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Case study and pilot results: Stepwise approach to teach a resident tube shunt surgery

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ABSTRACT

Purpose: To illustrate the utility of a previously published stepwise rubric for evaluating a resident's progress learning aqueous tube shunt surgery.

Method: Using a stepwise rubric, a single PGY3 ophthalmology resident and attending glaucoma surgeon evaluated the resident's performance after each aqueous tube shunt surgery. The rubric subdivides the surgery into 12 consecutive steps and scores the resident's proficiency in each step with either a 0 (observation), 2 (novice), 3 (beginner), 4 (advanced beginner), or 5 (competent).

Results: The resident's cumulative score increased significantly throughout the 17 surgeries performed, with the resident's self-evaluated score and attending's score increasing from 12 to 27 and 14 to 27 from the first to last surgery, respectively. Scores were consistent between the resident and attending; for any given surgery, the resident's own score never deviated from the attending's score by more than 1 point. The resident completed at least 50% of the steps in 11 of the 17 cases. While some surgical steps were mastered earlier on ("tube tying" and "suture implantation"), other steps were more challenging to master ("tunnel in sclera and enter the AC" and "close conjunctiva", as demonstrated by fewer overall attempts or never attaining a score of '5' despite multiple attempts.

Conclusions and Importance: This study demonstrates the utility of the stepwise rubric in tracking resident surgical scores chronologically via self and attending assessment. The ability to compare their own scores to that of an attending allows the resident to learn how to effectively evaluate their own performance. Most importantly, statistics obtained for each step provides the resident with personalized and real-time feedback for learning specific surgical steps. In conclusion, the stepwise rubric is a useful add-on to a resident's aqueous tube shunt surgery education.

1. Introduction

Ophthalmic microsurgery training can be challenging for both learners and educators. Cataract surgery steps involving stereopsis and precise hand control are particularly difficult for trainees,[1] and a stepwise curriculum for cataract surgery has been implemented by several institutions.[2,3] The Accreditation Council for Graduate Medical Education requires United States ophthalmology residents to perform at least five "filtering or shunting procedures," for example trabeculectomy or tube shunt surgery.[4] While some glaucoma training curricula have been described, a systematic stepwise approach to surgery education has not been widely adopted.[5,6]

2. Materials and methods

An internationally standardized and validated rubric for tube shunt surgery has been recently developed (Table 1).[7] The rubric divides the procedure into 12 steps: (1) draping, (2) corneal traction suture, (3) conjunctival peritomy & posterior dissection, (4) tube ligation, (5) tube fenestration, (6) implant insertion, (7) suture implantation, (8) trim tube, (9) scleral tunnel & enter eye with needle, (10) tube insertion, (11) patch graft placement, and (12) conjunctival closure. For each step, proficiency is scored from 0 (observation) to 5 (competent), and the rubric contains details describing the requirements to achieve each score. A score above 0 is only possible if the resident attempts that step.

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Table 1
Ophthalmology surgical competency assessment rubric (OSCAR) for tube shunts.

Surgical Step	Novice Score = 2	Beginner Score = 3	Advanced Beginner Score = 4	Competent Score = 5	Not applicable or done by preceptor Score = 0
Draping	Unable to start draping without help	Drapes with minimal verbal instruction. Incomplete lash coverage.	Lashes mostly covered, drape at most minimally obstructing view. Attains proper head position.	Lashes completely covered and clear of incision site, drape not obstructing view.	
Corneal traction suture	Unable to describe purpose and method of inserting corneal traction suture. Causes a full thickness corneal perforation that requires sutures to repair.	Difficulty loading needle, needs instruction for correct needle placement and completion of suture placement. Placement of traction suture prevents appropriate rotation of the globe.	Able to load and handle needle appropriately. Some difficulty in finding correct depth of suture, needs instruction, needle track too deep or too shallow or bite not of ideal size.	Able to place the suture with the appropriate length and depth and then achieve the desired rotation of the eye for exposure.	
Conjunctival peritomy & posterior dissection	Able to describe but not able to perform conjunctival incision for tube shunt surgery.	Able to perform conjunctival incision but is inefficient and requires guidance. Has difficulty judging appropriate length of incision, dissecting down to sclera. Inappropriate force applied to the tissues including the conjunctiva, sclera, or muscles.	Able to perform conjunctival incision but is inefficient or tentative and requires guidance with technique and/or position and size of incision.	Performs conjunctival incision without creating buttonholes and with no disruption of adjacent tissues. Incision is of correct size (i.e. enough to give proper exposure for performance of posterior subTenon's dissection and insertion of tube.	
Tie off the tube, confirm non-patency [For Non-Valved Tubes]	Unable to successfully ligate the tube.	Multiple attempts to achieve ligature. Failure to properly confirm/deny non patency.	Tube ligated on first attempt, but inefficiencies in achieving or confirming ligature.	Efficiently and effectively ligates the tube	
Fenestrate tube [For Non-Valved Tubes]	Unable to successfully fenestrate the tube or damages it irreparably	Fenestrations not patent or are sufficiently de-centered as to be less effective.	Obtains patent fenestrations but inefficiently, with multiple unsuccessful attempts or excessive handling of the tube.	Efficiently fenestrates the tube, the tract is well centered within the diameter of the tube, without multiple unneccessary or incorrect needle passes.	
Insert implant ± under muscles	Unable to place plate posteriorly	Implant is inserted too deep or too shallow. If implant was meant to be inserted under the muscle, this was not achieved. Requires guidance to achieve correct implant insertion site.	Implant is inserted into the correct position, but requires multiple attempts or there is moderate trauma to the surrounding tissues or excessive bleeding.	Implant is successfully and efficiently inserted into the correct position without any trauma to the surrounding tissues.	
Suture implant to sclera	Unable to successfully place sutures to secure the implant to the sclera - sutures too shallow or too deep or not tied so as to keep the implant in place	Difficulty loading needle, needs instruction for correct needle placement and completion of suture placement. Excessive bleeding from sclera obscuring view.	Multiple attempts. Suture breaks when trying to cinch it down. Needle cheese wires through the sclera. Needle pass is too superficial or too deep, but able to be successfully tied, but the knot is exposed.	Efficiently and effectively sutures the implant to the sclera, needle is the correct depth in the sclera, the suture does not break while trying it down, the knot is buried, there is adequate hemostasis and surgical exposure	
Trim the tube	Unable to cut tube or tube is unusable after this step	Excessive handling of the tube, tube is trimmed to the wrong length and inserted into the AC without revising it first.	Tube is cut too long and must be re-trimmed. Bevel is not facing the correct direction. Cut edge is jagged rather than smooth. Guidance is required to achieve appropriate length of tube.	Efficiently trims the tube with one attempt, without excessive handling of the tube with forcep.	
Tunnel in sclera and enter the AC with needle [or sulcus or vitreous cavity for pseudophakic or vitrectomized eyes respectively]	Unable to enter the anterior chamber with the needle, or the needle causes significant damage to tissue	Path of needle tract is sufficiently wrong that it must be re-done (multiple attempts)	Path of tract is acceptable but not ideal (too anterior, too posterior). Unintended trauma to adjacent tissues.	Needle is tunneled through sclera and enters the anterior chamber in the correct position on the first attempt with no trauma to the cornea or the iris.	
Insert tube in AC [as above]	Unable to successfully place tube into the anterior chamber	Requires significant guidance to get tube through tract into the anterior chamber.	Position in anterior chamber is correct, but there was excessive handling of the tube or the ocular tissues.	Tube is inserted into the scleral needle tract with minimal resistance and enters the anterior chamber at the correct angle, with minimal excessive manipulation or handling of the tube.	
Placement of patch graft	Unable to successfully pass sutures to secure patch graft	Graft is malpositioned and unable to revise without assistance.	Graft adequately if not ideally placed or sutures not with ideal tension or location.	Graft covers the maximum length of the tube, sutures are the correct tension, knots are buried.	
Close conjunctiva	Unable to close conjunctiva. Unable to differentiate Tenon's capsule from conjunctiva.	Able to perform basic conjunctival closure technique but is inefficient and requires significant guidance.	Able to safely close conjunctiva with good tissue approximation but is inefficient. Requires guidance to ensure closure is	Able to safely and efficiently close conjunctiva with good tissue approximation, no exposure of tube or patch. Has	

(*continued on next page*)

A score of 0 is given if the resident does not attempt that step due to insufficient skill or time at the attending physician's discretion.

At the University of Chicago, residents complete the glaucoma rotation during the PGY-3 year. During the 2022–2023 academic year, this rubric was immediately individually filled out by the resident and the attending each time a resident participated in a tube shunt surgery. The rubrics were immediately compared, the resident's performance was discussed, and feedback was given. At the end of the academic year, Institutional Review Board exemption was obtained, and informed consent was obtained from the resident who performed the most tube shunts (JW) to conduct a retrospective review of their rubrics. Herein, we describe a case study of a single glaucoma specialist (MQ) teaching a single PGY-3 resident (JW) to perform tube shunt surgery while utilizing this rubric to assess performance after each case during one academic year. This work is in accordance with the 1964 Helsinki declaration.

The resident's and attending's percentage and step-specific scores were trended over time. Descriptive statistics were collected, including the number of times each step was attempted, the surgery number during which the resident first attempted each step, and the surgery number during which the resident first received a score of '5' on each step.

3. Results

The resident participated in 17 tube shunt surgeries under the attending's supervision. Approximately 2 min were spent filling out each evaluation, after which the resident provided verbal self-evaluation and the attending provided verbal feedback and answered questions for approximately 5 min. Of note, the resident never received a score for step 2 (corneal traction suture) because the attending does not perform this step as part of their technique. The resident performed steps 4, 7, and 11 in all seventeen cases and performed steps 8, 9, 10, and 12 in five or fewer cases (Table 2). This was due to the attending's teaching philosophy of allowing residents to perform easily correctable steps earlier on and introducing higher-risk steps in future surgeries. The resident never gave themselves a score of '5' on steps 3, 8, and 10, despite the attending giving the resident a score of '5' at least once. The attending never gave the resident a score of '5' for steps 9 and 12. The resident's percentage score, calculated as a fraction of total points obtained by total points available for the steps attempted, increased throughout the year (Fig. 1). The resident's and attending's scores increased from 48% and 56%, respectively, for the first surgery to 93.3% and 90%, respectively, for the last surgery. The resident's and attending's scores never differed by more than 1 point on any step in any case, and the total percentage scores for a given case never differed by more than 8 percent.

Table 2
Learning Curve by Surgical Step. Steps are as follows: (1) draping, (2) corneal traction suture, (3) conjunctival periometry & posterior dissection, (4) tube ligation, (5) tube fenestration, (6) implant insertion, (7) suture implantation, (8) trim tube, (9) scleral tunnel & enter eye with needle, (10) tube insertion, (11) patch graft placement, and (12) conjunctival closure.

Step #	Total Attempts	Surgery # at First Attempt	Attempt # with First Score of '5' [Attending]	Attempt # with First Score of '5' [Resident]
1	14	1	3	3
2	N/A	N/A	N/A	N/A
3	9	5	10	Did Not Occur
4	17	1	3	3
5	13	5	3	1
6	15	1	6	9
7	17	1	3	3
8	1	13	1	Did Not Occur
9	2	11	Did Not Occur	Did Not Occur
10	2	11	2	Did Not Occur
11	17	1	2	4
12	5	8	Did Not Occur	Did Not Occur

This table depicts the total number of attempts required by the resident for each step, along with the surgery during which the resident first attempted the step, and during which attempt the resident first received a score of '5' via both self-evaluation and attending evaluation. Of note, because the attending does not perform step 2 as part of their technique, no scores were given for this step.

4. Discussion

The rubric data showcased many aspects of the resident's performance. Table 2 demonstrates that certain steps required more attempts to master than others. Step 4 (tube ligation) was performed by the resident in all 17 cases, and they received a '5' from the attending by the third case. This step may be easier to teach and learn than step 6 (implant insertion), as this was attempted 15 times and received a '5' on the sixth attempt. While residents may perceive that certain steps are harder, using a standardized rubric allows both the resident and attending to objectively assess which steps require more practice. This real-time feedback allows trainees to focus on improving specific skills, and this has also been replicated in other studies that use stepwise rubrics in cataract surgery.[8,9]

The total percentage score depicted a gradual improvement in the resident's surgical skills (Fig. 1). This can instill confidence for the resident, while also providing a means of comparison between their perceived performance to that of their attending.

Limitations include that these pilot results are only from a single resident-attending pair at a single academic center, and that the chosen resident is planning to pursue glaucoma fellowship training, so the results may not be generalizable to all trainees. This attending has a specific teaching style, including a specific order that they prefer to introduce each surgical step to a new learner, which could affect rubric scores and trends. Finally, the resident practiced certain steps in a simulation lab setting which may have impacted their apparent "learning curve" on certain steps. Future studies with trainees and educators from a wide variety of training levels and settings are needed to draw further conclusions about the utility of this rubric.

5. Conclusions

These pilot results demonstrate that a standardized rubric and

Table 1 (*continued*)

Surgical Step	Novice Score = 2	Beginner Score = 3	Advanced Beginner Score = 4	Competent Score = 5	Not applicable or done by preceptor Score = 0
		Additional sutures are required. Significant exposure of the patch graft, tube, or plate. May have buttonhole of conjunctiva.	effective without a leak. Placement of additional sutures or replacement of loose sutures required before closure is complete.	good understanding of various suture types, appropriate needles and different closure techniques.	

Adapted with permission from "Qiu M, Avdagic E, Ramulu PY, Golnik K, Boland MV. Ophthalmology Surgical Assessment of Tube Shunt Glaucoma Surgery. Ophthalmology Glaucoma. 2023; 6(1):100–105."

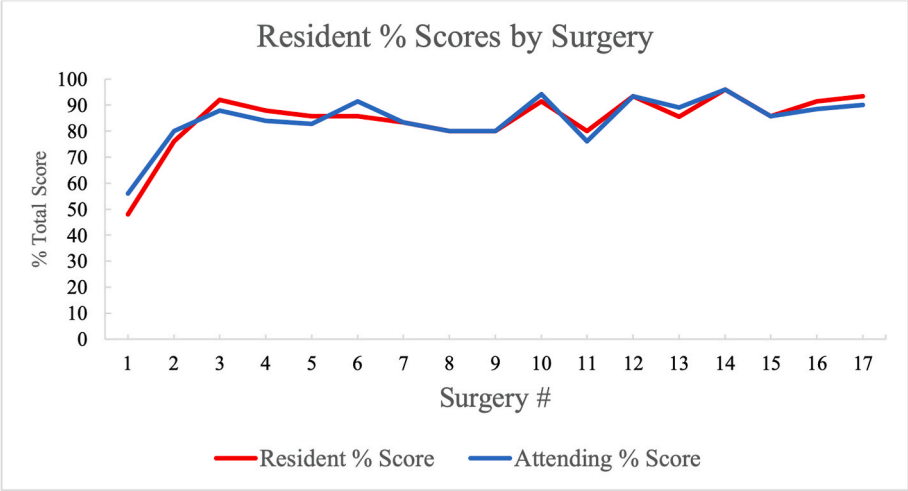

Fig. 1. Resident % Scores by Surgery. This figure depicts the percentage score the resident received for each surgery in chronological order based on both their own and the attending's evaluation. The percentage score for any surgery was calculated by dividing the total points obtained during that surgery by the total number of points available for steps attempted. The specific steps attempted and the number of steps attempted for any surgery was determined by the attending based on resident skill and scheduling constraints.

stepwise approach for teaching residents tube shunt surgery may be useful. The rubric enables trainees and educators alike to track progress over time, display personalized and real-time strengths and weaknesses for specific surgical steps, and depict differences between self-evaluation and formal attending evaluation. A future survey study of trainees and educators who have used this tube shunt rubric may reveal whether this tool enhances their ability to learn and teach, respectively. Similar studies to this one should also be performed on other non-glaucoma standardized rubrics that are currently publicly available to depict stepwise applications in other types of ophthalmic surgery.[10]

Participant consent

Informed consent to publish this case report was obtained by the participating resident.

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Authorship

All authors attest that they meet the current ICMJE criteria for authorship.

CRediT authorship contribution statement

Hassaan Asif: Formal analysis, Investigation, Project administration, Validation, Writing – original draft, Writing – review & editing. **Jessie Wang:** Conceptualization, Data curation, Investigation, Project administration, Validation. **Mary Qiu:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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