Development and Construct Validity of a Low-Fidelity Training Platform for Driving Large and Small Suture Needles

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BACKGROUND: The objective of this study was to describe and validate a novel training platform for driving large and small suture needles, which can ultimately be used for elemental vascular surgical training.

METHODS: We developed a novel trainer and proficiency-based training curriculum that provides a platform for practice with handling fine vascular tools and needles as well as precision in suture targeting. The trainer comprises 2 concentric circles printed on cotton fiber material with 8 evenly spaced targets on each circle. The first exercise was designed for practice with Castroviejo needle drivers and a fine needle such that the needle is passed through all targets in sequential order. A second, larger figure serves the same function but is designed for conventional needle drivers and a larger needle. A total of 5 attending surgeons from vascular and trauma surgery were recruited to serve as "expert" participants. These surgeons completed 3 repetitions of each task, which were used to develop proficiency timing and quality standards for practice. The curriculum was validated by recruiting 10 senior surgical residents and 12 surgical interns. Senior residents completed 3 repetitions of each task. Each first-year resident completed a proctored pretest, trained to proficiency by self-paced practice on the trainer according to standards set by the attending surgeons, and completed a proctored posttest.

RESULTS: First-year residents performed significantly worse on the pretest compared with senior residents and faculty surgeons on both exercises (small figure = 58.9 vs 174.2 vs 201.3, $p < 0.001$; large figure = 112.1 vs 202.9 vs 198.1, $p < 0.001$). After proficiency-based practice, first-year residents improved significantly from pretest to posttest (small figure = 216.0 vs 58.9, $p < 0.001$; large figure = 211.7 vs 112.1, $p = 0.001$).

CONCLUSIONS: The vascular trainer platform demonstrated construct validity for self-paced elemental vascular surgical practice. (J Surg 72:387-393. © 2015 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgical education, vascular anastomosis, elemental training, surgical skills

COMPETENCIES: Practice-Based Learning and Improvement, Systems-Based Practice, Medical Knowledge

INTRODUCTION

Surgeons in training are faced with a number of challenges that were not present in previous decades for trainees. Work-hour standards have been shown to limit clinical exposure, which may necessitate adjuncts to acquiring skills.[1,2] The Surgery Residency Review Committee mandated the inclusion of surgical skills laboratories at all general surgical residencies in an effort to address these clinical shortcomings.[3] Although there are a number of differing viewpoints about various curricula and implementation standards,[4] the general consensus from surgical faculty at academic institutions is that skills laboratories are beneficial for trainee education.[5]

In addition to work-hour time constraints, there are safety and cost concerns associated with resident participation in surgeries and procedures. A significant increase in cost has been associated with operations performed by residents and faculty vs faculty-only cases.[6] Furthermore, an increase in postoperative complications in patients where trainees participated has been reported.[7] It is not surprising that academic institutions seek additional resources to mitigate these problems.

Surgical skills training outside of the operating room predates the Surgery Residency Review Committee's

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mandate for skills laboratories. Suture training has been documented as early as 1968.[8] There are scores of published articles in the surgical education literature describing training devices and methodologies for the acquisition of open skills, laparoscopic skills, robotic training, and endovascular skills among others. A common theme for many of these publications is the degree to which the training device or apparatus represents actual clinical scenarios. This is referred to as fidelity. Although higher degrees of fidelity may provide a more accurate representation of what a trainee may encounter in the operating room, true novices may benefit from an initially more basic level (i.e., low fidelity) of skill practice. This may be especially true in highly technical tasks where novices do not yet possess the elemental skills to perform a complete surgical process. Thus, practicing the discrete constituent steps in the process may be helpful before attempting higher fidelity practice.

A particularly daunting open skill for surgical novices is the vascular anastomosis. Fine and precise technique must be used for a high-quality anastomosis. There is an abundance of reports on vascular anastomosis training and technique taught in skills laboratories[8–12]; however, no reports exist of a platform that allows for the elemental practice of fine-needle handling with Castroviejo needle drivers, estimation of needle travel, and precise suture targeting. In this study, we sought to create such a platform and describe the development, cost, and validity of this new platform. Input on this trainer was obtained from vascular surgeons within our institution. The trainer described in this report allows for elemental practice with vascular instruments and suture which may be beneficial when trainees are learning to perform anastomoses.

MATERIALS AND METHODS

Trainer Development

An informal needs analysis conducted with 4 vascular surgery faculty members and 1 trauma/emergency surgery faculty member revealed a deficiency in the handling of fine vascular tools and materials amongst junior residents. To address this need, we developed a low-fidelity training model to provide practice with handling fine vascular tools and needles as well as precision in suture targeting (Fig. 1). The training model consists of 2 figures, and each contains 2 concentric circles with 16 targets located at various points along the circles. The diameter of the inner circle in each figure was equivalent to the length of the needle to be used in the task. The smaller figure was designed for practice with Castroviejo needle drivers and 5-0 polypropylene suture on a 13-mm curved, reverse cutting P-3 needle, which is commonly used for fine vascular anastomosis. The larger figure was designed for practice with a standard needle driver and 2-0 polypropylene suture on a 26-mm curved, taper V-20 needle, which is commonly used for aortic procedures.[13] A total of 8 targets were placed at progressive 45° intervals on both the inner and outer circles of each figure for 16 targets per figure. These were numbered on the figure starting at the 270° position, with the first target being on the inner circle and the second target on the outer circle. Target 3 was placed at the 225° position on the inner circle and target 4 at 225° on the outer circle. This numbering continued in a counterclockwise manner such that the 16th target was located at the 315° position on the outer circle.

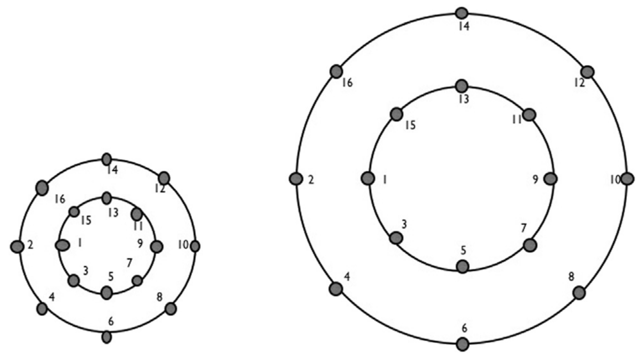

FIGURE 1. Vector drawing of the small and large figures.

In an effort to standardize the relative sizes of the figures, some basic assumptions were made. The first assumption was that the recommended positioning of the needle within the needle driver should be two-thirds of the way back from the tip of the needle. The choke on the needle for a given bite is somewhat variable depending on the task to be performed in a real operation; however, the recommendation of a two-thirds choke was felt to be acceptable by our surgeons. The second assumption was that ideal travel of the needle would be 60% of the remaining length of the needle. For example, a 13-mm needle would be grasped 8.7 mm back from the tip, which resulted in needle travel of 5.2 mm. Thus, the outer circle in the small figure had a diameter of 23.4 mm and the inner circle had a diameter of 13 mm. This allowed for the travel of the needle to always be 5.2 mm on the small figure. Similarly, the 26-mm needle should be grasped 17.3 mm back from the tip. Taking into account the fact that the travel should be 60% of this remaining length, the diameter of the inner circle for the large figure was 26 mm and the outer circle was 46.8 mm. This allowed for the needle travel to always be 10.4 mm when performing the task on the large figure.

The figures were then printed on Avery Fabric Transfer sheets (Avery Dennison Office Products Company, Brea, CA), ironed onto MCG Textiles Cross Stitch fabric—18 count (MCG Textiles, Chino, CA), and inserted into an 8-in wooden embroidery hoop. To provide stability, a wooden support base was constructed. This base was then secured to a tabletop with hook-and-loop fasteners (Fig. 2).

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