ORIGINAL REPORTS

A Vascular Anastomosis Simulation Can Provide a Safe and Effective Environment for Resident Skills Development

Alicia A. Heelan Gladden, MD,[*,1] Kendra D. Conzen, MD, FACS,[†] Michael J. Benge, MHA,[*] Jane Gralla, PhD,[‡,§] and Peter T. Kennealey, MD, FACS[†]

[*]Department of Surgery, University of Colorado School of Medicine, Aurora, Colorado; [†]Division of Transplant Surgery, University of Colorado School of Medicine, Aurora, Colorado; [‡]Department of Pediatrics, School of Medicine, University of Colorado Denver, Aurora, Colorado; and [§]Department of Biostatistics and Informatics, Colorado School of Public Health, University of Colorado Denver, Aurora, Colorado

OBJECTIVE: Vascular anastomoses are complex surgical procedures, performed in time-sensitive circumstances, making intraoperative teaching more challenging. We sought to evaluate whether a vascular anastomosis simulation was effective in developing resident skills.

DESIGN, SETTING, PARTICIPANTS: General surgery residents participated in a vascular anastomosis simulation for 1 to 2 hours during their transplant rotation. An attending transplant surgeon at the University of Colorado guided the resident through end-to-end and end-to-side anastomoses using bovine carotid artery (Artegraft). The residents completed a presimulation and postsimulation survey which quantitated their confidence. They also completed the MiSSES scale, which assessed the validity of the simulation.

RESULTS: Twenty residents participated in the simulation and completed the surveys. The residents reported increased understanding in how to set up an end-to-end anastomosis and an end-to-side anastomosis ($p = 0.001$ and $p = 0.009$, respectively). They reported increased ability to suture, forehand and backhand with a Castro-Viejo needle driver (both $p < 0.001$). The residents reported increased ability to manipulate the needle ($p = 0.006$), and increased ability to manipulate tissue without causing trauma ($p = 0.021$). They reported increased confidence in tying a surgical knot with 6-0 Prolene and in operating while wearing loupes ($p = 0.002$, and $p < 0.001$, respectively). Overall, the residents reported increased confidence when asked to perform part of a vascular anastomosis in the operating room ($p < 0.001$). Seventeen residents completed the MiSSES scale with median scores of "somewhat agree" to "strongly agree" on all domains of the scale.

CONCLUSIONS: The use of a simple, inexpensive vascular anastomosis simulation is an effective and safe environment to improve residents' surgical skills and the residents felt that the simulation was valid. (J Surg Ed ▮:▮▮▮-▮▮▮. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgical simulation, vascular anastomosis, resident education, MiSSES Scale

COMPETENCIES: Practice-Based Learning and Improvement, Patient Care and Procedural Skills, Systems-Based Practice, Medical Knowledge, Interpersonal and Communication Skills and Professionalism

INTRODUCTION

The traditional Halsted apprenticeship model of surgical education is being replaced, in part, with simulation and structured objective evaluation of skills acquisition.[1] Though Halsted's model was widely successful, the use of simulation in surgical training has become more prevalent with the development of work-hour limitations, stricter supervisory guidelines, and increasingly litigious environments.[1,2]

Though many lament the changes in surgical education, it is not all bad. Perhaps, the high-stress, time-sensitive environment of the operating room is not an ideal setting for new skill acquisition.[3] The external pressures of the operating room are felt by the attending surgeon and resident and this likely affects the attending surgeon's ability to teach and the surgical resident's ability to learn.[3] Many

Correspondence: Inquiries to Alicia A. Heelan Gladden, Department of Surgery, University of Colorado School of Medicine, 12631 E 17th Avenue, C302, Aurora, CO 80045; e-mail: Alicia.heelangladden@ucdenver.edu

[1]Heelan Gladden are both family names.

  1931-7204/$30.00 https://doi.org/10.1016/j.jsurg.2018.03.005

studies have demonstrated that simulation and deliberate practice outside of the operating room has a positive effect on skill acquisition.[4-6] Simulation provides a low-consequence environment in which the resident can repetitively practice both technical and cognitive skills. Though simulation has gained popularity over the last decade, we believe that it is still underutilized. There are several barriers that prevent widespread adoption of simulation models: cost, lack of dedicated resident and attending surgeon time, fidelity, and doubt over transferability of skills.[7-9]

Most operations can be subdivided into core components, and mastery of these components is fundamental to being a well-trained general surgeon. A core component of numerous operations is the completion of a vascular anastomosis. Vascular anastomoses are complex surgical procedures, often performed in time-sensitive circumstances, which complicates intraoperative teaching. Drake et al. recently reported on the global trend of surgical resident operative experiences over the past quarter century. One finding is the drastic decline in major vascular cases reported by graduating surgical residents, averaging 148 cases in the mid to late 1990s to 107 cases in the early 2000s, a 27% decline.[10] These findings can be attributed to the increase in cases performed by vascular fellows and the transition to endovascular therapies. However, the need for technical competency in the performance of vascular surgery remains a pillar of the Essentials of General Surgery content area as detailed by the American Board of Surgery.[11] Robinson et al.[12] demonstrated that vascular procedure simulation can improve self-rated procedural competence in a time and resource intensive course, but no studies have demonstrated increased skill after a low-resource vascular simulation experience.

Therefore, we sought to evaluate whether a simple, inexpensive, vascular anastomosis simulation was an effective environment to develop resident skills. We hypothesized that residents would report increased confidence in the technical and cognitive skills required to complete a vascular anastomosis after participation in the simulation.

MATERIALS AND METHODS

Participants

While rotating on the transplant surgery service, residents were offered the opportunity to participate in a transplant attending surgeon-guided anastomosis simulation session. They were also asked to complete a presimulation survey at the beginning of the rotation, and a postsimulation survey and the Michigan Standard Simulation Experience Scale (MiSSES) at the end of their rotation. Participation in all components of the study was elective with no offered incentives. The participating residents were not given a grade reflective of their performance during the simulation session.

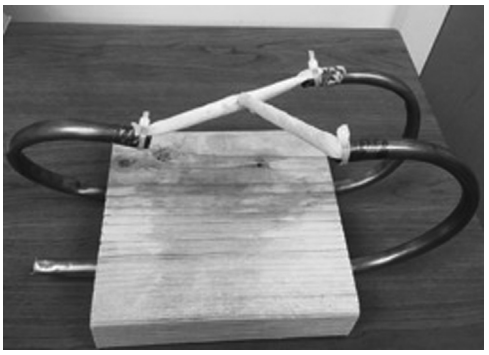

Figure 1. Platform set up for end-to-side anastomosis simulation.

Simulation Design

The surgical simulation setup used bovine carotid artery, Artegraft, as a surrogate for human vessels. The graft was secured to curved metal piping with zip-ties, and the piping was secured to a wood base that allowed the piping to rotate around the base. This allowed the graft to be suspended in the air, allowing for good visualization of the whole circumference of the vessel (Fig. 1). In addition to the wood base and bovine carotid artery, Castro-Viejo needle drivers, sterile gloves, forceps, and 6-0 polypropylene suture were provided. Residents were asked to wear their loupes, if they owned them, and to adjust their chairs or stand to achieve an ergonomic position appropriate for performance. The session was usually 1 to 2 hours in duration, but there were no time restrictions outside of the residents' and attending surgeons' clinical responsibilities.

At the beginning of the simulation session, the attending surgeon asked the resident to set up and perform an end-to-end anastomosis. Often, a brief, partial demonstration was required as most residents did not know how to set up the anastomosis. If more than 2 residents were present, then the residents were divided into pairs. Pairs were selected by the residents themselves, irrespective of postgraduate year. The "observing resident" served as first assist to the "operating resident." The "observing resident" was permitted, but not required, to provide feedback to the "operating resident." The attending surgeon observed the resident pair(s) as they practiced the anastomosis and provided specific feedback to each resident. There were never more than 2 "operating residents" at a time. After 1 resident successfully completed the anastomosis to the attending's satisfaction, the residents switched roles. After the completion of an end-to-end anastomosis by both residents in a pair, they moved on to end-to-side anastomosis. The feedback from the attending surgeon focused on physical and cognitive skills, including set up, instrument handling, and knot tying technique. The attending surgeon provided feedback according to the resident's skill level, irrespective of postgraduate year. Resident performance during the simulation session was not considered in their evaluation on the transplant service.