
A video-based, flipped classroom, simulation curriculum for dermatologic surgery: A prospective, multi-institution study



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Background: Medical education is evolving to emphasize trainee engagement. The impact of a flipped classroom curriculum and surgical simulation on dermatology resident education has not been evaluated.

Objective: To assess the impact of video education and surgical simulation on dermatology resident procedural skills.

Methods: We created a curriculum on foundational surgical skills for 31 first- and second-year dermatology residents at 3 institutions. The flipped classroom approach replaces traditional in-person lectures with at-home viewing of instructional videos. After this self-directed learning, trainees had 3 hands-on sessions using simulated skin models. The Objective Structured Assessment of Technical Skills (OSATS) instrument was used to assess residents performing a simulated elliptical excision with intermediate repair before and after the curriculum. Residents completed precurriculum and postcurriculum surveys evaluating operative confidence and perceived value of the curriculum.

Results: Residents' total OSATS score increased from a median of 27 (interquartile range, 22-38.5) before the curriculum to 46 (interquartile range, 39.5-51.5) after the curriculum ($P < .001$). Self-reported confidence in surgical performance significantly improved, and residents were highly satisfied.

Limitations: Limitations include the small sample size and potential influence from concurrent learning on surgical rotations.

Conclusions: Video education and simulation are effective for improving dermatology residents' procedural skills. We hope to serve as a template for other institutions and nondermatology trainees hoping to improve procedural skills. (J Am Acad Dermatol 2019;81:1271-6.)

Key words: dermatologic surgery; dermatology resident education; flipped classroom; medical education; simulation; surgical simulation.

Dermatology education is constantly evolving, from moulage and color slides to interactive online textbooks. The current

emphasis of medical education is a movement away from delivering content via lectures and texts and toward interactive learning that increases

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trainee engagement while providing safe hands-on training.

The flipped classroom approach and simulation are 2 educational modalities that meet these demands by allowing trainees to practice essential skills at their own pace in a low-stress, low-stakes environment that is not impeded by the normal flow of patient care. In a flipped classroom, learners are expected to review educational content outside of the classroom, thereby “flipping” the classroom and freeing up time previously spent on lectures for interactive, learner-centered activities.¹ This approach is particularly useful in the teaching of surgical skills for 2 reasons. First, the learner has the freedom to view our educational content, in this case surgical videos, at a time most optimized for their learning. Second, by removing the content material from traditional lecture formats, valuable in-person time can be reallocated such that learners can receive instant feedback from teachers to address the most difficult concepts.

Surgical simulation similarly provides interactive learning in a safe environment. Several studies have found that simulation programs in surgical residencies enable trainees to become more confident and technically proficient in manners that are directly transferable to patient-based settings.² Meta-analyses of simulation-based training have demonstrated results from deliberate practice that are superior to those from traditional medical education.^{3,4}

In this study, we combined these 2 approaches to assess a novel video-based, flipped classroom and simulation-based surgical curriculum for first- and second-year dermatology residents through a prospective, multi-institutional study.

METHODS

Setting

The curriculum was developed by faculty at the Brigham and Women’s Hospital, Harvard Medical School. A total of 31 first- and second-year dermatology residents completed the course across 3 residency programs: Harvard Combined Program (Boston, MA), Tufts Medical Center (Boston, MA), and Northwell Health (Lake Success, NY). The institutional review board at all 3 institutions approved this study.

Curriculum development

Content. The curriculum consisted of 2 modules: a video-based, flipped classroom curriculum and three 60-minute hands-on practice sessions (Fig 1). The educational objectives covered included aseptic technique, knowledge of instruments, suturing, knot tying, cyst excision, elliptical excision, and intermediate repair. These educational objectives were identified after a review of dermatology surgery textbooks and streamlined through an iterative process among dermatologists, dermatologic surgeons, and medical education experts experienced in simulation-based training.

Videos. A total of 13 annotated videos, with a total running time of 25 minutes were produced to demon-

strate each of the surgical techniques covered within the aforementioned learning objectives. Videos were filmed on both simulation models and live patients. The videos were edited and annotated by using Camtasia software (TechSmith, Okemos, MI), and audio explanations were added to accompany each video. Annotations included labels, animations, and cross-sectional illustrations. All videos were posted to a private YouTube channel, and the residents were provided with a link to view these videos before attending the simulation sessions (to see a sample video, visit: <https://tinyurl.com/y7ajt7a>).

Simulation. We enlisted 8 fellowship-trained dermatologic surgeons for the hands-on sessions across 3 sites. Standardized educational guides for teaching faculty were developed, distributed, and reviewed before each session. Residents worked on simulation models at separate stations while being observed by the surgeons. Standard materials (eg, gowns, gloves, sutures, instruments) and high-fidelity models (simulation skin, a silicone-based cyst model) were used. The simulation models, which included synthetic skin for suturing and a silicone-based cyst model, were created in collaboration with the STRATUS (Simulation, Training, Research and Technology Utilization System) Center at Brigham and Women’s Hospital and distributed to all 3 sites.

Evaluation design

We used a pre-post study design to evaluate changes in residents’ surgical skill. The residents were asked to perform an elliptical excision with

CAPSULE SUMMARY

- Video education and simulation significantly increased residents’ skin excision skills and operative self-confidence in this prospective study at 3 residency programs.
- Our findings suggest a potential role for video teaching and simulation training in dermatology residency education as an adjunct to traditional surgical education.

Abbreviations used:

OSATS:	Objective Structured Assessment of Technical Skills
GRS:	global rating scale
IQR:	interquartile range

intermediate repair on a simulation skin model at baseline and after completing the curriculum. Residents wore GoPro cameras (GoPro, San Mateo, CA) mounted on their heads during this exercise. This bird's-eye view meant that only the operating resident's hands and forearms were visible in the video. To remove any identifying features that might bias graders, residents were asked to glove and gown before all recordings. Apart from 1 resident whose schedule was constrained on account of an inpatient rotation, filming was conducted within 1 month of curriculum completion to minimize bias from ongoing learning.

Four dermatologic surgeons (A.W., E.R., J.T., and L.S.) analyzed the pretraining and post-training assessment videos by using the Objective Structured Assessment of Technical Skills (OSATS) tool. The OSATS tool, which was initially developed in the 1990s, consist of 2 rubrics: a procedure-specific checklist and a 7-item, 5-point global rating scale (GRS).⁵ The total OSATS score is the sum of the checklist scores and GRS. The procedure-specific checklist used consists of 23 specific surgical maneuvers that have been deemed essential to skin excisions, including excision of the lesion, suturing, and knot tying. The GRS includes 7 surgical behaviors, such as efficiency of motion, flow of operation, and knowledge of procedure. This assessment tool has been validated across numerous surgical specialties,⁶⁻⁸ including in dermatology, where the OSATS tool was used to evaluate senior dermatology residents performing elliptical excisions and bilayered repairs.⁹

The videos were de-identified and randomized before assignment to graders. A 12.5% sample (8 videos [2 from each grader]) were assessed by a second blinded reviewer (K.L.) to ensure accuracy of scoring. The checklist was tailored by removing elements not used routinely in dermatologic surgery, such as donning of sterile gowns or use of hand ties, as decided through consensus among 3 board-certified dermatologists (A.M., A.W., and K.L.). Unmodified GRS scores were used.

Perceived educational benefit to trainees

Residents also completed precurriculum and postcurriculum surveys evaluating their self-

confidence in various domains of surgical skill, including aseptic technique, knowledge of instruments, cyst excision, elliptical excision, and intermediate repair. They were also queried on the perceived value of various components of the curriculum, such as videos, flipped classroom, and simulation.

Statistical analysis

Nonparametric statistical methods were used with the Wilcoxon signed-rank test to analyze data within groups (eg, before and after intervention) and with the Mann-Whitney U test for between-group comparisons. The Kruskal-Wallis test was used to assess comparisons between sites. Inter-rater reliability was assessed by using the Krippendorff alpha. All statistical analyses were performed with R Statistical Software (version 3.5.1, R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

A total of 32 first- and second-year dermatology residents were recruited in this study. Of these, 31 residents completed the simulation curriculum, precurriculum assessment, and postcurriculum assessment (Fig 1). One resident who did not participate in the curriculum was excluded from analysis.

OSATS scores

Residents' total OSATS score increased from a baseline median score of 27 (interquartile range [IQR], 22.0-38.5) to 46 (IQR, 39.5-51.5) after the curriculum ($P < .001$). This increase was secondary to changes in both components of the OSATS, with an increase in GRS from a baseline median score of 14 (IQR, 9.5-19.0) to 26 (IQR, 20.0-30.0) after the curriculum ($P < .001$) and an improvement in checklist score from a baseline median score of 15 (IQR, 11.5-18.5) to 20 (IQR, 19.0-21.0) after the curriculum ($P < .001$) (Table 1).

Inter-rater reliability was very high for all 3 metrics (OSATS $\alpha = 0.96$, GRS $\alpha = 0.96$, checklist $\alpha = 0.93$). The improvements in all 3 metrics did not differ significantly across the 3 teaching sites (data not shown). Subgroup analyses of the checklist scores for 3 components (excision, suturing, and knot tying) all showed significant improvement (Table 1).

Subgroup analysis by year of training demonstrated increases in total OSATS, GRS, and checklist score for both first- and second-year residents. For first-year residents, the median total OSATS score increased from 25 (IQR, 17.8-28.0) to 46.5 (IQR, 39.3-49.8) after the curriculum ($P < .001$), the median GRS score increased from 11.5 (IQR, 8.8-14.5) to 26 (IQR, 21.0-30.0) after the curriculum ($P < .001$), and the

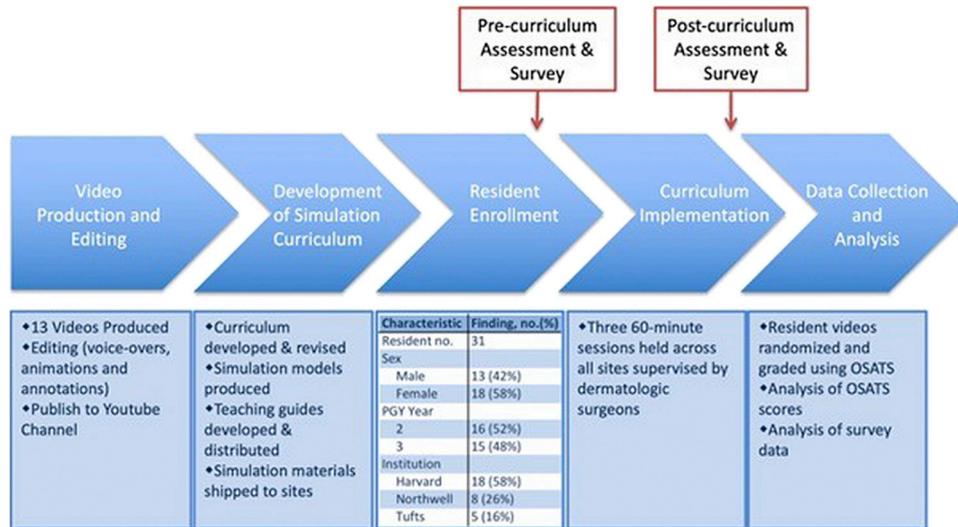


Fig 1. Schematic representation of study design. Schematic representation of the curriculum design, implementation, and data collection. Assessments were administered before and after residents attended simulation sessions. OSATS, Objective Structured Assessment of Technical Skills; PGY, postgraduate year.

Table I. Precurriculum versus postcurriculum OSATS scores, GRS score, and checklist scores according to year of training

Measure	Before the curriculum		After the curriculum		Median difference	95% CI	P value
	Median	IQR	Median	IQR			
First- and second-year residents							
Total OSATS score	27.0	22.0-38.5	46.0	39.5-51.5	19.0	(9.0, 20.0)	<.001
GRS	14.0	9.5-19	26.0	20.0-30.0	12.0	(6.5, 14.0)	<.001
Checklist score	15.0	11.5-18.5	20.0	19.0-21.0	5.0	(2.0, 7.0)	.001
Excision	7.0	5.5-7.5	8.0	7.0-9.0	1.0	(1.5, 2.5)	<.001
Knot tying	3.0	1.0-5.0	5.0	3.5-5.0	2.0	(0.5, 2.5)	.011
Suturing	6.0	4.0-8.0	8.0	7.0-8.0	2.0	(1.0, 3.5)	.006
First-year residents							
Total OSATS score	25.0	17.8-28.0	46.5	39.3-49.8	21.5	(10.5, 27)	.002
GRS	11.5	8.8-14.5	26.0	21.0-30.0	14.5	(7.5, 17.5)	.002
Checklist score	13.0	8.8-16.5	20.0	16.8-21.0	7.0	(2.5, 9.5)	.005
Second-year residents							
Total OSATS score	35.0	27.5-43.0	45.0	40.0-51.5	10.0	(2.0, 17.0)	.016
GRS	18.0	12.5-22.0	25.0	20.0-29.5	7.0	(1.0, 12.5)	.027
Checklist score	18.0	14.5-21.0	20.0	19.0-21.5	2.0	(0.1, 6.5)	.035

CI, Confidence interval; GRS, global rating scale; IQR, interquartile range; OSATS, Objective Structured Assessment of Technical Skills.

median checklist score increased from 13 (IQR, 8.8-16.5) to 20 (IQR, 16.8-21.0) after the curriculum ($P < .001$). For second-year residents, the median total OSATS score increased from 35 (IQR, 27.5-43.0) to 45 (IQR, 40.0-51.5) after the curriculum ($P = .02$), the median GRS score increased from 18 (IQR, 12.5-22.0) to 25 (IQR, 20.0-29.5) after the curriculum ($P = .03$), and the median checklist score increased from 18 (IQR, 14.5-21.0) to 20 (IQR, 19.0-21.5) after the curriculum ($P = .04$) (Table I).

Perceived educational benefit to residents

A comparison of the baseline and postcurricular surveys completed by residents using a 5-point Likert scale revealed improvements in self-reported confidence in aseptic technique (mean score, 3.7-4.3) ($P < .009$), knowledge of instruments and sutures (mean score, 2.9-3.8) ($P < .001$), cyst excision (mean score, 2.1-3.5) ($P < .001$), elliptical excision (mean score, 2.3-3.7) ($P < .001$), and intermediate repair (mean score, 2.1-3.4) ($P < .001$) (Fig 2). These

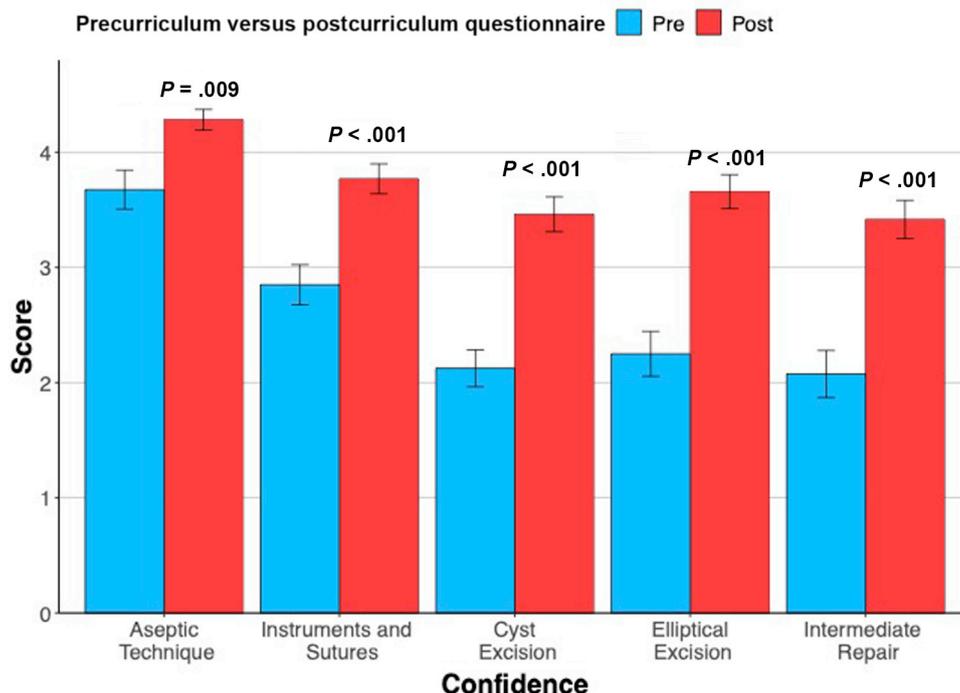


Fig 2. Resident-reported surgical confidence from baseline to after the curriculum. Residents reported being significantly more confident in knowledge and procedural domains after the curriculum as compared with at baseline.

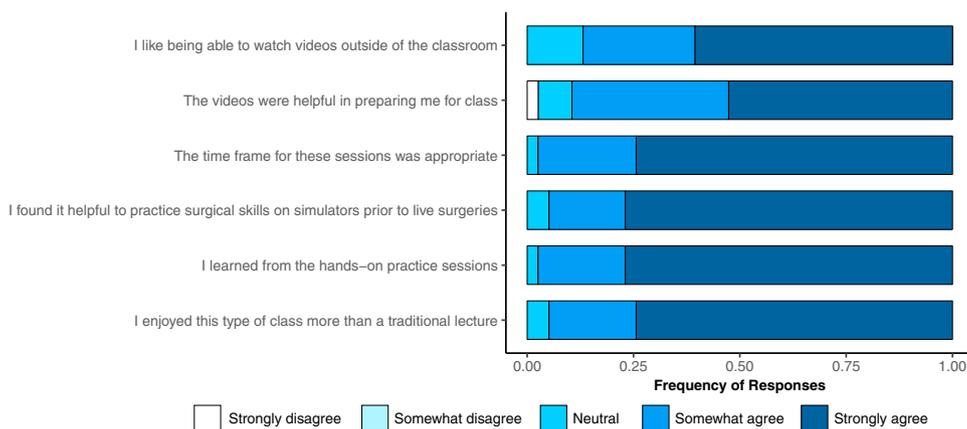


Fig 3. Resident feedback on the curriculum.

improvements in confidence were noted in both first- and second-year residents when analyzed separately (data not shown).

Residents were asked to rate their satisfaction with various components of the curriculum. Most residents strongly agreed that the flipped classroom format, surgical videos, and hands-on sessions were helpful and enjoyable (Fig 3). In all, 97% of residents thought that simulation added to surgical teaching received in clinics, and 83% of second-year residents believed that simulation training would have been helpful if taught earlier in residency.

DISCUSSION

In this article, we have demonstrated the impact of a flipped classroom, video-based surgical curriculum on improving surgical skills for dermatology residents across multiple institutions. Completion of our curriculum led to significant improvement in all domains measured by the OSATS, including the checklist, GRS, and total score. This improvement extended to both novice first-year residents and more experienced second-year residents.

In addition to improvements in surgical ability, residents reported high levels of satisfaction with the

various components of our curriculum. Most residents enjoyed the ability to view videos before hands-on sessions and found the videos helpful in preparation, demonstrating the utility of the flipped classroom approach. Importantly, the residents found the hands-on sessions helpful in preparing them for live surgical procedures and found simulation to be a helpful adjunct to the existing apprenticeship model.

These results reinforce and build on data suggesting a role for simulation in resident education. Excellent educational curricula should have quality content; be trainee focused; and deliver objective, measurable results.¹⁰ Simulation as an educational modality addresses these concerns by allowing trainees to practice in a risk-free environment that is not constrained by the flow of patient care.

Our data must be considered in the context of the study design. Strengths of our study include the multi-institution study design, as well as de-identification of resident videos and randomization among graders. The key limitation of our study is that residents' OSATS scores may be influenced by learning outside of the simulation curriculum, such as through excision clinics or dermatologic surgery rotations. We minimized this bias by condensing the curriculum such that it took place within 1 month across all sites, although this limited the ability to test for learning retention long-term. Another limitation may be the use of multiple graders, but we used a previously validated evaluation instrument, and our study demonstrated high intergrader correlation. The observed improvement in OSATS scores in our study resulted from both the video-based and hands-on simulation curriculum, and the individual effects of these 2 components were not independently measured. Furthermore, limited data are available on how traditional surgical teaching, such as didactics or sessions with pigs' feet, improve surgical skills.^{11,12} As such, comparison groups would be helpful in future studies to better assess the magnitude of our results.

Future research should focus on evaluating the long-term impact of surgical simulation training and identifying other domains in which simulation could have an impact. In the surgical literature, simulation not only improves performance in workstations but may also actually improve performance in the operating room.¹³ Similar efforts to connect simulation-based training for dermatology residents with changes in clinical performance should be undertaken.

Additional evaluation should determine whether simulation training should expand beyond suturing, knot tying, and excisions to encompass other

technical arenas, such as flaps, grafts, nail procedures, and cosmetic procedures. As simulation becomes more mainstream and potentially mandatory (as it already is in other surgical specialties), dermatology programs should embrace the use of these evidence-based training programs and objective evaluations. We hope that our curriculum can serve as a template for other institutions and nondermatology trainees hoping to improve procedural skills for dermatology procedures.

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