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Original Article

Low cost cadaveric training model in videolaparoscopy without pneumoperitoneum

Modelo de treinamento cadavérico de baixo custo em videolaparoscopia sem pneumoperitônio

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RESUMO: A laparoscopia consiste em acesso cirúrgico realizado por meio de diminutas incisões na parede abdominal seguidas de estabelecimento de pneumoperitônio, representando um avanço na recuperação pós-operatória em relação a cirurgia aberta. Modelos de treinamento em cirurgia videolaparoscópica utilizando de modelos inanimados, animados e envolvendo uso de realidade virtual (RV) foram desenvolvidos para facilitar a curva de aprendizado. Esses modelos procuram permitir aos cirurgiões em treinamento adquirir competências básicas em laparoscopia, tais como a coordenação mão-olho, destreza na utilização das pinças e melhora da percepção de profundidade na imagem bidimensional (2D). Os elevados custos dos modelos de treinamento têm levado instituições e cirurgiões a procurarem modelos menos onerosos, tais como caixa de treinamento e simuladores de RV. No entanto, não oferecem a mesma experiência de aprendizado que o treinamento VLP em porcos ou em cadáveres. Os custos para realização do pneumoperitônio e para utilização de equipamentos do set de vídeo são elevados. Buscando reduzir esses custos e a complexidade do treinamento VLP em cadáveres, desenvolveu-se um modelo de polietileno sem a necessidade de estabelecimento de pneumoperitônio.

Palavras-chave: Laparoscopia; Cadáver; Aprendizagem; Cirurgia; Pneumoperitônio.

ABSTRACT: Laparoscopy consists of surgical access performed using diminutive incisions in the abdominal wall followed by the establishment of pneumoperitoneum, representing an advance in postoperative recovery compared to open surgery. Models of training in laparoscopic surgery were developed to accelerate the technique's learning. The main ones are inanimate models, animated simulators, and virtual reality (VR). These models seek to allow surgeons in training to acquire basic skills in laparoscopy, such as hand-eye coordination, dexterity in using tweezers, and improvement of depth perception in two-dimensional (2D). The high costs of training models have led institutions and surgeons to look for less expensive models, such as training boxes and VR simulators. However, they do not offer the same learning experience as VLP training on pigs or corpses. Performing the pneumoperitoneum and using video set equipment is expensive. A polyethylene model was developed without establishing pneumoperitoneum to reduce these costs and the complexity of VLP training in cadavers.

Keywords: Laparoscopy; Cadaver; Education; Surgery; Pneumoperitoneum.

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INTRODUCTION

Laparoscopy consists of surgical access performed using diminutive incisions in the abdominal wall followed by the establishment of pneumoperitoneum, representing an advance in postoperative recovery compared to open surgery[1]. The laparoscopic technique results in more minor scars, lower surgical trauma, lower postoperative pain[2], and longer short hospitalization[2]. Its training requires technological resources and has an arduous learning curve, making its applicability and diffusion more restricted[3,4]. Models of training in laparoscopic surgery were developed to accelerate the technique's learning. The main ones are inanimate models, animated simulators, and virtual reality (VR)[4,5]. These models seek to allow surgeons in training to acquire basic skills in laparoscopy, such as hand-eye coordination, dexterity in using tweezers, and improvement of depth perception in two-dimensional (2D) images[6,7,8].

Cadaveric and porcine VLP training models are the methods of training in laparoscopic surgery with greater acceptance among students[12], and provide greater likelihood in the manipulation of living tissue (porcine) and in the use of surgical techniques[12,13]. The high costs of training models have led institutions and surgeons to look for less expensive models, such as training boxes and VR simulators[9,10,11]. However, they do not offer the same learning experience as VLP training on pigs or corpses.

Performing the pneumoperitoneum and using video set equipment is expensive[12]. A polyethylene model was developed without establishing pneumoperitoneum to reduce these costs and the complexity of VLP training in cadavers.

MATERIALS AND METHODS/ RESULTS

Two polyethylene dummies of gravidic abdomen were used because they are simulacra of abdominal distension provided by pneumoperitoneum. Orifices for the placement of laparoscopic trochanters were distributed respecting the distance of 8cm between them and distributed to allow the approach in the hypochondria, iliac fossa, and pelvis (Figure 1).

Figure 1 - Polyethylene manikin simulating gravidic abdomen with the demarcations of the trocars' placement points

The trowel holes were made with the aid of a 24 mm diameter drill WAP® while the 3mm holes were made with a 3mm drill along the lateral edges of the manikin to fix the model to the corpse (Figure 1B).

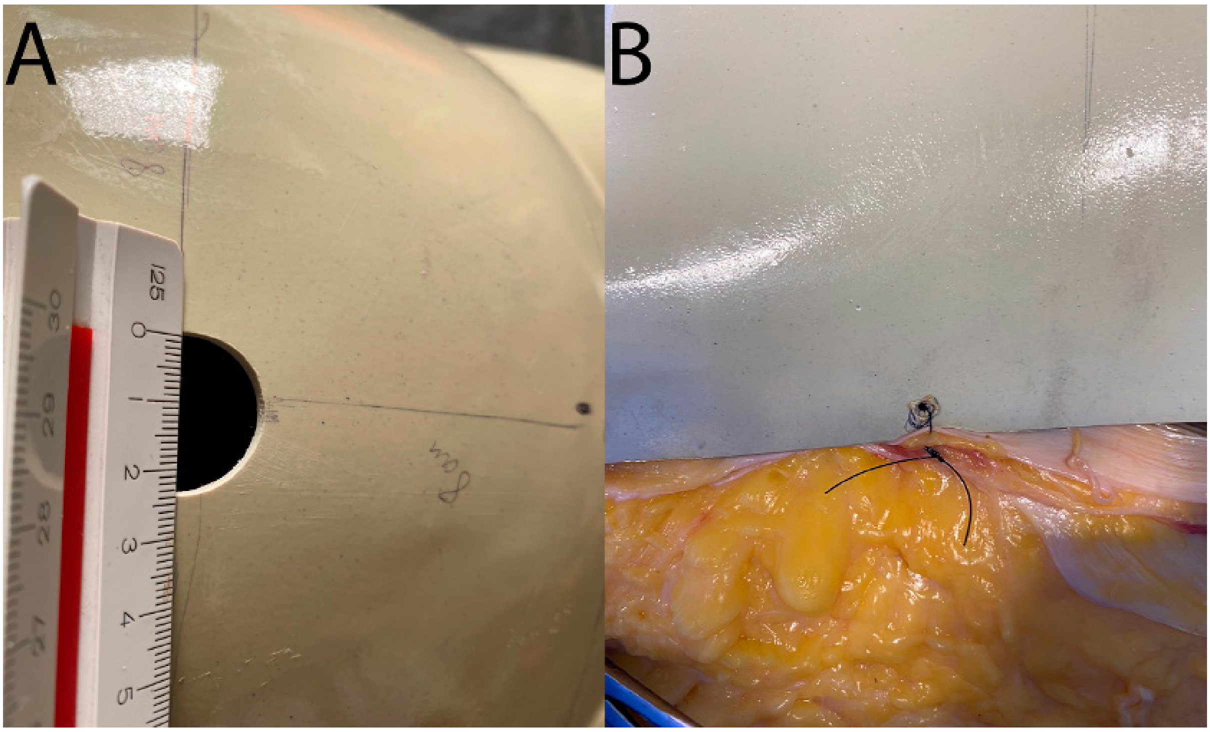

Figure 2 - (A) Hole with its Diameter in centimeters, (B) Holes near the lateral edge of the dummy for Attachment to the Corpse

Three multipurpose sponges were used on the inner face of the model to offer resistance similar to skin and subcutaneous cellular tissue, thus aiding the fixation of the trocars' (Figures 2A and 2B).

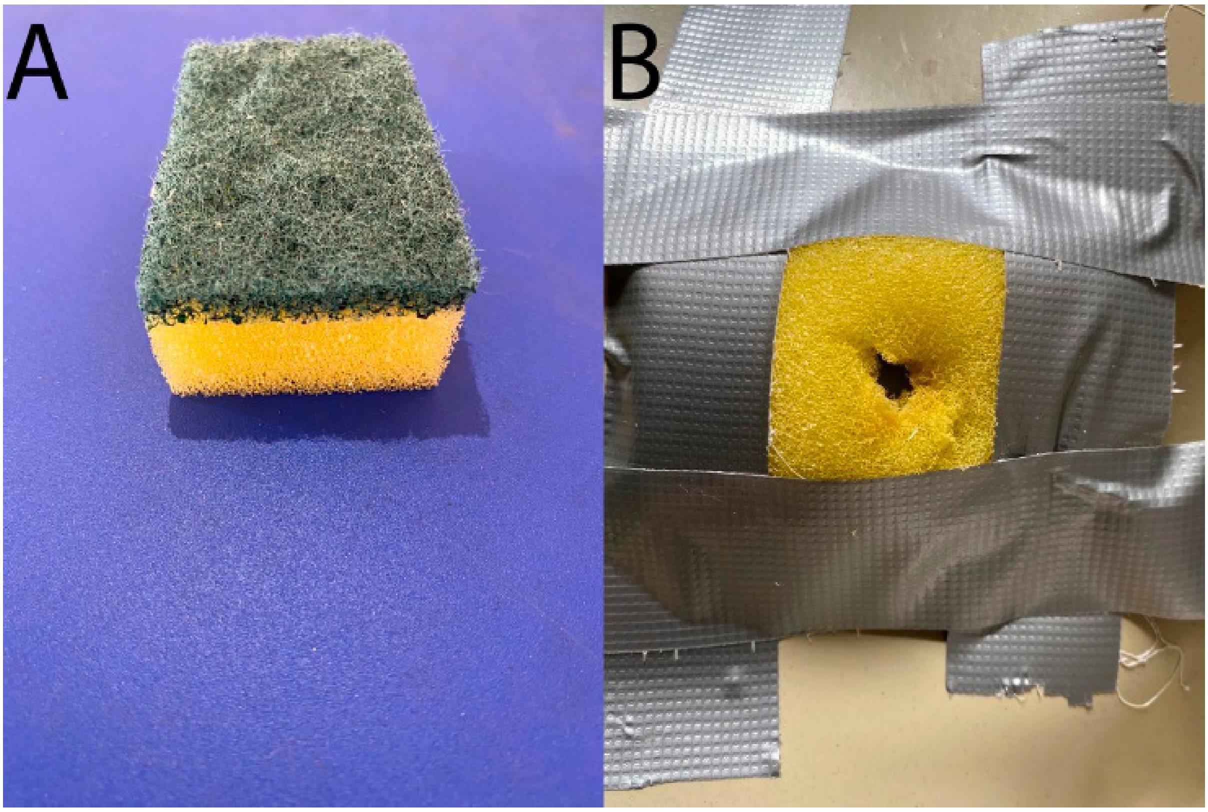

Figure 3: (A) Multipurpose sponge (B) Multipurpose sponge attached to the inner face of the manikin

Disposable trocars of 5mm, 11mm, and 12mm were used (Figures 4A and 4B). A flexible endoscopic camera (480p, 1.7mm, with built-in illumination) connected to a tablet and a rigid camera (480p, 2.0mm, RGB) from a previously disassembled black box laparoscopic trainer (Figures 5A and 5B). Using the two cameras, one flexible and the other rigid, allowed us to determine which has better performance in the model, the rigid camera more suitable for handling during training with the model (Figure 5B).

The disposable exchangers of 5mm, 11mm, and 12mm were passed through the holes of the dummy, being fixed by the multipurpose sponges (Figure 6).

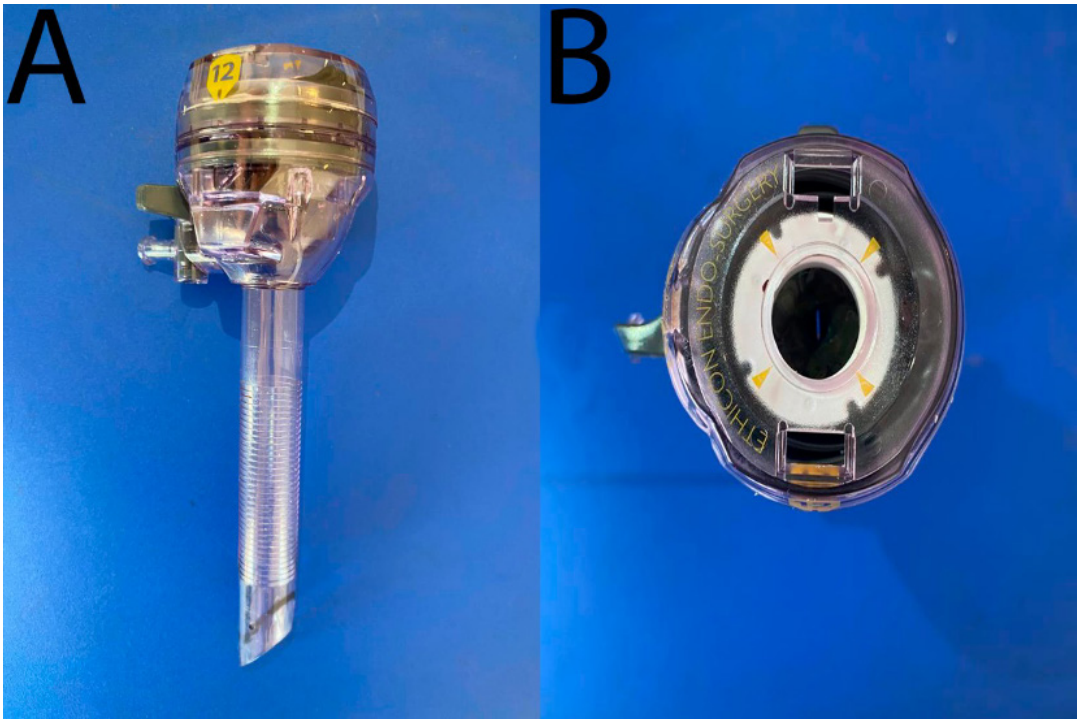

Figure 4: (A) 12mm trocar in side view, (B) 12mm trocar in top view

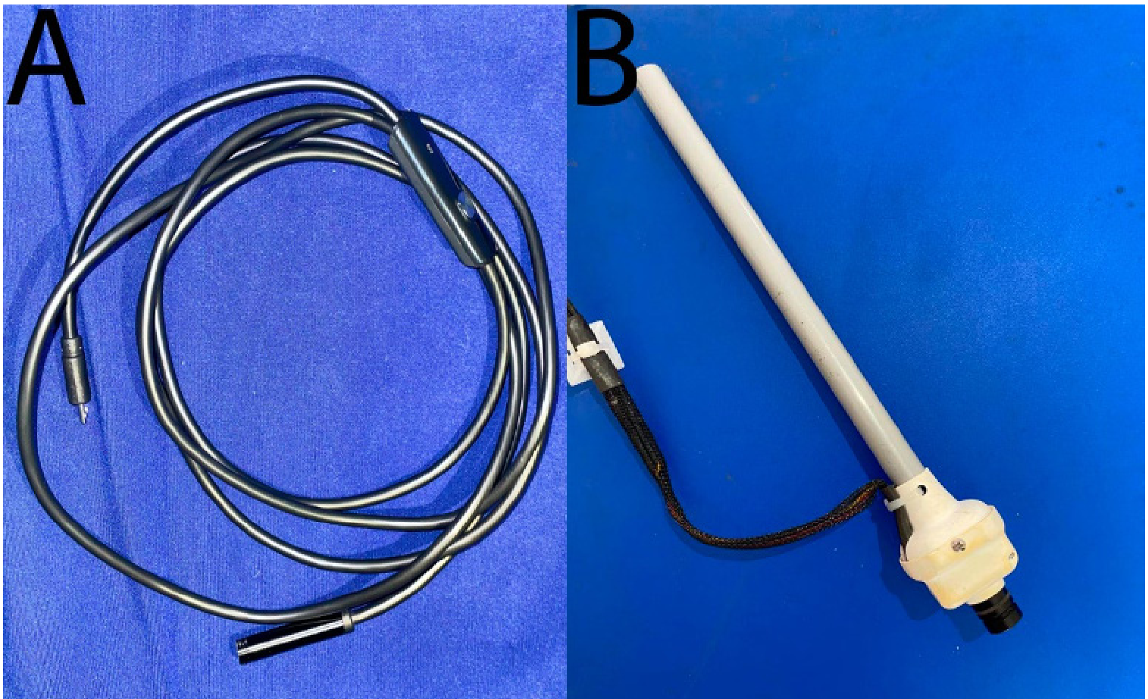

Figure 5: (A) The endoscopic camera, (B) The rigid camera of the laparoscopic trainer

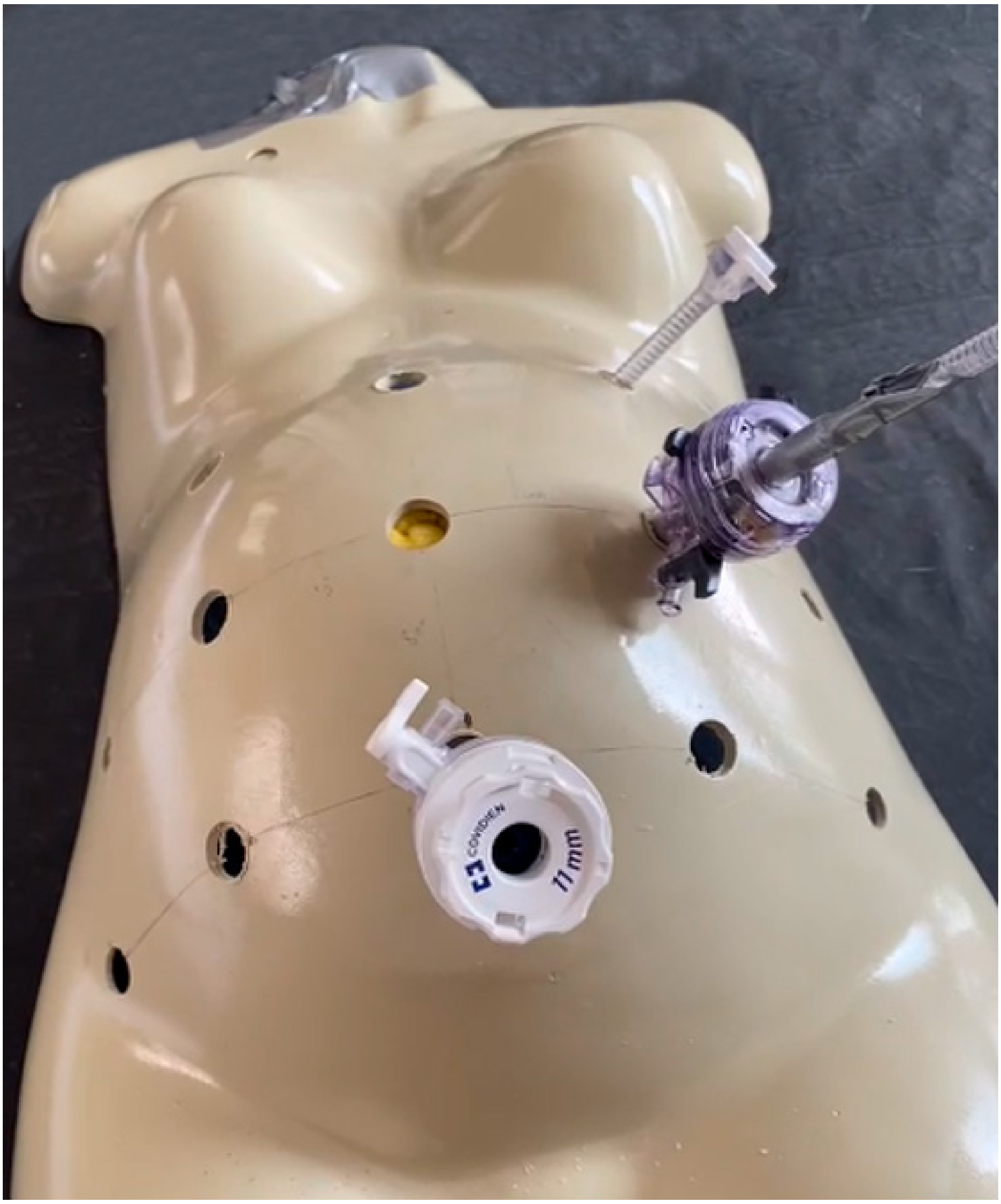

Figure 6 -Trocars placed through model holes

A median xifopubic abdominal incision is performed associated with a transumbilical transverse incision, allowing complete exposure of the abdominal cavity. The best visualization and manipulation of the retroperitoneal structures was achieved by performing total colectomy and enterectomy in order to avoid the distension of the intestinal loops enclosing the surgeon's vision, allowing free surgical manipulation of the anatomical structures.

The mannikin is fixed with cotton threads passed through the holes of 3 mm on the entire side, respecting a distance between holes of 5 cm, allowing the model more stability with the abdominal wall (Figure 7).

The portable screen is placed in an ergonomic position for surgeon comfort and the procedure to be trained can be performed without the need for pneumoperitoneum.

The diversity of portal options allows the approach of a wide range of surgical sites, and it can be used to simulate procedures in any anatomical region of the abdomen and pelvis.

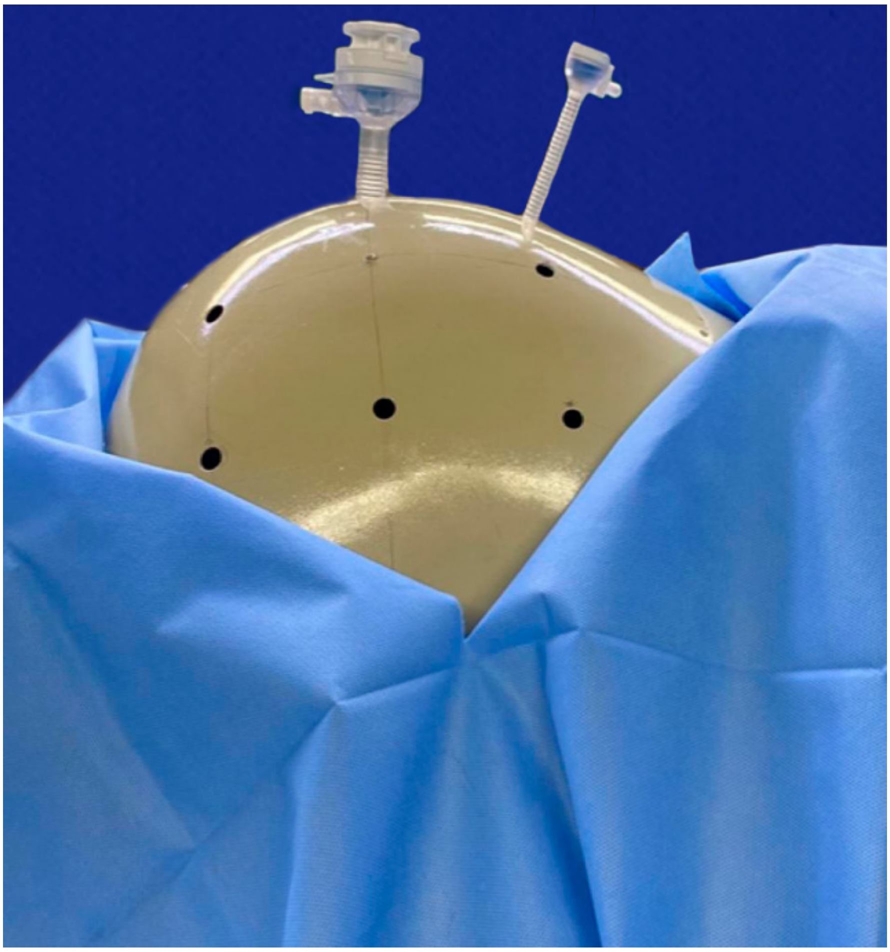

Figure 7 - Model installed and ready for the training

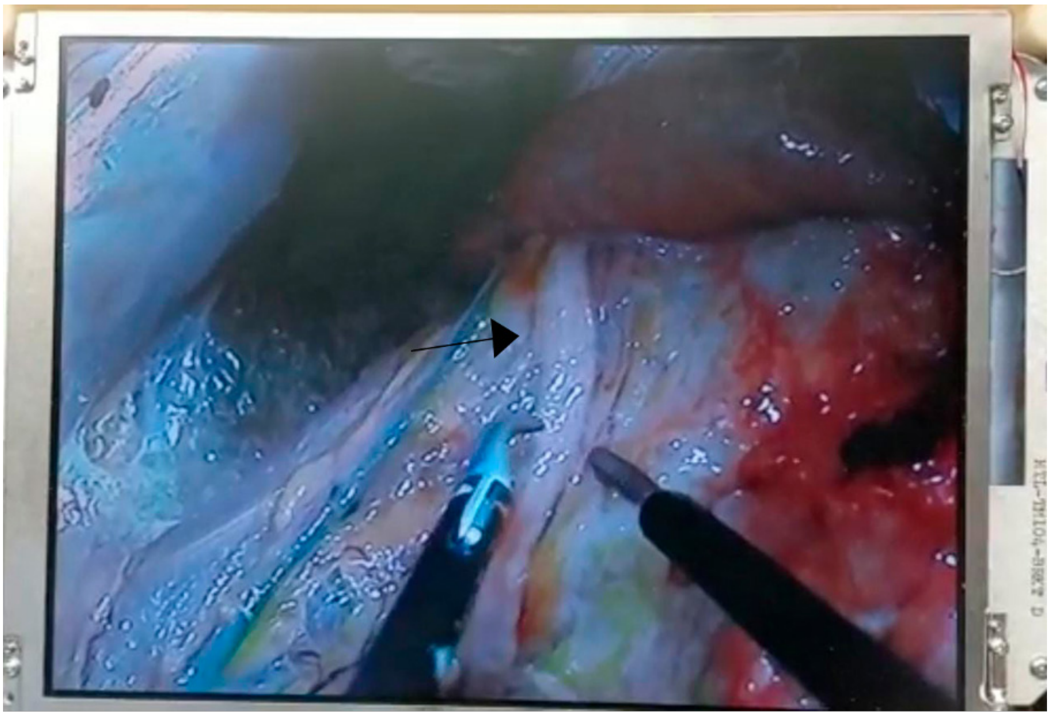

Figure 8 - Visualization of the surgeon during the procedure. Right ureter (Arrowhead) in its path over the psoas muscle

DISCUSSION

The beginning of the era of laparoscopy took place on September 23, 1901, when Georg Kelling performed in his doctoral thesis a celioscopy on a dog using a Nitze cystoscope. Since then, the improvement of the technique and the incorporation of new technologies allowed the first laparoscopic cholecystectomy in humans in 1987 by Philippe Mouret[6].

The 2D vision and new surgical skills required in laparoscopy make the training curve challenging and prolonged, requiring continuous and dedicated training to achieve technical excellence[14]. The qualification in laparoscopic surgery presupposes the use of specific tweezers, a video set, and an adequate training environment, which makes their learning more expensive and restricted to large centers[14].

The primary training option is the black box, which has simplicity, low cost, and portability but lacks realism, which makes it impossible to use for advanced laparoscopic training, restricting itself to the basic skills of gripper handling, objects, and sutures[14].

The animal model provides real manipulation of tissues, teamwork, bleeding, and movement of anatomical structures with breathing[14]. However, the porcine model is expensive due to the costs of laparoscopic equipment, laboratory management, acquisition, and sedation of the animal[14,19].

VR simulators appear as a possible solution but provoke divergent opinions in the literature. The simulator is high cost, with no possibility of teamwork, no tactile feedback or manipulation of tissues, and inaccessible to surgeons in training environments with lower availability of resources. However, it avoids sacrificing animals and dispenses with the availability of fresh cadavers for training[6,14,15,16,17,18].

The cadaveric model was previously described by Lim et al.[13] in which frozen corpses and carbon dioxide insufflation were used to make the pneumoperitoneum. Later, Imakuma[14] replaced the gas insufflation utilizing a metal frame. Both strategies allowed training in cadavers, but the first has the disadvantage of high costs and the second the low mobility of the tweezers with the metallic support.

Moreover, when comparing cadaveric and porcine models, it is noted that the cadaver has reliable anatomy. However, because it does not have to bleed, it limits the training of hemostasis. In contrast, the animal model simulates peristalsis, respiratory movements, and fluid flow (blood, urine, enteric content) but has limitations on anatomy.

In addition, other projects were developed, such as VR and dry laboratory. The virtual model allows the practice of infinite procedures but does not have tactile feedback and handling of accessories and does not allow the development of teamwork. The dry laboratory has as its main advantage the low cost and easy mobility, but it is limited in the practice of advanced techniques, does not have anatomical recognition, nor simulates tissue bleeding (Table 1).

Table 1. Comparison of videolaparoscopic training models

Skills/Models	Black Box	Virtual Reality	Cadaveric	Animal
Use of instruments	X	X	X	X
Tissue manipulation	X		X	X
Haptic feedback			X	X
Replication of operative steps		X	X	X
Real anatomy		X		X
Team work			X	X

Imakuma[14] (adapted).

The cadaveric model was Compared with the porcine model by Katz et al.[12]. In this study, 16 surgical residents tested the prototypes and answered questionnaires about the perception of practice. It was concluded that cadaver training provides an excellent surgical environment, allowing dissection, understanding of surgical anatomy and the possibility of completing procedures without anesthetic limits. Moreover, the practice with corpses is more accessible in medical schools and more realistic for laparoscopy[12,13,14]. It allows surgeons to develop dexterity with instruments, tissue manipulation, eye-hand coordination, notion of two-dimensional depth, bimanual manipulation, adjustment to fulcrum effect and recognition of real anatomical structures in 2D[14]. In addition, there was greater student satisfaction with the practice in cadaver[12,13,14].

In contrast, the presented model does not provide an accurate simulation of the development of pneumoperitoneum, marking, or insertion of the trocars. This last point presented can be performed in parallel to the proposed activity so that the student has the sensation of introducing the trocar in multiple planes until reaching the abdominal cavity. Another sensitive point of the project is the image quality, as there is the possibility of its optimization. In contrast, the presented model does not provide an accurate simulation of the development of pneumoperitoneum, marking, or insertion of the trocars. This last point presented can be performed parallel to the proposed activity so that the student has the sensation of introducing the trocar in multiple planes until reaching the abdominal cavity. Another sensitive point of the project is image quality, as there is the possibility of optimizing it using high-definition cameras, but this would increase the cost of the model, deviating from the initial purpose of facilitating access to video-laparoscopic training.

The presented model avoids high costs and is available in developing countries. The fake abdominal wall made of polyethylene costs $3.64, and the rigid camera with a screen costs $11.51. In academic services, free laparoscopic forceps and cadaver access may represent a valuable training option to dispense with carbon dioxide in establishing pneumoperitoneum.

The model can allow the development of operative skills, such as proper manipulation of surgical instruments, tissue apprehension, tactile feedback, reproduction of operative times, perception of movement in a two-dimensional view, and teamwork.

CONCLUSION

This paper presents a model of low-cost video-laparoscopy training that enables the practice in institutions with access to corpses. It is recognized that the model does not allow access to the abdominal cavity with trocars but favors the specific training of the technique and surgical tactics in a credible model for the surgical field. The next step of this project will be the implementation of this teaching modality and its validation through prospective studies seeking to evaluate and compare the training methods in video-laparoscopy.

Collaboration of the authors: *Caio Vinícius Suartz*: Idealization, development of the project and writing of the article. *Pedro Henrique Souza Brito*: Project development and presentation. *Ricardo Zugaib Abdalla*: Idealization, supply of materials, development. *Cristiano Mendes Gomes*: Development, presentation correction, article correction. *Anuar Ibrahim Mitre*: Article correction. *William Carlos Nahas*: Development and correction.

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