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Surgical skills training restructured for the 21st century

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ABSTRACT

Background: Few if any medical schools have a comprehensive surgical skills program taking medical students from learning basic knot tying and surgical skills to performing these skills at a level adequate for function during a primary care, surgical, or subspecialty residency. We have designed and continue to refine a program, which consists of five workshops focused on basic surgical skills, which are applicable to all medical and surgical disciplines.

Materials and methods: During the first workshop students learn how to tie both one- and two-handed surgical knots. The second workshop involves teaching students differences in suture type and use, instrument handling, and suturing techniques. The third workshop is used to address problems and refine techniques previously learned in the first two sessions. The fourth workshop comprises a final examination to evaluate suture and knot tying skills. The fifth session is a voluntary knot tying and suturing competition with awards for speed, finesse, aesthetics, and the watertightness of a vascular surgical repair. Surgical faculty and house staff are present at each workshop to provide direction and constructive criticism.

Results: Fifty-seven third-year medical students have completed the surgical skills curriculum. Statistical analysis demonstrates significant improvement in both knot tying and suturing ($P < 0.05$) for these students. Forty-four percent of students have successfully sewn a watertight anastomosis.

Conclusion: We hypothesize that this curriculum will produce medical students with basic surgical skills, appreciation of surgical technique, and the confidence to perform basic surgical skills at completion of the curriculum.

1. Introduction

Surgical education in the United States is currently undergoing reinvention and adaptation from the days of Sir William Halsted, when a formal system of graduated responsibility for surgical training was initially established at Johns Hopkins Hospital in 1889 [1,2]. This apprenticeship model exemplified by the phrase “see one, do one, teach one” is now under considerable strain [3]. Changes in the health care system and medical education model have made it more difficult for the operating room to be the predominant venue for acquisition of technical skills. Therefore, there is a need to develop educational methods for technical skills acquisition outside the operating room [4]. Factors, such as duty hour requirements, operating room efficiency, and decreased length of surgery clerkships have resulted in less emphasis on the acquisition of

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surgical skills training for medical students. Furthermore, society as a whole has become less tolerant of both residents and students learning technical skills on the job. As education of technical skills has been taxed by multiple variables, basic surgical skill acquisition of medical students has become deficient as emphasized by Forbes *et al*. [5]. This is disturbing, as many of these basic skills are necessary in almost every branch of modern medicine.

General surgery and the surgical subspecialties are responsible for providing the training necessary to acquire these skills during medical school and must lead the way in providing such training in the modern era of medical education. In an effort to ensure the acquisition of these basic surgical skills by all medical students during the third-year surgical clerkship, the Department of Surgery at the University of Mississippi has developed a new surgical skills curriculum. This curriculum systematically takes students through the basic surgical skills of knot tying to more complex suturing techniques using five bench model workshops. At the completion of these workshops, students are then tested under the supervision of a faculty member and two upper level residents to ensure performance adequate for function during an internship.

The use of educational workshops is not new to surgery and is common for teaching new technical skills to practicing surgeons [4]. However, there are no published reports to date that describe a curriculum based on workshops for teaching fundamental technical skills to third-year medical students. Few if any medical schools in the United States have a comprehensive surgical skills program which systematically builds the surgical skills of students during their surgery clerkship to the level adequate for performance during an internship. This program is focused on deliberate practice and skills acquisition for all students as deliberate practice is critical for skill development [6]. We wish to demonstrate that a short series of workshops based on a simple bench model can engage third-year students and reliably teach basic surgical skills.

2. Materials and methods

From July to December 2011, a total of 57 third-year medical students completed the new surgical skills curriculum at the University of Mississippi Medical School as a part of their surgical clerkship. These 57 students were divided into groups of 20, 17, and 20 as each group completed an 8-wk surgical clerkship. Medical students were divided into groups of 10 or less during all five workshops, whereas staff and resident physicians proctored each workshop to provide instruction and constructive criticism of performance. A ratio of 3:1 students to proctors was maintained to ensure necessary technical instruction during each hour-long workshop.

In the first workshop students were instructed on how to tie one- and two-handed surgical knots. During the second workshop, students learned the differences in suture type, instrument handling, and common suturing techniques, including simple interrupted, simple running, running locking, subcuticular, and mattress stitches. The third workshop was used to refine techniques, address technical errors, and provide individual assistance to each student. The fourth workshop was a technical skills examination to assess competencies learned. Two surgical house staff and the clerkship director proctored all skills examinations. Basic surgical skills assessed were two-handed knot tying on an Ethicon suture board (Ethicon Inc, San Antonio, TX) and simple suturing of a laceration on a fresh pig's foot. After completion of the fourth workshop, students were then invited to participate in elective competitions for two-handed knot tying, suturing, and a simulated vascular surgical repair.

In the first portion of the competition, each medical student was given 30 s to tie as many two-handed knots as possible using an Ethicon suturing board, and a technical score was assigned to each student for demonstrated proficiency. The total number of knots tied and technical score were recorded. The technical score ranged from 0 to 5 with points lost for nonsquare knots, excessive platform movement or tension, air knots, not crossing hands, and dropping suture. No more than two technical points were lost by a participant for the same technical error. This technical score was then added to the number of knots tied to provide the total score for this event. A student t-test was performed to compare the performance of medical students after completion of the technical skill curriculum to a cohort of 20 third-year students not yet trained, and significance was defined by a P value <0.05.

The second portion of the technical skills examination assessed student proficiency at closing an approximately 8 cm, full-thickness linear laceration on a fresh pig's foot. Simple interrupted or simple running sutures were allowed for completion of this task. Sutured wounds were assessed by two house staff and the surgery clerkship director for symmetry, tightness, and aesthetics on a scale of 1 to 3 for each category. These scores were then added to produce the total score for this event.

In the final task of the competition, students attempted closure of a transected piece of latex tubing used to simulate a vascular anastomosis. The latex tubing was transected for approximately 50% of its total diameter and was closed with 5.0 prolene suture material. After closure of the tubing defect, the repair was tested for leak using water dyed with crystal violet. Each repair was tested up to 5 cm of water pressure and observed for leakage along the suture line. Endovascular insufflators also were used for pressure testing to provide an objective measure of atmospheres (atm) until leak along the anastomosis; however, needle holes were noted to leak at 1 to 2 atm and prevented further objective pressure testing.

At the end of each third-year surgical clerkship, a voluntary course survey was provided to students. Question 4 of 8 asks, "Did you find the knot tying and suturing sessions with the residents helpful?" Third-year students are asked to answer yes or no but may provide opinions.

3. Results

Statistical analysis demonstrates significant improvement for knots tied in 30 s (12.5 ± 2.9 *versus* 8.7 ± 2.1, P value <0.0001), technical score (3.5 ± 1 *versus* 0.6 ± 0.8, P value <0.0001), and total score (16 ± 3.3 *versus* 9.4 ± 2.8, P value <0.0001) for trained students in comparison with untrained control (Fig. 1). The performance of the three separate cohorts participating in the knot tying competition is outlined in Table 1.