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Does Previous Laparoscopic Experience Influence Basic Robotic Surgical Skills?

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OBJECTIVE: Studies addressing the effect of laparoscopic experience on robotic skills have produced conflicting results. This study aimed to compare simulated robotic surgical tasks using the virtual reality simulator dV-Trainer between laparoscopically experienced surgeons and first-year surgical residents.

DESIGN: A cross-sectional study. Participants completed 4 trials of the following tasks on the dV-Trainer: Peg Board 2, Ring and Rail 1, and Suture Sponge 1. Performance was recorded using a computerized built-in scoring algorithm. Scores and metrics were compared between groups 1 and 2 and between the first and subsequent trials.

SETTING: Hospital de Clínicas, Porto Alegre, Brazil, a tertiary care teaching hospital.

PARTICIPANTS: Twenty laparoscopically experienced surgeons (group 1) and 20 first-year surgical residents (group 2). All participants completed the study.

RESULTS: The overall scores for Peg Board 2 (738.04 ± 267.83 vs 730.39 ± 225.31; $p = 0.57$), Ring and Rail 1 (919.03 ± 242.69 vs 965.84 ± 222.96; $p = 0.13$), and Suture Sponge 1 (563.62 ± 185.50 vs 560.99 ± 152.71; $p = 0.67$) did not differ significantly between groups 1 and 2. Group 1 had better results for master workspace range in Peg Board 2 and Ring and Rail 1. Group 2 had higher scores for economy of motion in Peg Board 2 and Ring and Rail 1 and for excessive instrument force in Ring and Rail 1. In both groups, the overall scores in the third and fourth trials were significantly higher than those in the first trial.

CONCLUSIONS: There are no significant differences in the performance of simulated robotic surgical tasks between laparoscopically experienced surgeons and laparoscopically naïve surgical residents. Some slight differences were observed in specific metrics, but these differences were not sufficient to change the final results. We may assume that laparoscopic experience should not be an essential step in the initial learning curve of robotic surgery. (J Surg Ed ▮:▮▮▮-▮▮▮. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: minimally invasive surgical procedures, robotics, laparoscopy, education, simulation training

COMPETENCIES: Patient Care, Practice-Based Learning and Improvement

INTRODUCTION

Since publication in 2001 of the first series of robot-assisted laparoscopic prostatectomies by Binder and Kramer,[1] there has been a steady increase in the number of robot-assisted surgical procedures in various specialties, including urological, gynecological, general and thoracic surgery. The da Vinci Surgical System (dVSS) (Intuitive Surgical, Sunnyvale, CA) is the robotic platform most commonly used worldwide. It is the only robotic surgical assistance system approved by the US Food and Drug Administration for use in the United States. In 2016, approximately 3900 dVSS were in clinical use and approximately 753,000 surgical procedures were performed worldwide, compared with

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approximately 652,000 and 570,000 procedures performed in 2015 and 2014, respectively.[2]

Considering the exponential increase in the use of robotic surgery, efforts have been made toward developing a curriculum for this surgical modality.[3-5] However, an important unresolved issue is whether laparoscopic skills transfer to robotic surgery. Also, an unanswered question is whether conventional laparoscopic training should be incorporated into robotic training programs or surgeons should be trained in laparoscopic surgery to achieve mastery before moving on to robotic surgery. The answer to this question will have important implications for the development of robotic surgery training methods and curriculum.

Studies addressing the effect of previous laparoscopic experience on robotic skills have produced conflicting results. Good outcomes have been reported for surgeons experienced in open procedures, but with no laparoscopic experience, in an initial series of advanced robot-assisted laparoscopic procedures.[6,7] Conversely, some series have shown that experienced laparoscopic surgeons have initial results similar to those of surgeons more experienced in robot-assisted laparoscopic procedures.[8,9] Therefore, there is still debate as to whether previous laparoscopic experience influences or not the learning curve of robotic surgery.

The present study aimed to compare simulated robotic surgical tasks using the virtual reality simulator dV-Trainer (Mimic Technologies, Seattle, WA) between a group of laparoscopically experienced surgeons and a group of first-year surgical residents.

METHODS

Participants

Twenty laparoscopically experienced surgeons (group 1) and 20 first-year surgical residents (group 2) were invited to participate in the study. Laparoscopically experienced surgeons were defined as those who had incorporated procedures requiring laparoscopic suturing into their practice, such as pyeloplasty, partial nephrectomy, colorectal surgery, and fundoplication. All participants in both groups had never used virtual reality simulators for robot-assisted surgery and had no robot-assisted surgical experience. Sample size was defined according to previous studies of virtual reality surgical simulation.[10]

Simulator and Tasks

The dV-Trainer is a virtual reality simulator specifically designed for robot-assisted surgical training with the dVSS. This simulator consists of a 2-handed haptic system with grips that emulate the master grips on the surgeon's console. Together with pedals and a high-definition stereoscopic display, it simulates the console of the dVSS. The haptic device is networked with a computer that runs the dV-Trainer simulation software.

Before testing, participants were instructed on how to use the dV-Trainer with a standardized verbal explanation. After this, each participant completed 3 trials of the overview of controls, pick and place, and basic camera targeting tasks to become familiar with the various dV-Trainer commands. Each participant was then instructed to complete 4 trials, in sequence, of the following tasks: Peg Board 2, Ring and Rail 1, and Suture Sponge 1. Before each task, an instructional video produced by the manufacturer was delivered. Peg Board 2 consists in grasping rings on a vertical stand with 1 hand and then passing them to the opposite hand before placing them on a peg. Ring and Rail 1 consists in moving a ring up to the end of a twisted rail. Suture Sponge 1 consists in driving a needle through a predetermined target on a sponge, with both right- and left-hand and up and down movements.

Performance was recorded using a computerized built-in scoring algorithm developed by the manufacturer, considering the following metrics: drops (number of times an object or objects are dropped in an inappropriate region of the scene), economy of motion (total distance, measured in centimeters, traveled by all instruments), excessive instrument force (total time, measured in seconds, applied instrument force exceeded given threshold), instrument collisions (total number of instrument-on-instrument collisions exceeding a minimum force threshold), instruments out of view (total distance, measured in centimeters, traveled by instruments outside the user's field of view), master workspace range (diameter, measured in centimeters, of user's working volume on master grips), missed targets (number of missed targets), and time to complete task (total time, measured in seconds, the user spends on the exercise). An overall score was calculated based on the weighted average of metric scores. Higher scores indicate superior performance.

Statistical Analysis

Scores and values for each task and metric were compared between groups 1 and 2 and between the first and subsequent trials. These data were analyzed by Mann-Whitney and Friedman tests. A $p < 0.05$ was considered statistically significant. All statistical analyses were performed using SPSS, version 17.0 (SPSS Inc., Chicago, IL).

Ethical Considerations

The study was approved by the Institutional Review Board at the Hospital de Clínicas, Porto Alegre, Brazil, and written informed consent was obtained from all participants before beginning the study.