The Impact of Early Exposure to Microsurgery Training on Undergraduates, A Pilot Course

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ABSTRACT

Introduction: This case study aimed to investigate a disparity in the medical education pipeline by investigating the impact of fundamental microsurgical training on interest and desire to pursue a career in medicine. This research introduces a method to attract undergraduate students from various backgrounds to the field of microsurgery through a hands-on microsurgical training course.

Methods: Microsurgical training took place 6 hours a week for 6 weeks. Techniques included knot-tying and anastomoses on 1-, 2- and 3-mm synthetic vessels using both end-to-end and back-wall techniques. Participant's knowledge and confidence in microsurgical skills were evaluated using a presurvey, postsurvey, and vessel patency. One undergraduate student with no prior surgical knowledge completed one-on-one microsurgical training designed for integrated plastic surgery residents and was supervised by a microsurgical educator.

Results: The undergraduate student achieved the microsurgery level equivalent to a third-year surgical resident in the same training program and could complete patent anastomoses using end-to-end and back-wall methods on a 1-mm, 2-mm, and 3-mm synthetic vessel. The student's timing for different skills decreased over time while their confidence level increased. Their time for tying 3 knots decreased from 2.53 minutes to 19 seconds, while their time for a 3-mm end-to-end anastomosis decreased by 5.13 minutes.

Conclusions: Medical knowledge may not be necessary before starting microsurgery training. Early, hands-on exposure may make a medical career less intimidating.

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INTRODUCTION

Medical career paths typically begin at the premedical level, with residency selection representing a critical juncture in specialty choice. Critical factors influencing medical students' specialty choice include personality fit, specialty content, and role model influence, but less is known about what drives students to attend medical school.[1] An increasing body of literature is emerging in support of early exposure and mentorship as a means of attracting motivated trainees of increasingly diverse backgrounds.[2-4]

Different subspecialties within the broader field of surgery utilize different methods to attract a more diverse population to their field since surgery is a field in medicine that is not as diverse as other medical fields in regard to gender and race.[5] Surgery programs may provide exposure to the field through hands-on experience and shadowing opportunities for premedical students interested in pursuing a career in medicine from the undergraduate and high school levels. This allows students an opportunity to gauge if surgery may be a suitable field for them.[6] It also gives them an awareness of what actually will be involved in the day-to-day activities of a surgeon, enabling them to have realistic expectations for their future if they choose to pursue a career in surgery.[7] Realistic expectations could lead a student to commit to a field early, which allows them to explore different pathways to becoming a specialist in that field. The most common path for surgical specialties is the traditional (independent) path, in which a formal residency is completed before a fellowship in the target

n which a residency in the target specialty is completed simultaneously.[8] Some popular integrated programs are for the specialties of cardiothoracic surgery, vascular surgery, and plastic surgery. Additional training can be completed for a person to become a microsurgeon, which is a popular subspecialty among plastic and reconstructive surgeons.

Academic microsurgery is a highly competitive surgical subspecialty that is typically introduced to medical students during their plastic surgery rotations through observation – not participation – with formal training beginning at residency. Microsurgery is a crucial skill set for a well-rounded reconstructive surgeon and an increasing number of surgical fields – such as vascular and ear, nose and throat – though there is limited exposure prior to residency and a lack of standardized curriculum. It has been demonstrated recently that new medical students are capable of learning microsurgical techniques and that such an experience influenced their career trajectory toward specialties that include microsurgery.[9,10]

Diversity in Training Practices

An added benefit to providing early, hands-on exposure to microsurgery is the potential to influence a more diverse population. As evidenced by numerous studies, applicant pools for many medical specialties, including plastic surgery, have a less diverse applicant pool concerning gender and race when compared to medical school demographics.[2,11,12] Early premedical exposure to surgery directed explicitly at women without prior exposure to surgery was shown to directly affirm their decision to attend medical school and positively influenced their interest in pursuing a surgical career.[4] Newly admitted medical students who received hands-on training in surgical skills were more confident in their ability to become a surgeon and viewed the field of surgery more positively.[13,14] Early exposure to specialty training can provide positive experiences with potential role models and an improved understanding of key skills, roles, and responsibilities required for a career in academic medicine.[15] Mentorship relationships can be established at this point, providing premedical students with a positive role model who can offer professional guidance and advice.[16] Early mentorship can be used strategically to help increase the level of diversity within the surgical field.[6,17-19]

Establishing a Curriculum

One way to increase the general level of interest in microsurgery is to have a microsurgical curriculum available at medical schools, as an established curriculum provides an opportunity that was previously unavailable for medical students.[20] Proficiency in microsurgical procedures within the operating room would require the completion of a surgical residency, but due to the importance of acquiring and maintaining a microsurgical skillset, medical students – especially those pursuing surgical specialties – may benefit from earlier exposure. This would likely increase the number of medical students interested in microsurgery, as observed in a comparative study between surgical residents who had completed microsurgical cases during at least 1 rotation and medical students undergoing microsurgery training.[10] The medical students within the study showed more engagement in the microsurgical training than the surgical residents. This may be because medical students often have more free time and a less routine schedule than surgeons.[10] This level of engagement and free time is more extensive among premedical undergraduate students, more specifically, students who are pursuing careers as physicians but are not yet in medical school. Medical schools may leverage a student's premedical years to expose more diverse cohorts of students open to the exploration of different career paths, including within the medical field.

Microsurgery training for premedical undergraduate students and medical students is an effective way to increase students' level of interest in joining a surgical field that involves and requires the expertise of microsurgery since it gives the students direct, hands-on experience. Additionally, a student's completion of a surgical skills workshop before obtaining their medical degree has been shown to increase the student's confidence level and competence in surgical skills.[9,14] Even if a student chooses not to pursue a career involving microsurgery in the future, that student may be more likely to choose a specialty that involves surgery or procedural and hands-on skills more generally, which is beneficial as surgery is a realm that still struggles with diversification in terms of gender and race/ethnicity.[21] Early mentorship, at the high school or undergraduate levels, is a method that many institutions are leaning toward to increase the diversity within certain fields, including surgical fields.[19,22]

The objectives of this case study were to retrospectively review how exposure to basic microsurgical concepts and techniques increased the student's level of interest in pursuing a surgical career involving microsurgery in the future. We sought to: (1) report the capacity of a premedical student with no prior knowledge of the field of microsurgery to learn basic microsurgical techniques, and (2) to explore the impact of early exposure to a microsurgical curriculum on medical career interests.

METHODS

This case study consisted of a single, visiting premedical student (MF) paired with a microsurgical mentor/educator (WZ) during summer 2022 as part of an internship funded by the Doris Duke Charitable Foundation (grant #2020221). Data reported in this manuscript were collected as standard operating procedure for this training. The manuscript was conceived after the fact by lead author (MF) and supported by the senior author (AD). Following communications with our institutional ethics committee, it was determined that review/approval was not needed for this study as learning experience was not designed to develop generalized

knowledge and there was no systematic investigation, only information collected as per usual for training purposes.

Microsurgical training took place for 3 hours twice a week over 6 weeks. The training program was based on a series of 15 lessons from a previously established training program for integrated surgical residents. The materials were altered in accordance with grant requirements. Synthetic vessels were used in place of animal products. The premedical student completed one-on-one microsurgical training with a microsurgical educator.[20] Techniques were guided by the free microsurgery education website (https://microsurgeryeducation.org/) and consisted of naming and proper use of microsurgical instruments; management of the microscope; placement of sutures; manipulation of the needle; placement and manipulation of a stitch on the glove and sponge model; tying a knot on glove and sponge model; handling a synthetic vessel; placing a stitch on a synthetic vessel; tying a knot on a synthetic vessel; completing end-to-end anastomosis using two-stay method on 1-mm, 2-mm, and 3-mm synthetic vessels; completing an anastomosis using the back-wall-first anastomosis technique on 1-mm, 2-mm, and 3-mm synthetic vessels; and overall hand dexterity.

Lesson Plans

Lesson 1 focused on the management of the microscope and instrument used for microsurgery, as well as the acquisition of basic microsurgical techniques, including how to tie a square knot and a surgeon's knot. Lesson 2 focused on proper needle and suture management and a non-crossing knot-tying technique. Lesson 3 focused on learning to use the two-stay method to perform an end-to-end anastomosis on a biomedical synthetic vessel. Lesson 4 focused on using the back-wall-first method to complete an end-to-end anastomosis. (Beginning here the lessons deviated from the original online curriculum, substituting animal tissues for synthetic vessels to follow the guidelines set by the grant). Lesson 5 focused on performing anastomoses on decreasingly small synthetic vessels (3 mm, 2 mm, and 1 mm).

Evaluation

The microsurgical educator was present to assist, observe, and evaluate the student's progress in real time. Each session was recorded. The microscope was connected to a camera, so the microsurgical educator could record the student's technique, which enabled comparison of the technique and monitorization of the student's progress throughout the training period. The microsurgical educator used the videos to evaluate the student's timing and proficiency, with direct comparison to the microsurgical educator's time and proficiency. The student was evaluated using a Likert scale based on surveys of knowledge and confidence level before and after training (see Appendix).

RESULTS

Over the 6-week period, the premedical student achieved the microsurgery level equivalent of a third-year surgical resident undertaking the same training at our institution. The student completed an anastomosis using both the traditional approach, where the sides of the vessels are connected first, as well as the back-wall-first method (Figures 1 and 2). All anastomoses were patent as demonstrated by perfusion of blue dye in water with no through-stitch catching the back-wall or obvious leaking.

Figure 1. Image of 3-mm Vessel After Student's Traditional Anastomosis Approach

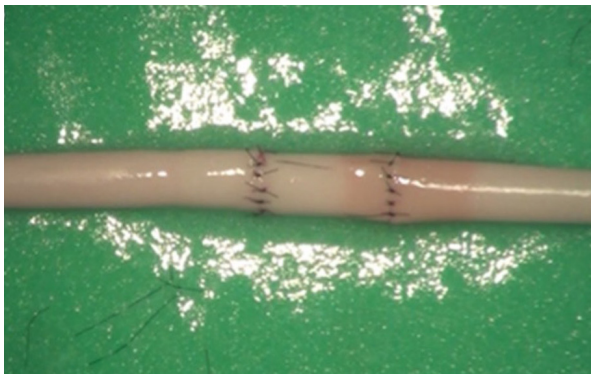


Figure 2. Image of 1-mm, 2-mm and 3-mm (top to bottom) Vessels Following the Student's Back Wall First Method of Anastomosis

The student's timing for different skills decreased over time, while their confidence level for each skill increased over time. Their time for tying 3 knots decreased from 2 minutes 32 seconds during their first attempt to 19 seconds, which is only 3 seconds longer than the instructor's best time (Figure 3).

The student's time for an end-to-end anastomosis started at 46 minutes and 32 seconds and decreased to 41 minutes and 24 seconds (Figure 3). Confidence levels demonstrated an inverse relationship to time, increasing confidence after each lesson (Figure 3).

DISCUSSION

Many factors contribute to a student deciding to pursue a specific career, especially in medicine. The premedical student in

this study was already intent on pursuing medical school with an interest in surgery but was unaware of microsurgery before starting the microsurgical course. Receiving hands-on experience within the program led the student consider pursuing a career in microsurgery. Over the 6-week period, the student was able to learn about and become proficient in several critical microsurgical skills (Figures 1-3). This, in turn, improved the student's confidence with each lesson and was recorded to have had a direct impact on their career path (Figure 4). Additionally, the student appreciated that they could go through the same training as a surgical resident at our institution and develop similar skills, though some aspects of the training were altered in accordance with the specific funding requirements. The student was able to get a genuine feel for what is required to succeed within this field.

The student noted that though they were successful with the microsurgery training, that does not guarantee that others will mirror the same enjoyment or success in microsurgery training. Both positive and negative experiences in microsurgery—or any specialty—may help adjust one's career trajectory prior to medical school or residency training.[9,10]

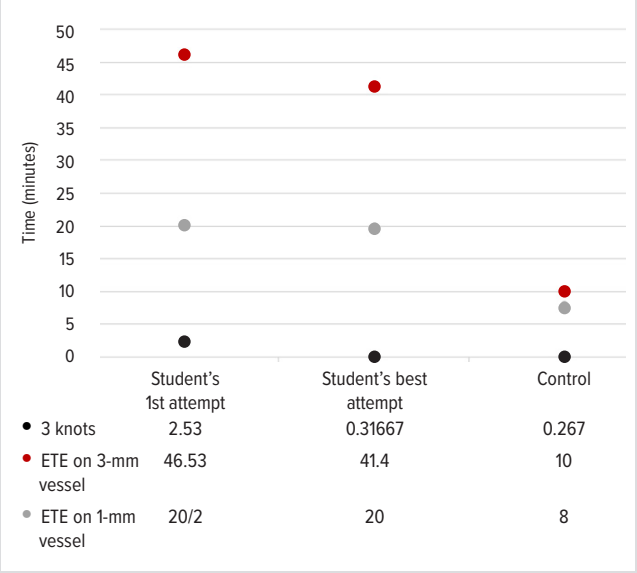
One study displayed a correlation between microsurgical course performance and surgical career paths, with interns and junior residents who performed poorly less likely to pursue surgical residency than those who performed well.[23] If students who do well with the training are more likely to pursue surgical careers, early exposure to specialties like microsurgery may benefit, given the large learning curve with microsurgery.[24] Figure 3 shows how regular practice in microsurgical skills can significantly decrease the amount of time needed to complete a specific microsurgical skill, despite no prior knowledge or experience with surgery. The student's best time to complete specific microsurgical skills was comparable to that of the microsurgical educator, which also has been displayed in another study.[10]

Early exposure to surgery is important because even if the student does not enjoy their experience, they would be free to explore other career options before mentally and professionally committing to becoming a surgeon. But if a student enjoys their experience, they will have opportunities to arrive at their desired career in a shorter time period through an integrated pathway, which can save a year or two versus traditional pathways to arrive at the same career.[8]

Studies already have confirmed that medical students and interns are capable of excelling in microsurgery training,[9,10] but since this training is not extended to premedical students, much has not been studied on the microsurgical capabilities of premedical students and the long-term professional impact of early microsurgical training. This case study exemplifies that microsurgery is a great hands-on experience for premedical students that could encourage more students to consider a career in microsurgery as its stature as a subspecialty becomes visible. The acquisition of microsurgical skills has been hypothesized to benefit most surgical residents since these skills could lead to better control of surgical instruments and the ability to handle tissues on the macroscopic level more gently.[9]

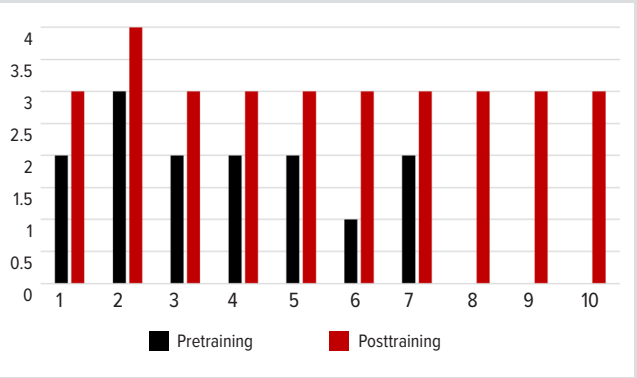
Experiences similar to this also could help address disparities in health care if these opportunities are open to and directly targeted to students within underrepresented populations in medicine.[25] The student in this case study, who identifies as an individual with

Figure 3. Premedical Student's Time Taken to Complete Different Skills



Abbreviation: ETE, end-to-end.
Time taken to complete different skills: tying 3 knots (black), ETE anastomosis on a 3-mm synthetic vessel (red), and ETE anastomosis on a 1-mm synthetic vessel (gray). The student's first time and best time are compared to their microsurgical educator's time (control).

Figure 4. Confidence Level for Milestones: Lesson 3



Student's reported confidence level before and after completion of the following tasks: (1) instrument naming and use, (2) methods of managing microscope, (3) use of sutures and needles, (4) manipulation of needle, (5) placing stitch on glove and sponge model, (6) manipulating sutures on glove and sponge model, (7) tying knot on glove and sponge model, (8) handling synthetic vessel, (9) placing stitch on synthetic vessel, (10) tying a knot on synthetic vessel. Black bars = pretraining confidence (no black bar = 0 confidence), red bars = posttraining confidence.

a background historically underrepresented in medicine, stated that their early, hands-on training in a medical specialty reaffirmed their commitment to becoming a doctor. The student was interested specifically in joining the surgical field due to their increased level of confidence in surgical and procedural skills following their microsurgical training (Figure 4). Early medical students who had taken an introductory surgical skills course acquired basic surgical skills, had an increased level of interest in becoming a surgeon, and increased confidence in their technical abilities.[13,14] If more students from underrepresented populations were given opportunities to complete basic surgical skills, it would likely lead to more individuals within underrepresented communities becoming surgeons.[21] This idea also can be applied to attracting more women to the surgical field—especially through programs directly involving female surgeons.[4] When used in combination with each other, medical schools may be able to attract a larger number of non-White females to their surgical programs since members of this demographic are currently considered rare in the surgical realm.[17] This could slowly improve the demographics of surgeons to better mirror and represent the general population in the United States, which, in turn, could lead to improved health care outcomes due to better patient-clinician communication, since being a part of a historically underrepresented group is associated with poor patient-clinician communication.

The undergraduate student also built a mentorship relationship with their microsurgical educator, which provided the student continuous opportunities to ask questions about the field, a source of professional advice and encouragement, and a good role model. The importance of a committed mentor with a passion for their job cannot be understated. A successful mentor can establish a connection with their mentee built on the foundations of trust, mutual respect, clear communication, established boundaries, and shared interests and values.[16] Mentorship during the undergraduate years is also a way to increase diversity in medicine, specifically in the field of surgery—especially if the mentor and mentee are of the same gender or ethnic/racial background, since that has been shown to improve motivation among mentees.[6,17-19]

CONCLUSIONS

Medical knowledge is not a necessity before starting microsurgery training. Early, hands-on exposure is motivating as it makes the career less intimidating and more achievable. This training introduced and exposed the primary author to the field of microsurgery and encouraged them to pursue a career in this field or another surgical subspecialty. Given the measurable success in microsurgical skill acquisition and positive feedback from the primary author on this course, we intend to provide microsurgery workshops for future Doris Duke Scholarship undergraduate students attending our institution. We hope that moving forward, this course becomes highly valued by our students and is implementable at other institutions as a means of enhancing the visibility, accessibility, and the reality of careers in surgery and microsurgery for undergraduates, particularly those historically underrepresented in medicine.

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Appendix: Available at www.wmjonline.org.

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