Artificial eye models: An opportunity to increase surgical training exposure in ophthalmology during and beyond the COVID-19 pandemic.

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Abstract

Purpose: To review 3 recently published articles regarding the face and content validity of 3 artificial eye models used for practicing ab-interno goniotomy, ab-interno canaloplasty, and anterior vitrectomy (SimulEYE® KDB/TrabEx, ABiC iTrack and A-Vit, InsEYEt, Westlake Village, CA)

Participants: A total of 71 surveys were completed by ophthalmologists following a surgical simulation session at the 2019 Canadian Ophthalmological Society annual meeting.

Methods: A 15-question survey to assess the face and content validity of the model was given immediately following the surgical simulation session. Responses to each survey question were recorded on a 5-point Likert scale ranging from (5) strongly agree to (1) strongly disagree.

Results: Respondents rated statements regarding the models with a median response ranging from 5 (Strongly agree) to 3 (Neither agree nor disagree). Mann-Whitney U nonparametric analysis revealed no significant difference in responses between instructor vs. non-instructor or between prior experience vs. no prior experience in each study. The models received the highest combined ratings for their usefulness in training residents, utility in novice skill acquisition prior to in vivo procedures and higher likelihood of success with the procedure than theory and observation alone. The lowest aggregated score for the models was for realism of the models compared to a human cadaveric eye.

Conclusion: Results from these studies suggest the SimulEYE KDB/TrabEx, AbiC iTrack and A-Vit models are a reasonably cost-effective solution for surgical simulation of ab-interno goniotomy, ab-interno canaloplasty, and anterior vitrectomy.

Keywords: Education, Glaucoma, Ophthalmic surgery, Surgical training, Resident training, Artificial eye model.

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About the study

The COVID-19 pandemic has caused major disruptions to ophthalmology residency training programs across the world [1-6]. Many ophthalmological societies have adopted guidelines that highlight the need for extra safety measures, including postponing non-urgent medical and surgical care [7]. These guidelines have had a negative impact on surgical training as the volume of surgeries being performed has decreased significantly [2,5]. The long-term impacts on trainee's core competencies caused by a decrease in clinical and surgical exposures during the pandemic are not yet clear [2]. To mitigate potential gaps in learning, many ophthalmology training programs around the world have recognized the need to adapt and change their teaching methods [8]. There is a critical need for programs to adopt validated and reproducible surgical training models that are high fidelity, low cost, reproducible, accessible, and easy for the trainee to set up and use. Various training models have been used in ophthalmology to simulate surgical techniques, including post-mortem human eyes, post-mortem animal eyes, synthetic eyes, computer simulated eye surgery and foodstuffs such as fruits and vegetables [9-12]. In this article we summarize three recently published papers that each analyzed the face and content validity of an artificial eye model produced by InsEYEt LLC (Westlake Village, CA) designed to practice specific ophthalmologic surgical techniques (Table 1) [13-15].

Discussion

In each study the face and content validity of the models was assessed using a short (15 question) survey (Appendix A). Questions used in the surveys were designed using McDougall's definition of face and content validity where face validity is the realism of the simulator and content validity is a judgment of the appropriateness of the simulator as a teaching modality [16]. Responses were recorded on a 5-point Likert scale ranging from strongly agree (5) to strongly disagree (1). In addition to the 15 questions assessing face and content validity, other questions included whether the respondent was a course instructor or participant and the number of times they had performed the specific procedure on live patients in the past (Table 2).

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Table 1. *Eye models analyzed for face and content validity in recent survey studies at the 2019 Canadian Ophthalmological Society (COS) annual meeting.*

Model	Surgical Technique Designed to Practice	Current Cost (USD)	Features of the Model
SimulEYE® KDB/ TrabEx	Ab-interno goniotomy using the Kahook Dual Blade (KDB)*, TrabEx and Trabectome†.	70	• Contains TM which can be visualized using viscoelastic and a gonio prism
			• Multiple clock hours of the TM can be treated before the model is consumed
SimulEYE® ABiC iTrack	Ab-interno canaloplasty (AbiC) using the Ellex iTrack device‡.	200	• Angle structures can be visualized using a gonioprism and gel
			• Pre-placed opening in the pigmented TM for placement of the iTrack catheter
			• Allows visualization of the red blinking light on the outside of the model
			• Model can be reused multiple times
SimulEYE® A-Vit	Bimanual anterior vitrectomy via pars plana approach	50	• Model filled with synthetic vitreous
			• Single use

*New World Medical, Rancho Cucamonga, CA, USA
†MicroSurgical Technologies, Redmond, WA, USA
‡Ellex iScience, Inc., Freemont, CA, USA
TM=Trabecular Meshwork

Each survey was completed by ophthalmologists at the 2019 Canadian Ophthalmological Society (COS) annual meeting immediately following a surgical training session. Before each session, a brief instructional presentation, free of any product endorsement, was given by a course instructor followed by 90 minutes of hands-on practice. Each ophthalmologist was given their own model and equipment to practice with. Surveys were filled out by course instructors and participants with no financial or other incentives provided. The surveys for each of the models were analyzed using Mann–Whitney U nonparametric analysis to determine whether prior experience performing the procedure on live patients or being a course instructor had significant influence on responses.

Survey results from each study are combined and summarized in Table 3. Respondents rated all questions for the SimulEYE® KDB/TrabEx and ABic iTrack models with a median score ranging from 5 (strongly agree) to 3 (neither agree nor disagree) and the A-Vit model ranging from 5 to 4 (agree). When responses from all participants are aggregated together, all three models received a favorable median rating between 5 and 4. Furthermore, respondents rated all statements specifically regarding face validity of each model (questions 1-2, 14; Appendix A) with a median response of 4. Statements specifically addressing content validity of the models (questions 4-7, 9-11; Appendix A) all received a median response of either 5 or 4.

Table 2. *Respondent's self-reported experience with in vivo procedures prior to using the simulation eye models at the 2019 Canadian Ophthalmological Society annual meeting.*

	Ab-interno goniotomy using KDB		Ab-interno canaloplasty		Bimanual ant vitrectomy- pars plana approach	
Procedure Range	Number of respondents in past year	Number of respondents lifetime	Number of respondents in past year	Number of respondents lifetime	Number of respondents in past year	Number of respondents lifetime
0	7	7	10	9	11	4
1-10	2	2	2	3	25	14
11-20	1	0	0	0	1	6
21-30	0	1	1	0	1	5
31->100	0	0	3	3	0	8
Respondent Count (n)	10	10	16	15	38	37

*KDB=Kahook Dual Blade (New World Medical, Rancho Cucamonga, CA, USA)

Table 3. *Summary of 5-point Likert scale survey responses of each model ranging from strongly agree (5) to strongly disagree (1).*

	SimulEYE® KDB/TrabEx			SimulEYE® ABiC iTrack			SimulEYE® A-Vit			Aggregated responses for all models		
Survey Question	5-Point Likert total	# Responses	Median	5-Point Likert total	# Responses	Median	5-Point Likert total	# Responses	Median	5-Point Likert total	# Responses	Median
Q1	53	13	4	75	18	4	165	40	4	293	71	4
Q2	56	13	4	77	18	4	167	40	4	300	71	4
Q3	59	13	5	81	18	5	178	38	5	318	69	5
Q4	60	13	5	85	18	5	182	34	5	327	65	5
Q5	58	13	4	81	18	5	167	40	4	306	71	4
Q6	58	13	4	82	18	5	163	40	4	303	71	4
Q7	58	13	4	83	18	5	169	39	4	310	70	4
Q8	59	13	5	78	18	4	178	40	4	315	71	4
Q8	56	13	4	72	18	4	175	40	4	303	71	4
Q8	42	13	3	53	17	3	143	38	4	238	68	4
Q9	60	13	5	79	17	5	178	40	4	317	70	5
Q10	43	11	4	68	17	4	141	38	4	252	66	4
Q11	45	11	4	72	17	4	145	38	4	262	66	4
Q12	46	11	4	71	17	4	156	38	4	273	66	4
Q13	46	11	4	72	17	4	145	40	4	263	68	4
Q14	48	11	4	75	17	4	161	40	4	284	68	4
Q15	44	11	4	74	17	4	147	40	4	265	68	4

The models received the highest combined ratings for their usefulness in training residents, utility in novice skill acquisition prior to in vivo procedures and higher likelihood of success with the procedure than theory and observation alone. The lowest aggregated score for the models was for realism of the models compared to a human cadaveric eye. This is not surprising since cosmetic details, like conjunctival vessels, are purposely omitted to maximize cost-effectiveness. Using Mann–Whitney U nonparametric analysis each study found that the models demonstrated no significant difference in responses observed between instructors versus non-instructor or between prior experiences versus no prior experience for each of the survey statements.

Limitations of the studies include a relatively small sample size and selection bias as all respondents in each study had self-selected to attend the COS review course. Furthermore, there was no control group or alternate model for comparison used in any of these studies. Another limitation is the low number of questions used in the surveys that related specifically to face and content validity. Survey questions can be strengthened in future studies by adapting a well validated assessment tool for simulation of glaucoma surgery proposed by Dean et al in 2019 [17].

Declarations

Conflict of interest

No conflicting relationship exists for either author

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