

Development and Face and Content Validity of an Eye Surgical Skills Assessment Test for Ophthalmology Residents

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Purpose: The Accreditation Council for Graduate Medical Education has called for the development of new tools for teaching and assessment in core residency competencies. Aims of this study were to respond to this mandate by developing an objective method of evaluating the surgical skills of ophthalmology residents in a microsurgery laboratory environment that could become a part of the ophthalmic surgical curriculum and competency determination, and to evaluate the face and content validity of this assessment by surveying experts in the field.

Design: Survey.

Participants: Twenty-two content experts (residency program directors and faculty members involved with resident surgical training).

Methods: We have developed a 3-station (skin suturing, muscle recession, phacoemulsification/wound construction and suturing technique) wet laboratory surgical skills obstacle course for ophthalmology residents. Each station includes instructions to the resident for completing the task as well as assessment forms, a station-specific checklist, and a global rating scale of performance, for expert surgeons to complete while reviewing the resident's videotaped performance. To establish face and content validity, content experts were sent a detailed explanation of the assessment along with a survey to facilitate constructive feedback.

Main Outcome Measures: Survey responses.

Results: Experts felt that the Eye Surgical Skills Assessment Test (ESSAT) is a useful and representative tool for assessing surgical skills of residents. Suggestions were incorporated, thus establishing the face and content validity.

Conclusions: The ESSAT has face and content validity. This tool will be useful for assessing residents' surgical skills in a laboratory environment and the impact of various teaching methods on performance. Further studies to establish the interrater reliability and construct validity of the ESSAT are underway. *Ophthalmology* 2006;113:2364–2370 © 2006 by the American Academy of Ophthalmology.

The Accreditation Council for Graduate Medical Education (ACGME) has mandated that all residency programs develop new tools for teaching and evaluating residents in 6 core competencies: patient care, medical knowledge, practice-based learning, interpersonal and communication skills, professionalism, and systems-based practice.¹ The American Board of Ophthalmology has added surgery as a separate seventh competency. These mandates represent a paradigm shift away from the traditional accreditation model for residency program review towards a competency

model. Programs now will be required to demonstrate objectively that their residents are qualified in several areas, not just the traditionally emphasized competency of medical knowledge. The ACGME has set in motion a 10-year educational process wherein residency programs must devise and implement new tools for teaching and assessing residents in the core competencies with the ultimate goals of promoting excellence in medical education and increasing public confidence.^{2–4}

Despite the obvious importance of ensuring the technical competence of residents in the operating room, the traditional methods for assessing surgical skills are inadequate and largely subjective. The absence of useful assessments has inspired the recent development of 2 tools for evaluating residents in the operating room, the Objective Assessment of Skills in Intraocular Surgery (OASIS) and Global Rating Assessment of Skills in Intraocular Surgery (GRASIS),^{5,6} as well as our development of the wet laboratory-based Eye Surgical Skills Assessment Test (ESSAT). The ESSAT is modeled after the Objective Structured Assessment of Technical Skill (OSATS) developed by Reznick et al at the University of Toronto.⁷ The OSATS is a promising tool that

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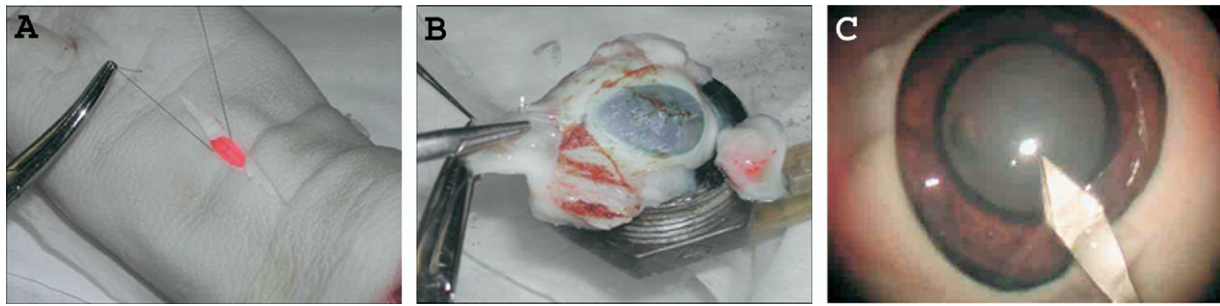


Figure 1. Photographs of Eye Surgical Skills Assessment Test stations. **A**, Station 1: temporal artery biopsy (pig foot), silk tie around simulated artery. **B**, Station 2: muscle recession (pig eye), initial weaving suture through muscle insertion. **C**, Station 3: phacoemulsification/wound construction and suturing technique (pig eye), keratome entry into anterior chamber.

has been refined by educators in the fields of general surgery and obstetrics and gynecology and is likely to satisfy the requirements of the ACGME mandate. This assessment consists of multiple simulated surgical tasks for residents to perform while faculty members evaluate them using task-specific checklists and a global rating scale of performance. Several studies have demonstrated the interrater reliability and validity of this tool.⁸⁻¹¹ Although such a surgical assessment does rely on the judgments of examiners, the inclusion of set criteria for assessing skill removes much of the subjectivity from the evaluation process.

In contrast to other surgical assessments, the ESSAT is designed to evaluate residents' basic skills before entering the operating room, where the consequences of inexperience are high. By using the controlled environment of the microsurgical laboratory, the ESSAT also offers the ability to standardize procedures so that each resident is tested under comparable conditions. The ESSAT thus provides a critical complement to the OASIS and GRASIS, which focus on the performance of residents during real-life operative experiences.

Our goal is to introduce to the field of ophthalmic surgical education a method of assessment for the microsurgical laboratory that has been proven to be reliable and valid in other fields. Our hope is that the concept will be embraced as valid and ultimately adopted by ophthalmology residency programs in the United States as a useful measure of the basic surgical skills of ophthalmology residents. This tool will be useful not only for ensuring the basic surgical competency of residents as they progress through their training, but also for evaluating the effectiveness of new teaching methods. In this preliminary study, we developed a survey to assess the ESSAT's face validity and content validity.

Materials and Methods

Eye Surgical Skills Assessment Test Design

We developed 3 simulated surgical procedures: (1) temporal artery biopsy, (2) muscle recession, and (3) phacoemulsification/wound construction and suturing technique. All procedures were designed to be performed in a wet laboratory environment using pig eyes and feet. The temporal artery biopsy is performed on a pig's foot

that has been prepared by inserting a piece of red plastic tubing, which serves as the artery, into the superficial fascia (Fig 1A). The muscle recession and cataract stations are performed on pig eyes (Fig 1B, C). For the temporal artery biopsy and muscle recession, the resident may wear loupes, and the cataract procedure is done under the surgical microscope. At each station, the resident is given instructions detailing what they are being asked to do. All necessary instruments, as well as distracter instruments, are laid out at the station for the resident. The resident is videotaped at each station, and the videos are later watched by expert surgeons who complete a task-specific checklist and global rating scale of performance for each station. Each checklist identifies the steps necessary to complete the task properly, and the global rating scale, modified from the scale developed and validated by Reznick et al at the University of Toronto,⁷ consists of 5 generic components of performance to be rated on a 5-point Likert scale, anchored by behavioral descriptors. This global rating form is also similar to the global rating scale validated in the GRASIS, which is also a modification of the Reznick et al scale.⁶

Survey

The survey was designed to determine whether the ESSAT is an appropriate way to assess residents' beginning surgical skills (face validity) and whether the content of the ESSAT stations and assessment forms represents the surgical skills and techniques upon which residents should be evaluated (content validity). Survey questions addressed the assessment as a whole as well as the individual stations (Fig 2). We distributed the survey to residency program directors using the American Academy of Ophthalmology's e-mail distribution list for program directors. This distribution list included approximately 80 program directors (all those registered on the listserv at that time). A few program directors forwarded the e-mail to other surgeons who are closely involved with resident education. Along with the survey, we sent a computer slide presentation that detailed the elements on each checklist as well as the global rating scale and provided step-by-step photographs of each station being completed by a member of the research team. The survey results were tabulated and the ESSAT was modified accordingly.

Results

Twenty-two residency program directors and surgical educators responded to the survey. Although these respondents represent a small percentage of all U.S. ophthalmology programs, they are a diverse group in terms of both program size and geographical

Station 3 – Phacoemulsification: Wound Construction & Suturing Technique:

13. Were the instructions to the resident self explanatory? Yes _____ No _____
Comments:
14. Does the checklist include the most essential elements of the procedure?
Yes _____ No _____
Comments:
15. Is this simulated procedure similar enough to its real-life counterpart?
Yes _____ No _____
Comments:
16. Are the skills needed for this procedure representative of the skills that residents should be mastering during their training? Yes _____ No _____
Comments:
17. Will this procedure capture important deficiencies, if present, in residents' surgical technique? Yes _____ No _____
Comments:
18. Is there anything else that should be added/changed regarding this station?
Yes _____ No _____
Comments:

General

19. Does the global rating scale include all the essential and most fundamental categories of technique?
Yes _____ No _____
Comments:
20. Are there any essential elements of surgical skill that are not assessed at these three stations? (Note: the intent is to assess technique and minimal competency rather than be an exhaustive assessment of knowledge or ability)
Yes _____ No _____
Comments:

Figure 2. Survey sent to content experts to determine content validity of the Eye Surgical Skills Assessment Test. Questions 1 to 12 consisted of the same questions asked in 13 to 18, but in reference to stations 1 and 2 rather than station 3.

location. Overall, most of the responding content experts thought that each station was similar enough to its real-life counterpart (station 1, temporal artery biopsy, 86%; station 2, muscle recession, 95%; station 3, phacoemulsification, 100%) and representative of the skills that residents should be mastering during their early training (1, 86%; 2, 95%; 3, 100%). The majority of responders agreed that the ESSAT would be able to capture important deficiencies, if present, in residents' surgical technique (1, 95%; 2, 86%; 3, 95%) (Table 1). The suggestions of content experts were incorporated into the final assessment forms (Figs 3–6). Three of the 22 responding content experts noted that some elements of the

temporal artery biopsy station do not represent the basic skills required of a general ophthalmologist. In addition, 2 of these 3 experts and 1 additional expert noted that our model is not sufficiently similar to the real procedure, particularly for the management of hemostasis, which is a crucial component of any temporal artery biopsy. Due to this feedback, combined with the difficulty of consistently ensuring proper placement of the tubing in the superficial fascia, we made significant alterations to this station. We eliminated the elements of this station that were unrealistic or unreliable (plastic tube) and uncommon for the general ophthalmologist (temporal artery biopsy itself). However, the general

Table 1. Survey Responses to Selected Questions

	Is This Simulated Procedure Similar Enough to Its Real-Life Counterpart?	Are the Skills Needed for This Procedure Representative of the Skills That Residents Should Be Mastering during Their Training?	Will This Procedure Capture Important Deficiencies, if Present, in Residents' Surgical Technique?
Temporal artery biopsy	18/21 (86)	18/21 (86)	20/21 (95)
Muscle recession	20/21 (95)	20/21 (95)	18/21 (86)
Phacoemulsification	22/22 (100)	22/22 (100)	21/22 (95)

Reported as the fraction (percent) of respondents answering "yes" to the question.

Skin Suturing

Instructions given to resident:

At this station, you will partially close the incision that has been made on this pig's foot. Prepare the wound for closure by sterilizing and anesthetizing the field. Then close the wound partially with one deep vertical suture and two throws on a running skin suture.

ITEM	Not Done or Incorrect	Done Correctly
Thoroughly sterilizes field	0	1
Injects anesthetic subcutaneously	0	1
Always pulls back on syringe before injecting	0	1
Selects appropriate instruments for deep suture	0	1
Loads needle 1/2 to 2/3 from tip	0	1
Needle enters perpendicular to tissue	0	1
Correctly completes deep vertical suture	0	1
Selects appropriate instruments for superficial suture	0	1
Correctly completes 2 throws running skin suture	0	1
Knots are tied properly	0	1

Figure 3. Checklist for station 1.

concept of the station, assessment of macroscopic skin suturing skills, remains the same. As a consequence of these changes, we have changed the title of station 1 from “temporal artery biopsy” to “skin suturing.” We also added a section on local anesthesia and skin preparation to this station, as suggested by several survey respondents. Other useful comments that were incorporated into the ESSAT included phrasing all checklist items positively to be consistent, avoiding checklist items that involve more than one step in the procedure, making items on checklists vague enough to allow for variations in technique (e.g., for station 2, change “completes 2-1-1 surgeons knot correctly” to “completes an appropriate knot correctly”), and clarifying the instructions for the muscle recession. Several respondents suggested the addition of stations on capsulorrhexis and nuclear removal and eyelid surgery. By surveying content experts and incorporating their suggestions, we have established the face validity and content validity of the 3-station ESSAT.

Muscle Recession

Instructions given to resident:

This station is designed to test your ability to perform a rectus muscle recession. A member of the research team will identify for you the muscle which will be weighed down with a hemostat. First, demonstrate technique for a conjunctival peritomy in any area where conjunctiva is available on the specimen eye. You are then required to suture and cut the muscle and then reattach the in a recessed position behind the original insertion.

ITEM	Not Done or Incorrect	Done Correctly
Incises conjunctiva at limbus with scissors	0	1
Bluntly dissects conjunctiva with scissor	0	1
Holds scissor in correct orientation while dissecting	0	1
Cuts conjunctiva	0	1
Spreads into posterior segment using scissors	0	1
Isolates muscle and places muscle hook at an appropriate distance from the sclera	0	1
Selects appropriate suture (polysorb with 6-0 spatulated needle)	0	1
First throw uses appropriate weaving pattern	0	1
Second throw in correct orientation through full-thickness	0	1
Locks second throw	0	1
Always approaches eye with flat portion of needle	0	1
Leaves needles on sutures	0	1
Holds up suture and muscle hook while detaching muscle	0	1
Inspects field between cuts on the muscle	0	1
When reattaching muscle to sclera needle passes through partial thickness sclera	0	1
Needle is always visible through sclera	0	1
Completes an appropriate knot correctly	0	1
Completes three throws per suture	0	1

Figure 4. Checklist for station 2.

Phacoemulsification: Wound Construction & Suturing Technique

Instructions given to resident:

This pig has come to your operating room for a phacoemulsification procedure. Prepare the wounds using two handed technique (ie create paracentesis, inject viscoelastic and create a self-sealing wound for the phaco tip). Enlarge wound to be large enough for three sutures and then close the wound by performing one of each of the following knots: a slip knot, a 2-1-1 and a 3-1-1 instrument tie. When finished, check the wound for leaks.

ITEM	Not Done or Incorrect	Done Correctly
Uses second hand to appropriately assist with paracentesis (grasps tissue or applies pressure)	0	1
Uses correct blade to enter through clear cornea at the appropriate site	0	1
Blade travels through the cornea parallel to the iris and pierces Descemet's membrane while avoiding the iris and lens	0	1
Injects viscoelastic into anterior chamber	0	1
Grasps tissue with 0.12, uses crescent blade to tunnel up cornea, dipple down and then enter the anterior chamber	0	1
Blade enters at 10 or 2 o'clock on side of dominant hand	0	1
Enlarges wound	0	1
Selects appropriate needle and loads properly and with ease	0	1
Needle entry and depth are appropriate	0	1
Properly completes slip knot	0	1
Properly completes 2-1-1 knot	0	1
Properly completes 3-1-1 knot	0	1
Successfully avoids breaking sutures, tying air knots and inadvertent pull throughs	0	1
Ensures good wound apposition	0	1
Checks wound for leak by applying pressure with a cellulose sponge	0	1

Figure 5. Checklist for station 3.

Discussion

Our main purpose is to introduce to the field of ophthalmic surgical education a method of assessment for the microsurgical laboratory that has been proven in other fields to be reliable and valid. Such a standardized assessment tool is needed to ensure residents' basic competency before entering the operating room and to improve the overall process of early surgical education in ophthalmology residency. To this end, we have developed the ESSAT and have assessed its face validity and content validity by analyzing the responses of 22 content experts to a detailed questionnaire about the ESSAT. We have incorporated their suggestions for improving the assessment. Experts felt that the ESSAT appears to be an appropriate way to assess residents' early surgical skills (face validity) and that the content of the ESSAT represents the skills and techniques upon which residents should be evaluated (content validity).

Ensuring the surgical competency of residents is one of the most critical responsibilities of an ophthalmology residency program; however, the formal assessment of residents' surgical skills is poorly developed. Resident assessment traditionally has focused primarily on medical knowledge through the ophthalmic knowledge assessment program and other written and oral examinations. However, with the shift toward competency-based accreditation, residency programs are responding to the call to develop valid assessment tools in all of the competencies, including surgery.^{5,6,12-15}

Unstructured faculty evaluations written at the end of a rotation and faculty meetings with discussion of residents' abilities are the main form of surgical assessment in ophthalmology. These summative reviews tend to use imprecise language and be subjective and unreliable, often with little



Global Rating Scale of Operative Performance

Please circle the number corresponding to the subject's performance in each category

Respect for Tissue:				
1	2	3	4	5
Frequently used unnecessary force on tissue or caused damage by inappropriate use of instruments		Careful handling of tissue but occasionally caused inadvertent damage		Consistently handled tissues appropriately with minimal damage
Time and Motion:				
1	2	3	4	5
Many unnecessary or repetitive movements		Efficient time/motion but some unnecessary and repetitive moves		Clear economy of movement and maximum efficiency
Instrument handling:				
1	2	3	4	5
Repeatedly makes tentative or awkward moves with instruments by inappropriate use of instruments		Competent use of instruments but occasionally appeared stiff or awkward		Fluid moves with instruments and no awkwardness
Flow of Operation:				
1	2	3	4	5
Frequently stopped operating and seemed unsure of next move		Demonstrated some forward planning with reasonable progression of procedure		Obviously planned course of operation with effortless flow from one move to the next
Knowledge of Procedure:				
1	2	3	4	5
Deficient knowledge. Did not know what to do at most steps		Knew all important steps of operation		Demonstrated familiarity with all aspects of operation

Figure 6. Global rating scale of performance.

agreement between surgeons on the skill level of a given resident.¹⁶ Procedure logs also are usually included in a resident's portfolio; however, these logs reflect only quantity of experience, not quality of performance. Other techniques available for resident surgical assessment include written or oral examinations, which can assess surgical knowledge but not technical competence. Morbidity and mortality data can be used as a proxy for surgical skill but are influenced by patient characteristics and may not reflect an individual resident's surgical ability.¹⁷ Surgical skills assessment forms, such as the GRASIS,⁶ that are filled out by faculty members after a resident performs a surgical procedure or after video review of operative procedures are promising tools for assessing the performance of residents in real-life situations. The drawback of the GRASIS is that these real-life operative situations cannot be standardized, given the variability and unpredictability of live surgery. The OASIS is a promising and purely objective tool for assessing residents' performance in the operating room.⁵ Virtual reality simulations and hand motion analysis show promise as tools of the future to assess technique objec-

tively. In Grober et al's recent study, hand motion analysis was shown to have construct validity for the evaluation of performance on microsurgical tasks.¹⁸ Construct validity is another way to ensure that a test is measuring what it is intended to measure. In this context, construct validity is used to ensure that individuals who are likely to be more competent surgeons do better on the proposed test than those who are less likely to have good surgical skills. In the study by Grober et al, the economy of hand motion of residents at different levels in their training was compared (e.g., postgraduate year 2 vs. postgraduate year 4 residents) and those with more training performed superiorly (i.e., fewer hand movements). With all of these assessment options, new and old, there is still the need for a standardized assessment tool to evaluate residents' surgical skills before entering the operating room; for this reason, we began the development of the ESSAT.

The task of developing the ESSAT was facilitated by the efforts of educators in other fields over the past decade. These groups not only pioneered the design of the OSATS but have explored its test characteristics and applications.

As a result, they have demonstrated that the examination format of the OSATS can satisfy the essential requirements for an assessment tool: reliability; validity; and, to an extent, feasibility. In these studies, task-specific checklists and the global rating scale have yielded consistent results even when multiple faculty members are rating an individual (interrater reliability, 0.64–0.98).^{8–10,19,20} This finding is important because, in contrast to the OASIS form, which uses only objective surgical data,⁵ the OSATS and ESSAT rely on the judgments of examiners. The strong interrater reliability of the checklists and global rating scale supports the objectivity of these examinations. Construct validity, as defined previously, also has been established for the checklists and global rating scale used in the OSATS.^{8–10,19–21} Comparing the 2 rating methods, global rating scales have superior ability to discriminate among resident levels when compared with checklists.^{7,8,10} Despite this, checklists are valuable to include because they can provide the resident with a list of specific items upon which to improve.

Many other test characteristics and principles have been examined for the OSATS. For instance, bench model simulations have been demonstrated to be as reliable as using live anesthetized animals.⁸ This allowance greatly improves the feasibility of such examinations. The OSATS format also has been used to assess the effectiveness of different teaching methods. This provides evidence that the OSATS is useful not just for assessing residents but also for improving the quality of teaching.^{22,23} One study showed equal reliabilities and validities for an OSATS using raters blinded to the residents' level of training and for one using unblinded raters.¹⁹ This lack of rater bias offers further evidence of the objectivity of the examination. In addition, one group demonstrated that their OSATS functioned well at more than one residency program, providing evidence of the generalizability of the test.²⁴

Some major obstacles to the implementation of the OSATS are the time and resources required to coordinate several faculty members to observe the performance of the residents. In the ESSAT, retrospective video watching will allow faculty to complete their assessments when their schedules permit and will provide the added benefit of blinding the raters, thus eliminating a potential source of bias. One study that used video review showed strong construct validity and interrater reliability.²⁵ High-quality recording is a necessity, as the utility of videotapes is proportional to their realism. The amount of faculty time the ESSAT would require for an average-size residency program (4 residents/year), if the ESSAT is performed twice a year and requires 45 minutes per resident (15 minutes/station), is approximately 18 hours. If 2 raters watch each video segment and 4 faculty members agree to participate, the time commitment for each faculty member would be 9 hours per year. Additional resources and time will be required initially to ensure that the microsurgical laboratory is appropriately equipped and to purchase video equipment.

Another shortcoming of the OSATS or ESSAT is that performance in the wet laboratory does not provide information about the resident's decision making, judgment, and handling of complications during real procedures. The wet laboratory assessment, however, has other unique benefits.

The ESSAT is able to assess residents' competence in basic surgical skills before they begin to test these skills in the operating room. The laboratory setting allows residents to complete tasks without the time constraints and patient risks present in the operating room. In addition, procedures in the laboratory can be standardized so that each resident is tested under comparable conditions. To assess resident performance in the operating room, complementary assessments, such as the OASIS and GRASIS,^{5,6} are necessary.

One weakness of our study is that a small percentage of content experts responded. It is therefore possible that those with a positive impression of the ESSAT were more likely to have responded to the survey than those with a negative impression. We believe such response bias is unlikely, however, given the nature of the research and population being surveyed. Although several experts recommended stations involving capsulorrhexis and nuclear removal as well as eyelid suturing, we have held off on adding these elements to the ESSAT. Despite the critical importance of these skills to the competency of an ophthalmic surgeon, we do not yet have an affordable and widely available model that adequately represents these tasks.

In summary, our goal was to develop an objective and standardized test of beginning surgical skills and establish the face validity and content validity of this test. Continued progress is needed to meet the aims of the ACGME mandate. Future studies will assess the interrater reliability; construct validity; and, eventually, predictive validity of the ESSAT. Through these studies, the specific stations and assessment forms used in the ESSAT will be further refined. Whether using these 3 stations or others, we propose that a specific group of tasks rigorously assessed in a laboratory environment should become a part of the surgical curriculum in all residency programs. Our hope is that once the reliability and validity of the ESSAT have been established definitively, this tool will be applied in a variety of ways. Future roles for the assessment include testing of residents at the beginning of residency and at the end of each residency year to provide constructive feedback and target residents who may need remediation. The ESSAT will open the door to testing the effectiveness of various surgical training methods by performing controlled experiments where the assessment is taken both before and after a training session. In addition, the ESSAT will provide specific goals and a structure that will guide and facilitate residents' use of wet laboratory facilities for improving their skills. Ultimately, this assessment may be used to ensure that all ophthalmic surgeons achieve a certain level of technical proficiency before training in the operating room, where other assessment tools can be applied.

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