Anticoagulation for Minimally Invasive Glaucoma Surgery: An American Glaucoma Society Survey

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Précis: Perspectives and practice patterns regarding perioperative anticoagulation management and minimally invasive glaucoma surgery were queried among surgeons of American Glaucoma Society. Management varied based on surgeon preference and the type of procedure performed.

Purpose: The purpose of this study was to characterize anticoagulation and antiplatelet practice patterns for minimally invasive glaucoma surgery (MIGS) in the perioperative period.

Materials and Methods: This was a survey of surgeons of American Glaucoma Society (AGS) about anticoagulation decision-making for their most performed MIGS procedures.

Results: A total of 103 surgeons completed the survey, with 43.6% in an academic setting, 49.5% in a private practice setting, and 6.8% in a mixed practice. Median MIGS per month was 10 [interquartile range (IQR) 20–5]. The 2 most performed MIGS were trabecular meshwork (TM) bypass with either device implantation (24.9%) or tissue excision (40.0%). Half of the respondents (50.5%) deferred to the primary care physician about anticoagulation most/all the time. Most (59.3%) managed anticoagulation differently for MIGS compared with trabeculectomy and tube implantation. Respondents reported an average of 1.3 (SD 2.5) bleeding complications related to anticoagulation and MIGS in the last year. Bleeding risk perception depended upon the type of surgery (e.g., 74.0% reported no/mild concern regarding surgeries involving TM bypass with device implantation vs. 48.0% reported high concern for TM bypass with tissue excision). Respondents stopped blood thinners at the highest rates for procedures enhancing aqueous outflow through the subconjunctival space and stopped least frequently for iStent implantation. Antiplatelets were held for a longer duration than anticoagulants before surgery, and most resumed both agents within 1–4 days after surgery.

Conclusions: Anticoagulation management is highly varied, and this study may help to inform practice guidelines and optimize surgical outcomes by elucidating surgeon perspectives toward MIGS and anticoagulation management.

Key Words: minimally invasive glaucoma surgery, anticoagulants, antiplatelets, clinical practice patterns, perioperative period

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The advent and rise of minimally invasive glaucoma surgery (MIGS) has significantly expanded options for treating glaucoma. MIGS encompass a vast armamentarium of procedures aiming to lower intraocular pressure by increasing aqueous humor outflow or by decreasing aqueous humor production, while attempting to minimize disruptions to the conjunctiva and the sclera.[1] Procedures that target increasing aqueous humor outflow include, among others, trabectome, Kahook Dual Blade, iStent, Hydrus Microstent, gonioscopy-assisted transluminal trabeculectomy (GATT), excimer laser trabeculotomy, Cypass microstent, and the XEN gel stent, whereas ciliary body ablation by endocyclophotocoagulation is used to decrease aqueous humor production.[2] Although clinical trials evaluating the efficacy of MIGS compared with medical management or traditional penetrating surgeries are numerous, there is a scarcity of literature assessing determinants in practice pattern variations. One such area is the effect of perioperative anticoagulation (AC) and antiplatelet (AP) management associated with MIGS.

Although AC and AP guidelines are not well-defined in ophthalmic surgery, broadly accepted guidelines exist for managing AC in cataract surgery.[3] Supported by a body of literature showing no increase in risks for hemorrhagic complications when AC or AP agents are continued perioperatively in cataract surgery, most surgeons choose to continue AC for cataract removal.[4–6] For example, Katz and colleagues found nearly identical hemorrhagic complication rates in non-aspirin users and those who continued aspirin perioperatively during cataract removal (0.56/1000 and 0.59/1000, respectively).[7] In addition to aspirin and warfarin, the more recent novel oral anticoagulants (NOACs) have also been deemed safe for continuation in cataract surgery. In a retrospective evaluation of 20,100 cataract cases, there was no significant difference in hemorrhagic complications between those who continued NOACs versus those who stopped NOACs preoperatively.[8]

Beyond cataract surgery, AC in ophthalmic surgery is often managed on a case-by-case basis rooted in surgeon preference.[3] In a survey of ophthalmic consultants and oculoplastic specialists in the UK, 40%–68% of oculoplastic surgeons reported discontinuing aspirin whereas 60–85% reported discontinuing warfarin preoperatively in a procedure dependent manner.[9] Likewise, significant variabilities exist between surgeons in perioperative AC and AP management for glaucoma surgery; in a survey of 93 English surgeons, the majority continued warfarin and aspirin during glaucoma surgery whereas a survey of glaucoma surgeons in Brazil found that 86% of surgeons have different approaches from each other regarding perioperative AC and AP management.[10,11] Because MIGS are highly variable by design, it may be difficult for existing data to determine best practices in AC management for all MIGS procedures. In this study, we examined surgeon practice patterns regarding AC management in the MIGS perioperative period.

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MATERIALS AND METHODS

A 10–15 minutes online anonymized survey was administered to members of the American Glaucoma Society (AGS) using the Penn Medicine Qualtrics platform. This study was approved by the Institutional Review Board at the University of Pennsylvania and the AGS Research Committee. This study was HIPAA compliant and adhered to all tenets of the Declaration of Helsinki. The survey was

TABLE 1. Demographic Information of Survey Respondents and Responses to Descriptive Questions

Demographic and descriptive questions	Responses (n/total; % of total)
Sex	Males (60/103; 58.3%), females (43/103; 41.7%)
Race	Caucasian (68/103; 66.0%), Asian (31/103; 30.1%), African American (3/103; 2.9%), Other (1/103; 0.9%)
Practice setting	Academia (45/103; 43.6%), private practice (51/103; 49.5%), mixed setting (7/103; 6.8%)
Years in practice as attending physician	Median 10 y (IQR 23–6 y)
Total MIGS per mo	Median 10 procedures (IQR 20–5 procedures)
"I think about anticoagulation management prior to every MIGS"	• Strongly agree (41/91; 45.1%) • Somewhat agree (21/91; 23.1%) • Neither agree/disagree (8/91; 8.8%) • Somewhat disagree (13/91; 14.3%) • Strongly disagree (7/91; 7.7%)
"I use a bleeding risk stratification tool to assist with AC decisions prior to MIGS"	Always (1/91; 1.1%) Most of time (4/91; 4.4%) About half the time (1/91; 1.1%) Sometimes (8/91; 8.8%) Never (77/91; 84.6%)
"I defer the AC decision prior to MIGS to the primary care physician or other specialist"	• Always (26/91; 28.6%) • Mostly (20/91; 21.9%) • About half the time (2/91; 2.2%) • Sometimes (24/91; 26.4%) • Never (19/91; 20.9%)
"I alter my surgical technique for MIGS based on AC status"	Percent answering never or sometimes (162/189; 85.7%;): • TM with iStent: (33/36; 91.7%) • TM with Hydrus: (32/33; 97.0%) • TM with Tissue Excision (GATT or Trab 360/OMNI): (14/20; 70.0%) • TM with Tissue Excision (Kahook): (32/42; 76.2%) • Enhancing outflow through Schlemm's Canal: (14/18; 77.8%) • Enhancing outflow through Xen: (17/20; 85.0%) • Ciliary body ablation: (20/20; 100.0%)
"My approach to peri-operative anticoagulation management differs with MIGS surgeries compared to trabeculectomy or tube surgeries"	• Strongly agree (24/91; 26.4%) • Somewhat agree (30/91; 33.0%) • Neither agree/disagree (9/91; 9.9%) • Somewhat disagree (19/91; 20.9%) • Strongly disagree (9/91; 9.9%)
"Which category of MIGS procedure do you perform the most?"	1. TM bypass with tissue excision (Trabectome or Kahook Dual Blade) (34/100; 34.0%) 2. TM bypass with device implantation (iStent, Hydrus) (30/100; 30.0%) 3. Procedures enhancing outflow through Schlemm's canal (Visco360/ Omni, Ab Interno Canaloplasty) (12/100; 12.0%) 4. TM bypass with tissue excision (GATT or Trab 360/OMNI) (11/ 100; 11.0%) 5. Shunting aqueous into subconjunctival space i.e., Xen (8/100; 8.0%) 6. Reducing aqueous by CB ablation (4/100; 4.0%) 7. Enhancing outflow through suprachoroidal space (1/100; 1.0%)
"Which MIGS procedure do you perform the 2nd most?"	1. Reducing aqueous by CB ablation (20/85; 23.5%) 2. TM bypass with device implantation (16/85; 18.8%) 3. TM bypass with tissue excision (Trabectome or Kahook) (15/85; 17.6%) 4. TM bypass with tissue excision (GATT or Trab 360/OMNI) (14/85; 16.5%) 5. Shunting aqueous into subconjunctival space i.e., Xen (13/85; 15.3%) 6. Procedures enhancing outflow through Schlemm's canal (7/85; 8.2%) 7. Enhancing outflow through suprachoroidal space (0/85; 0.0%)

103 total surgeons responded to the survey, but not every participant answered every question. For a certain subset of questions, surgeons were asked to answer twice, once for each of their 2 most commonly performed MIGS.

AC indicates anticoagulation; IQR, interquartile range; MIGS, minimally invasive glaucoma surgery; TM, trabecular meshwork.

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TABLE 2. Bleeding Concern and Percent of Respondents Stopping Anticoagulation or Antiplatelet Agents Stratified by MIGS Procedure

MIGS procedure	Bleeding risk score* Mean (SD)	Stopping AC+ (n/total; % of total)	Stopping AP+ (n/total; % of total)
Trabecular meshwork bypass by excision	3.3 (1.2)	(23/57; 40.4%)	(10/20; 50.0%)
Trabecular meshwork bypass by:	2.1 (0.9)		
iStent		(20/105; 19.0%)	(6/35; 17.1%)
Hydrus Microstent		(22/96; 22.9%)	(9/31; 29.0%)
Enhance outflow through suprachoroidal space	3.1 (1.2)	No responses	No responses
Enhancing outflow through subconjunctival space	3.1 (1.1)	(34/60; 56.7%)	(12/20; 60.0%)
Enhancing outflow through Schlemm's canal	2.5 (1.1)	(22/48; 45.8%)	(10/17; 58.8%)
Reducing aqueous through ciliary body ablation	1.6 (0.7)	(18/60; 30.0%)	(4/20; 20.0%)

*Bleeding concern was scored from 1 to 5, with 1 = no concern, and 5 = very high concern. +AC include LMWH, NOACs, and warfarin; AP includes aspirin, NSAIDs, and ADP inhibitors

AC indicates anticoagulation; ADP, adenosine diphosphate; AP, antiplatelet; LMWH, low molecular weight heparin; MIGS, minimally invasive glaucoma surgery; NOAC, novel oral anticoagulant; NSAID, nonsteroidal anti-inflammatory drug.

distributed through email in December 2021, with responses allowed between December 2021 and October 2022. Individual respondents were not identifiable and participation in the survey was entirely optional. This survey can be viewed online at https://upenn.co1.qualtrics.com/jfe/form/SV_3DUYkWnrawSqd9A.

After first obtaining participant agreement to proceed with the survey, questions about demographic information, including sex, racial and ethnic identity, training institutions/locations, primary practice location, and numbers of years in practice, were obtained. Participants were then asked about the number of total MIGS procedures performed in the past 12 months, followed by questions designed to assess general attitude and approach to AC and AP management in MIGS. AC therapy was defined as any of the following: heparin, Vitamin K antagonists (Warfarin), and NOACs. NOACs included apixaban, dabigatran, rivaroxaban, and edoxaban. AP therapy was defined to

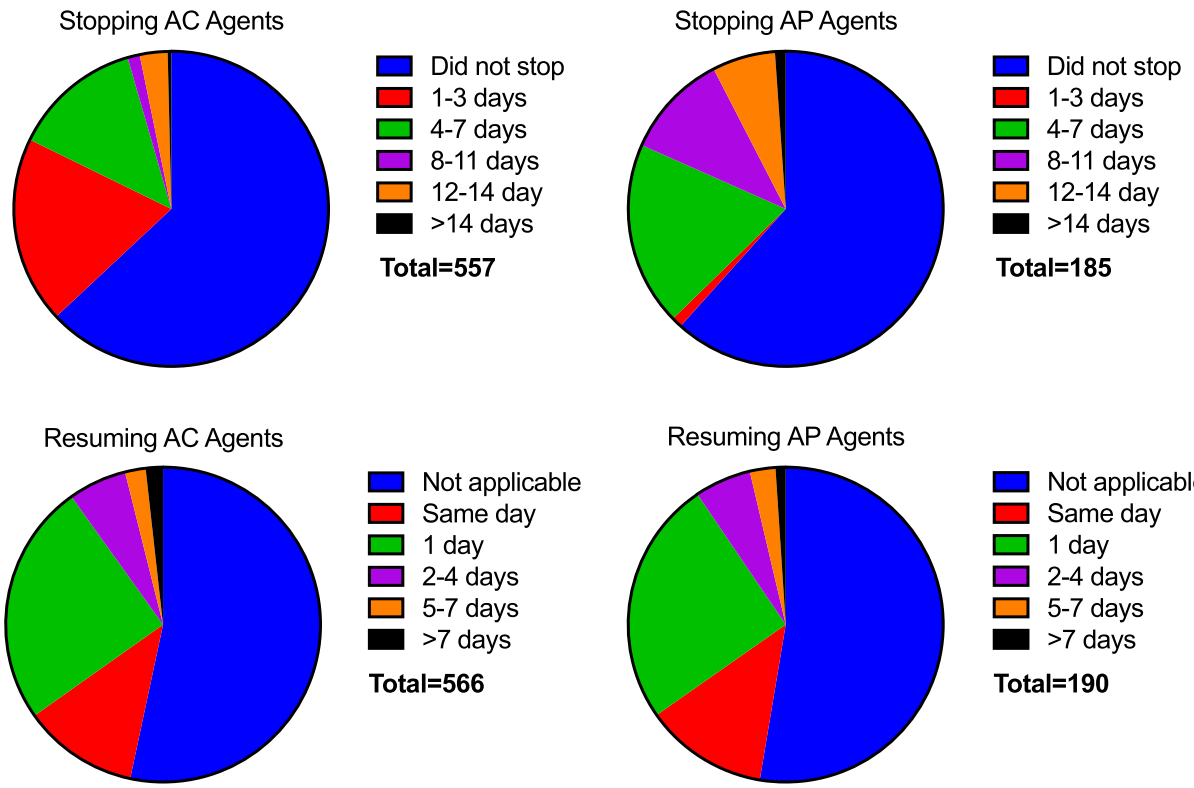

FIGURE 1. Rates of stopping and resuming AC and AP agents for all MIGS procedures on which data were collected through the survey. Totals differ based on participant response rates. The category "procedures enhancing outflow through suprachoroidal space" was included in the questionnaire but omitted in this graph as there were 0 responses. AC indicates anticoagulation; AP, antiplatelet. Figure 1 can be viewed in color online at www.glaucomajournal.com.

TABLE 3. Rates of Stopping and Restarting AC and AP Agents Stratified by Procedure, Agent, and Timing

	Stopping agents							Resuming agents						
Ciliary body ablation														
	Did not stop	**1–3 days**	**4–7 days**	**8–11 days**	**12–14 day**	**> 14 days**	**Total**	**Not applicable**	**Same day**	**1 day**	**2–4 days**	**5–7 days**	**> 7 days**	**Total**
Antiplatelet	16	1	1	0	2	0	20	14	3	4	0	0	0	20
LMWH	15	3	2	0	2	0	22	13	3	4	0	0	0	20
NOACs	14	5	1	0	2	0	22	13	3	4	0	0	0	20
Warfarin	13	5	2	0	2	0	22	13	3	4	0	0	0	20
TM bypass with iStent implantation														
	Stopping agents							Resuming agents						
Antiplatelet	29	0	3	2	1	0	35	27	2	6	0	0	0	35
LMWH	29	4	1	0	0	0	34	25	1	8	1	0	0	35
NOACs	28	6	1	0	0	0	35	25	2	8	0	0	0	35
Warfarin	26	3	4	1	0	0	34	25	1	8	1	0	0	35
TM bypass with Hydrus microstent implantation														
	Stopping agents							Resuming agents						
Antiplatelet	23	0	4	2	2	0	31	23	3	6	0	0	0	32
LMWH	26	3	2	0	0	0	31	25	1	5	2	0	0	33
NOACs	24	6	2	0	0	0	32	24	3	5	2	0	0	34
Warfarin	23	4	4	1	0	0	32	25	1	5	2	0	0	33
Procedures enhancing outflow through Schlemm's canal (i.e., VISCO 360/OMNI)														
	Stopping agents							Resuming agents						
Antiplatelet	7	1	1	6	2	0	17	6	5	4	1	0	2	18
LMWH	12	2	2	1	0	0	17	5	5	2	2	1	2	17
NOACs	7	3	5	1	0	0	16	5	5	4	1	1	1	17
Warfarin	8	4	3	1	0	0	16	5	5	2	2	1	2	17
Procedures shunting aqueous outflow into subconjunctival space (i.e., Xen Glaucoma Implant)														
	Stopping agents							Resuming agents						
Antiplatelet	8	0	6	4	2	0	20	8	1	9	2	1	0	21
LMWH	11	7	1	0	0	1	20	8	1	8	2	1	0	20
NOACs	7	7	5	0	1	0	20	7	1	10	2	1	0	21
Warfarin	8	5	6	1	0	0	20	8	1	8	2	1	0	20
TM bypass by tissue excision (i.e., GATT or TRAB 360/OMNI)														
	Stopping agents							Resuming agents						
Antiplatelet	10	0	7	2	0	1	20	6	3	5	5	1	0	20
LMWH	12	3	4	0	0	0	19	8	4	6	1	0	1	20
NOACs	12	3	4	0	1	0	20	8	5	5	2	0	0	20
Warfarin	11	2	4	0	2	0	19	8	4	6	1	0	1	20
TM bypass by tissue excision (i.e., Trabectome or Kahook Dual Blade Goniotomy)														
	Stopping agents							Resuming agents						
Antiplatelet	21	0	13	4	3	1	42	16	7	14	3	3	0	43
LMWH	25	11	3	0	2	1	42	18	6	13	3	2	1	43
NOACs	18	13	8	0	3	0	42	16	6	13	5	2	1	43
Warfarin	22	8	10	1	1	0	42	18	6	13	3	2	1	43

Note that totals may differ based on participants opting to not respond to certain questions. The category "procedures enhancing outflow through the suprachoroidal space" was included in the survey but omitted in the table as there were 0 responses in this subsection.

AC indicates anticoagulation; AP, antiplatelet; LMWH, low molecular weight heparin; NOAC, novel oral anticoagulant; TM, trabecular meshwork.

include aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs), and adenosine diphosphate (ADP) inhibitors.

Next, participants were asked to identify 2 categories of MIGS they performed the most. MIGS was defined as any of the following categories/groups of surgeries: (1) trabecular meshwork (TM) bypass with device implantation (iStent, Hydrus microstent), (2) TM bypass with tissue excision (Trabectome, Kahook Dual Blade), (3) TM bypass with tissue excision like Gonioscopy-assisted transluminal trabeculectomy (GATT) or Trab 360/OMNI, (4) Enhancing aqueous outflow through Schlemm's canal (VISCO360/OMNI, Ab Interno Canaloplasty), (5) Enhancing aqueous outflow through the suprachoroidal space (CyPass Micro-Stent; this option was added to gauge respondent perspectives on a historically often performed MIGS procedure), (6) Shunting aqueous outflow into the subconjunctival space (XEN Glaucoma Implant), and (7) Reducing aqueous production by ciliary body ablation (Endocyclophotocoagulation, Micropulse, CPC). For each MIGS category, participants were then asked detailed questions concerning their management of individual AC and AP therapies before, during, and after surgery. Participants were also asked whether they utilized a bleeding risk stratification score such as HAS-BLED to aid in decision-making.[12]

Deidentified survey responses were stored securely in the Penn Medicine cloud server and analyzed in RStudio 1.2.5033 (RStudio Inc.). For questions about the concern of bleeding, responses of "No Concern", "Low Concern", "Mild Concern", "High Concern", and "Very High Concern" were converted to a numerical scale, 1–5 respectively, and averaged to compute a bleeding risk score for each category of MIGS.

RESULTS

Demographic Characteristics

A total of 103 AGS surgeons completed the full survey, constituting 60 males (58.3%) and 43 (41.7%) females (Table 1). The majority of responders self-identified as Caucasian (68/103, 66.0%), with the majority of the remainder self-identifying as Asian (31/103, 30.1%). Practice setting was an approximately equal mix of academia (45, 43.6%) and private (51, 49.5%). The median years in practice after completion of training was 10 [interquartile range (IQR) 23–6), whereas the median number of MIGS procedures per month was 10 (IQR 20–5).

Survey Responses

Among the 91 surgeons who responded to the question, "I think about anticoagulation management prior to every MIGS", 68.1% of surgeons agreed with the statement, 22.0% disagreed, and the remainder neither agreed nor disagreed (Table 1). Most respondents (84.6%, n = 77/91) do not utilize a bleeding risk stratification tool like HAS-BLED to assist with AC management. However, risk stratification tools like HAS-BLED were developed to assess bleeding risk where hemorrhages are associated with high rates of morbidity and mortality. Because this is rarely the case for MIGS procedures, the results of such stratification calculations do not carry the same salience for MIGS procedures. Surgeons were divided on who should make the decision about AC management, with 50.5% either "Always" or "Mostly" deferring to the primary care physician (PCP) versus 47.3% who deferred either "Sometimes" or "Never." Surgeon preferences with respect to who should manage AC did not differ between academic and private respondents. Most respondents did not alter the surgical technique for MIGS based on AC status (85.7%; 162/189 total responses). Most surgeons (59.3%) agreed with the statement "My approach to peri-operative anticoagulation management differs with MIGS surgeries compared to trabeculectomy or tube surgeries" whereas 30.8% disagreed. A summary of demographic and descriptive responses is provided in Table 1.

TABLE 4. Summary of Survey Responses Regarding Management of MIGS-Related Bleeding Complications, Subjectively Self-Attributed to Anticoagulation Use

Responses (N = 67)	n (%)
Required additional procedures	11 (16.4)
Required additional clinic visits	37 (55.2)
Required additional operations	11 (16.4)
Impacted final surgical outcome	8 (11.9)

MIGS indicates minimally invasive glaucoma surgery.

The most often performed MIGS categories were TM bypass with tissue excision (trabectome, KDB; 49/185 first or second choice responses, 26.5%), TM bypass with device implantation (iStent, Hydrus; 46/185 first or second choice response, 24.9%), and TM bypass with tissue excision (GATT, Trab 360/OMNI; 25/185 first or second choice responses, 13.5%; Table 1). Concerns about bleeding risk depended on MIGS type and varied widely. For example, 74.0% reported no or mild concern with TM bypass with device implantation, whereas 48.0% reported high concern for TM bypass with tissue excision modalities. Responses about level of concern for bleeding were summarized by bleeding risk score in Table 2. TM bypass by tissue excision carried the highest perceived bleeding risk (3.3/5). In contrast, TM bypass by device implantation carried less perceived risk (2.1/5). The least perceived bleeding risk was associated with ciliary body ablation procedures (1.6/5).

Most surgeons opted not to stop AP or AC agents before MIGS (Fig. 1). Table 3 provides granularity about specific AC/AP decision-making stratified by types of MIGS. AC and AP agents were held more often for tissue excision MIGS procedures than procedures like iStent or Hydrus implantation (Table 3). Taken together, when agents were held, AP agents were held for a longer duration than AC before surgery (Fig. 1). The majority of respondents resumed both agents within 1–4 days after surgery (Fig. 1, Table 3).

On average, reports of bleeding complications were rare, with surgeons reporting an average of 1.3 (SD 2.5) bleeding complications attributable to AC during a MIGS procedure in the previous 12 months. However, these instances were reported to have led to additional clinic visits over half of the time and impacted the final surgical outcome 11.9% of the time (Table 4). To illustrate the diversity of opinion regarding MIGS, bleeding risk, and AC practices, a representative summary of free responses is provided in Supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/IJG/A946.

DISCUSSION

The lack of practice pattern guidelines and wide variability in perceptions about perioperative AC/AP management for MIGS make it an interesting topic worthy of evaluation. In our study, surgeons showed a strong interest in the topic but

remained divided in their viewpoints, perhaps either influencing or influenced by low rates of self-reported bleeding complications attributable to AC/AP. Although most surgeons reported thinking about AC/AP before every MIGS, practice patterns varied regarding who made management decisions (i.e., PCP vs. surgeon), how they made that decision (i.e., using a bleeding risk score vs. relying on experience with glaucoma procedures), what was decided and for which MIGS procedure.

Our results showed that surgeons managed AC/AP in MIGS differently from that for trabeculectomy and tube surgeries, which is in line with a recent survey of AGS members where physicians were found to be more likely to discontinue AC in trabeculectomies than in MIGS.[13] Further, most surgeons were found to stop P2Y12 inhibitors, NOACs, and warfarin for trabeculectomy, whereas only 47% stopped aspirin.[13]

This difference in management between MIGS and traditional glaucoma surgery revealed by our survey is supported by what has been reported on bleeding risks and complications. Aspirin continuation was found to be safe in trabeculectomy in a retrospective analysis of 367 trabeculectomies, where patients continuing aspirin perioperatively achieved equal surgical efficacy at 2 years despite experiencing a higher risk for hyphema.[14] Warfarin was associated with significant hemorrhagic complications in the same study. Other studies have also shown AC use to be a risk factor for hemorrhage, surgical failure, and poor visual outcomes in both trabeculectomy and tube-shunt surgeries.[14–16] AC is also associated with increased risks for suprachoroidal hemorrhage and vision-threatening sequalae during trabeculectomy.[17]

Compared with trabeculectomy and tube-shunt implantation, studies examining trabecular meshwork (TM) bypass surgeries such as iStent, Hydrus, and KDB goniotomy have not found an association between AC/AP use and rates of surgical success and hemorrhagic complications.[18–20] Overall, however, such studies are sparse and have thus far failed to capture the diversity of MIGS, necessitating surgeons to rely on personal experience, intuition, and borrowed recommendations from other types of glaucoma surgeries in MIGS AC/AP management. Our highlight of subjective free responses captured resulting variations and diversity of opinion (Supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/IJG/A946). For example, one surgeon stated, "my cases seem to have bleeding 100% of the time and it goes away on its own", whereas another mentioned, "I prefer not to have additional bleeding during/after surgery. It is not good for the patient, makes the MIGS fail, and stresses the surgeon" (Supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/IJG/A946). Several surgeons preferred to avoid angle-based MIGS for patients on any AC/AP agent other than aspirin. Another mentioned that in the case of a patient with a recent pulmonary embolus requiring AC, for example, they would opt to perform a micropulse or CPC procedure rather than another MIGS. Several surgeons expressed concern over increased risk for thromboembolism after stopping AC/AP, whereas others advised diving into the specifics of why AC/AP was prescribed to maximize surgical success. Importantly, although most surgeons did not alter surgical techniques in the presence of anticoagulation, many varied MIGS selections and techniques for postoperative intraocular pressure management to help mitigate bleeding risk.

Our study also highlighted the potential utility of creating a bleeding risk score to inform surgical decision-making. In other specialties, bleeding scores, such as HAS-BLED for atrial fibrillation, have been developed to help stratify risk based on patient characteristics and guide clinician decision-making.[21] Future studies could consider adapting existing risk calculators such as HAS-BLED, ATRIA, HEMORR2HAGES, or mOBRI for bleeding risk stratification in glaucoma surgery. However, given the variability in risk estimates among the various risk calculators, perhaps the creation of a MIGS-specific bleeding risk score is advisable.[22] Ideally, such a tool would provide risk assessment, stratified based on type of surgery, indication for AC/AP, patient characteristics, and type of AC/AP. By establishing a baseline of how AC/AP management is viewed among surgeons performing MIGS, this study establishes the foundation for this next step. Limitations of this study include the subjective and self-reported nature of surveys, as well as unknown and possibly low response rates which may limit the generalization of findings. In addition, although many participants voluntarily shared their nuances in MIGS management, we did not specifically query about surgical techniques, or decisions about switching MIGS in cases where bleeding risk was felt to be high. In addition, apart from the aggregated information in Fig. 1 and our tables, we do not have access to individual provider-level granularity about how each surgeon utilized anticoagulation drugs or for how many days. Specifics of glaucoma diagnoses and prior ocular history of patients were not considered in the survey. Future studies are needed to evaluate several follow-up questions including if surgeon characteristics affect procedure selection or anticoagulation management, and whether outcomes differ based on who makes the perioperative anticoagulation management decision.

In summary, although the growth of MIGS has paralleled the rapid advancement of individualized medicine and personalized management in the field of glaucoma, there is scope for improving outcomes and bringing rigor to practice patterns. Further study of bleeding rates, type of MIGS, AC/AP status, and indications for AC/AP can help inform risk-benefit decision-making for the surgeon and ultimately improve patient outcomes.

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