Development of a Surgical Skills Curriculum for the Training and Assessment of Manual Skills in Orthopedic Surgical Residents

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OBJECTIVE: To develop and conduct a pilot study of a curriculum of 4 surrogate bone training modules to assess and track progress in basic orthopedic manual skills outside the operating room.

DESIGN: Four training modules were developed with faculty and resident input. The modules include (1) cortical drilling, (2) drill trajectory, (3) oscillating saw, and (4) pedicle probing. Orthopedic resident's performance was evaluated. Validity and reliability results were calculated using standard analysis of variance and multivariate regression analysis accounting for postgraduate year (PGY) level, number of attempts, and specific outcome target results specific to the simulation module.

SETTING: St. Mary's Medical Center in San Francisco, CA.

PARTICIPANTS: These modules were tested on 15 orthopedic surgery residents ranging from PGY 1 to PGY 5 experience.

RESULTS: The cortical drilling module had a mean success rate of 56% ± 5%. There was a statistically significant difference in performance according to the diameter of the drill used from 33% ± 7% with large diameter to 70% ± 6% with small diameter. The drill trajectory module had a success rate of 85% ± 3% with a trend toward improvement across PGY level. The oscillating saw module had a mean success rate of 25% ± 5% (trajectory) and 84% ± 6% (depth). We observed a significant improvement in trajectory performance during the second attempt. The pedicle probing module had a success rate of 46% ± 10%.

CONCLUSION: The results of this pilot study on a small number of residents are promising. The modules were inexpensive and easy to administer. Conclusions of statistical significance include (1) residents who could easily detect changes in surrogate bone thickness with a smaller diameter drill than with a larger diameter drill and (2) residents who significantly improved saw trajectory with an additional attempt at the module. (J Surg 72:47-52. ©2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: education, orthopedics, motor skills, internship and residency

COMPETENCIES: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement

INTRODUCTION

The traditional method of surgical training relies on didactic lectures and clinical/surgical apprentice-based learning. The apprenticeship model requires direct patient care for resident education. There are inherent barriers to this education style, which include increased cost, limited training time, and a lack of a standardized way to monitor progress. There is a significant financial burden to society with our current educational model. Farnworth et al.[1] reported an increased cost of $661 per anterior cruciate ligament reconstruction when performed by a resident compared with an attending physician. In addition, the current educational model inherently lacks a way to standardize educational progression. Karam et al.[2] surveyed orthopedic residents and program directors and 58% of directors and 83% of residents believed that surgical skill improvement was not being

Disclosure: Dimitriy Kondrashov is in association with AO Foundation, Spineart, SI-Bone, and LifeSpine. Jeremi Leasure is in association with DePuySynthes, Medtronic, Stryker, Exactech, Spineart, SI-Bone, ConforMIS, Kinamed, Cotera, RJI Orthopaedics, and Neptune Orthopaedics. Adam Brooks, Eric Hohn, William Camisa, Jennifer Van Warmerdam, William Montgomery, and William McGann have nothing to disclose.

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  1931-7204/$30.00 http://dx.doi.org/10.1016/j.jsurg.2014.06.005

objectively measured. In the general surgery community there are attempts to standardize educational progress by assessing psychomotor skills.[3-5,8] In the orthopedic community, there have been similar attempts at standardizing surgical skills.[6,7] As of 2013, 76% of orthopedic residency programs have surgical skills laboratories, and 46% of those have a scheduled curriculum.[2] Most of the most recent literature on the development of skills modules emphasizes the critical need for skills tests to be proven valid and reliable.[3,5-8] A common method to determine psychomotor test validity is through an evaluation of its construct performance, or the degree to which the test captures the hypothetical quality it was designed to measure.[3] Common methods to determine reliability are interrate, intrarate, and test-retest reliability.[6]

For simulation efforts to be successful, orthopedic residents must first recognize and accept that these models are indeed valuable. Multiple studies have established that residents and program directors value skill training opportunities.[2,9] However, Hagen (society simulation) surveyed general surgery residents, and although they did value simulation opportunities, most thought these opportunities would be more valuable for junior residents. Although surgical residents do have positive attitudes toward these modules, it was seen that mere availability of such resources was not enough to motivate residents to use them.[10] Pedowitz agreed that such skills laboratories should be mandatory and codified within the surgical curriculum.[11] At the University of Iowa, a 1-month protected surgical skills program was implemented for interns with overwhelmingly positive subjective findings, including the improvement of surgical skills and safety in the operating room.[2]

Orthopedic surgery residency training programs are faced with the difficult challenge of increasing efficiency with fewer training hours available to residents. The American Academy of Orthopaedic Surgeons has taken certain steps to improve residency training programs by increasing the number of months interns spend on an orthopedic service to 6 months and by defining specific milestones and skills that residents must attain before graduation (www.aaos.org/news/aaosnow/jul13/clinical7.asp). With these American Academy of Orthopaedic Surgeons goals in mind, residency programs must supplement live/operative experience with various degrees of simulation to expand the orthopedic resident's exposure to various skills in a low-risk environment and to maximize efficiency in the operating room (American Board of Orthopaedic Surgery website). Based on our review of the literature, understanding of the Accreditation Council for Graduate Medical Education requirements, and focus on the needs of orthopedic residents in our program, we developed the following guidelines for our skills curriculum:

1. Skills aimed to decrease operative costs.
2. Skills training and assessment must be standardized and objective.
3. Manual skills should focus on training, concept of safety, and assessing junior residents.
4. Modules should be mandatory and codified with the curriculum.

With these guidelines in mind, our main goal was to design and conduct a pilot study on a skills curriculum for the 15 orthopedic surgery residents in our program. Our specific aim was to design and develop 4 skills modules and test the validity and reliability of these modules. We hypothesized the modules would accurately capture varied performance among all residents and that no test would receive all success or all failures.

METHODS

Study Population

A total of 15 orthopedic surgeons ranging from postgraduate year (PGY)-1 to PGY5 were asked to complete each of the 4 skills modules. The study protocol was submitted to our hospital's institutional review board committee and was approved as an exempt human subjects investigation.

Module and Curriculum Design

We designed 4 orthopedic surgery skills modules designed with input from orthopedic surgery faculty and residents as well as construction support for Sawbones (Pacific Research Laboratories). Our first module was named the "cortical drilling module" and was performed on surrogate cancellous and cortical bone test blocks as shown in Figure 1. Without knowing the thickness of each layer, the subject was asked to drill through the first cortical layer and through the underlying cancellous layer and to stop at the subsequent cortical layer. The objective of the module was to drill to a specific depth. Each attempt was categorized as a success if the subject pierced the cortical layer but stopped within a specified distance thickness. It was designed to provide experience with the tactile responses of cortical and cancellous bone using a drill. Our second module was named the "drill trajectory module" and was performed on surrogate cancellous bone test domes (Fig. 2). Subjects were instructed to drill starting at the top mark and drill through to a corresponding mark on the side of the dome. The objective of the module was to drill and "hit" a specified "target" on the first attempt. Each attempt was categorized as a success if the subject drilled through any portion of the intended target. This was designed to help develop hand-eye coordination with a drill. Our third module was named the "oscillating saw skills module" (Fig. 3) and was performed on surrogate cancellous and cortical bone test blocks similar to the cortical drilling setup. Without knowing the thickness of each layer, the subject was asked to saw through a top cancellous layer and to pierce through a cortical layer.