Review Article

Wet Laboratory Training in Ophthalmology as a Tool for Formative Assessment

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Abstract

Surgical skills training and assessment have always remained a critical issue for both trainees and trainers. Ophthalmology being a microsurgical specialty, its training in the operating theater further faces a lot of challenges. Wet laboratory training and simulation training were, therefore, developed so that residents acquired certain basic skills in controlled laboratory settings before they could operate on patients and patient safety could thereby be ensured. Unfortunately, most literature focuses on the benefits such practice has on operating room performance; but not much attention has been paid to the use of such training for formative assessment, feedback, and its importance in effective learning. In this article, we highlight the challenges faced in surgical skill transfer and also give an insight into how wet or dry laboratory training can be of formative value in postgraduate training.

Keywords: *Dry laboratory, formative assessment, rubric, simulation, surgical skills, wet laboratory*

Introduction

Ophthalmology is a surgical specialty with rapid technological advancements necessitating continued surgical education. The making of a trainee into a competent surgeon is a challenging task. The Accreditation Council For Graduate Medical Education mandates six core competencies for trainee residents patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice.[1] The competency-based medical education (CBME) curriculum for postgraduation in ophthalmology lists various clinical/surgical skills to be acquired during residency training.[2] CBME has also brought a paradigm shift from "assessment of learning" (summative) to "assessment for learning" (formative). The expression "Teaching is not equivalent to learning" means that competence must be assessed. Although surgical competence is just one part of the vast skill set an ophthalmology resident is expected to acquire, it is undoubtedly the most important factor that has a direct relationship with the patient outcome; however, surgical skill assessment is a critical issue for both trainees and trainers.

In this article, we highlight the challenges faced in surgical skill transfer and also give an insight into how wet or dry laboratory training can be of formative value in postgraduate training.

Challenges in Surgical Skill Transfer

Training in the operating theater is often unstructured and occurs by chance encounters dependent on patient and disease variability. Although training is supervised and in accordance with the informed consent of the patient, ethical concerns do exist about a novice surgeon performing a procedure in a live patient. It is thus essential to develop surgical skills training in a way that does not expose the patients to preventable errors.[3] Further, ophthalmic surgery is different from other surgical fields as it requires additional skills of hand–eye coordination. Microsurgery allows only one person to operate at a time; hence, does not give ample time for the supervisor to attend a case before a complication occurs.[4] Second, operating inside the eye makes it difficult to demonstrate what not to do and even seemingly small mistakes in surgical judgment or technique may result in irreversible adverse events.[5] Finally,

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most ophthalmic surgeries are performed on awake patients which makes constructive real-time feedback very difficult. The residents operate under a highly demanding and stressful environment that may hamper their development as good surgeons.[4] There are added costs associated with the inherent inefficiencies of resident-performed surgery.[5]

Role of Wet Laboratory Training and Simulation for Teaching Surgical Skills

To overcome the above challenges, it has been proposed that a structured wet laboratory-based curriculum should be designed so that residents acquired certain basic skills in controlled laboratory settings before they could operate on patients, patient safety could be ensured, and actual operating times could be reduced.[4] The training process should constitute knowledge-based learning, a stepwise technical skills pathway, ongoing feedback, and progression toward proficiency goals, enabling transfer to the real environment.[3]

Wet laboratories provide a safe, risk-free, and less stressful environment, which offers to trainees the opportunity to gain self-confidence; try various methods and techniques and select the most appropriate for their convenience; improve psychomotor skills, coordination between hands and eyes as well as ambidexterity; master the initial steps of stereoscopic vision; discuss their questions without time pressure; learn how to manage possible complications and develop self–awareness; all in a nonstressful laboratory setting; eventually improving their surgical skills with a reduced rate of complications and a better visual outcome for patients.[6,7] Laboratory practice allows students to "learn by doing" according to Piaget's and Vygotsky's pedagogical philosophy.[3] Wet laboratories have been considered a successful and fundamental strategy for trainees to achieve surgical proficiency.[8]

Unfortunately, various studies report inconsistencies in the training across institutes and a lack of wet laboratory training in Indian institutes.[9-11] A concern in this is the cost involved in setting up and maintaining the wet laboratory. Wet laboratories use cadaveric human or animal models or synthetic eyes to rehearse the surgical steps. However, these methods have been criticized for being unrealistic with the inaccurate simulation of tissue consistency and anatomy, and also lacking any form of objective assessment. Simulation in the form of virtual reality (VR) and synthetic models have been, therefore, proposed (dry laboratory training). There are many simulators now available for various diagnostic techniques and surgeries.[3] These need an initial capital investment but the training of multiple residents makes it cost-effective over time. Other reasons reported for poor adoption of simulator-based training facilities are lack of structured or poorly organized training programs, lack of infrastructure, and lack of trained instructors or personnel, disinterest, and poor student–teacher ratio for teaching.[12]

All of the prior literature focuses on the tangible benefits laboratory-based practice has on operating room performance; but not much attention has been paid to the use of such laboratory training for assessment, feedback, and its importance in effective learning.

Assessment of Surgical Skills

The aim of the assessment of surgical skills is to demonstrate learning (summative assessment) or to facilitate learning (formative assessment)[13] [Figure 1].

What makes an assessment "formative" is not the design of the test or technique but the way it is utilized. Formative assessment helps the trainees to identify their strengths and focus on skills needing enhancement.[13] Moreover, it helps the faculty recognize suboptimal performance and take remedial measures. An ideal surgical training program must adopt an objective, transparent, and valid formative assessment which gives continuous feedback to the learners. It is important, therefore, to think about how feedback and guidance are given during surgery, as both positive feedback and negative feedback have a significant impact on the trainees. Positive feedback helps learning and increases the motivation and performance of surgical trainees whereas negative feedback can have a detrimental effect. Feedback is best done directly, one-on-one, and during or immediately after the training session. This initial conversation should be followed up during the next week in the clinic or before the next list, often with an assessment tool to help provide formative feedback and documentation. The use of video assessment, if available, provides an added opportunity for discussion.[14] Every assessment should be converted into a learning experience.

Traditionally, ophthalmology residency programs mandate a minimum number for supervised and independent surgeries (quantity) with experience and volume of surgery considered a surrogate for competence, but more often than not, there are no standard measures for assessing how well the surgeries are performed (quality). There is an obvious lack of standardization in surgical training and objectivity in assessment and feedback.[15] However, assessment tools and defined curricula and outcomes are now being developed to better allow the supervising surgeon to objectively assess the trainee's competence in performing a specific procedure allowing the surgical training to be individualized for the trainee's stage of training.[14] The importance of VR simulators in assessing the training of ophthalmic surgeons has been acknowledged in the work-based assessments (WBAs) for ophthalmic specialist training released by the Royal College of Ophthalmologists.[16] The practical skills WBAs such as the direct observation of procedural skills and the objectively structured assessment of technical skills include a simulator, together with wet laboratory and patient, to assess the procedure performance.[17,18]

Many different types of surgical assessments have been described, which include

1. Procedure-related checklists and global rating scales

2. Simulated (wet laboratory, dry laboratory, or virtual)
3. Knowledge-based
4. Outcomes data and
5. Motion analysis.

It is important to evaluate whether these assessment tools have been properly validated, provide both appropriate feedback to learners and ideally a threshold of competency, and are practical to implement.[19] WPBAs provide a structure to assessing observed skills in the clinic and operating room. Most WPBAs are rubrics which are defined as an explicit set of criteria used to assess a particular skill. Good rubrics consist of three parts: (1) dimensions (e.g., steps of a surgical procedure), (2) levels (e.g., score of 1–5 or novice, beginner, advanced beginner, competent, and expert), and (3) behavioral descriptors (what it means to perform at a certain level for any of the dimensions). The requirement for the level of performance to achieve each grade in each step is very clearly specified.[20] The descriptors standardize the assessment and help the assessor's rate similarly thus producing a more reliable tool.[21] Rubrics should be given to the resident in advance to learn what is required to be competent in various stages of the procedure; completed by the teacher immediately after the observed performance; and then reviewed with the resident to provide effective formative feedback as described above.[20] The conventional "case audit" generally states whether the step was "performed" or "not performed" and lacks the "criterion-based performance feedback" which can be a frustrating learning experience, especially for sensitive learners, but the rubric-based assessment tool serves four distinct purposes: (1) It minimizes subjectivity by clearly defining the skills that must be observed at each level of proficiency, (2) The rubric clearly states what is expected of the trainee to attain competence at each level and thus can be used for both assessment and teaching, (3) It allows areas of deficiency to be identified and remediated, and (4) Self-assessments by reflective practice is possible when the trainees' surgical procedures are recorded.[21] Thus, rubrics help to train in the right direction.[22] It is helpful to outline the teaching plan for the term and how feedback will be given so that both trainer and trainee have the same expectations.[14]

Tools for Formative Assessment of Surgical Skills

There are several specific proposed methods of formative assessment of surgical skills [Tables 1 and 2].

Table 1: International Council Of Ophthalmology-ophthalmology surgical competency assessment rubric and modified International Council Of Ophthalmology-ophthalmology surgical competency assessment rubric tools for formative assessment of surgical skills in ophthalmology

Tool	Characteristics
The ICO-OSCARs[23,24]	Standardized, validated, reliable, behavioral, and skill-based internationally applicable rubrics
	Available online, in multiple languages, free of charge
	Being developed for multiple ophthalmic surgeries
OSACSS	A six-item global rating system and a 14-item task-specific component checklist particular to cataract surgery
	Each component is rated on a 5-Point Likert Scale with the scale anchors being 1="poorly or inadequately performed," 3="performed with some errors or hesitation," and 5="performed well with no prompting or hesitation"[25]
	The ICO modified it to include a Dreyfus-inspired model of skill acquisition[23,26,27]
The modified OSCAR	The ICO-OSCAR being best used during surgical training and not directly suited for wet lab training. Farooqui JH *et al*. proposed the modified ICO-OSCAR tool for wet laboratory training for phacoemulsification[28]
SICS Sim-OSSCAR	For use during simulation-based training of MSICS, based on the ICO-OSCAR[29]
	Uses the Peyton 4-stage approach for MSICS. Once all steps of the surgery are covered, the full procedure is performed on high-fidelity synthetic simulation eyes after a round of mental rehearsal. Participants record their surgical performance and then engage in reflective learning[30,31]
Modified OSSCAR	Distance wet laboratory courses were administered through a telemedicine platform[32]
	Each lecture had two accompanying wet laboratory assignments which residents completed, recorded, and uploaded for grading which was done using a modified standardized competency rubric
	This OSSCAR has only 16 steps as steps inappropriate or too advanced for the wet laboratory setting were removed and has just 3 grades (0–2) for each surgical step, corresponding respectively to novice, advanced beginner, and competent. A passing score of 1 on the 0–2-point scale for each surgical step was necessary to proceed further
	Residents obtained unstructured informal ongoing feedback for each assignment and overall performance
	This model could deliver wet laboratory training in locations having lack of structured programs, limited faculty, lack of access to training institutions, and situations like the recent pandemic[32]

SICS: Small incision cataract surgery; MSICS: Manual SICS; ICO: International Council of Ophthalmology; ICO-OSCARs: ICO Ophthalmology surgical competency assessment rubrics; OSACSS: Objective structured assessment of cataract surgical skill; OSSCAR: Ophthalmic Simulated Surgical Competency Assessment Rubric; SICS: Small incision cataract surgery

In our tertiary center and medical college, the students are exposed to three different types of laboratory training – cadaveric eyes, goat eyes, and simulator-based. Fruits and vegetables such as tomatoes, bananas, and onions are also often used to understand the surgical nuances, practice eye–hand coordination, and learn some basic surgical steps. All wet and dry laboratory training is associated with immediate individual and subsequent general feedback from the trainers. It has been noted that students who have been exposed to laboratory training and feedback perform much better and have fewer errors when they operate on patients resulting in a significantly higher level of patient safety. Our students have shared that laboratory practice and feedbacks prove very helpful to enhance their surgical competence. It helps them to get acquainted with depth perception, hand–eye coordination, handling of instruments with swiftness, and in building reflexes for different maneuvers. When the same steps are performed subsequently on patients, they feel more confident which helps them to operate with ease, save time, and even perform better during stages of difficulty. The occurrence of many intraoperative complications significantly reduces after effective laboratory training. Some of the simulator-based trainings, for example., for manual small incision cataract surgery and phacoemulsification, are also associated with a longitudinal International Council of Ophthalmology rubric assessment which helps to gauge their progress.

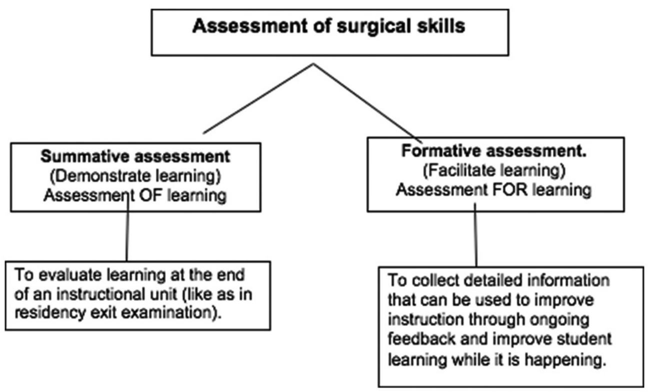

Figure 1: Assessment of surgical skills

Conclusion

Whether the formative assessment of surgical skills becomes an integral part of our formal residency training program or not, it would be in everyone's interest to adopt the rubric tools to train and assess the residents. These tools could also be used for summative assessment upon which to progress the successful trainee. The use of technology

Table 2: Other tools for formative assessment of surgical skills in ophthalmology

Tool	Characteristics
OASIS	A one-page objective evaluation form to assess resident's skills in cataract surgery[33]
	Can be modified for use during lab training
GRASIS	A subjective rating of surgical skills
	The one-page form allows the evaluator to assign scores from 1–5 based on domains such as preoperative knowledge, microscope use, instrument handling, and tissue treatment in addition to seven other areas[34]
	Can be used in conjunction with the OASIS
OSATS	The UK RCOphth WPBA handbook describes several OSATS
	OSATS 2 and 3 are specifically for use of the operating microscope and aseptic technique. OSAT 1 is generic for all surgical procedures[16]
Human reliability analysis (HRACS)	Originally developed to improve human performance and safety in high-risk industry
	With the underlying principle of error analysis, it has been modified for use in ophthalmology[35]
SPESA	Designed for intraoperative assessment of resident PCE surgery
	Delineates the surgery into overall performance and specific steps[36]
	The same could perhaps be modified for laboratory training
Cataract surgery assessment tool	A valid and reliable tool developed in Canada[37]
ESSAT	A 3-station (skin suturing, muscle recession, phacoemulsification/wound construction and suturing technique) wet laboratory obstacle course[38]
	Includes a station-specific checklist and a global rating scale performance for resident's videotaped performance[39]
	Evaluates resident's basic skills before entering the operating room
Wet laboratory curriculum for teaching and assessing cataract surgical competency	Includes pre- and post-tests of cognitive skills in addition to a structured wet laboratory curriculum with observed ratings of surgical skill[40,41]
	Video-based assessments help to reduce subjectivity

OASIS: Objective assessment of skills in intraocular surgery; GRASIS: The Global rating assessment of skills in intraocular surgery; OSAT: Objective structured assessment of technical; OSATS: OSAT skill; HRACS: Human reliability analysis of cataract surgery; SPESA: Subjective phacoemulsification skills assessment; ESSAT: Eye surgical skills assessment test; PCE: Phacoemulsification cataract extraction; RCOphth: Royal college of ophthalmologists; WPBA: Workplace-based assessment in laboratory training is promising, but it is important to train the faculty in these newer modalities. In high-stakes assessments, rigorous validation of the assessment tools is also required before implementation. Skill acquisition and maintenance, feedback, sustained deliberate practice, curriculum integration, outcome measurement, simulation fidelity, and critical reflective learning are the keys to success.[35]

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Conflicts of interest

There are no conflicts of interest.

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