Impact of visualization on simulation training for vascular anastomosis

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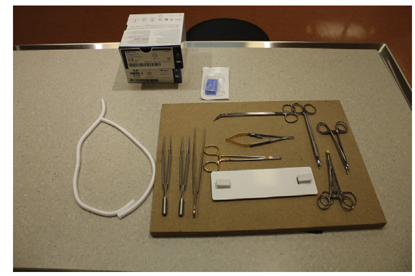
ABSTRACT

Objective: There is mounting evidence supporting the benefit of surgical simulation on the learning of skills independently and in a patient-safe environment. The objective of this study was to examine the effect of visualization of surgical steps via instructional media on performance of an end-to-side microvascular anastomosis.

Methods: Thirty-two first- and second-year surgical trainees from the University of Ottawa received an expert-guided, didactic lecture on vascular anastomosis and performed an end-to-side anastomosis on a procedural model to assess baseline skills. Assessments were performed by 2 blinded, expert observers using validated measurements of skill. Subjects were then proctored to perform anastomoses using the model. Subjects were then randomized to watch an instructional video on performance of vascular anastomosis using visualization as the education strategy. One week later, subjects were again assessed for technical skill on the model. The primary outcome was the score achieved on the Objective Structured Assessment of Technical Skill (OSATS) scale. Secondary outcomes included an anastomosis-specific End-Product Rating Score and time to completion.

Results: Compared with residents who received expert-guided simulator training alone, those who used the supplementary multimedia scored significantly greater on OSATS (17.4 $\pm$ 2.9 vs 14.2 $\pm$ 3.2, $P = .0013$) and on End-Product Rating Score (11.24 $\pm$ 3.0 vs 7.4 $\pm$ 4.1, $P = .011$). However, performance time did not differ between groups (15.7 vs 14.3 minutes, $P = .79$).

Conclusions: Residents with supplemental instructional media performed an end-to-side anastomosis more proficiently as assessed by OSATS and with a greater quality end-product. This suggests that both didactic simulation training as well as use of visualization multimedia improves learning and performance of vascular anastomosis and should be incorporated into surgical curricula. (J Thorac Cardiovasc Surg 2018;155:1686-93)



Bench model for vascular anastomosis (4-mm polytetrafluoroethylene grafts, Prolene suture, microvascular equipment).

Central Message

Trainees who watched a video performed vascular anastomosis more proficiently with greater quality, suggesting that simulation and visualization multimedia improves learning and should be integrated in curricula.

Perspective

Surgical training is challenged by work-hour restrictions, growing public scrutiny of surgical outcomes, increasingly complex cases, and a suboptimal high-stress environment. To facilitate teaching trainees important complex skills such as vascular anastomosis, we demonstrated that visualization multimedia, which has not been examined in a randomized study, has significantly improved their acquisition of skills.

See Editorial Commentary page 1694.

The traditional methodology of surgical education, pioneered by Dr John Halstead, involves learning skills in an operating room setting in a progressive fashion. Although this apprenticeship model has formed the backbone of most surgical residency training programs, multiple constraints limit this approach and can threaten the learning of operative skills.[1] Implementation of work-hour restrictions has significantly reduced clinical exposure and educational opportunities.[1-3] Furthermore, with growing public scrutiny of surgical outcome and an increasing complexity of surgical cases, surgeons are less inclined to engage residents, particularly in the face of time to

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Scanning this QR code will take you to supplemental figures and video for this article.

Abbreviations and Acronyms

EPRS	= End-Product Rating Score
OSATS	= Objective Structured Assessment of Technical Skill
PGY	= postgraduate year

complete a surgical procedure safely and efficiently.[4] These factors contribute to a high-stress environment that can be suboptimal for surgical education.

In response to these constraints, surgical simulation has emerged as a successful tool in the learning of surgical skills.[4-6] Simulation permits repetitive, independent training of skills in a patient-safe environment. In effect, the methodologic aspects of surgical skills education have considerably evolved over the past decade. There is mounting evidence in the literature to support the use of simulation in multiple surgical fields.[5,7] Despite this evidence, however, the use of simulation is underdeveloped in the field of cardiovascular surgery.

Vascular anastomosis is an important skillset that is extensively used in cardiovascular surgery and in most surgical subspecialties. This complex procedure requires expertise in a wide range of skills: cognitive planning, instrument and suture handling, vascular tissue manipulation, and economy of motion.[4] Similar to other studies, we have demonstrated significant improvement in the performance of vascular anastomosis in our previous study using simulation on a bench model.[4,8] However, although independent simulation training tackles "mechanical" motor skills successfully, it often lacks in the development of cognitive factors involved in psychomotor development. The use of cognitive visualization has not been examined in vascular anastomosis in a randomized trial setting. The objective of this study was to examine the effect of visualization of surgical steps via instructional media on performance of an end-to-side microvascular anastomosis during simulation.

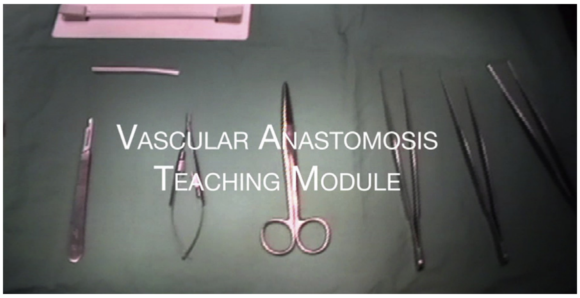
METHODS

Study Population

All subjects recruited to this study were first- and second-year surgical trainees of all subspecialties at the University of Ottawa tertiary care hospital system based in Ottawa, Canada. Subjects were excluded if they had previously participated in an expert-guided teaching session on vascular anastomosis, used the bench model, or had previously completed residency training.

Study Design

This was a single-center, single-blinded randomized control trial run at the University of Ottawa Skills and Simulation Center (Appendix E1). The study was approved by the Ottawa Hospital Research Ethics Board, and all subjects provided consent to participate. The study protocol adhered to the consolidated standards of reporting trials under the Consolidated Standards of Reporting Trials Statement. Between September 2013 and April 2014, a total of 32 surgical trainees were recruited.



VIDEO 1. Video illustrating the use of visualization techniques to teach vascular anastomosis. Video available at: http://www.jtcvsonline.org/article/S0022-5223(17)32414-5/fulltext.

A commercially available procedural trainer (Limbs & Things, Savannah, Ga) was used to simulate an end-to-side anastomosis (Figure 1). Nonringed, 4-mm polytetrafluoroethylene grafts (W. L. Gore & Associates, Inc, Flagstaff, Ariz) were sutured with a 5-0 polypropylene suture (Covidien AG, Mansfield, Mass) in a running fashion with microvascular surgical instruments.

All subjects received an initial didactic session involving a comprehensive overview of the technical steps and principles of performing an end-to-side microvascular anastomosis (Figure 2). Next, subjects independently performed one anastomosis on the procedural trainer. This "pretest" established subject baseline surgical skills, and subjects were informed they were going to be videotaped and scored. Videotaping focused only on performance of anastomosis on the bench model and did not include subject names or faces to avoid identification of the subject. Subsequently, subjects were given the opportunity to perform 2 anastomoses under the expert guidance of cardiac and vascular surgeons in a one-to-one teaching strategy using a consensus-determined standardized teaching strategy. No magnifying loops were used in the study by any subject.

Subjects were then randomized to either intervention (those who received the supplementary instructional multimedia to use independently) or control arms. Computer-generated randomization was performed with stratification based on postgraduate year (PGY) of training (PGY1 and PGY2). The intervention was a professionally made, high-definition video illustrating the use of visualization in describing all important steps, anatomical landmarks, and pitfalls involved in performing vascular anastomosis (Video 1). The video divided the procedure into a logical flow of steps to facilitate visualization of the procedure as a mental task. This video was password-protected and conveniently accessible on iPads, tablets,

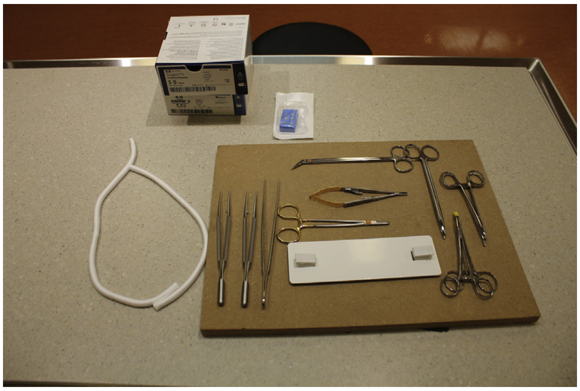


FIGURE 1. Bench model for vascular anastomosis, involving 4-mm polytetrafluorene grafts, Prolene suture, and microvascular equipment.