotin et al., 1999) have been developed to introduce physics into the new recently simulation processes.

Virtual environments can allow residents to practice both basic skills and procedural logic at extremely low cost, allowing the presentation of a wide variety of operating-room scenarios that cannot be duplicated in cadaver labs.

Furthermore, computer-based simulation can offer even to experienced surgeons a chance to practice infrequently performed procedures, to learn new surgical techniques, and to rehearse procedures preoperatively on patient-specific anatomy. An analogy can be made to the highly successful field of flight simulation, which has been routinely used to train and re-educate pilots for decades.

However, significant technical challenges stand between actual surgical simulation systems and the virtual operating room that will become a standard part of tomorrow medical training. Simulators are still limited in rendering quality, immersiveness, intuitiveness, and simulation realism (Morris 2006).

BACKGROUND

The use of simulation in laparoscopic surgery training appears to be qualitatively effective if supported by a suitable evaluation system.

The increasing demand of more complex laparoscopic simulators has inspired the creation of a 4d simulator which is a physical low-cost laparoscopic training platform that reproduces the tactile feedback: eLaparo4d) integrated with a software for virtual anatomical realistic scenarios (Unity3D V 4.1).

The School of Medicine of Genoa and the Biomedical Engineering and robotic Department (DIBRIS) have cooperated to create a low-cost model based on existing and brand new software. Aim of this work is to describe the educational-training course and tools that students can use.
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