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Original Article

Development of a laparoscopic training model using a smartphone

Desenvolvimento de modelo treinamento em cirurgia laparoscópica com utilização de smartphone

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A B S T R A C T

Objective: *to develop a model of training in video-surgery, of low cost and that uses a smartphone as an image-generating source.* **Methods:** *We developed a 38cm high, 40cm wide, 40cm long hexagonal-shaped training box, with a front opening of 12x8 cm for coupling the smartphone. The internal illumination is made with LED lamps and for the support of the smartphone, we used a selfie stick, fixed in the upper part of the box, that allows control of height, distance, angulation, and the coupling of devices with different formats. We selected 20 undergraduate students without previous training in video-surgery, who performed four exercises in the box, with assessment of the time and amount of errors in the execution of the tasks. Each student completed the training for three consecutive weeks. We collected the data in spreadsheets for later analysis.* **Results:** *Nineteen students completed the training program, with significant improvement in the times and in the number of errors.* **Conclusion:** *the developed model was feasible and promoted the acquisition of skills in this group of students. In addition, it presents low cost, is portable and uses common equipment, such as smartphones.*

Keywords: Surgery. Training. Education, Medical.

INTRODUCTION

Since the first laparoscopic cholecystectomy in 1987, video-surgery has spread rapidly because of the advantages over the conventional technique, such as reduction in hospitalization time and postoperative pain, as well as better aesthetic results[1,2]. Their increasing presence in the surgical routine, however, did not accompany the greater access to the method in the teaching centers. The main obstacles are the difficulty of access to materials and the high cost of equipment[3,4]. In addition, the method requires specific training to be performed safely[5-8].

Several models have been developed to meet this need. Despite the significant increase in the gain of abilities with such models, all used high-cost image sources, such as camcorders, webcams, tablets and laparoscopic optics[9 11]. Image capture equipment is usually expensive because it needs to be compact, lightweight, and produce images with quality and sharpness. An appliance that has these characteristics is the smartphone, besides being present in everyday life, without the need of extra expenses with its acquisition. Its adaptation to a training box would represent an imaging source available at any time, which would allow recording and playback of training sessions. Thus, the objective of this work was to develop a model of a training box in video-surgery using a smartphone.

METHODS

The study was approved by the Ethics in Research Committee on Human Subjects (CAAE: 48743115.0.0000.5174). We summoned students from the 1st to 5th year of medical schools in Belém (PA), of both genders, aged 16 to 25 years, through an online call. All signed the free and informed consent form and filled the questionnaire with basic personal information and academic background. We excluded students who participated in previous video-surgery training and those

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who did not finish the training program.

Training box

Made of recycled wood, which provides lightness and cost reduction, we developed a training box in hexagonal format to facilitate the entry angle of the tweezers and better ergonomics, measuring 38cm in height, 40cm in width and 40cm in length, with an opening of 12x8cm in the frontal region. We made the internal lighting with rechargeable LED lamps attached to the upper portion. As support for the Smartphone, we used a selfie stick, which allows control of height, distance, angulation, and enables the coupling of devices with different formats. We attached the selfie stick to the top of the box, allowing the capture of different angles of the interior of the prototype (Figure 1). We standardized, as an imaging source, an equipment with an eight-megapixel camera and a 4.6-inch screen.

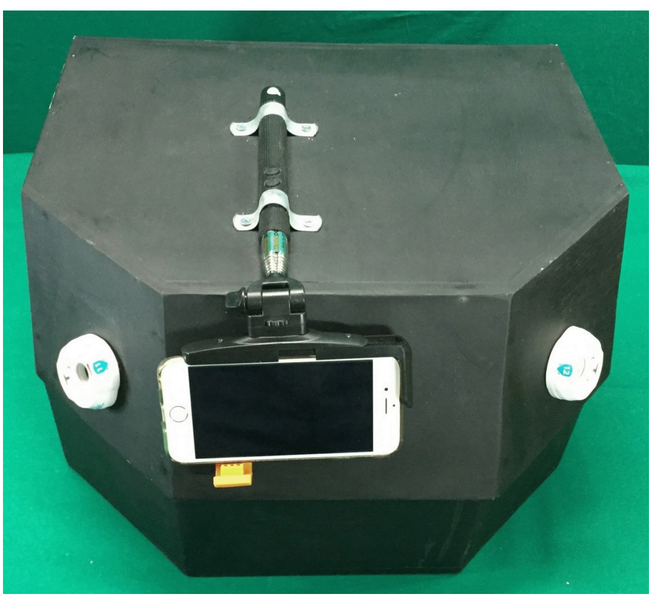

Figure 1. *Training box in hexagonal format.*

Exercises

We adapted to the boxes four work platforms of well-established programs, such as the Fundamentals of Laparoscopic Surgery (FLS)[12] and McGuil Inanimated System for Training and Evaluation of Laparoscopic Skills (MISTELS)13 (Figure 2).

Objects transfer: consists of a platform with five pins on each side, with a ring inserted in one of the pins. The student must remove the ring from the right support with the ipsilateral hand clamp, pass to the left hand clamp and deposit on the pin on the contralateral side. After the transfer of all rings, the student carried out the exercise in the opposite direction.

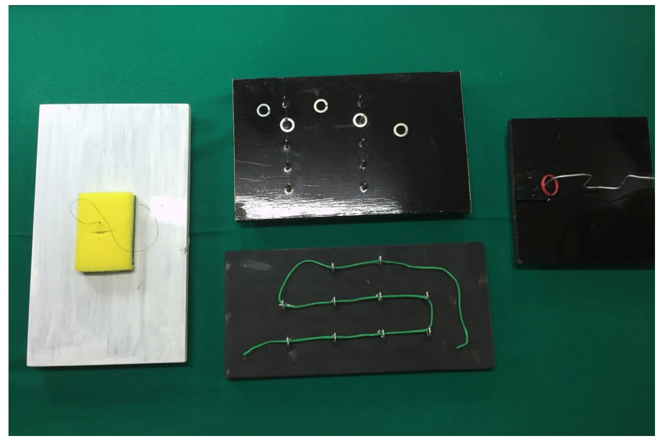

Figure 2. *Training platforms.*

Wire path: The ring must travel through a wire path without touching it or being dropped.

String passing: series of rings of the same size, fixed on a platform and queued in different positions. The student must take the string with the right tweezers, cross the string through the ring and capture it with the left tweezers, following a pre-established sequential course, in the shortest time possible.

Knot making: the student must make a knot in three strings attached to a sponge in the shortest possible time.

Course Dynamics

The students received initial guidance through video lessons with notions about the management of the instruments and demonstration of the exercises. Then they performed the first training, rested two minutes and started the second exercise, and so on. At the end of the fourth and last practices, there was a five-minute break to start the new cycle. The training was conducted during weekly sessions, for three consecutive weeks, with no time restrictions. In each week, three cycles of the same exercise were performed, and at the end of the course, each student performed nine times the same exercise. We measured the times in seconds and the errors noted during the completion of each task by individual monitors.

Statistical analysis

We compiled the data in Microsoft Excel® and submitted them to statistical analysis with the software Bioestat® 5.3. We used the ANOVA test for analysis of variance and the Student t test for analysis of significance between the times. We considered significant results those with $p<0.05$.

RESULTS

We enrolled 62 students and selected 20, of whom 19 completed the training. Regarding the mean of the times in each exercise, we observed a significant improvement at the end of the course in relation to the initial time (Figure 3). There was a decrease in the number of errors in relation to the beginning of the program, besides stabilization in the acquisition of skills during the fourth practice, and significant improvement from that point on (Figure 4). The use of recycled wood, simple labor and the use of materials present in the daily life reduced the manufacturing costs of the boxes, which had a unit value of R$ 167.66 (about US$ 53.35).

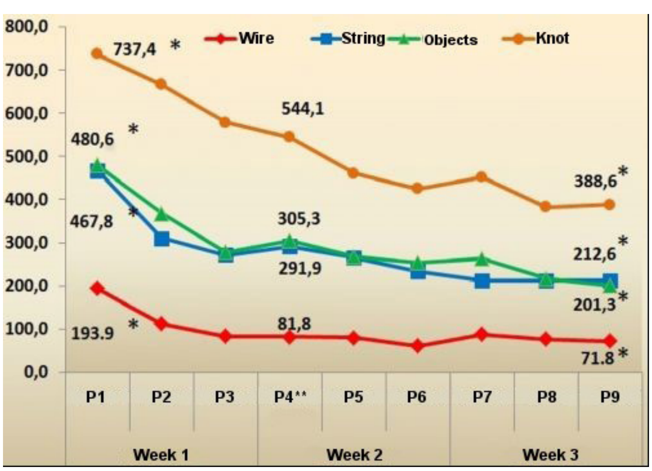

Figure 3. *Average execution times of the exercises. P1: practice 1, P2: practice 2,…, P9: practice 9.*

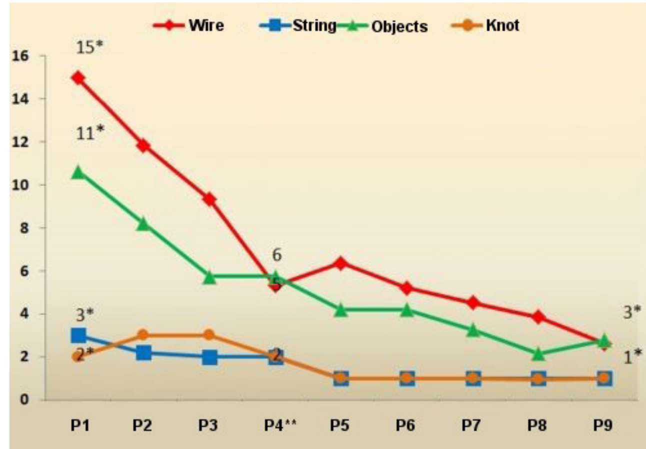

Figure 4 . *Mean errors during the exercises. P1: practice 1, P2: practice 2,…, P9: practice 9.*

DISCUSSION

The training of the surgeon in video-surgery requires the acquisition of skills such as adaptation to two-dimensional vision, due to loss of depth perception, limitation of movements and adequacy to the long instruments, characteristic of the method. The learning curve is also higher when compared with the conventional technique and the development of these skills can be done through simulator practices[14-16]. In the search for the ideal training model, several authors developed boxes with different characteristics, aiming at improvements such as portability, lower cost, availability and greater realism. At the same time, programs such as FLS[12] and MISTELS[13] have been created, based on tests of theoretical and practical knowledge, in order to enable professionals in the area. We based the present study on these programs, adapting them to the local reality, with the intention of developing a new, more accessible training model.

The high cost of materials and equipment is still the main obstacle to the installation of laparoscopic training laboratories[17], whether in colleges or medical residency programs. Several models in the literature have attempted to reduce costs through cheaper materials[18,19], more accessible imaging sources[17,20] and simpler open models[21]. There are publications of models similar to the one developed in this work, which use a smartphone as image source, but using another box format and made with other materials[3,18,22]. This equipment is designed with simple, low cost, portable material, and accessible at any time.

Despite the simple model, there was a statistically significant improvement in all exercises, confirming the results of other studies with similar low cost and more accessible technology[15,23]. Willaert[14], in a systematic review, found no difference in the acquisition of basic skills between simpler models compared with virtual reality simulators. In our study, the students achieved stabilization in the acquisition of skills in the fourth practice, without the need for several repetitions in each exercise, allowing training to be performed in a shorter period in the future[24]. Recent articles have demonstrated a higher frequency of training when there is greater flexibility of time and place, hence the importance of this model's portability. Training centers where the simulators are fixed prevent the displacement and, consequently, there is less adherence to training[25,26].

In the state of Pará, there are no routine courses in video-surgery training, which leads the student to move to other states in search of immersion courses, with very high costs. The development of an accessible training model and the creation of a local course could change this context. The training box with a smartphone promoted the acquisition of video-surgical skills in the group of students studied, thus providing an accessible and affordable alternative in undergraduate education and training, which can be applied to postgraduate surgery.

R E S U M O

Objetivo: desenvolver modelo de treinamento em vídeo-cirurgia, de baixo custo e que utiliza *smartphone* como fonte geradora de imagem. **Métodos:** foi desenvolvida uma caixa de treinamento em formato hexagonal de 38cm de altura, 40cm de largura e 40cm de comprimento e com abertura na região frontal de 12x8 cm para acoplamento do *smartphone*. A iluminação interna é feita com lâmpadas de LED e para o suporte do *smartphone* foi utilizado um *selfiestick*, fixado na parte superior da caixa, que permite controle de altura, distância, angulação, e possibilita acoplamento de aparelhos com diferentes formatos. Foram selecionados 20 alunos de graduação, sem treinamento prévio em vídeo-cirurgia, que realizaram quatro exercícios na caixa com aferição do tempo e quantidade de erros na execução das tarefas. Cada aluno realizou o treinamento durante três semanas consecutivas. Os dados foram coletados em planilhas e analisados posteriormente. **Resultados:** dezenove alunos concluíram o treinamento, com melhora significante nos tempos e na quantidade de erros. **Conclusão:** o modelo desenvolvido mostrou-se viável e promoveu a aquisição de habilidades neste grupo de alunos. Além disso, apresenta baixo custo, é portátil e utiliza equipamento comum, como *smartphones*.

Descritores: Cirurgia. Treinamento. Educação Médica.

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