Intracorporeal suturing: Transfer from Fundamentals of Laparoscopic Surgery to cadavers results in substantial increase in mental workload

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Introduction. *A spatial secondary task developed by the authors was used to measure the mental workload of the participant when transferring suturing skills from a box simulator to more realistic surgical conditions using a fresh cadaver. We hypothesized that laparoscopic suturing on genuine bowel would be more challenging than on the Fundamentals of Laparoscopic Surgery (FLS)-simulated bowel as reflected in differences on both suturing and secondary task scores.*
Methods. *We trained 14 surgical assistant students to FLS proficiency in intracorporeal suturing. Participants practiced suturing on the FLS box for 30 minutes and then were tested on both the FLS box and the bowel of a fresh cadaver using the spatial, secondary dual-task conditions developed by the authors.*
Results. *Suturing times increased by >333% when moving from the FLS platform to the cadaver* $F(1,13) = 44.04$, $P < .001$. *The increased completion times were accompanied by a 70% decrease in secondary task scores,* $F(1,13) = 21.21$, $P < .001$.
Conclusion. *The mental workload associated with intracorporeal suturing increases dramatically when trainees transfer from the FLS platform to human tissue under more realistic conditions of suturing. The increase in mental workload is indexed by both an increase in suturing times and a decrease in the ability to attend to the secondary task. (Surgery 2015;158:1428-33.)*

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Laparoscopy has replaced open surgery for many common operations, but is more demanding mentally than traditional open surgery based on the need to maneuver in a 3-dimensional environment while viewing a 2-dimensional monitor. Although laparoscopy provides benefits to the patient, there are substantial challenges to surgeon training to do laparoscopic procedures. Simulation has been used increasingly for training of fundamental laparoscopic skills outside of the operating room,[1] and proficiency in simulation is now required of graduating surgical residents. The Fundamentals of Laparoscopic Surgery (FLS) program, created to teach and assess surgeon's cognitive and psychomotor skills, was designed by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and endorsed by the American College of Surgeons (ACS). In the initial 5 years of testing, begun in 2004, there were 2,689 test takers with an overall pass rate of 88%.[2] Successful completion of the FLS program is now mandated by the American Board of Surgery to ensure laparoscopic proficiency of surgical trainees.

Laparoscopy places more demands on visual attention, while at the same time requiring the surgeon to have spare attentional capacity to monitor the activity in the room and plan for the next steps of surgery. Currently, there is no standard method to assess the mental demands

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required during laparoscopic surgery. Based on the multiple resource theory of attention, a secondary task that uses the same visual–spatial attentional resources needed for laparoscopy can provide an index of spare attentional capacity, or mental workload, when it is performed simultaneously with a laparoscopic task.[3] Stefanidis et al[4] used a secondary task technique to assess laparoscopic workload with a spatial task and found that subtle differences in laparoscopic skill were revealed by the secondary task.

Our group described a new secondary task developed specifically for laparoscopic procedures that superimposes the secondary task on the image of the laparoscopic task, resulting in a combined video image with both tasks in the same visual focus and requiring the same visual resources. Initial studies have shown that this secondary task is sensitive to differences among laparoscopic training tasks and surgical experience.[5,6] The goal of the present study was to use the new spatial secondary task to measure the difference in mental workload when transferring skills from a procedural simulator to more realistic conditions in the operating room using a fresh cadaver. We hypothesized that laparoscopic suturing on genuine bowel would be more challenging than on the FLS-simulated bowel as reflected in differences on both suturing and secondary task scores and subjective reports of mental workload.

METHODS

Participants. Fourteen students in a surgical assistant (SA) education program (Master of Surgical Assisting; 3 males and 12 females) at the Eastern Virginia Medical School participated in this institutional review board-approved study. Their ages ranged from 23 to 28 years, and all had normal or corrected-to-normal vision. All but 1 participant were right handed. Participants were compensated monetarily.

Primary task. Participants performed the intracorporeal suturing task from FLS. All participants had been trained previously to FLS proficiency using the criteria described by Ritter and Scott.[7] Before participation in the study, the SA students had no substantial experience with laparoscopic suturing. Participants were provided with 2 laparoscopic needle drivers and 1 endoscopic scissor, and a 26-mm 1/2c taper needle with Perma-Silk suture that had been cut to a length of 6 inches. The primary dependent measure was completion time. There were no accuracy or knot errors on the FLS task. Moreover, accuracy of needle placement was not possible to judge within the cadaver, and participants were instructed to continue until they achieved a secure knot.

Secondary task. The secondary task was a signal detection task referred to as the ball-and-tunnel task.[8] Participants were shown a 234.95 × 196.85-mm, 2-dimensional simulated tunnel composed of dots with 4 colored balls floating within. Each ball measured 22.22 mm and was located at the 12, 3, 6, and 9 o'clock positions within the tunnel, appearing to be the same simulated distance from the observer. This constitutes the "standard" image. A target is defined as an image in which one of the balls moves in apparent depth within the tunnel represented by a change in the diameter of the ball and a shift in its location. When a ball moves closer, its diameter increases by approximately 50%, and it shifts 53 mm from the center. When it moves further, its diameter decreases by approximately 50%, and it shifts 11 mm from the center (Figure). Each image was presented for 0.3 seconds and then removed, with an interstimulus interval that varied from 2 to 4 seconds. Participants were instructed to respond to any image that differed from the standard image (ie, targets) using a Savant Elite USB 3, pedal triple action foot switch. There was no importance placed on the color of the balls that moved, or the direction in which the ball moved. The ball-and-tunnel image was superimposed over the laparoscopic display at 40% transparency, ensuring that both tasks were viewed within focal vision. The dependent variable for the ball-and-tunnel task was the proportion of correctly identified target images.

Mental workload. Mental workload was measured with the NASA-Task Load Index (TLX).[9] Participants provide subjective ratings of mental workload on six subscales that range from 0 to 20. The subscales address mental demand, physical demand, temporal demand, performance, effort, and frustration. Participants rated workload by circling the appropriate maker on each subscale. The dependent measure is total workload derived by summing the ratings across the subscales. The TLX was administered immediately after completion of the box trainer and cadaver tasks.

Materials. Participants performed suturing on a VT Medical brand box trainer provided for FLS with a 15-inch Dell monitor. The cadaver portion utilized Stryker high definition endoscopic towers and Stryker 10 mm × 30° scopes. The cadavers were Soft Embalmed prepared using a Modified Theil method of fixation that uses nitrate salts so as to maintain tissue flexibility and allow for full joint and tissue mobility.