




Evolution of a Glaucoma Fellow's Surgical Training: Improvements in Tube Shunt Case Times during the Academic Year

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Abstract

Purpose The aim of the study is to report changes in tube shunt placement surgical case times for glaucoma fellows during the course of the academic year.

Patients and Methods Electronic health records were retrospectively reviewed to determine patient demographics, surgical case times (defined as procedure start time to procedure end time), and glaucoma fellow involvement. Only cases with a glaucoma fellow as the primary surgeon were included. Operative case times were compared by first and second halves of the academic year (beginning in July and ending in June) using a two-tailed *t*-test.

Results Five hundred and seventy-three individual tube shunt surgeries (385 Ahmed, 188 Baerveldt) performed by 28 glaucoma fellows (17 females, 11 males) at Duke University Eye Center and University of North Carolina Medical Center were included. Overall, case times were significantly shorter in the second half of the academic year as compared with the first (55.3 ± 17.1 minutes vs. 61.0 ± 17.4 minutes, $p < 0.001$). Both male (57.3 ± 16.8 minutes vs. 63.2 ± 18.6 minutes, $p = 0.008$) and female (53.5 ± 17.3 minutes vs. 59.3 ± 16.4 minutes, $p = 0.003$) fellows demonstrated shorter case times over the academic year; additionally, female fellows trended toward shorter case times than male fellows in both the first half ($p = 0.072$) and second half ($p = 0.053$) of the academic year. Fellows also exhibited shorter case times with both Ahmed implants (54.1 ± 16.2 minutes vs. 59.3 ± 15.8 minutes, $p = 0.002$) and Baerveldt implants (57.8 ± 18.9 minutes vs. 64.2 ± 20.0 minutes, $p = 0.025$) cases over the academic year. Baerveldt case times were significantly longer than Ahmed cases in the first half ($p = 0.028$) and trended toward being longer than Ahmed cases in the second half ($p = 0.070$).

Conclusion Across 5 years at two academic institutions, glaucoma fellows had shorter primary tube shunt surgical case times in the second half of the academic year. These findings reflect improvement in surgical efficiency throughout glaucoma fellowship. These findings should be taken into consideration when scheduling trainee surgeries at academic medical centers at different points in the academic year.

Keywords

- ▶ glaucoma
- ▶ surgery
- ▶ tube shunt
- ▶ Ahmed
- ▶ Baerveldt
- ▶ fellows
- ▶ surgical education

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Surgical education in ophthalmology is imperative for ensuring patient safety and preparing future physicians for independent surgical practice. In the subspecialty of glaucoma, fellows commit 1 year following ophthalmology residency to gain additional surgical experience in complex aqueous filtering surgeries, including tube shunt placement and trabeculectomy. While the importance of surgical education in glaucoma fellowship is widely acknowledged, there is limited literature reporting the quantitative impact of a dedicated fellowship program on surgical efficiency. Additionally, the logistical implications of surgical scheduling in ophthalmology fellowship programs at various points in the academic year have not been explored in detail.

Several studies have sought to characterize trainee surgical outcomes in ophthalmic surgical training programs.^{1–7} For residents, surgical experience is one of the primary drivers of improvements in operative case times for cataract surgery over the course of training, with more cases yielding shorter case times, particularly early in training.^{8–10} While trainees may need a considerable number of cases as primary surgeon to gain surgical mastery, there is a clear opportunity cost of trainee surgical involvement. A recent cost-analysis paper found that in California (fiscal year 2014), 1 minute of operating room time was worth \$36 to \$37.¹¹ In strabismus surgery, the cost of resident involvement was reported to be \$3141.95 per year due to increased operative times.¹² For orthopaedic surgery residents in 1996 to 1997, operating room costs were increased by \$661.85 on average for trainee cases due to increased operative time.¹³ In plastic surgery, 2011 costs were estimated to be \$275 per trainee involved in a given case, and over \$440 per case for craniofacial surgical fellows.¹⁴ As such, understanding potential improvements in surgical case times over the course of glaucoma fellowship could help us better measure surgical training and could galvanize efforts to improve surgical education for fellows.

The landscape of glaucoma filtering surgery has changed dramatically in the last two decades. Studies have shown an increase in tube shunt placement with a concomitant decrease in trabeculectomy surgery among national Medicare claims¹⁵ as well as resident and fellow case logs^{16,17}; this may be due to several factors, including the feared complications of bleb filtering surgery (bleb-related endophthalmitis, hypotonous maculopathy) as well as improvements in tube shunt devices. In the wake of the Tube versus Trabeculectomy study¹⁸ and the Primary Tube Versus Trabeculectomy study,¹⁹ which have provided invaluable comparisons between tube shunt and trabeculectomy surgeries, it is likely that rates of tube shunt administration will continue to increase. Education in tube shunt placement will be a core component of glaucoma surgical training for the foreseeable future; however, the current state of glaucoma fellows' case times for tube shunt placement has not been reported. As such, we sought to report operative case times for glaucoma fellows at the Duke University Eye Center and the University of North Carolina (UNC) over a 5-year period (2014–2019), to determine whether fellows attain greater surgical efficiency over the course of the academic year.

Materials and Methods

Prior approval for this retrospective study was obtained from the Duke University Health System and University of North Carolina Institutional Review Boards, and the requirement for informed consent was waived. This study complied with the Health Insurance Portability and Accountability Act of 1996 and followed the tenets of the Declaration of Helsinki.

Retrospective clinical data regarding tube shunt placement cases was abstracted using the electronic health record at UNC and Duke (Epic, Verona, WI). We reviewed all procedures coded using Current Procedural Terminology 66180 for aqueous shunt placement performed from July 2014 to June 2019. All cases that were primarily performed by the fellow were identified and included by attending faculty attestation and/or documentation. The cases included constitute a representative sample of each fellow's surgical cases with select faculty at each institution and are not intended to represent the holistic surgical curriculum offered by each respective program. Tube shunt procedures performed in combination with a secondary procedure (i.e., cataract surgery, trabeculectomy, vitrectomy) were excluded from analysis to eliminate the confounding effect of a second procedure on operative time.

Patient demographic data (age and sex), procedure date, fellow involved, attending/supervising surgeon, and type of tube shunt placed (Ahmed glaucoma valve, New World Medical Inc, Rancho Cucamonga, CA; Baerveldt glaucoma implant, Abbott Laboratories Inc, Abbott Park, IL) were recorded. For the purposes of statistical analysis, procedure dates were characterized as occurring during the first or second half of the academic year (July–June); as such, first-half cases were performed between July 1 and December 31 of a given year, and second-half cases were performed between January 1 and June 31 of a given year.

Statistical analysis was performed using Stata, software version 16.1 (StataCorp, College Station, TX). Operative case times were compared between groups using an independent-sample, two-tailed *t*-test, with the level of significance defined as <0.05 .

Results

Five hundred and seventy-three tube shunt placement surgeries performed by 28 glaucoma fellows at Duke University Medical Center and UNC Health System over a 5-year period (2014–2019) were analyzed. Of the 28 fellows, 22 (79%) were trained at Duke and six trained at UNC (21%). Seventeen (61%) fellows were female, and 11 (39%) were male. Of the 573 surgeries performed, all operations involved the fellow as primary operator under supervision of an attending surgeon, and no surgeries included a combined procedure (i.e., cataract surgery, trabeculectomy, vitrectomy, etc.). Demographic data pertinent to the surgeries performed is detailed in ▶Table 1. Of 573 tube shunt placements, 385 (67%) were Ahmed glaucoma valves and 188 (33%) were Baerveldt glaucoma drainage devices. The mean patient age

Table 1 Demographic data for surgical cases

Characteristic	Value
Tube shunt surgeries	
Ahmed	67% (385/573)
Baerveldt	33% (188/573)
Patient age in years (mean ± SD)	66.3 ± 14.1
Patient gender	51% female (279/573)
Fellow gender	61% female (17/28)
Institution	
Duke Eye Center	57% (328/573)
UNC	43% (245/573)

Abbreviations: SD, standard deviation; UNC, University of North Carolina.

was 66.3 (standard deviation 14.1) years. Two hundred seventy-nine (51%) patients were female, and 328 (57%) of the surgeries were performed at Duke.

Surgical case times by half of the academic year (i.e., first half, July–December, second half January–June) are reported in ► **Table 2**. When pooling data from all fellows, second half cases were significantly shorter than first half cases, by an average of 6 minutes per case (55.3 ± 17.1 minutes vs. 61.0 ± 17.4 minutes, *p* < 0.001). Female fellows trended toward shorter first and second half case times than male fellows; however, both female (53.5 ± 17.3 minutes vs. 59.3 ± 16.4 minutes, *p* = 0.003) and male (57.3 ± 16.8 minutes vs. 63.2 ± 18.6 minutes, *p* = 0.008) fellows had significantly shorter second half case times when compared with first half case times. Duke (55.5 ± 14.4 minutes vs. 59.2 ± 15.9 minutes, *p* = 0.026) and UNC (55.0 ± 20.2 minutes vs. 63.3 ± 19.2 minutes, *p* = 0.001) fellows both had significantly shorter case times in the second half of the academic year. Baerveldt case times were significantly

longer than Ahmed case in the first half (64.2 ± 20.0 minutes vs. 59.3 ± 15.8 minutes, *p* = 0.028) but only trended toward being longer than Ahmed cases in the second half (57.8 ± 18.9 minutes vs. 54.1 ± 16.2 minutes, *p* = 0.070).

Discussion

In this retrospective study of surgical case times among glaucoma fellows at two tertiary academic medical centers, we found that surgical case times were significantly shorter in the second half of the academic year for all fellows, suggesting an improvement in surgical efficiency with increasing surgical volume and supervised surgical education. We also report that surgical case times in the first half of fellowship (which may, in part, reflect baseline surgical experience prior to fellowship) did not significantly differ between male and female fellows, although female fellows tended to have shorter case times in the first and second halves of the academic year. Additionally, after 1 year of glaucoma fellowship, fellows at Duke and UNC had nearly identical average case times (UNC 55.0 ± 20.2 minutes, Duke 55.5 ± 14.4 minutes). While Baerveldt cases were longer than Ahmed cases in the first half of the academic year, this difference only trended toward significance in the second half, and significant improvements in both Ahmed and Baerveldt case times were observed when comparing first to second half cases. These findings, taken together, suggest that fellows become significantly more efficient surgeons during the academic year, which may have implications for surgical scheduling at academic medical centers and emphasizes the value of surgical experience in glaucoma training.

In an analysis of resident-performed and attending-performed tube shunt placements in a United States ophthalmology residency program, clinical outcomes were found to be similar; however, resident-performed cases were significantly longer than the attending cases (55 minutes vs. 50 minutes, *p* = 0.02).⁷ While our study did not seek to

Table 2 Surgical case times for tube shunt placements by glaucoma fellows at Duke University Eye Center and University of North Carolina over a 5-year period (2014–2019)

	First half ^a case times in minutes, mean ± SD (N)	Second half case times in minutes, mean ± SD (N)	<i>p</i> -Value ^b
All fellows	61.0 ± 17.4 (264)	55.3 ± 17.1 (309)	<0.001
Male fellows	63.2 ± 18.6 (111)	57.3 ± 16.8 (145)	0.008
Female fellows	59.3 ± 16.4 (153)	53.5 ± 17.3 (164)	0.003
UNC fellows	63.3 ± 19.2 (112)	55.0 ± 20.2 (133)	0.001
Duke fellows	59.2 ± 15.9 (152)	55.5 ± 14.4 (176)	0.026
Ahmed cases	59.3 ± 15.8 (175)	54.1 ± 16.2 (210)	0.002
Baerveldt cases	64.2 ± 20.0 (89)	57.8 ± 18.9 (99)	0.025

Abbreviations: SD, standard deviation; UNC, University of North Carolina.

^aDate used were from the academic calendar year. First half dates fell between July and December in a given year; second half dates fell between January and June.

^b*p*-Value from two-tailed *t*-test, *p*-value less than 0.05 was considered significant.

explicitly compare fellow-performed cases with attending-performed cases, these results are consistent with our study, which showed longer case times at the beginning of fellowship (just following residency) when compared with the end of fellowship (at the point of transition to attending surgeon). Understanding fellow-performed surgical case times is important for assessing the true cost of glaucoma fellow education, as case times significantly influence the cost and efficiency of providing surgical care.^{11,12} While our study only characterizes surgical case times among fellows at two academic centers over 5 years, we are able to provide an estimate of expected, average case times for glaucoma fellows during the first and second half of academic training, which may be used by perioperative administration to forecast operating room availability and minimize unnecessary costs associated with under-prediction of operative case times, particularly in the beginning of the academic year. A prior study showed that first cataract surgery cases in a given day are longer than subsequent cases; further analyses may reveal unique trends in glaucoma surgery performed by fellows throughout the day, which could further inform planned case times.²⁰

Our preliminary analysis suggests that fellow gender and training institution did not significantly impact operative case times at the end of the academic year. In this study of 28 fellows, a variety of ophthalmology residency programs were represented; however, we did not specifically assess variation in first half surgical case times with varying levels of glaucoma surgical experience during residency. This would likely be difficult to assess without residual confounding, as most training programs have exceedingly few primary glaucoma surgeries performed by residents, and resident wet laboratory/simulation experience may also influence surgical comfort/efficiency in early fellowship. It is possible that further study across multiple institutions may reveal disparities in surgical experience prior to glaucoma fellowship between various fellowship programs. The relationship between fellow gender and surgical case times may be non-contributory; however, it is notable that female surgeons trended toward shorter cases in both halves of the academic year.

This study is limited by several factors inherent to its retrospective nature. As we are collecting historical case times using the electronic health record retrospectively, we cannot independently confirm that recorded case times are reflective of actual intraoperative time. Additionally, while case times were generally consistent between Duke and UNC, we cannot rule out that minor differences in operating room workflow and recording of procedure start and end times between institutions could have influenced our results. We also only included cases in which we could definitively state that the fellow was the primary operator in all cases. Thus, each fellow performed significantly more cases in a given academic year that were not included in this study. As such, our study is not reflective of the holistic surgical experiences at either fellowship program and should not be taken as an objective assessment of fellow surgical volume and/or experience at the program. Additionally,

while we excluded combination surgeries due to case-to-case variability, we cannot fully control other factors contributing to case time variability, including prior ocular surgeries, intraoperative complications, or extenuating circumstances leading to outliers in operative case times. We have attempted to control for these potential confounders by including a large number of primary tube shunt placements (intentionally excluding tube shunt revision/replacement) which are likely very homogenous inpatient presentation and case difficulty. We analyzed Ahmed and Baerveldt tubes separately and compared with one another given the potential for differences due to procedural considerations. Overall, we feel that our cohort is representative of routine, uncomplicated primary tube shunt placements by glaucoma fellows at tertiary academic medical centers. The inclusion of other centers in future studies would improve the generalizability of our results. Finally, one cannot presume that shorter case times are equivalent to “better” surgical care, as one can perform a surgery quickly and carelessly. However, it is exceedingly unlikely that 28 fellows under close and direct supervision by attending faculty became more reckless over the course of the academic year. To definitively state this, visual outcomes would need to be included, which would require a carefully designed prospective study with strict exclusion criteria for alternative sources of complications including comorbid ocular conditions and unrelated surgery or trauma, for example.

This study provides a foundation for further research into glaucoma fellow education and surgical performance throughout the academic year. This study can also be applied to other surgical fields and could serve as a basis for more efficient operative room scheduling with regards to trainees. Future directions for research include assessing clinical outcomes (i.e., intraocular pressure control, visual acuity) in fellow-performed cases throughout the academic year, characterizing operative case times for other common surgical procedures (i.e., trabeculectomy, phacoemulsification), characterizing fellows' subjective perceptions of improvement throughout the academic year prospectively, and inclusion of fellow-performed cases at other tertiary academic medical centers. In this study, we show that surgical efficiency, as assessed using the surrogate of operative case times, improves over the course of the academic year among glaucoma fellows.

Précis

This retrospective analysis of glaucoma fellows at two academic institutions over a 5-year period demonstrates that surgical tube shunt case times decrease over the academic year. These findings may be used to guide operative scheduling of trainee surgical cases at academic centers.

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None.

Conflict of Interest

None declared.

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