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The Effect of Visual-Spatial Ability on the Learning of Robot-Assisted Surgical Skills

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BACKGROUND: The aim of this study was to determine the correlation of visual-spatial ability with progression along the learning curve for robotic surgical skills training.

METHODS: A total of 21 novice participants were recruited. All participants completed a training program consisting of 5 training sessions of 30 minutes of virtual reality (VR) simulation and 30 minutes of dry laboratory training. The VR simulation part was the subject of the present study. During VR simulation training, participants performed the basic skill exercises of Camera Targeting 1, Pick and Place, and Peg Board 1 followed by advanced skill exercises of Suture Sponge 1 and Thread the Rings. The visual-spatial ability was assessed using a mental rotation test (MRT). Pearson correlation coefficients were used to assess the relationship between the MRT score and simulator score for the aforementioned 5 tasks. Student *t* test was used to compare the simulator score between high- and low-MRT score groups.

RESULTS: A median MRT score of 26/40 (range: 13-38) was observed. Approximately 19 participants completed the full curriculum but 2 did not complete "Thread the Rings" during the study period. A significant correlation was observed between the MRT score and simulator score only in "Suture Sponge 1" over the first 3 attempts (first: $r = 0.584$, $p = 0.0054$; second: $r = 0.443$, $p = 0.0443$; third: $r = 0.4458$, $p = 0.0428$). After the third attempt, this significant correlation was lost. Comparison of the score for "Suture Sponge 1" between the high-MRT and low-MRT scoring participants divided by a median MRT score of 26 also showed a significant difference in the score until the third trial.

CONCLUSION: Our observations suggest that the spatial cognitive ability influences the initial learning of robotic suturing skills. Further studies are necessary to verify the usefulness of an individual's spatial ability to tailor the surgical training program. (J Surg Ed ∎:∎∎∎-∎∎∎.)

KEY WORDS: robot-assisted surgery, spatial cognitive ability, mental rotation test, learning curve

COMPETENCIES: Practice-Based Learning and Improvement

INTRODUCTION

Recent advances in minimally invasive surgery have led to several improvements, including reduced pain, less scarring, lower-level blood loss, and earlier recovery to a normal daily life. As a result, laparoscopic and robotic techniques are now widely accepted in general surgery, thoracic surgery, urology, and gynecology. At the same time, the growing complexity of surgical procedures means that surgeons are expected not only to learn the novel techniques but also transfer those skills to the next generation effectively. This must also be achieved in the context of working-hour restrictions, fiscal limitations, and patient safety concerns. Maintaining efficient and effective training is becoming increasingly important, and several previous studies discussed the associations among the visual-spatial ability, acquisition of surgical skills, and prediction of technical aptitude.[1-6] Wanzel et al.[1] examined several types of visual-spatial ability test, and observed that the mental rotation test (MRT) was the most closely associated with better performance of 2- and 4-flap *Z*-plasty of surgical residents, and their group also reported a positive correlation between the MRT score and performance on internal fixation of a mandibular fracture.[2] Another group also reported a positive correlation in reef knot-tying.[3] In terms of the relationship between the skills of robotic surgery and visual-spatial ability, there were 2 previous studies, and their observations were

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conflicting.[7,8] Furthermore, their assessments were performed based on a single session, and not the course of the learning curve. The aim of the present study was to gain further insights in terms of the effect of the visual-spatial ability on robot-assisted surgical skills, focusing on progression along the initial learning curve.

MATERIAL AND METHODS

Participants

This study was approved by the institutional review board, and performed as part of a larger randomized study comparing cognitive training with standard training. A group of 21 novices in robot-assisted surgery volunteered for and participated in the study. All participants completed a questionnaire on background variables including the age, sex, currents status (students or doctor), dominant hand, suturing experience, experience of open, laparoscopic, and robotic surgery, and experience of a laparoscopic or robotic simulator.

Simulation Task

In this study, during the 2-week study period, participants were required to complete a minimum of 5 training sessions consisting of 30 minutes of Xi backpack simulator-training

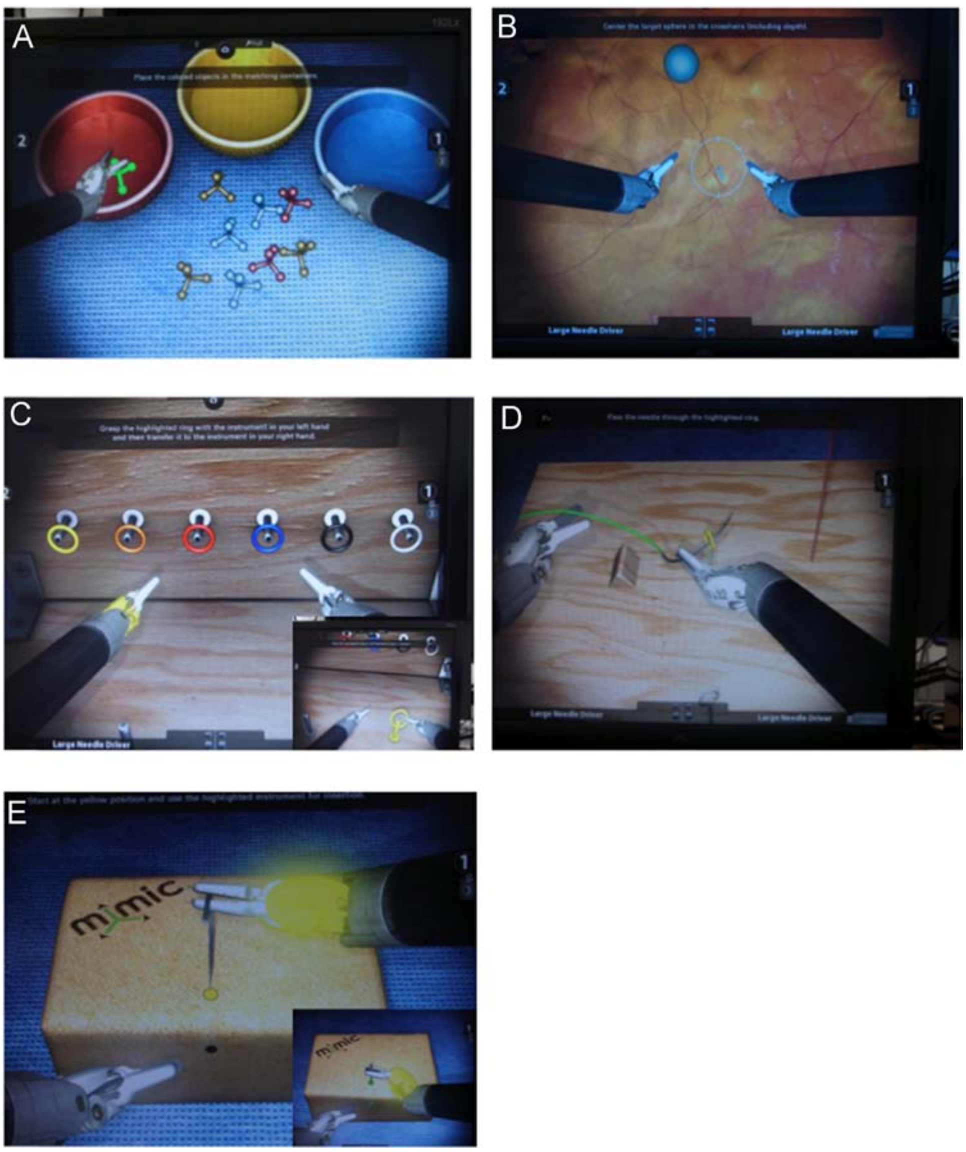

FIGURE 1. Five skill exercises in the present curriculum. (A) Pick and Place: A trainee is required to place colored objects in the matching containers. (B) Camera Targeting 1: A trainee is required to center the target sphere in the crosshairs (including depth). (C) Peg Board 1: A trainee is required to grasp the highlighted ring with the instrument in the left hand, then transfer it to the instrument in the right hand, and place it on the highlighted peg on the floor. (D) Thread the Rings: A trainee is required to pass the needle through the highlighted ring. (E) Suture Sponge 1: A trainee is required to thread the needle through the indicated position using the highlighted instrument for insertion. A trainee is required to finish forehand/backhand suturing tasks with both hands.