ORIGINAL REPORTS

Practice Makes Perfect: Correlations Between Prior Experience in High-level Athletics and Robotic Surgical Performance Do Not Persist After Task Repetition

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OBJECTIVE: Robotic surgical skill development is central to training in urology as well as in other surgical disciplines. Here, we describe a pilot study assessing the relationships between robotic surgery simulator performance and 3 categories of activities, namely, videogames, musical instruments, and athletics.

DESIGN: A questionnaire was administered to preclinical medical students for general demographic information and prior experiences in surgery, videogames, musical instruments, and athletics. For follow-up performance studies, we used the Matchboard Level 1 and 2 modules on the da Vinci Skills Simulator, and recorded overall score, time to complete, economy of motion, workspace range, instrument collisions, instruments out of view, and drops. Task 1 was run once, whereas task 2 was run 3 times.

SETTING: All performance studies on the da Vinci Surgical Skills Simulator took place in the Simulation Center at Dartmouth-Hitchcock Medical Center.

PARTICIPANTS: All participants were medical students at the Geisel School of Medicine. After excluding students with prior hands-on experience in surgery, a total of 30 students completed the study.

RESULTS: We found a significant correlation between athletic skill level and performance for both task 1 ($p = 0.0002$) and task 2 ($p = 0.0009$). No significant correlations were found for videogame or musical instrument skill level. Students with experience in certain athletics (e.g., volleyball, tennis, and baseball) tended to perform better than students with experience in other athletics (e.g., track and field). For task 2, which was run 3 times, this association did not persist after the third repetition due to significant improvements in students with low-level athletic skill (levels 0-2).

CONCLUSIONS: Our study suggests that prior experience in high-level athletics, but not videogames or musical instruments, significantly influences surgical proficiency in robot-naive students. Furthermore, our study suggests that practice through task repetition can overcome initial differences that may be related to a background in athletics. These novel relationships may have broader implications for the future recruitment and training of robotic surgeons and may warrant further investigation. (J Surg Ed ■:■■■-■■■. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: robotic surgery, surgical education, simulation, surgical skills training

COMPETENCY: Practice-based Learning and Improvement

INTRODUCTION

Minimally invasive surgery (MIS) has become the gold standard for many surgical procedures, typically leading to superior clinical and economic outcomes including lower blood loss, complications, and length of hospital stay.[1-7] Robot-assisted surgery was developed to overcome visual and dexterity limitations of pre-existing MIS procedures such as conventional laparoscopy,[8] and was first approved for human use in 2000 by the US Food and Drug Administration (FDA).[9] Since this approval, multiple robotic surgery devices have been developed, among which the da Vinci

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Surgical System (DVSS; Intuitive Surgical Inc., Mountain View, Sunnyvale, CA) is the most widely used. Robot-assisted MIS has undergone multiple cycles of technological advances and improvement since its inception, and has emerged as the standard for many surgical procedures in urology, gynecology, and other surgical specialties.[10-12]

Owing to the increased popularity of robot-assisted MIS, robotic surgical skill development has evolved as a central component of training in many surgical disciplines. The da Vinci Skills Simulator (Intuitive Surgical, Sunnyvale, CA and Mimic Technologies, Seattle, WA), a virtual reality (VR) simulator, was developed to enable the objective evaluation of robotic surgical performance by acquisition of variables such as speed, workspace efficiency, and force,[13] and it has been tested and confirmed for validity.[14-17] This simulator uses the same base console used by the da Vinci Surgical Systems, and contains 3D exercises and videos covering all operational aspects of the robot.

Since the inception of these training tools, a major topic of research has been the study of determinants of robotic surgical performance, as this may inform future training and recruitment strategies. Studies have investigated a wide range of possibilities, including baseline IQ and dexterity, prior laparoscopic experience, and background experiences in videogames.[18-22] For example, the effect of background videogame experience on robotic surgical skills has been investigated extensively, because (1) previous studies have documented a significant positive effect of videogames in laparoscopic performance[23-25] and (2) videogames share significant visuospatial similarities with surgical simulators. Unfortunately, the studies involving the effect of videogame experience on robotic surgical performance have yet to reach a clear consensus, with studies suggesting a positive,[26] neutral,[22] or negative[21] effect on performance.

In this study, we sought to clarify the role of videogames, musical instruments, and athletics on robotic surgery performance in robot-naive students; these activities were chosen because they each share characteristics important to the robotic surgeon, such as dexterity and hand-eye coordination.

METHODS

Study Design

The study design is summarized in Figure 1. Preclinical medical students (before any clinical rotations) were surveyed for basic demographic information (age, sex, and medical year) and for previous background experiences in videogames, musical instruments, and athletics. Fields obtained for background experiences included experience level, hours per week played, total years played, and type of videogame/instrument/sport played. Experience level was rated on a 5-point scale ranging from 0 to 4. Videogames and musical instruments were rated on the following scale: 0 = no experience, 1 = beginner level, 2 = intermediate level, 3 = advanced level, and 4 = expert level. Athletics were rated on an equivalent scale: 0 = no experience, 1 = recreational level, 2 = intramural level, 3 = club level, and 4 = varsity level. Students with prior hands-on experience with open surgery or MIS (laparoscopic, robotic, or other) were excluded from analysis.

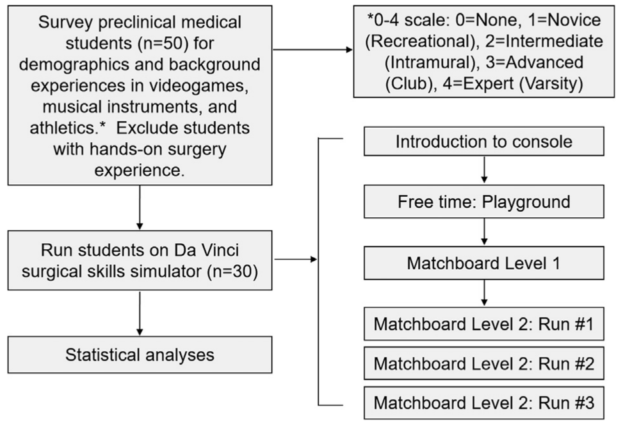

FIGURE 1. Flowchart of study design.

From this surveyed group, 30 medical students met selection criteria and were available for a follow-up session on the da Vinci Skills Simulator at Dartmouth-Hitchcock Medical Center. Each session began with a 5-minute introduction to the machine and its basic operation. This was followed by 5 minutes of “practice” using the “Playground” game on the simulator, which allowed the subject to freely manipulate the robotic arms and move virtual objects in a small area. Two tasks were chosen to represent an appropriate difficulty level for robot-naive students: Matchboard Level 1 and Matchboard Level 2. Matchboard Level 1 requires students to place letter or number objects into the correct place and orientation on a board; Matchboard Level 2 requires students to lift up a panel connected to a hinge with one arm, and place letter or number objects into their appropriate position with the other. For each task, students were presented with a brief 1-minute video introducing the task, followed by a complete run. Matchboard Level 2, the more difficult of the 2 tasks, was run 3 times to assess changes attributed to task repetition. Each run was independently rated by a scoring system (intrinsic to the da Vinci Skills Simulator program) on an overall point scale of 0 to 100. This score is calculated based on points scored for time to complete (total time to complete the task), economy of motion (total distance traveled by all instruments in the exercise), master workspace range (average size of the surgeon's hand control workspace), and an exercise constant, with points subtracted for instrument collisions (number of times instruments collided), excessive instrument force (time during which the force on an instrument is too large), instruments out of view (time during which the instruments are taken outside of the visible work field), and drops (number of times a handled object is dropped).