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Education

Intraoperative "Spare Parts": A Novel High-fidelity Suturing Model for Trainees

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Summary: Many models exist to help the medical student learn how to suture at a competency level required to progress to suturing on patients. However, these models do not readily simulate the qualities of live human tissue. We propose a simple intraoperative high-fidelity model that places the excised autologous patient tissue (eg, panniculectomy and breast reduction) on a sterile side table to allow the trainee to practice their skills alongside the staff surgeon on comparable tissue for the remainder of the case. We believe that the adoption of this practice allows a unique opportunity for medical students to advance their suturing techniques in a low-stress environment with staff surgeon guidance, further preparing them to perform high-quality closures on live patients. *(Plast Reconstr Surg Glob Open 2022;10:e4628; doi: 10.1097/GOX.0000000000004628; Published online 1 November 2022.)*

INTRODUCTION

Suturing is a necessary skill as a physician, irrespective of their chosen specialization.[1] Learning this skill begins at the medical student stage; however, traditional teaching techniques may not adequately prepare the students for real-life closures.[2,3] Further experience requires the student's own initiative, via peer mentorship or participation in interest groups or skill workshops. Often, the first exposure to suturing human tissue is on real patients, a high-stress environment. As well, suturing on patients requires a baseline level of competence and familiarity of the staff surgeon with the student's skills—which is challenging in a team-based elective model where students rotate among many staff surgeons—and often only permits limited suturing practice due to time constraints.[4]

ACQUISITION OF SKILLS

Medical students acquire the ability to suture and handle tissue with a mixture of didactic training from peers, as well as practical hands-on training by utilizing a variety of models that differ in fidelity, or realism.[4] Inanimate bench models that include organic mediums, such as fruits, and synthetic materials, such as silicone suture pads and sponges, have been used. Ex-vivo animal models, such as porcine tissue, have also been used in these bench models. Some of the highest fidelity models have been cadaveric tissue. All of these models and modes of training differ in many important parameters when compared with human tissue. Variables such as the density, elasticity, rigidity, viscosity, and shear strength of the medium will all be affected by virtue of not being actual human tissue.[2] Each model has its own limitations, highlighted in Table 1. Gonzalez-Navaro et al[2] evaluated different suturing models on basic surgical skill acquisition in trainees by analyzing their perceptions on the characteristics of the models. Evaluation of the suturing models according to criteria such as ease of handling and resistance/durability of the medium found statistically significant differences between all models. This highlights the variability of the models available to trainees. One model that has not been described in the literature, yet is readily utilized at our institution is the intraoperative use of excised autologous patient tissue as an ex-situ model. The only model that may approximate this method is the use of frozen-thawed abdominal flap remnants, described by Song et al.[5]

INTRAOPERATIVE AUTOLOGOUS EX-SITU MODEL

Surgical procedures involving the excision of large pieces of benign tissue, such as abdominoplasty, panniculectomy, and breast reduction, are ideal for this model. The excised tissue is set aside during the operation on a sterile side table, replete with the surgical tools and sutures needed to incise the skin and perform closures (Fig. 1). While the staff surgeon completes the case on the actual patient, the trainee works on the side table practicing their suturing on human tissue (Fig. 2). Using the patient's own tissue immediately after excision poses no harm to the

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Fig. 1. Setup for suturing model: calpel, needle driver, and blade visible. Type of suture provided at surgeon's discretion.

patient, requires minimal time commitment from the staff surgeon to set up for the trainee, allows immediate expert feedback, and is a low-stress environment that allows ample time to slowly practice meticulous closure. This model affords continual progression of the trainee's skills, as it can be utilized any time there is excised tissue as opposed to using other models at infrequent club events throughout the year or at home with no instruction on a low-fidelity model. In fact, distributed learning has been shown to be superior to massed learning in terms of surgical skill acquisition.[6] As the student progresses, more advanced suturing techniques can be acquired, along with other skills, such as gaining a deeper understanding of local flaps. Minimal material is wasted, as the student uses the same materials they would use if allowed to suture on the live patient. This model is only used for benign tissue, utilizing skin only. No tissue is grossly altered, and everything is sent to pathology. Finally, as per standard hospital consent, patients are aware of the involvement of trainees in their care, and the use of this model actually serves to minimize the trainee's direct involvement in the patient's operation.

Unlike most of the other models described above, which attempt to replicate the qualities of human tissue, this "spare parts" method is a high-fidelity model that allows the duplication of most human tissue qualities. The haptics or tactile feedback the trainee experiences while passing a needle through the ex-situ tissue is almost exactly that experienced by the staff surgeon with the in-situ tissue. Blau et al[7] suggest that through formal instruction in suturing skills by trained teachers, a student's confidence with their abilities improves. Importantly, the results of

Takeaways

Question: How can medical students achieve a level of competence in suturing skill to be readily offered the opportunities to assist closures intraoperatively?.

Findings: Autologous tissue excised from patients intraoperatively can be set aside on a table as a high-fidelity suturing model for medical students to practice closure on.

Meaning: Using excised autologous tissue intraoperatively to practice suturing will likely increase confidence and competency levels in students due to the ease of setup as well as the availability of staff surgeons to offer guided teaching.

their study and many others emphasize that the fidelity of the medium used to train students on suturing does not influence overall performance.[1,2,7,8] However, the highest fidelity model used in these studies was cadaveric tissue, a model that is of lower fidelity than ex-situ tissue. It is conceivable with this higher fidelity model, with the frequency and duration of practice it can provide, that improvement would be seen in overall performance. Other benefits of the model include the opportunity to practice incisions, as well as local flap planning and execution (eg, Z-plasty and transposition flaps), all without the stress of direct

Fig. 2. Resident and attending surgeon working on patient's (blurred) abdominal closure following completion of a unilateral DIEP flap, as the two medical students practice their suturing skills on a sterile side table using the extra abdominal tissue. DIEP indicates deep inferior epigastric perforators.

Table 1. Benefits and Limitations of Conventional Models and the Proposed Intraoperative Model

Model Evaluation	Fresh Human Cadavers, Live Animals, and Bench Models Utilizing Ex-vivo Animal Tissue	Low-fidelity Bench Models (Silicone Suture Pads and Foam)	Intraoperative Autologous Ex-situ Model
Benefits	Closer to approximating human tissue[4]	Portability, more affordable, potential for repetitive usage,[1] avoids infectious, ethical, and availability issues seen with higher fidelity models	Near duplication of human tissue qualities, availability, minimal to no increased cost to system or impact on operative time
Limitations	Higher costs, possibility of infectious transmission, limited availability or access to specialized facilities, and ethical concerns[1,4]	Lack of human tissue approximation[1,4]	Case and staff dependency (supply of spare parts), setup and instruction time, and more resources (extra scalpels and sutures)

observation and a live patient. Finally, use of this model has minimal impact on operative time as the setup is quick and is offset by limiting trainee involvement on the live patient, minimizing the time needed to correct any errors. The benefits and limitations of this model are illustrated in Table 1. A future survey of end users could be valuable to gather feedback surrounding the model's implementation.

CONCLUSIONS

This is the first description of an intraoperative high-fidelity suturing model that can be easily reproduced at other centers. We believe that this model of ex-situ human tissue is of a quality and fidelity unmatched by synthetic, animal, or food analogues. We encourage dissemination of this idea to prepare medical students more readily for their clinical rotations, residencies, and future careers. In doing so, we might expect increased competency and confidence in suturing by the students.

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