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Education

Microsurgical Practice with Use of Smartphone Camera as the Microscopic Field

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Summary: Accessibility of microsurgical equipment is a major barrier to proper training of surgeons before live patient free flap surgery. A technique is presented that uses a smartphone camera as the microscopic field, eliminating the need for an expensive operative microscope for surgical practice. A convenient and cost-effective simulation protocol could reduce the time frame of the microsurgery learning curve. Furthermore, the use of the smartphone video function may allow improved feedback by mentors, improving access and communication between microsurgical teachers and learners. The PocketSuture smartphone stand is a commercially available device that allows the smartphone camera to be used as magnification. The proposed education protocol included suture practice, vessel dissection, and free tissue transfer in nonliving animal models, with vessel anastomosis and patency confirmation performed with a smartphone camera for field magnification. Video of the suturing technique allowed feedback from the mentor. A progressive suturing protocol leading to the ability to perform microsurgical anastomosis on nonliving animal models was developed. The basic costs for the stand, instrument set and suture were less than $500. The PocketSuture smartphone stand can be used for microsurgical training with real-time video for plastic surgery learners with limited access to microscopes and local mentors. *(Plast Reconstr Surg Glob Open 2024; 12:e5651; doi: 10.1097/GOX.0000000000005651; Published online 1 March 2024.)*

INTRODUCTION

Access to plastic surgery education and mentorship is not universal. According to the Liaison Committee on Medical Education and the American Council on Graduate Medical Education websites,[1,2] there are a total of 197 medical schools. There are 157 traditional allopathic medical schools and 40 osteopathic medical schools. In terms of plastic surgery programs, 89 integrated plastic surgery programs are accredited, whereas another 47 programs are independent. However, 29 institutions have both integrated and independent programs. Only 107 (54.3%) of 197 individual medical schools have plastic surgery residency programs. Many potential plastic surgery learners are without home programs.

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Early development of technical skills is desirable in plastic surgery learners. Microsurgery is a core skill learned by plastic surgeons. Microsurgical practice is now possible in any location and with limited inexpensive resources. The PocketSuture smartphone stand is a practical, commercially available device that allows a smartphone camera to be used as the microscopic field. By eliminating the need for an expensive training microscope or affiliation with a home plastic surgery program, accessibility to microsurgical training is increased, allowing medical students and residents to become involved in practice of microsurgical skills earlier and more consistently. Although events like organized suture laboratories and cadaver laboratories are extremely beneficial and necessary for surgeons before live surgery, they do not happen frequently enough to master microsurgical skills. The ability to easily film and send to mentors allows for convenient feedback.

MICROSURGICAL SKILLS

After development of basic surgical skills and vascular anastomotic skills, microsurgical skills can be developed

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with use of a magnified field and microsurgical instruments such as Castroviejo needle holders, jeweler's forceps, and small caliber sutures such as 8-0 nylon. Initially, microsurgical skills were developed using Silastic vessels ranging from 2 to 3 mm in diameter for end-to-end anastomosis and one-way-up techniques. To further expand on these skills, mismatched vessel sizes were also used to create anastomoses between 2 and 3 mm diameters. After development of microvascular skills on synthetic vessels, the final step of our protocol expanded on previously described nonliving animal models, which involve vessel dissection, preparation, and microvascular anastomosis[3] to also include free tissue transfer and patency confirmation using a smartphone camera as the microscopic field. [**See Video 1 (online)**, which displays end-to-end anastomosis using 3-mm diameter Silastic vessels and 8-0 nylon; performed by a senior medical student.]

The next progression in the development of microsurgical skills involved applying these concepts learned on synthetic vessels to a higher fidelity model. We developed a protocol that involves flap and vessel dissection, vessel preparation, free tissue transfer, microvascular anastomosis, and patency confirmation on nonliving animal models, mainly pig trotters, turkey wings, and turkey thighs. [**See Video 2 (online)**, which displays end-to-side anastomosis on a pig trotter using 8-0 Ethilon. Anastomosis performed by senior medical student using PocketSuture and smartphone camera.] [**See Video 3 (online)**, which displays patency confirmation of end-to-end anastomosis using angiocath and blue food coloring.]

Materials used for microsurgery practice include the PocketSuture smartphone stand ($189); a microsurgical instrument set (including needle driver, jeweler's forceps, and microsurgical scissors; $9-180; AliExpress microsurgical set $9.38); sutures (8-0 nylon; $40/box); and a smartphone camera [Apple iPhone (Apple Inc, Cupertino, Calif.) with dual 12MP camera system, 2532×1170 pixel resolution at 460 ppi] typically used at 2.5–3× magnification. This essentially means students are able to create their own microsurgical laboratory in their home for less than $500, compared with surgical training microscopes that average around $2500 and require access to a skills laboratory.[4] However, it is important to note that not all smartphones are the same and that image quality and magnification may vary between phone types.

DISCUSSION

Studies have been conducted comparing outcomes between interval and massed microsurgical training. In a study by Schoeff et al,[5] residents were stratified in groups of interval and massed microsurgical training and compared by blinded evaluators using pre- and posttraining graded assessment tools. Overall, interval training groups showed statistically significant improvement in early development of microsurgical anastomotic skills, whereas the mass training group did not.[4] There is evidence that self-directed learning may benefit microsurgical skills and improve confidence and competence.[5,6] A commercially available product and smartphone camera provides an avenue for medical students and residents to consistently practice and develop their own interval training regimen. However, massed microsurgical training such as directed cadaver laboratories and flap courses may serve as a supplement to personalized interval training programs for students and residents. Although there are key benefits of student-centered learning, such as increased responsibility and accountability on the part of the student and the deep understanding that comes from first-hand personal experience and direct involvement, the role of mentorship and interdependence between the teacher and student becomes even more important.[7] Student-driven learning allows medical students to actively participate in the discovery of new learning processes from a more autonomous vantage, but strong mentorship is necessary to ensure these processes are done well and accurately to prevent perpetuation of bad habits or incorrect techniques.

This student-centered learning should serve the purpose of making medical students more aware of what they are doing and why they are doing it. The student may be more active in acquiring knowledge and skills and seek to look beyond the immediate course requirements at the bigger picture of how this learning might make them a better doctor or surgeon.[8,9] In reflection, Hassan reported that student-centered learning promotes stimulation of deep learning and assimilation of core knowledge.[7] However, an important consideration for student-centered learning is the unique differences between each student. Students are therefore able to focus on their own strengths and weaknesses and tailor their own curriculum to address these. This is typically lacking in a mass surgical training setting because consideration must be given to the whole group without taking into account individual differences.

Takeaways

Question: This protocol aims to increase accessibility of microsurgical practice to young aspiring surgeons.

Findings: Medical students were able to develop microsurgical skills through progressive skill progression.

Meaning: With this protocol, medical students may be able to achieve higher technical skill than previously thought and demonstrate dedication to the field with the avenue to consistently practice.

CONCLUSIONS

Motivated learners may be able to achieve and maintain a higher level of technical skill than previously believed, due to the ability to practice consistently and at their own pace with extra consideration for their own weaknesses. The PocketSuture phone stand is a device that allows sophisticated microsurgical practice using a smartphone camera as the operative field. Instructional support from experienced mentors to promote correct technical skill and good habits is possible in an efficient manner.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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