Original Research Article

Affordable laparoscopic simulator to acquire basic skills in undergraduate surgery students

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ABSTRACT

Background: The simulation emerges as an option that allows students to practice in a safe environment, all this in a scenario that resembles the real situation.
Methods: We developed a prototype of a low-cost simulator that mimics the dimensions of the abdominal cavity and allows the undergraduate students to acquire the basic skills in minimally invasive surgery.
Results: In the 10 competencies evaluated, statistically significant improvement was found in both groups being higher in the students who were trained by our simulator of laparoscopic surgery compared with students who attended surgeries and participated as seconds assistants, taking as reference a value of $p \leq 0.05$.
Conclusions: The simulation as new teaching strategy generates a real environment and scenarios that can be recreated in multiple occasions, being able to change depending on the objectives for the acquisition of skills. This simulator gives the user skills for more types of simulation as it progresses in its surgical training.

Keywords: Endotrainer, Laparoscopic surgery, Medical teaching, Medical students, Simulation, Undergraduate surgery

INTRODUCTION

The laparoscopic surgery has proved to be the main approach for a number of pathologies that require surgical intervention. This due to its lower incidence of complications, to a faster recovery time compared to traditional open surgery and reduction of surgery time[1]. This has led to the need in training and acquisition of skills in minimally invasive surgery in early stages of the medical career of students inclined toward a surgical specialty. The complications during this learning process have resulted in ethical considerations, imposed by the medical profession, specifically in the use of humans and animals in the surgical training.[2] This has led to the development of simulator devices to develop skills and training of surgeons. These aspects are not confined to the postgraduate students, study plans at the undergraduate level generate an imminent need to

implement this type of surgical training since the beginning of the medical-surgical training with the objective of consolidating this skills and competencies from the early stages, as well as to prepare our students to face the current situation of surgery. With the presence of these variables in medical education, we developed a prototype of a low-cost simulator that mimics the dimensions of the abdominal cavity and allows the undergraduate students to acquire the basic skills in minimally invasive surgery, that differ from the traditional open surgery. The use of long instruments amplify the natural tremor, they also change the perception of depth and spatial orientation when viewed three-dimensional elements in only two dimensions. The use of these simulators, through multiple exercises, allows the student to perform each time more precise this movements, with better perception of depth, best eye-hand coordination and to adapt to a surgical field with reduced vision. The simulation emerges as an option that allows students to carry out this type of simulator, in a safe environment that allows mistakes and the repetition of exercises, all this in a scenario that resembles the real situation.[2,3]

Objectives was to develop a low-cost laparoscopic simulator for training of basic skills in minimally invasive surgery in undergraduate surgery students.

METHODS

We developed a mechanical simulator based on a translucent rectangular container of 40x60cm (capacity 10lt) that simulates the abdominal cavity, has three ports of entry for the surgical instruments with an equidistant separation of 7 to 10 cm between them with the aim of representing the disposition to use the principle of triangulation (Figure 1).
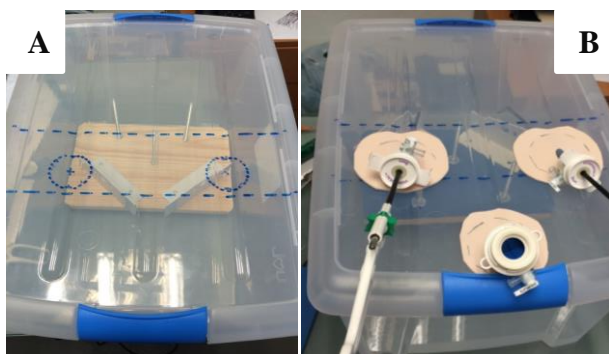

Figure 1: A. Translucent rectangular container of 40x60cm (capacity 10lt) that simulates the abdominal cavity. B. Ports of entry for the surgical instruments with an equidistant separation of 7 to 10cm between them.

The model has a system of illumination with white light (5V) adapted to emit uniform light in the entire cavity. The image system by frontal video recording has the capacity of auto adjusting to the desired position, this

mechanism can be manipulated directly or be fixed, without the use of a second person for its manipulation. The image system consists of a USB endoscope video camera, with a 0° lens, resolution of 720P/30fps, DATA transmission is by USB interface 2M and 5M compatible with multiple image projection devices (PC, lap-top, projectors, screens) this characteristic provides a suitable quality of image with the objective to make it possible to reproduce the model by any means, promoting self-regulated learning (Figure 2).
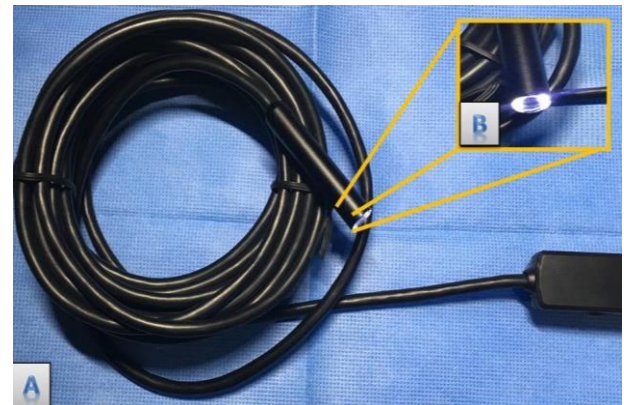

Figure 2: A. Image system by frontal video recording/USB. B. System of illumination with white light (5V) adapted to emit uniform light in the entire cavity.

The simulator has 4 training platforms, that can be removed and placed depending on the competition that you want to develop, the simulator is designed to perform the different basic skills in minimally invasive surgery outlined in the MY- TELS.[4,5] "The McGill inanimate system for training and evaluation of laparoscopic skills" program validated and thoroughly used in the world for the acquisition of the required skills in laparoscopic surgery. The ports of entry have an average distance from the port to the base of the simulator of 10cm deep, this allows the insertion laparoscopic instruments up to two thirds of its length.

RESULTS

To validate the acquisition of basic skills in minimally invasive surgery using the model that we propose, we previously performed a study in which we used two groups, each group with 50 students belonging to the current career program during the 2014-2015 school year. For the experimental group were included regular students with a minimum grade average of 8.0/10 that were in the second year of UNAM medical career and who had not previously attended a course of minimally invasive surgery or related courses. Irregular students were excluded and those who had previously attended a course on minimally invasive surgery or related. The experimental group was trained by using our simulator and the control group (fourth year medical students) attended laparoscopic surgeries in different hospitals

participating as second assistant surgeon with direct supervision (Figure 3).

Figure 3: Theoretical-practical sessions.

We carried out 7 theoretical and practical sessions of 40 minutes each, every student was assessed on two separate occasions, one at the beginning of the study and the second at the end of the same. On both occasions evaluation was made with a checklist that enlisted the basic skills and competencies (Table 1).

Table 1: Checklist for the initial and last evaluation in both groups.

Skill evaluated	Performed correctly by the student	Not correctly performed by the student
Identifies the source of light		
Makes the connection of the light source to the laparoscope		
Identifies the Veress needle		
Connects the cable of CO_2 to the Veress needle		
Identifies theloaded trocar		
The student explains in a general way and with order the procedure for the placement of a trocar.		
Identifies the basic instruments in minimally invasive surgery:		
Tweezers Maryland		
Tweezers Grasper		
Needle carrier		
Electrosurgical-harmonic drive		
Sliders knots		
Irrigation-aspiration unit		
Explains in a general way the uses of the instrumental in minimally invasive surgery		
Tweezers Maryland		
Tweezers Grasper		
Needle carrier		
Electrosurgical-harmonic drive		
Sliders knots		
Irrigation-aspiration unit		
Performs the video assistance effectively during the surgical act		
Makes an instrumented stitch.		

The collection of data was made using Microsoft Excel 2010, for the statistical analysis we used: Mann-Whitney U-test and Wilcoxon Ranks in the IBM statistical program SPSS v 21, the first test was used considering

that each group had learned laparoscopic skills by two different methods, the second test was used for comparing the scores of each individual in the initial and last assessments of both groups.

In the 10 competencies evaluated, statistically significant improvement was found in both groups being higher in the students who were trained by our simulator of laparoscopic surgery compared with students who attended surgeries and participated as seconds assistants, taking as reference a value of p ≤0.05.

DISCUSSION

The use of simulators has had great acceptance by the medical profession in recent years, given that they reduce the need to use biological simulators, thereby reducing the ethical conflicts, although these are still required on certain occasions, it has been necessary to replace them with other techniques that also help the acquisition of surgical skills.[6]

Our model allows a first approach to the minimally invasive surgery and the possibility of being used by several students by being of low cost and easy construction, it also has the advantage of being able to be used not only within the departments of education of the hospitals or universities, but also from their own homes. By augmenting the time of practice, the acquisition and upgrading of manual skills in shorter periods of time also increases, which will vary depending on each student. The skills cannot be taught, they are only acquired by practice.[7] For future models, we have planed the adaptation of a system that allows to record the practice session, although it implies a little raise in the cost of the model, it also has benefits for the students as the student will be able to receive feedback from teachers, colleagues, and even by himself, improving the process of teaching and learning.[8]

Since the effectiveness of our model has been tested in the previous study, the next step will be to adapt it at the undergraduate level, which will prepare students for the rise in the demand that has experimented the minimally invasive surgery in the last years.[9] Also, a follow up study with the same group to compare skills during their surgical rotations, surgery internship rotation or even during their first years of postgraduate surgery training. It is important to emphasize that in order to achieve the aims and objectives of this simulator is necessary the close supervision of the pupil by an expert, only by this way they will learn the correct technique of each procedure.[10]

Our model is also complemented with other types of simulation like virtual simulation, all the skills learned in this type of simulator are also useful in the other types, with the benefit that it is able to evaluate the progress and student performance in an objective way, with the addition of being a prior experience that allows the student to take advantage and develop in a better way in the other resources of simulation.[11]

CONCLUSION

It is a fact that the training of any ability must be started in non-biological models, but many times it happens the simulators for these purposes are considered to be of high cost for both the institution and the student, in the same way the number of supplies and simulators are not enough, allowing its use in very specific contexts and populations, usually only by postgraduate students. This situation has led us to the development of a low cost model accessible to all our student population because we are convinced that the early training in minimally invasive surgery in undergraduate education generates basic skills useful for students interested in a surgery specialty, also for future surgical rotations, as students or undergraduate medical interns, who will have an active participation and is a competent professional, but does not have as its objective the development of skills required to complete surgical procedures that fall within the surgical specialties.

The model that is proposed beside being easy to build and of low cost, does not require the infrastructure and resources, present in the hospital environment, that is necessary in other simulators especially in developing countries or in medical schools with a high load of students such as ours with over 1,000 students per year. The simulation as new teaching strategy generates a real environment and scenarios that can be recreated in multiple occasions, being able to change depending on the objectives for the acquisition of skills. This simulator gives the user skills for more types of simulation as it progresses in its surgical training.

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