Assessment of Virtual Reality Robotic Simulation Performance by Urology Resident Trainees

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OBJECTIVES: To examine resident performance on the Mimic dV-Trainer (MdVT; Mimic Technologies, Inc., Seattle, WA) for correlation with resident trainee level (postgraduate year [PGY]), console experience (CE), and simulator exposure in their training program to assess for internal bias with the simulator.

DESIGN: Residents from programs of the Southeastern Section of the American Urologic Association participated. Each resident was scored on 4 simulator tasks (peg board, camera targeting, energy dissection [ED], and needle targeting) with 3 different outcomes (final score, economy of motion score, and time to complete exercise) measured for each task. These scores were evaluated for association with PGY, CE, and simulator exposure.

SETTING: Robotic skills training laboratory.

PARTICIPANTS: A total of 27 residents from 14 programs of the Southeastern Section of the American Urologic Association participated.

RESULTS: Time to complete the ED exercise was significantly shorter for residents who had logged live robotic console compared with those who had not ($p = 0.003$). There were no other associations with live robotic console time that approached significance (all $p \geq 0.21$). The only measure that was significantly associated with PGY was time to complete ED exercise ($p = 0.009$). No associations with previous utilization of a robotic simulator in the resident's home training program were statistically significant.

CONCLUSIONS: The ED exercise on the MdVT is most associated with CE and PGY compared with other exercises. Exposure of trainees to the MdVT in training programs does not appear to alter performance scores compared with trainees who do not have the simulator. (J Surg 71:302-308.

KEY WORDS: robotic surgery, simulation, resident training, robotic training, robotic prostatectomy

COMPETENCIES: Medical Knowledge, Professionalism

INTRODUCTION

Complex surgical technology, such as the da Vinci surgical robot (Intuitive Surgical Inc., Sunnyvale, CA), comes with a distinct learning curve. This steep learning curve coupled with increased Accreditation Council for Graduate Medical Education work-hour limitations for resident trainees makes incorporation of advanced robotic technology into training programs difficult. Introduction of the same technology for clinically practicing urologists is just as challenging and is accompanied by a steep learning curve as well. Virtual reality robotic simulation has been proposed as a bridge for new and intermediate learners to decrease some of the learning curve associated with robotic surgery. The Mimic dV-Trainer (MdVT; Mimic Technologies, Inc., Seattle, WA) is the most studied virtual robotic surgical simulator and has demonstrated fairly consistent face and content validity in initial studies.[1-4] These studies have demonstrated that individuals using the simulator believe that its content is realistic, and performance on the simulator has been able to differentiate expert and novice robotic surgeons.

One concern with virtual reality simulation, which is not isolated to robotic simulators, is the possibility that learners become experts in using the simulator, although they do not

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  1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2013.09.009

necessarily translate it to improvement in actual surgical skills. Southeastern Section of the American Urologic Association (SESAUA) hosts an annual robotic training course for urology resident trainees. Trainees were assessed for their utilization of virtual reality robotic surgical simulation in their home programs, and their performance on the MdVT was recorded. The purpose of this study was to evaluate whether resident trainee level, actual console experience (CE), or exposure to virtual reality robotic simulation was associated with trainee performance on the virtual reality robotic simulator.

MATERIALS AND METHODS

Study Setting

This prospective study involved 27 residents from 14 programs of the SESAUA, all of whom were invited to participate in a 2-day robotic training course consisting of didactic training and console simulation training. The course is based in Orlando, FL, and details of this course have been previously published.[5] Invitations were sent to all chairmen and program directors, inviting up to 3 residents from each program for a formal robotic training course. All expenses for the course, except travel, were paid by industry support and grants from the Nicholson Center for Surgical Advancement and the SESAUA. The course lasted 2 full days. Expert volunteer faculty was recruited from several SESAUA training programs.[5]

The first day of the course consisted of a fully video-based didactic session focusing on robotic basics/safety, patient positioning, port placement, and proper surgical steps for robotic-assisted radical prostatectomy (RARP) and robotic-assisted laparoscopic partial nephrectomy. On the second day, the trainee group was asked to perform skills and tasks on the MdVT (Mimic Technologies, Inc., Seattle, WA).

Study Design

A brief tutorial was given of the MdVT console and its functionality. The trainees practiced basic simulation functionality with the "pick-and-place" application. The trainees were then systematically led through other exercises such as the "ring walk," "thread the rings 1," and "tubes 2." Trainee performance was scored on "peg board," "camera targeting," "energy dissection (ED)," and "needle targeting." Three scores were recorded for each exercise, using the proprietary Mimic software "M-Score," and the scores were "final score," "economy of motion score," and "time to complete exercise." Data were collected regarding resident characteristics, including year of urology residency, utilization of a robotic simulator in the home training program, use of a robotic console for an actual case, and estimated number of actual robotic console cases completed. A small number of residents did not complete all 4 tasks. Better performance was indicated by high "final score," high "economy of motion score," and shorter "time to complete exercise" values.

Simulator Exercises

The "pick-and-place" (Fig. 1A) application is the easiest of all the exercises offered on the trainer and provides an excellent backdrop to teach the simulator functionality. Camera movements and clutching are not usually required. Color-coded jacks are placed into their respective container. "Peg board" (Fig. 1B) is a more advanced version of "pick and place" and involves moving rings from horizontal pegs to vertical pegs. Completion of the drill requires the learner to move the camera and clutch instruments in a coordinated fashion. "Camera targeting" (Fig. 1C) optimizes the learner's camera mobility. The drill is designed to teach the surgeon how to maintain the target operative field in the surgical center of view. "Energy dissection" (Fig. 1D) tests the learner's ability to apply dissecting energy in a fixed space without thermal spread to undesirable surrounding structures. The learner must be facile with camera movement and instrument clutching while using focused ED in a fixed space. "Needle targeting" (Fig. 1E) simulates the ability of the learner to pass suture needles accurately into an identified target at the proper angles. Coordinated foot-and-hand movements are required for accurate needle placement at the proper angles.

Statistical Analysis

Continuous variables were summarized using the sample median, minimum, 25th percentile, 75th percentile, and maximum. Categorical variables were summarized with number and percentage. Separately for each task, associations of final score, economy of motion score, time to complete exercise with year of urology residency, previous access to a robotic simulator, and prior use of a robotic console for an actual case were evaluated using the Wilcoxon rank sum test or the Spearman test of correlation. We considered year of urology residency as a dichotomous categorical variable (Year 1 or 2 vs Year 3 or 4) as well as an ordinal variable in association analysis. No adjustment for multiple testing was done for these exploratory analyses, and $p \leq 0.05$ were considered statistically significant. Statistical analyses were performed using SAS (version 9.2; SAS Institute Inc., Cary, NC).

RESULTS

A total of 27 residents from 14 programs of the SESAUA participated in the trial. Nineteen (70.4%) were senior-level residents (urology training Years 3 and 4), whereas 8