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Validating the Efficacy of a Stepwise Video Module for Conjunctival Closure

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Abstract

Objective The aim of this study is to describe a cost-effective and portable surgical training module for ophthalmology trainees and demonstrate its effectiveness in building confidence and reducing stress with conjunctival closure.

Methods A total of 29 trainees (fourth year medical students, postgraduate year (PGY) 1 ophthalmology residents, PGY2 ophthalmology residents) participated in the module during July 2022. They completed a Pre-Module and Post-Module Questionnaire, with some questions assessing their confidence level and other questions assessing their stress level with conjunctival closure. A Likert scale of 1 to 10 was used to evaluate their level of confidence or stress (with 1 indicating low confidence or low stress and 10 indicating high confidence or high stress).

Results Prior to completing the module, participants had an average conjunctival suturing skills confidence level score of 2.6 ± 1.6, which increased significantly to 5.6 ± 1.6 after completing the module ($p < 0.001$). Participant's stress level score with performing conjunctival closure on live patients significantly decreased from 7.5 ± 2.4 to 5.6 ± 1.5 ($p < 0.001$) after completion of the module. When participants were separated into two groups, participants in the PGY1 residents/medical students group had an average conjunctival suturing skills confidence level score of 2.7 ± 1.8, which rose significantly to 5.1 ± 1.5 after completing the module ($p = 0.008$), whereas PGY2 residents had an average conjunctival suturing skills confidence level score of 2.6 ± 1.6, which rose significantly to 5.8 ± 1.7 after completing the module ($p < 0.001$). Participant's stress level scores with performing conjunctival closure on live patients did not show significant results in the PGY1 residents/medical students group but significantly decreased from 7.2 ± 2.2 to 5.2 ± 1.3 ($p < 0.001$) in PGY2 residents. Participants agreed that the video presented was effective for learning the surgical skill and that the module was engaging and prepared them well to learn more advanced conjunctival suturing techniques.

Conclusion Our surgical training module is an effective teaching tool for ophthalmology trainees to increase confidence and decrease stress about performing conjunctiva closure. It provides an opportunity for trainees to repetitively practice key surgical techniques on an inexpensive and reusable training model.

Keywords

- COVID-19
- ophthalmology surgical education
- conjunctival closure
- video-based curriculum
- stepwise teaching method
- virtual resident education

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Conjunctival closure is an important step of many ophthalmic surgeries and is typically one of the initial surgical steps performed by ophthalmology residents during strabismus surgery. The conjunctiva is reflected at the beginning of strabismus surgery to expose the sclera and extraocular muscles and must be reapproximated to its original position at the end of the case.[1] Conjunctival suturing is also performed in retina, glaucoma, and globe trauma repair surgeries. Building a foundation of this skill is critical to success for the ophthalmology resident.

Dexterity and proficiency with basic surgical technique are fundamental skills needed to be a competent and successful surgeon.[2] Practicing suturing technique in the nonclinical setting has been shown to build confidence in trainees by learning in a less stressful environment.[3] Traditionally, residents have utilized the wet laboratory to improve their technique during their training.[4] In the midst of the coronavirus disease (COVID) era, new strategies to allow for surgical practice while adhering to social distancing guidelines were needed. We developed a module for ophthalmology trainees to practice placing interrupted sutures and replicate skills necessary for conjunctival closure in surgery. The module is a low-cost, reusable teaching tool that can be performed at home.

Stepwise teaching interventions, in conjunction with video-based education, have been shown to improve resident preparedness by allowing independent review and mastery of each step before attempting more complex techniques.[5–9] In this module, we constructed a stepwise teaching method to improve the suture technique required for successful conjunctival closure. Our team created a surgical video, utilizing a stepwise approach to teach conjunctival suturing. In a previous study, we had fellowship-trained faculty ophthalmologists review the video and materials to evaluate the suitability of the module.[10] This study validated our training video and model as a teaching tool for conjunctival suturing, but its efficacy in building confidence and reducing stress among trainees needs to be determined.

Methods

Fourth year medical students on a month-long ophthalmology rotation, postgraduate year (PGY) 1 ophthalmology residents, and PGY2 ophthalmology residents at an accredited medical school or residency program were eligible as participants. Participants were recruited from five programs: University of Maryland, Wilmer Eye Institute, Georgetown University, George Washington University, and Kresge Eye Institute. Recruitment was via email, and informed consent was obtained from all study participants. The protocol was approved by the University of Maryland Baltimore Institutional Review Board and determined to be exempt. All participants completed the module during July 2022.

The surgical training module representing conjunctival closure tissue was created using commercially available polyester–spandex (95% polyester, 5% spandex) white fabric that was cut into a $6'' \times 8''$ rectangle. A $5'' \times 7''$ picture frame was dissembled to create the model. The glass insert and cardboard backing were removed, and a $2'' \times 4''$ rectangular shape was cut out (►**Fig. 1A**). The fabric was secured into the frame and three 1″ incisions were created in the fabric (►**Fig. 1B**). Each trainee was provided with a kit that includes the model, instructions, and surgical instruments, including conjunctiva forceps, Westcott 4–5/8″ scissors, Barraquer's curved delicate needle holders with lock, and an 8–0 Vicryl suture with a spatulated needle (►**Fig. 1C**).

Prior to beginning the module, trainees completed a six-item Pre-Module Questionnaire assessing their confidence, stress level, and prior experience with conjunctival closure techniques (see ►**Supplementary Material S1**, Pre-Module and Post-Module Questionnaire; available in the online version). Statements on confidence level about conjunctival suturing, stress level with completing the module, and stress level with performing conjunctival closure on live patients were evaluated for level of confidence/stress on a Likert scale of 1 to 10 (with 1 indicating low confidence/stress and 10 indicating high confidence/stress). They then viewed an instructional video that highlights a surgical case showing interrupted suture technique and a demonstration of suturing on the surgical training module with voice-over explaining the steps to complete each suture. The video can be viewed on YouTube: "Conjunctiva Closure - Interrupted Suture" under the University of Maryland Ophthalmology channel.[11] Trainees were instructed to complete three single interrupted suture closures for each 1″ incision, for a total of nine suture closures. A video of each trainee's hands was recorded while performing the module, and pictures of the completed fabric inserts were taken at the end (►**Fig. 1D**). Once the module was completed, trainees completed a Post-Module Questionnaire assessing the same criteria from the Pre-Module Questionnaire in addition to questions assessing the overall effectiveness of the module using the same Likert scale (see Supplementary Material S1, Pre-Module and Post-Module Questionnaire; available in the online version). The three statements that were paired between the Pre-Module Questionnaire and Post-Module Questionnaire were: (1) "My confidence level about my conjunctival suturing skills; (2) "My stress level with completing this module"; (3) "My stress level about performing conjunctival closure on live patients." Participant responses to these statements prior to and after completing the module were compared.

Results

There were 29 participants in this study: 20 (69%) PGY2 residents, 5 (17%) PGY1 residents, and 4 (14%) fourth year medical students. The mean amount of hands-on participation in surgeries in participants was 26.9 ± 30.5 (range: 0–125). Hands-on participation in surgery was classified as any surgical case (not limited to just ophthalmology cases) in which a participant was scrubbed in and had hands-on involvement. There were eight participants that had sutured conjunctiva in a live surgical setting prior to completing the module. The mean number of live conjunctival closures was 1.9 ± 1.1 (range: 1–4) for these eight trainees. To assess the

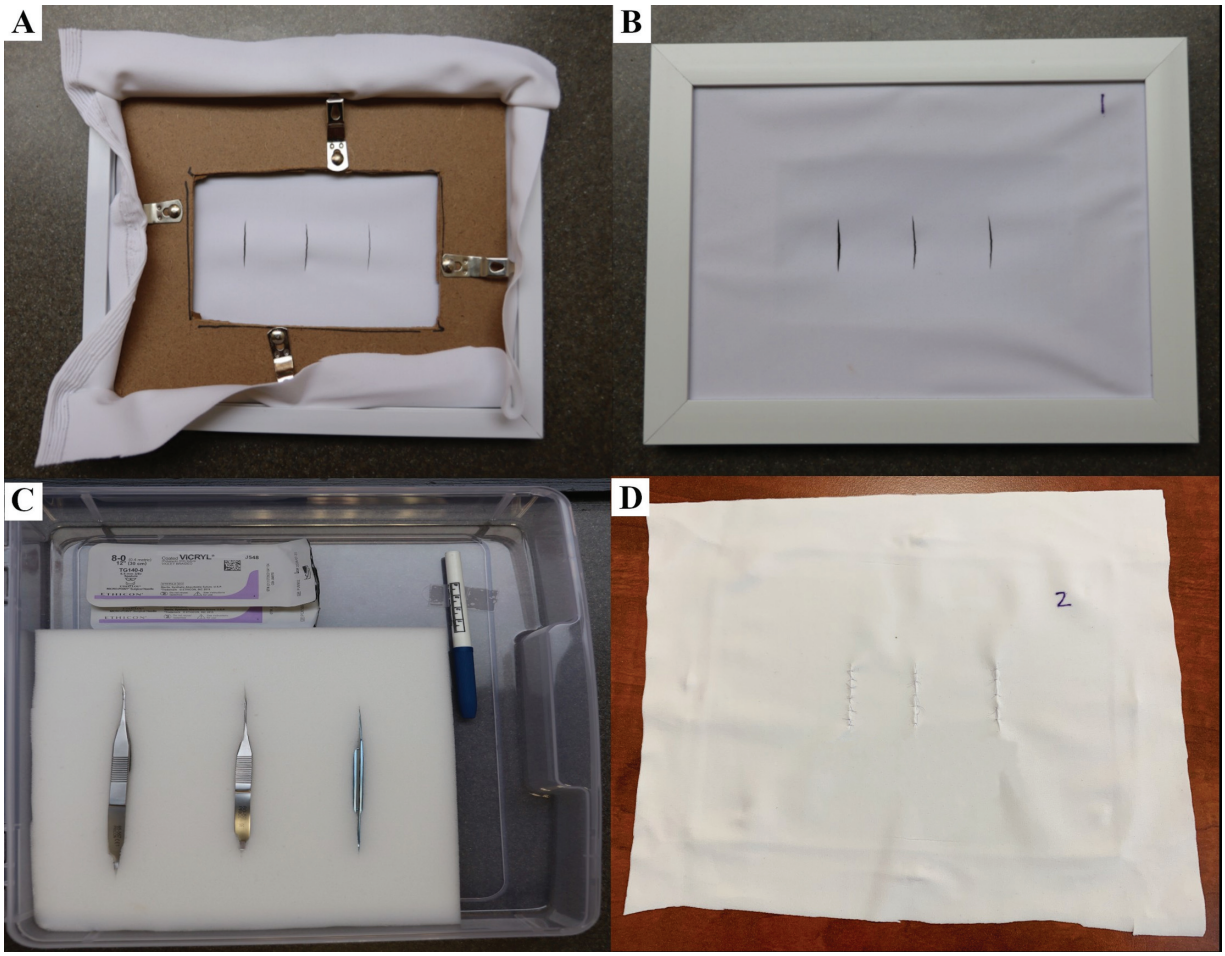

Fig. 1 The back (**A**) and front (**B**) of the model shows the fabric, frame, and three 1-inch incisions. All instruments and supplies were provided in a kit (**C**). Pictures of the completed fabric insert were taken at the end of the module (**D**).

significance between the paired Pre-Module Questionnaire and Post-Module Questionnaire statements, a paired *t*-test was used. ►**Table 1** compares the mean scores of the three paired statements. Prior to completing the module, participants had an average conjunctival suturing skills confidence level score of 2.6 ± 1.6, which rose significantly to 5.6 ± 1.6 after completing the module ($p < 0.001$). Stress level with completing the module did not show significant results. The average stress level score with completing the module was 4.0 ± 2.3 prior to participation, which decreased to 3.7 ± 1.7 after completion ($p = 0.565$). For the third statement, participant's stress level with performing conjunctival closure on live patients significantly decreased from 7.5 ± 2.4 to 5.6 ± 1.5 ($p < 0.001$).

►**Table 2** compares the mean scores of the same three paired statements when participants were separated into two groups: PGY1 residents and fourth year medical students ($n = 9$) versus PGY2 residents ($n = 20$). Prior to

Table 1 Comparing the mean scores of paired Pre-Module Questionnaire and Post-Module Questionnaire statements across all participants ($n = 29$)

Statement	Pre-Module		Post-Module		Paired *t*-test	
	Mean	SD	Mean	SD	*p*-Value	*t*
1. My confidence level about my conjunctival suturing skills	2.6	1.6	5.6	1.6	<0.001[a]	8.62
2. My stress level with completing this module	4.0	2.3	3.7	1.7	0.565	0.583
3. My stress level about performing conjunctival closure on live patients	7.5	2.4	5.6	1.5	<0.001[a]	5.282

Abbreviation: SD, standard deviation.
[a]For *p*-values less than 0.05, the difference between the paired Pre-Module and Post-Module statement was statistically significant.
Statement 1 was scored on a Likert scale of 1 to 10 (1 = least confident, 10 = most confident). Higher numbers correspond to a more favorable score.
Statement 2 and 3 were scored on a Likert scale of 1 to 10 (1 = least stress, 10 = most stress). Lower numbers correspond to a more favorable score.

Table 2 Comparing the mean scores of paired Pre-Module Questionnaire and Post-Module Questionnaire statements between postgraduate year 1 residents and fourth year medical students ($n = 9$) versus PGY2 residents ($n = 20$)

Statement		Pre-Module		Post-Module		Paired *t*-test	
		Mean	SD	Mean	SD	*p*-Value	t
PGY1 residents and fourth year medical students	1. My confidence level about my conjunctival suturing skills	2.7	1.8	5.1	1.5	0.008[a]	3.546
	2. My stress level with completing this module	3.6	2.1	4.4	1.8	0.218	1.357
	3. My stress level about performing conjunctival closure on live patients	8.1	2.8	5.2	1.3	0.077	2.031
PGY2 residents	1. My confidence level about my conjunctival suturing skills	2.6	1.6	5.8	1.7	<0.001[a]	8.166
	2. My stress level with completing this module	4.2	2.4	3.4	1.6	0.143	1.526
	3. My stress level about performing conjunctival closure on live patients	7.2	2.2	5.2	1.3	<0.001[a]	5.119

Abbreviations: PGY, postgraduate year; SD, standard deviation.
Notes: Statement 1 was scored on a Likert scale of 1 to 10 (1 = least confident, 10 = most confident). Higher numbers correspond to a more favorable score.; statements 2 and 3 were scored on a Likert scale of 1 to 10 (1 = least stress, 10 = most stress). Lower numbers correspond to a more favorable score.
[a]For *p*-values less than 0.05, the difference between the paired Pre-Module and Post-Module statement was statistically significant.

completing the module, participants in the PGY1 residents/medical students' group had an average conjunctival suturing skills confidence level score of 2.7 ± 1.8, which rose significantly to 5.1 ± 1.5 after completing the module ($p = 0.008$). PGY2 residents had an average conjunctival suturing skills confidence level score of 2.6 ± 1.6, which rose significantly to 5.8 ± 1.7 after completing the module ($p < 0.001$). Stress level scores with completing the module did not show significant results for both groups. For PGY1 residents and medical students, the average stress level score with completing the module was 3.6 ± 2.1 prior to participation, which increased to 4.4 ± 1.8 after completion ($p = 0.218$). Average stress level score for PGY2 residents with completing the module was 4.2 ± 2.4 prior to participation, which decreased to 3.4 ± 1.6 after completion ($p = 0.143$). For the third statement, participant's stress level scores with performing conjunctival closure on live patients did not show significant results in the PGY1 residents/medical students group. Prior to participation, the average stress level score was 8.1 ± 2.8, which decreased to 5.2 ± 1.3 ($p < 0.077$) after completing the module. On the other hand, the stress level scores with performing conjunctival closure on live patients for PGY2 residents significantly decreased from 7.2 ± 2.2 to 5.2 ± 1.3 ($p < 0.001$).

►**Table 3** summarizes the mean scores of the additional statements in the Post-Module Questionnaire assessing the overall effectiveness of the module. Participants all agreed that the video presented accurately and clearly demonstrated what they were expected to do (8.9 ± 1.1), demonstrated the clinical relevance of the module (8.8 ± 1.6), and decreased their stress about performing the task (8.0 ± 1.9). They also felt that the materials presented for the module matched their preferred style of learning (8.6 ± 1.7) and that they felt prepared to practice the skill following the video and explanation (8.7 ± 1.4). After completion of the module, participants strongly agreed that the module was engaging

Table 3 Mean scores of additional Post-Module Questionnaire statements

Statement	Mean	SD
The video presented accurately and clearly demonstrated what I am expected to do	8.9	1.1
The video presented demonstrated the clinical relevance of this module	8.8	1.6
The video presented decreased my stress about performing this task	8.0	1.9
The materials presented for this module matched my preferred style of learning	8.6	1.7
I feel prepared to practice this skill following the video and explanation	8.7	1.4
Overall, this module was engaging	9.2	1.1
My overall learning experience and satisfaction with this wet laboratory was great	8.8	1.4
The module provided an appropriate balance between instruction and practice	8.7	1.4
After this course, I feel prepared to learn more advanced conjunctival suturing techniques	8.4	1.4

Abbreviation: SD, standard deviation.
Note: Statements were scored on a Likert scale of 1 to 10 (1 = strongly disagree, 10 = strongly agree). Higher numbers correspond to a more favorable score.

(9.2 ± 1.1) and agreed that their overall learning experience and satisfaction with the wet laboratory was great (8.8 ± 1.4). They believed that the module provided an appropriate balance between instruction and practice (8.7 ± 1.4) and reported that after the course, they felt prepared to learn more advanced conjunctival suturing techniques (8.4 ± 1.4).

Discussion

During the COVID-19 pandemic, there was a need to develop educational tools that could be used at home to teach basic surgical techniques to ophthalmology trainees. Our surgical training module was designed to be a cost-effective, representative, and accessible tool to teach conjunctival closure suturing. Our results align with previous studies showing stepwise teaching and video-based education as effective methods to improve resident preparedness.[5,6,8,9,12] We found that, generally, confidence level about conjunctival suturing skills significantly increased and stress level about performing conjunctival closure on live patients significantly decreased in ophthalmology trainees after completing this module. It is important to note that when participants were stratified into separate groups based on level of training, confidence level results were similar for both groups but stress level results about completing the surgical skills module and performing conjunctival closure on live patients differed between groups.

Stress level while completing the surgical skill module on average may have increased for the PGY1 residents/medical students group due to a lack of knowledge regarding the surgical skill, which would have resulted in a lower stress level score prior to module. If this was a participant's first exposure to conjunctival closure, they may have reported an increased stress level while completing the module as they experienced the difficulty of learning the new skill compared with PGY2 residents who may have had prior knowledge of conjunctival closure. Additionally, stress level scores about performing conjunctival closure on live patients may have only showed significant results in PGY2 residents because they were more likely to be performing conjunctival closure imminently compared with PGY1 residents and medical students.

Wet laboratory training with human cadaver and porcine eyes has been primarily used to build confidence and technical proficiency in ophthalmology trainees prior to the COVID-19 pandemic.[4,13,14] However, these eyes require special preparation, access to a dedicated wet laboratory facility, and are not reusable. Synthetic simulation models have been created to bypass these issues, but current commercially available training models can cost over $200 per eye.[15] Our training module is inexpensive and uses nonbiologic material that has been shown to adequately replicate human conjunctiva.[10] The portability of this module, as well as its ability to be easily reused, allows for trainees to practice surgical techniques more often and encourages adherence to self-directed training.

Strengths of this study included an evidence-based teaching approach and use of an easily accessible module that produced similar results across different training levels. The study's inclusion of participants with limited exposure to live conjunctival closure suggests that this training module is especially beneficial for beginning surgeons. A limitation of this study is the use of confidence and stress levels, which are subjective, to determine if the module was effective. We understand that these measures can vary between individuals depending on their personality and approach to learning. Additionally, the construct validity of this surgical training module has not been compared with traditional wet laboratory training. In future studies, we will have ophthalmology faculty watch the video recordings of the trainees performing the module and grade them using an International Council of Ophthalmology–Ophthalmology Surgical Competency Assessment Rubrics (ICO-OSCAR) scale. The ICO-OSCAR score will provide an objective measurement of a participant's surgical skills and allows for direct comparison to wet laboratory training.

Conclusion

In conclusion, our surgical training module is an effective teaching tool for ophthalmology trainees to increase confidence and decrease stress about performing conjunctival closure. Objective assessment of each participant's surgical competency should be explored in future studies, which will allow for comparison with traditional wet laboratory training methods.

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Conflict of Interest
None declared.

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