Psychomotor skills assessment in basic procedures of laparoscopic surgery in undergraduate medical students at the School of Medicine of the University of Colima

ABSTRACT

Background: Changes in recent decades in the training of medical students seem to agree that the educational model for professional skills is most appropriate. The virtual simulator translates skills acquired in the operating room. The Faculty of Medicine of the University of Colima noticed the need to prepare undergraduate students by transferring surgical trainees' skills in basic laparoscopic activities that require a simple cognitive effort. The hypothesis in this study was to evaluate the acquisition of skills in laparoscopic simulator in undergraduate students.

Methods: Educational research and analytical comparison was conducted within the activities of the program of Problem-Based Learning in the program of Education and Surgical Technique, Faculty of Medicine, University of Colima, Colima, Mexico.

Results: All participants in the simulator achieved a higher level during task one after three repetitions ($p = 0.001$). Upon evaluation of final qualification of students, we observed significant differences in means, being lower during the initial assessment (8.60 ± 0.76) compared to the end (8.96 ± 0.58) $p = 0.001$.

Conclusions: Skills acquisition in the simulator is longer but the end result demonstrates that this method is superior to the acquisition of skills using the traditional method, leading to the acquisition of skills that promote the transfer of skills to the surgical environment.

Key words: Basic skills, competencies, laparoscopic surgery.
BACKGROUND

In the last decade the paradigm of medical student training in the Mexican educational system has undergone significant changes. The change in the educational model to professional skills seems to be the most appropriate for the students and for today's learning requirements.\textsuperscript{1,2} This model offers an alternative to traditional educational practice and is based on an opposite epistemological proposal.

The introduction of laparoscopic surgery, or minimally invasive surgery, has changed the way that patients prefer to be operated on and surgeons have the knowledge to carry this out. In an effort to improve surgical education and following the example of other disciplines such as aviation,\textsuperscript{3} one of the concerns of universities is that students acquire skills in different types of surgical procedures using animal models and simulators. Human resources trainers have adopted laparoscopic simulation in order to improve the performance of students before entering a clinical setting in hospitals. It has been proven that a virtual reality simulator has sufficient sensitivity to distinguish between different levels of psychomotor skills acquired by a surgeon and may be a useful tool to assess the learning curve\textsuperscript{4-7} using simple metric scales, feedback error, and facilitating performance assessment.\textsuperscript{8}

For 7 years, in the course called “Surgical Technique” taught at the Faculty of Medicine of the University of Colima, training of students in laparoscopic techniques began with the use of simulators. However, we have not evaluated the impact of this training on psychomotor skills of the students. Therefore, we conducted this study whose primary objective was to assess the skills obtained after a 1-year course with a laparoscopic surgery simulator.

METHODS

We carried out a descriptive study performed in students during the sixth and seventh semesters of Education and Surgical Technique courses in a training laboratory of the Virtual Reality Center of the Faculty of Medicine, University of Colima (January 2006 – July 31, 2009). Students acted as their own controls. The study was approved by the Local Research Committee. All students lacked knowledge of laparoscopic surgery, and three expert instructors in laparoscopic surgery with > 10 years of experience in the field taught the theoretical and practical knowledge of the technique twice weekly with a duration of 1 h during a 1-year period.

To carry out the practices, the Procedicus MIST\textsuperscript{®} simulator by Mentice with a 200 MHz computer processor with 32 MB of RAM attached to a staff of two laparoscopic instruments in the anatomic position with 5° of freedom was used. This provides a real-time exposure of movements of the instruments that produce a graphic display on a 15° color monitor. The simulator tasks are represented by a three-dimensional cube and circular objects with a 12-mm diameter that appear randomly within the operative field and can be handled and gripped by the operator.

Evaluation

Using the Procedicus MIST\textsuperscript{®} simulator the following basic tasks were evaluated:

a) Acquire place task (AP)—to record a series of repetitions of movements to take an object and place it in a receptacle destination. This task assesses the time spent, commission of errors and saving instrument movements relative to the target object (Figure 1).

b) Withdraw Insert context (WI)—this records the user's ability to take an object and move it out to the other forceps simulating stabilization of the neck of the gallbladder (Figure 2).

c) Transfer place (TP)—this task assesses the user's manipulation ability: how to take an
object with forceps and transfer it to the opposite hand; using that virtual manner the elevation of the bottom of the gallbladder toward the upper right quadrant is simulated (Figure 3).

d) Diathermy (DT)—the user’s ability is recorded to apply diathermy to a chosen target on the surface of an objective (Figure 4). Students were assessed at the beginning of the sixth semester (baseline measurement) and at the end of the seventh (final evaluation).

Types of Tasks Performed

**Dependent Variable**

Laparoscopic clinical competence is the proficiency in basic movements and in the absence of third dimension that minimizes the commission of errors.

**Independent Variable**

Training in virtual reality simulator with emphasis on the domain of engagement strategies for the development of clinical skills such as domain and economy of movements.

**Assessment Tool**

Laparoscopy simulator is able to graph and automatically quantify the average completion time of movements and the number of errors of the right hand, the left hand and both, and quantitatively evaluate on a check Excel sheet the efficiency levels achieved. For intergroup
comparison of the initial and final global medium results, Kruskall-Wallis test was used.

RESULTS

There were 425 students with a mean age of 22 ± 2.3 years representing four levels who were evaluated. All participants achieved a significantly higher level at the simulator during the first task (AP) after three repetitions that were steady and statistically significant with a median value of 47.67 ± 33.4 for the initial task and 62.2 ± 40.5 for the final task. To facilitate the analysis of all the results these were transformed into a scale of 0 to 10, i.e., 8.214 ± 1.61 in the initial group vs. 9.04 ± 0.85 in the final group (p= 0.001) with a 95% confidence interval (CI) of 4.10-10.

In task two (WI) there was a significantly higher efficiency at the final assessment compared to the baseline with scores of 9.21 ± 0.79 vs. 8.54 ± 1.05, respectively (p= 0.001) with 95% CI 4.75-10.

In the objective scores obtained for task three (TP) in the initial and final groups during testing, the p value reflected differences between groups in the range; the performance was significantly higher at the end with a mean of 8.98 ± 0.96 compared to the starting point with a mean of 8.32 ± 1.07 (p= 0.001) with 95% CI 4.54-10.

Regarding the performance of the intervention during the final grade for assignment four (DT), it was greater than the initial, with a mean of 8.84 ± 0.63 at the beginning vs. 8.63 ± 1.07 at the end, with statistical significance (p= 0.001) and 95% CI of 5.0-10.

Finally, evaluation of the final grade of the students comparing the initial and final results had significant differences in means; they were lower during the initial evaluation (8.60 ± 0.76) compared to the final (8.96 ± 0.58) with p= 0.001.

DISCUSSION

As a rule, the acquisition of surgical skills has always been considered difficult not only for the student but also for the teacher. The potential benefits of the acquisition of basic psychomotor skills in laparoscopic procedures in undergraduates have led teachers to design strategies for proper training in these procedures. Traditional surgical training has been left behind because the educational process should be staggered and open surgery that could jeopardize patient safety does not allow focusing on the acquisition of key competencies. We propose an option to acquire basic laparoscopic skills based on an objective assessment with a computer system.

The results of this study confirm the hypothesis that the transfer of skills in the simulator allows the acquisition of skills of laparoscopic surgery in the clinical setting. We demonstrate with our results that mastery of skills by undergraduate students leads to the acquisition of skills in laparoscopic surgery compared with traditional methods based on traditional educational training.

Repeating tasks were reflected in significant improvement in students’ abilities and skills to master the basic movements in the absence of the third dimension that minimizes the commission of errors. In addition, this study showed that based on objective indicators it is possible to learn and improve psychomotor skills of basic laparoscopy.

The tasks performed with the simulator were simple, with only four possible outcomes clearly defined compared with those reported in studies with MIST simulators. To perform a cholecystectomy, the six original tasks are used with different levels of complexity for teaching psychomotor skills and management of laparoscopic instruments. Because of the high level of competition, these were not considered compared to those required by medical students.
In our study we show that virtual training in laparoscopic simulators according to Jakimowicz and Jakimowicz in their review minimizes the number of errors and censors movements in students. We agree with Aggarwa et al., that at the time of exposure in patients fewer mistakes are made and basic professional requirements of uniformity are also improved. This is what is achieved with laparoscopic training during undergraduate education. After the intervention, participants achieved better performance, which provides them with greater security in the operating room at the beginning of their clinical practice compared with the lack of training for initial mastery of this competition.

Sereno-Trabaldo et al., demonstrated that individuals trained in simulators achieved a significant improvement in efficiency and made fewer errors as they develop more skills in basic laparoscopic procedures; this was comparable with our results. These findings suggest that the assessment tool is reliable to measure the skills that students acquire in performing basic laparoscopic procedures in the simulator.

In conclusion, the ability is acquired through repetition. In the case of laparoscopic skills the ideal method is with the use of simulators. These systems should be included in surgical residency programs. At present it is necessary to generalize their practice to undergraduates based on the contact with patients who would have this procedure, increasingly common among internists.

Simulator training takes longer but has proven to be superior to the acquisition of skills based on traditional training. This study showed that the acquisition of skills by mastering the tasks performed favors the transfer of skills to the surgical environment at the beginning of the clinical practice of the new surgical graduates.

REFERENCES