ARTICLE

Effect of fine-motor-skill activities on surgical simulator performance

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Purpose: To determine the effect of fine motor activity and nondominant-hand training on cataract surgical simulator (Eyesi) performance.

Setting: Departments of Ophthalmology, University of Iowa, and Veterans Affairs Health Care Systems, Iowa City, Iowa, USA.

Design: Prospective controlled trial.

Methods: Medical students completed a questionnaire and baseline microsurgical dexterity evaluation using the following 3 surgical simulator tasks: navigation, forceps, and bimanual. Participants were randomized to control (16) or intervention (17) consisting of writing, completing a labyrinth, eating, and brushing teeth once per day with their nondominant hand. Participants returned 4 weeks after baseline evaluation for follow-up simulator testing.

Results: Of the 33 students, regular video game players had greater baseline scores than nonplayers on navigation ($P = .021$) and bimanual tasks ($P = .089$). All participants showed statistically significant improvements in all 3 tasks at follow-up after a single baseline evaluation on the surgical simulator (navigation: $P = .004$; forceps: $P < .001$; bimanual: $P = .004$). Nondominant-hand training with daily activities did not show statistically significant differences for dominant hands or nondominant hands. The intervention group ($n = 17$) trended toward greater improvement than the control group ($n = 16$) in navigation (14.78 versus 7.06; $P = .445$) and bimanual tasks (15.2 versus 6.0; $P = .324$) at follow-up.

Conclusions: Regular video game play enhanced baseline microsurgical performance measured on the surgical simulator. Simulation performance improved significantly in the intervention group and control group after 1 session on the simulator. Although not statistically significant, training the nondominant hand with daily activities showed a trend toward improved navigation and bimanual performance.

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The use of surgical simulation has been surging in many fields, particularly regarding its impact on resident training. Use of laparoscopic and cataract surgical simulators have been shown to enhance the acquisition of surgical skills and improve surgical performance in the operating room.[1–4] In regard to ophthalmology, the Eyesi cataract simulator (VRmagic Holding AG) has shown construct validity and efficacy in training of cataract surgery techniques.[5–10] Furthermore, capsulorhexis training with the cataract simulator has been shown to be as efficacious as wet lab training for residents.[11]

Dexterity acquisition and surgical skill training outside the operating room is a rising topic in the field of resident education. Habitual video game play has been shown to improve fine motor skills and movement coordination on manual dexterity tests.[12] Although individual studies of the effect of video games on surgical simulation skills have been controversial, several reviews have suggested weekly video game play benefits learning of surgical skills, improves surgical times, and reduces the number of errors on laparoscopic simulators.[13–15] General surgery faculty and residents who systematically played video games for 5 weeks were found to perform better on laparoscopic simulations.[16] In addition, those who played video games for 6 weeks performed better on a laparoscopic simulator than those who trained on the simulator itself for 6 weeks.[17] The Wii (Nintendo) has also

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been shown to improve simulated laparoscopic performance of the nondominant hand in participants who played the Wii for a mere total of 2 or 4 hours spread out over 3 days before testing on the laparoscopic simulator compared with those who did not play the device.[18]

Handedness has been shown to play a crucial role in the performance on surgical simulation, procedural training, and postoperative outcomes. Compared with the dominant hand, the nondominant hand had lower total scores, longer operating times, and greater damage to the lens on Eyesi cataract simulation in physicians with no previous cataract training.[19] A survey of pediatricians found that handedness impaired learning in 60.0% of those who were left-handed as opposed to 7.7% of their right-handed colleagues for procedures such as intubation, suturing, and lumbar puncture.[20] Function and pain scores were higher for patients having left-knee replacements compared with right-knee replacements when performed by a right-handed surgeon.[21] Because of the importance of handedness on surgical skill acquisition and patient outcomes, surgical faculty often recommend residents train their nondominant hand.

A study by Nieboer et al.[22] in 2012 examined the outcomes of nondominant-hand training in surgical residents and faculty. This randomized controlled trial evaluated the effect of training via writing, completing a labyrinth, brushing teeth, and eating daily for 3 weeks on laparoscopic simulation scores. Training of the nondominant hand did not result in improved performance of the nondominant hand; however, a statistically significant reduction in simulator time and path length was noted in the dominant hand. This phenomenon has been described in the literature as inter-manual transfer of skills.[22]

The effect of fine-motor activities and nondominant-hand training on microscopic surgery or simulation has not been studied in ophthalmology. The purpose of this study was to examine the effect of fine-motor activities and nondominant-hand training on Eyesi cataract simulation performance.

PARTICIPANTS AND METHODS

This study adhered to the tenets of the Declaration of Helsinki and was compliant with the U.S. Health Insurance Portability and Accountability Act. The study was performed in compliance with the authors' institutional review board guidelines governing interventional studies.

All University of Iowa Carver College of Medicine medical students were invited to participate in the study via e-mail. All participants completed a questionnaire requesting demographic information and a self-reported history of video game play, musical instrument play, and other fine-motor activity; they also completed the Edinburgh handedness inventory.[23] The baseline evaluation of surgical dexterity was performed on the Eyesi cataract simulator. Participants were randomized to control or intervention using Excel software (Microsoft Corp.). Those randomized to intervention were asked to perform activities with their nondominant hand daily for 4 weeks. All participants were asked to return for follow-up 4 weeks after randomization.

Intervention

The intervention training regimen was developed by Nieboer et al.[22] and was used with permission. Training consisted of performing daily activities with the nondominant hand for 4 weeks. Participants wrote the following sentence 5 times per day: "I am participating in ergonomic research and this is my nondominant hand." Participants were also asked to complete 1 labyrinth (Figure 1), brush their teeth once, and eat 1 meal with the nondominant hand every day. The intervention group was provided with 28 labyrinths and a checklist to record completion of these tasks. Those in the control group were not informed of the details of the intervention.

Surgical Simulator

The cataract surgery simulator was used to measure surgical dexterity via 3 level-2 training modules as follows: navigation, forceps, and bimanual training. The navigation training module required participants to hold the tip of an instrument in a red sphere until the sphere turned green (Figure 2, *A*). Participants then maneuvered red cubes with a forceps into a mesh sphere for the forceps training module (Figure 2, *B*). The bimanual training module consisted of 2 spheres connected to each other by a virtual cylinder. Participants were asked to hold the tips of 2 instruments in each sphere simultaneously until both turned green (Figure 2, *C*).

All participants at both the baseline and follow-up evaluations completed 2 trials of all modules in the following order: navigation, forceps, and bimanual training. In the first trial, the participants used their right hand followed by their left hand and then completed the modules with their left hand followed by their right hand for the second trial. In total, navigation and forceps training was completed twice with each hand and bimanual training was completed twice with both hands simultaneously. Figure 3 shows the evaluation procedure.

Statistical Analysis

Total scores of navigation, forceps, and bimanual were averaged for both hands. Baseline measurements were associated with questionnaire responses and analyzed using ordinary linear regression. Changes before and after the training session were analyzed using a paired *t* test. All statistical analysis was performed in the statistical computing environment R.[A]

RESULTS

The study comprised 33 participants. Sixteen participants were randomized to the control group and 17 to the intervention group. All participants in the control group and

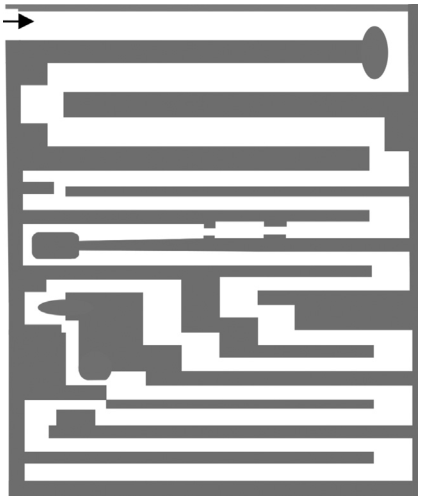

Figure 1. An example of the labyrinth completed by participants in the intervention group.

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