Does Warm-Up Training in a Virtual Reality Simulator Improve Surgical Performance? A Prospective Randomized Analysis ☆

José Arnaldo Shiomi da Cruz, MD,,† Sabrina Thalita dos Reis, PhD,* Rodrigo Marcus Cunha Frati, MD,* Ricardo Jordão Duarte, MD,* Hiep Nguyen, MD,‡ Miguel Srougi, MD, PhD,* and Carlo Camargo Passerotti, MD, PhD*,†*

*Urology Department, Faculdade de Medicina da Universidade de Sao Paulo, São Paulo, Brazil; †Center for Robotic Surgery, German Hospital Oswaldo Cruz, São Paulo, Brazil; and ‡Urology Department, Cardon Children Medical Center, Mesa, Arizona

INTRODUCTION: Virtual reality surgical simulators (VRSS) have been showing themselves as a valuable tool in laparoscopy training and education. Taking in consideration the effectiveness of the VRSS, new uses for this tool have been purposed. In sports, warming up before exercise clearly shows benefit in performance. It is hypothesized that warming up in the VRSS before going to the operating room may show benefit in surgical performance.

OBJECTIVE: Verify whether there is benefit in surgical performance with preoperatory warm-up using a VRSS.

MATERIALS AND METHODS: A total of 20 medical students with basic knowledge in laparoscopy were divided in 2 groups (I and II). Group I performed a laparoscopic cholecystectomy in a porcine model. Group II performed preoperative warm-up in a VRSS and then performed a laparoscopic cholecystectomy in a porcine model. The performance between both groups was compared regarding quantitative parameters (time for dissection of the gallbladder pedicle, time for clipping the pedicle, time for cutting the pedicle, time for gallbladder removal, total operative time, and aspirated blood loss) and qualitative parameters (depth perception, bimanual dexterity, efficiency, tissue handling, and autonomy) based on a previously validated score system, in which the higher the score, the better the result. Data were analyzed with level of significance of 5%.

RESULTS: The group that underwent preoperative warm-up (group II) showed significantly superior results as to the time for dissection of the gallbladder pedicle (11.91 ± 9.85 vs. 4.52 ± 2.89 min, $p = 0.012$), time for clipping the pedicle (5.51 ± 2.36 vs. 2.89 ± 2.76 min, $p = 0.004$), time for cutting the pedicle (1.84 ± 0.7 vs. 1.13 ± 0.51, $p = 0.019$), aspirated blood loss (171 ± 112 vs. 57 ± 27.8 ml, $p = 0.006$), depth perception (4.5 ± 0.7 vs. 3.3 ± 0.67, $p = 0.004$), bianual dexterity (4.2 ± 0.78 vs. 3.3 ± 0.67, $p = 0.004$), tissue handling (4.2 ± 0.91 vs. 3.6 ± 0.66, $p = 0.012$), and autonomy (4.9 ± 0.31 vs. 3.6 ± 0.96, $p = 0.028$). There was no difference in time for gallbladder removal (11.58 ± 4.31 vs. 15.08 ± 4.51 min, $p = 0.096$), total operative time (30.8 ± 11.07 vs. 25.60 ± 5.10 min, $p = 0.188$), and efficiency (4 ± 0.66 vs. 3.6 ± 0.69, $p = 0.320$).

CONCLUSION: The practice of preoperative warm-up training seems to benefit surgical performance even in subject with mild laparoscopic experience. (J Surg Ed ■:■■■-■■■. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: laparoscopy, simulation training, warm-up exercise, work performance

COMPETENCIES: Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

Yearly, approximately 500,000 laparoscopic cholecystectomies are performed in the United States, with complication and death rates of approximately 1.5% and 0.1%, respectively. This means 7500 complicated cases and 500 deaths from one of the most common surgical procedures.[1] For

☆This study was funded by FAPESP (Fundacao de Amparo a Pesquisa do Estado de Sao Paulo), Brazil and by CNPQ (National Counsel of Technological and Scientific Development), Brazil.

Correspondence: Inquiries to José Arnaldo Shiomi da Cruz, MD, Urology Department, Faculdade de Medicina da Universidade de Sao Paulo, Av Dr Arnaldo, 455, Room 2145 01246-903, São Paulo, Brazil; fax: (112) 364-7595; e-mail: arnaldoshiomi@yahoo.com.br

  1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2016.04.020

diminishing these numbers to a minimal, several measures have been added to surgical training and practice.

One of these measures was the use of surgical simulators for training. To increase the realism and the learning process efficiency, virtual images were incorporated into surgical simulators, resulting in the virtual reality surgical simulators (VRSS), similar to flight simulators deployed in pilot training.[2]

Nowadays, the use of VRSS is widely known for surgical training in the literature.[3] Nevertheless, other uses have been suggested for the VRSS, including warm-up training.

Warm up in sports is defined as a preparatory exercise period to be done to enhance a performance in competition or training.[4] The ideal warm up in sports consists of 3 main components.[5]

(1) Aerobic exercise to increase body temperature,
(2) specific stretching for a given task, in that stretch the muscle groups to be used in subsequent exercises, and
(3) period of activity incorporating movements similar to those that would be made in the year to be practiced.

Performing warm up is a practice highly widespread especially in physical activities of high performance. Studies show that performing warm up before an intense physical practice improves performance and reduces fatigue during practicing this activity.[6]

Taking in account the benefits brought by warming up, it was thought that there could be other applications for the VRSS, for its practice comprises 2 components of the ideal warm up in sports proposed by Fradkin: specific elongation of certain muscle groups to be used during the following procedure, and especially allows to incorporate movements similar to those that would be made in the surgical procedure.[5]

In view of the apparent benefits of VRSS in the surgical performance and the lack of studies, especially prospective randomized controlled studies on the effect of warm up in laparoscopy, the purpose of this study is to check whether there is a benefit in practicing warm up before surgery in the operating performance.

MATERIAL AND METHODS

In total, 20 medical students of the fifth and sixth graduation year with experience in laparoscopic principles (received basic training in the first, third, and fifth year of graduation) were randomly divided into 2 groups (I and II) with 10 subjects each at www.random.org. Group I was the control group, in which each individual performed a laparoscopic cholecystectomy in a porcine model. Group II held a brief session of basic exercises—warm up—immediately before making a laparoscopic cholecystectomy also in porcine model. Before each procedure, the participant watched a video explaining the procedure that would be performed.

All procedures were assisted by an experienced surgeon. The participants did not know the parameters that were being evaluated (blinded) and signed an informed consent term. All surgeries were recorded and the aspirated blood volume was quantified.

The warm up before surgery was performed in a VRSS LapVR (Immersion Medical, San Jose, CA). Each participant performed 4 tasks—camera skill, clipping skill, cutting skill, and peg transfer skill. Each of these activities were performed in 2 difficult levels (1 and 2, which are the easiest levels of the VRSS). The warm-up time was recorded by the simulator. Soon after the end of warm up, participants began to perform the cholecystectomy in porcine model.

The animals were anesthetized with telazol (4.4-6.6 mg/kg intramuscularly), xylazine (1.1-2.2 mg/kg intramuscularly), and atropine (0.04 mg/kg intramuscularly), anesthesia was maintained with isoflurane (1%-4%) mixed with 1 to 2 L of oxygen administered through an endotracheal tube. The animal was intubated and mechanically ventilated during the procedure. After the procedures, the swines were sacrificed with a lethal dose of intravenous injection of KCl.[7]

Laparoscopic cholecystectomy was performed with the animal in the supine position under general anesthesia. A 4-port technique was used. The experienced surgeon wielded the camera and the gallbladder with a grasper through the more lateral 5-mm trocar. Initially, the participant should dissect the pedicle of the gallbladder without the need for separating cystic artery and cystic duct for these structures are closely related and technically difficult to separate in the porcine model, when compared with the human model.

After isolation of the pedicle of the gallbladder, the participant should clip the pedicle with 2 clips proximally and 1 distally to the point at which section of the pedicle should be made. The next step was to make section of the pedicle and to free the gallbladder from its bed. Once the gallbladder was loose, the procedure was considered ended. The blood loss was then aspirated and quantified.

Videos of each procedure performed were subsequently evaluated by 2 surgeons with experience in laparoscopy. The evaluators did not know from which group the video belonged ("blinded").

The videos were assessed quantitatively and qualitatively. The quantitative parameters to be analyzed during the procedures were as follows: the time spent for dissection of the pedicle of the gallbladder, the time spent clipping of the pedicle, the time taken to pedicle section, the time taken to removal of the gallbladder, the total time of the procedure, and the aspirated blood volumes (irrigated volume was recorded and subtracted from the aspirated volume).

The qualitative parameters were evaluated according to an assessment tool called GOALS from Vassiliou et al.[8] The