DEVELOPMENT OF A VERSATILE, ADAPTABLE AND MULTIFUNCTIONAL SURGICAL TRAINING MODEL

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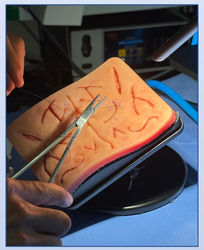
Introduction

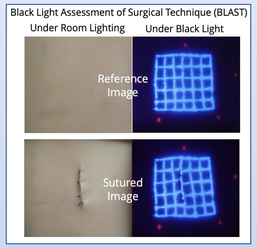
Simulation-based training has been proven to be effective at reducing complications and improving patient outcomes through focused and deliberate training. However, many current training models being rigid, usually cover only one task, often lacking the adaptability, realism, and effective feedback necessary to fully optimize the learners' performance, skill acquisition and development.



Design Materials & Procedure

We designed and developed this surgical training model, with the use of SolidWorks 3D CAD software. The initial build was 3D printed, enabling us to gather valuable feedback from early trials before refining it into a sturdy version of it. This training model consists of a metallic, articulated base with a metallic flexible arm incorporating two ball sockets joints, thereby delivering six degrees of freedom while supporting and accommodating two different interchangeable frame tops (one flat and one wavelike). The final training model platform integrates seamlessly with major simulation training platforms, thereby making it easy to adapt and be used across diverse training environments and different educational scenarios and settings.

A unique suture pad was also designed and created along with the model that could be used alone or conjunction with it. It was made in a way that it would be able to replicate tissue properties. It was build using multiple layers of silicone with varying densities and colors, to closely mimic tissue texture and resistance. To enrich the training experience of the learners, distinct suture patterns of different depths and designs (straight lines, curves, zig-zag, elliptical, S-shaped, and ridges) were engraved on the surface of suture pad. Two meshes were also embedded between the different silicone layers which further simulate underlying tissues as well as the structural complexity of the suture pad. Finally, we incorporated an innovative technique for evaluation, utilizing a hidden fluorescent grid layout (BLAST) that becomes visible under black light, thereby enabling objective assessment of suturing performance.



[1] Sweet, Robert M, "The CREST Simulation Development Process: Training the Next Generation." Journal of Endourology, vol. 31, no. S1, 2027, pp. S69-S75. Liebert Publishing, doi:10.1089/end.2016.0613

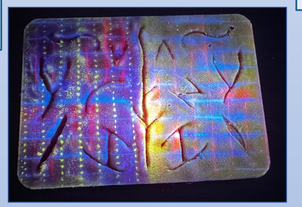
Results

Our surgical training model proved exceptional versatility, effortlessly adapting to a range of simulation scenarios and simulator environments that it was tested, while delivering outstanding usability. Both novice learners, who appreciated its intuitive design and forgiving feedback during initial attempts at needle handling and basic suturing, as well as experienced surgeons, who valued the nuanced adjustability for refining advanced knot-tying techniques under realistic angles and tensions, reported consistently high satisfaction. This broad appeal underscores the model's potential to enhance procedural training programs effectively across diverse educational settings.

Objectives

Our goal was to design, construct and eventually evaluate a new highly versatile surgical training model tailored for today's demanding educational needs. We aimed to achieve the following:

1. **Core Skills Training**: Master essential techniques like needle handling, suturing, and knot tying through realistic, hands-on practice.
2. **All-Level Adaptability**: Seamlessly accommodate learners from absolute beginners to advanced practitioners with scalable challenges.
3. **Flexible Adjustments**: Provide intuitive controls for angle, tilt, direction, and positioning to mimic diverse surgical scenarios.
4. **Portable & Compatible**: Offer standalone portability or easy integration with open tabletop, laparoscopic box trainers, and robotic dome simulators.
5. **Comprehensive Application**: Enable effective training, teaching, and objective assessment of needle driving, suturing, and knot-tying skills.
6. **Affordable Construction**: Build from everyday commercially available materials and at a minimal cost for broad accessibility and scalability.



Conclusions

This practical, multifunctional training model can be used by surgeons at every skill level, from wide-eyed novices to battle-tested experts, and spans across various surgical specialties with ease. It delivers hands-on skill development in open, laparoscopic, and robotic training techniques, giving trainees the opportunity to practice and build confidence and precision.

Best of all, it's affordable, able to be manufactured from commercially available materials while offering the kind of versatility that makes it perfect for widespread adoption in different training programs and diverse settings.

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