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ORIGINAL ARTICLE

Comparative study of 2-year outcomes for Hydrus or iStent inject microinvasive glaucoma surgery implants with cataract surgery

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Abstract

Background: To compare real-world 24-month outcomes of phacoemulsification combined with either iStent inject or Hydrus Microstent.

Methods: Analysis of data from the Fight Glaucoma Blindness (FGB) international registry. Anonymized data from 344 eyes with mild-to-moderate open-angle glaucoma, normal-tension glaucoma or ocular hypertension that underwent phacoemulsification combined with either iStent inject (224) or Hydrus Microstent (120) were included. Data were adjusted for baseline characteristics using linear regression and propensity score matching. The primary endpoint was a comparison of mean intraocular pressure (IOP) at 24 months.

Results: At 24 months, there was no significant difference in IOP reduction between the two groups, consistent across all analyses. The matched cohort showed iStent inject achieved 3.1 mmHg reduction and Hydrus a 2.3 mmHg reduction ($p = 0.530$) and a mean medication reduction of 1.0 for iStent inject versus 0.5 for Hydrus ($p = 0.081$). 5.4% of eyes in the iStent inject group and 7.5% of eyes in the Hydrus group required subsequent procedures to improve IOP control within 24 months. Complications were rare with no significant differences between the groups.

Conclusions: Twenty-four-month outcomes showed sustained IOP reduction with a good safety profile for both groups. There was no significant difference in IOP outcomes between the groups. There may be a small additional reduction in glaucoma medication usage following cataract surgery with iStent inject compared to Hydrus.

KEYWORDS

glaucoma, Hydrus Microstent, iStent inject, minimally invasive glaucoma surgery

1 | INTRODUCTION

There are only limited data from routine clinical practice on the new wave of devices to treat glaucoma, the leading cause of irreversible blindness worldwide,[1] While clinical trials of these devices have reported positive results, such results are notoriously difficult to replicate in routine clinical practice.

The two glaucoma devices investigated here are the Schlemm's canal scaffold Hydrus Microstent (Ivantis Inc., Irvine, CA) and the trabecular meshwork bypass iStent inject (second-generation trabecular bypass stent) (Glaukos Corporation, San Clemente, CA).[2,3] Both are inserted ab interno through a corneal micro-incision and in clinical practice are commonly implanted concurrently with phacoemulsification.

The HORIZON study was the U.S. Food and Drug Administration (FDA) pivotal trial of the Hydrus Microstent which randomised 556 eyes in a 3:1 ratio to combined cataract surgery with Hydrus Microstent, versus cataract surgery alone. The primary outcome was the proportion of eyes achieving a 20% reduction in washed-out (unmedicated) intraocular pressure (IOP) between baseline and 24 months. Seventy-seven percent of Hydrus eyes achieved a 20% reduction in IOP whereas only 58% of cataract alone patients achieved the same. The reduction in unmedicated IOP (secondary endpoint) was also significantly greater in the Hydrus arm at 7.6 ± 4.1 versus 5.3 ± 4.2 mmHg in the no stent group, a difference in reduction of 2.3 mmHg favouring Hydrus (95% CI, -3.0 to -1.6; $p < 0.001$).[2]

The FDA pivotal trial of the iStent inject was also recently published using a very similar method to the HORIZON study above. The number of cases was similar, as was the primary outcome measure. For the iStent inject, the proportion of eyes achieving a 20% reduction in washed-out (unmedicated) IOP between baseline and 24 months was 76% of iStent inject eyes and 62% of cataract alone eyes. The reduction in unmedicated mean diurnal IOP (secondary endpoint) was also significantly greater in the iStent inject arm at 7.0 ± 4.0 versus 5.4 ± 3.7 mmHg in the control group, a difference in reduction of 1.6 mmHg favouring iStent inject ($p < 0.001$) These results are remarkably similar to the above HORIZON results.[3]

This study provides complementary 24-month real-world outcomes of combined cataract surgery with either the Hydrus Microstent or the iStent inject.

2 | METHODS

This observational study analysed anonymized data from the Fight Glaucoma Blindness (FGB) registry which were captured during routine clinical practice. The FGB registry is part of the Save Sight Registries group, which includes the Fight Retinal Blindness registry of The University of Sydney. It is a web-based platform available to specialists worldwide to capture clinical data for the purpose of audit and research of real-world glaucoma treatment outcomes. All treatment decisions and visit schedules were entirely at the discretion of the treating physician and patient. FGB data capture includes a baseline visit capturing a minimum dataset that accurately phenotypes a patient's glaucoma subtype and relevant clinical metrics. Each follow-up visit collects mandatory fields of IOP (Goldmann applanation only), visual acuity (VA), medical treatments, and procedures. For any eye which has previously had a procedure, the software automatically generates a field requiring the clinician to indicate if there have been any relevant adverse events. Data from each visit must be finalised with all mandatory fields completed for it to be available for analysis. The full details of the development of the registry and a full list of data fields has previously been published[4] Institutional ethics approval was obtained from the Human Research Ethics Committee of the Royal Australian and New Zealand College of Ophthalmologists. All ethics committees approved the use of 'opt out' patient consent. The research described adhered to the tenets of the Declaration of Helsinki. All surgeons contributing data had undergone required company led training and certification to insert each device.

2.1 | Inclusion and exclusion criteria

Registry patient data extracted to be part of this analysis met the following inclusion criteria: Minimum of 24-month follow-up data available, a diagnosis of open-angle glaucoma (OAG) (primary or secondary), normal-tension glaucoma or ocular hypertension as defined by Mills et al.,[5,6] who had undergone combined phacoemulsification and Hydrus Microstent insertion (Group 1) or combined phacoemulsification and iStent inject insertion (group 2) with at least 24 months of follow-up data available. For iStent inject, two stents were inserted in each eye. Each surgeon included consecutive cases that met inclusion and exclusion criteria.

Exclusion criteria were any prior incisional glaucoma surgeries or intraoperative complications at cataract surgery. Only cases with all preoperative and postoperative IOP measurements taken using Goldman applanation tonometry (GAT) were included. As an observational study of routine clinical care, ocular hypotensive medications could be added or subtracted during follow-up at the discretion of the surgeon, and there was no mandated medication washout period at any point.

2.2 | Statistical analysis

The primary analysis was a comparison of the mean 24-month post-procedure IOP of each group to detect a difference in of >1.5 mmHg between the two groups. Secondary outcomes included differences in medication use, difference in percentage IOP reduction, and adverse event rates. No sub-analysis by glaucoma subtype was performed as the absolute numbers were too small to provide meaningful comparative information.

Complete and qualified success reported as per the World Glaucoma Association (WGA) guidelines for reporting outcomes of clinical trials, including a 20% reduction from baseline IOP at three IOP levels (15, 18 and 21 mmHg) of complete (achieved without medications) and qualified (achieved with medications) success.[7] Comparisons were made between each treatment group for each outcome level. Failure was defined as not achieving the WGA guideline IOP levels on two consecutive visits.

The WGA guidelines were developed primarily for incisional glaucoma surgery and are included here to allow comparative analysis of these results. However, we also report safety and efficacy outcomes as recommended by the ANSI Z80.27 standard. This more recent standard was developed to address the interpretation of study results for minimally invasive glaucoma surgery (MIGS) devices implanted during cataract surgery in patients with mild-to-moderate glaucoma, controlled on topical medication.[8]

Baseline characteristics between treatment groups were compared using *t* tests and chi-square tests as appropriate. Propensity score matching (ratio of 1:1) using logistic regression based on the preoperative IOP, preoperative number of medications, age at procedure, Humphrey visual field (HVF) mean deviation (MD) and gender was then used to help account for differences in baseline characteristics. Briefly, the propensity score is the conditional probability of being assigned a particular treatment given the observed covariates in the propensity score model such that the distribution of the observed covariates is similar between the matched cohorts.[9] The results of both the matched and unmatched cohorts are reported.

Linear mixed models were used to compare the change in IOP and medications between groups. Logistic regression was used to compare the proportion of qualified and complete success at 24 months. Cox-proportional hazards models were used to compare survival curves between groups. All models included adjustments for preoperative IOP, preoperative medications, age, gender, HVF MD and nesting of outcomes within doctor and patient (for bilateral cases) and were applied to both the unmatched, and the matched cohort.[10]

Excluding patients requiring secondary laser or surgical interventions biases results in favour of the relevant device by removing cases with a poor outcome. We, therefore, analyzed them using a 'last observation carried forward' analysis.

In this report, we provide the raw ('crude') outcomes adjusted for preoperative IOP, preoperative medications, age, gender, HVF MD and nesting of outcomes within doctor and patient for bilateral cases using regression models only ('adjusted'), and outcomes using propensity score matching (ratio of 1:1) on preoperative IOP, preoperative number of medications, age at procedure, HVF mean deviation and gender ('propensity matching').

A p value <0.05 was considered statistically significant. Analyses were conducted using R software version 4.0.2.[11] We used the *glmmTMB* package (version 1.0.2.1) for linear and logistic regression,[12] and the *coxme* package (version 2.2–16) for Cox-proportional hazards models.[13]

3 | RESULTS

3.1 | Baseline characteristics of the study patients

A total of 344 eyes from the FGB Registry met the inclusion criteria with the baseline characteristics summarised in Table 1. Of these, 120 had undergone combined phacoemulsification and Hydrus Microstent insertion and 224 had undergone combined phacoemulsification and iStent inject insertion. Within these cohorts, the demographic characteristics were well matched with the mean age being early 1970s and a slight female preponderance in both groups. There were however significant differences in baseline ocular characteristics. Compared with the iStent group, the Hydrus group had significantly higher median IOP *SD* 18.1 (5.5) versus 16.3 (4.4) ($p = 0.003$), preoperative number of medications (*SD*) 2.1 (1.2) versus 1.5 (1.2) ($p < 0.001$) and visual field MD (*SD*) -8.8^{8} versus -4.1 (4.4) ($p < 0.001$). This baseline data suggested a bias towards implanting Hydrus in eyes with more advanced glaucoma.

After propensity matching, 150 eyes remained in the study, 75 in each arm. The ocular characteristics were more closely matched, with the only statistically significant difference being the visual field MD (*SD*) which was greater in the Hydrus arm, -8.8^{8} versus -6.6 (5.1) in the iStent inject group ($p = 0.046$) summarised in Table 1. They had mean IOP of 17.5 mmHg (iStent inject) and 18.2 mmHg (Hydrus) ($p = 0.431$) and mean (*SD*) glaucoma medications of 2.0 (1.3) for iStent inject and 2.2 (1.2) for Hydrus ($p = 0.408$).

TABLE 1 Demographic and baseline characteristics of eyes meeting the criteria

	Hydrus	iStent inject	*p* value
Eyes	120	224	
Patients	91	155	
Procedures	120	224	
Gender, % female	57.1%	60.6%	0.981[a]
Age, mean (*SD*)	72.7 (7.2)	72.6 (8.3)	0.927[b]
Best corrected visual acuity (BCVA), mean (*SD*)	70.8 (14.7)	74.7 (11)	0.011[b]
IOP, mean (*SD*)	18.1 (5.5)	16.3 (4.4)	0.003[b]
Medications, mean (*SD*)	2.1 (1.2)	1.5 (1.2)	<0.001[b]
Visual field MD, mean (*SD*)[c]	−8.8 (8)	−4.1 (4.4)	<0.001[b]
CCT, mean (*SD*)[d]	539.3 (37.7)	537.6 (37.9)	0.693[b]
Demographic and baseline characteristics of eyes after propensity score matching			
Eyes	75	75	
Patients	62	63	
Procedures	75	75	
Gender, % female	56.5%	57.1%	1.000[a]
Age, mean (*SD*)	72.6 (7.8)	72 (8.8)	0.638[b]
BCVA, mean (*SD*)	69.5 (16.4)	73.8 (11.7)	0.067[b]
IOP, mean (*SD*)	18.2 (6)	17.5 (5)	0.431[b]
Medications, mean (*SD*)	2.2 (1.2)	2 (1.3)	0.408[b]
Visual field MD, mean (*SD*)	-8.8 (8)	−6.6 (5.1)	0.046[b]
CCT, mean (*SD*)[c]	530.7 (38.8)	528.2 (40.6)	0.707[b]

[a]Chi-square test.
[b]Two sample *t* test.
[c]Data available for 75 Hydrus and 169 iStent inject procedures.
[d]Data available for 113 Hydrus and 219 iStent inject procedures.

3.2 | Efficacy

Primary and secondary end points are shown in Table 2. There was no significant difference in IOP change between the groups after 2 years. This finding was consistent across for the crude, adjusted and propensity-matched data. The propensity-matched data showed an IOP reduction at 2 years of 3.1 mmHg for cataract with iStent inject versus 2.3 mmHg for cataract with Hydrus ($p = 0.530$).

There were also no significant differences in complete success (CS) or qualified success (QS) at the 15, 18 or 21 mmHg endpoints in the propensity matched cohort. The rates of complete success and qualified success are shown in Table 2. Similarly, Cox-proportional hazards models found no difference in the time taken to achieve CS or QS.

The crude data did not show any significant difference in the medication reduction when comparing the two groups. However, after adjusting for baseline characteristics, there was a significantly greater average medication reduction of 0.9 medications for cataract with iStent inject compared with 0.4 for cataract with Hydrus ($p = 0.025$). In the analysis using propensity matching, the magnitude of the medication differences for each group was very similar with an average medication reduction of 1.0 medications for cataract with iStent inject versus a 0.5 for cataract with Hydrus. However, this result was not statistically significant ($p = 0.081$).

There were 12 (5.4%) eyes in the iStent inject group and 9 (7.5%) eyes in the Hydrus group that required subsequent procedures, all of which were to improve IOP control and were not related to other adverse events (Table 3).

3.3 | Safety

Best corrected visual acuity (BCVA) and the presence or absence of any adverse events are mandatory fields requiring a response in the registry for each visit following a glaucoma procedure. Overall, there was a low rate

TABLE 2 Twenty-four-month crude and adjusted outcomes of Hydrus versus iStent inject for all eligible eyes and the propensity matched cohort

	Hydrus	iStent inject	*p*-value
Procedures	120	224	
IOP outcomes			
Preoperative, mean (*SD*)	18.1 (5.5)	16.3 (4.4)	0.003[a]
Final, mean (*SD*)	15.1 (5)	14.1 (4.2)	0.076[a]
Change, mean (95% CI)	−3 (−4, −2)	−2.2 (−2.8, −1.6)	0.158[a]
% Change, median (Q1, Q3)	−12.8% (−31.8, 0)	−13.3% (−26.7, 0)	0.372[b]
Medication outcomes			
Preoperative, mean (*SD*)	2.1 (1.2)	1.5 (1.2)	<0.001[a]
Final, mean (*SD*)	1.3 (1.4)	0.8 (1.2)	0.001[a]
Change, mean (95% CI)	−0.8 (−1.1, −0.6)	−0.8 (−0.9, −0.6)	0.615[a]
Qualified success, *n* (%)[c]			
IOP 15 mmHg	38 (31.7%)	73 (32.6%)	0.957[d]
IOP 18 mmHg	46 (38.3%)	85 (37.9%)	1.000[d]
IOP 21 mmHg	48 (40%)	86 (38.4%)	0.861[d]
Complete success, *n* (%)[e]			
IOP 15 mmHg	17 (14.2%)	47 (21%)	0.161[d]
IOP 18 mmHg	19 (15.8%)	50 (22.3%)	0.197[d]
IOP 21 mmHg	19 (15.8%)	50 (22.3%)	0.197[d]
Adjusted outcomes[f]			
IOP change, mean (95% CI)	−1.4 (−4.2, 1.3)	−2.4 (−4.7, −0.0)	0.394[g]
Meds change, mean (95% CI)	−0.4 (−0.8, 0.0)	−0.9 (−1.1, −0.6)	0.025[g]
Qual. suc. 15 mmHg, % (95% CI)	22% (12, 37)	35% (26, 45)	0.127[h]
Qual. suc. 18 mmHg, % (95% CI)	25% (14, 42)	43% (32, 54)	0.066[h]
Qual. suc. 21 mmHg, % (95% CI)	27% (15, 43)	43% (33, 54)	0.090[h]
Comp. suc. 15 mmHg, % (95% CI)	9% (4, 18)	17% (12, 25)	0.108[h]
Comp. suc. 18 mmHg, % (95% CI)	9% (4, 19)	19% (13, 27)	0.079[h]
Comp. suc. 21 mmHg, % (95% CI)	9% (4, 19)	19% (13, 27)	0.079[h]
Propensity matched adjusted outcomes[f,i]			
IOP change, mean (95% CI)	−2,3 (−5.2, 0.5)	−3.1 (−5.5, −0.7)	0.530[g]
Meds change, mean (95% CI)	−0.5 (−1.1, 0.0)	−1.0 (−1.3, −0.7)	0.081[g]
Qual. suc. 15 mmHg, % (95% CI)	24% (13, 40)	34% (22, 49)	0.285[h]
Qual. suc. 18 mmHg, % (95% CI)	31% (17, 49)	47% (32, 62)	0.157[h]
Qual. suc. 21 mmHg, % (95% CI)	33% (19, 50)	47% (33, 61)	0.210[h]
Comp. suc. 15 mmHg, % (95% CI)	7% (3, 16)	12% (6, 22)	0.350[h]
Comp. suc. 18 mmHg, % (95% CI)	8% (4, 18)	14% (8, 25)	0.268[h]
Comp. suc. 21 mmHg, % (95% CI)	8% (4, 18)	14% (8, 25)	0.268[h]

[a]Two sample *t* test.
[b]Wilcoxon rank-sum test.
[c]Qualified success is defined as a 20% reduction from preoperative IOP with final IOP less than 15, 18 or 21 mmHg at the 24-month visit.
[d]Chi-square test.
[e]Complete success is defined as a qualified success with 0 medications used at the endpoint.
[f]Adjusted for baseline IOP, baseline medications, age, gender, visual field MD and nesting of outcomes within doctor and patient (for bilateral cases).
[g]Linear mixed-effects regression model.
[h]Logistic mixed-effects regression model.
[i]Propensity matched on baseline IOP, baseline medications, age, gender and visual field MD.

of ocular adverse events for eyes in each arm of this study and there was no significant difference between the two groups.

The visual outcome for most eyes in both groups was good. During months 3–24, the number of patients with loss of BCVA of ≥2 lines was 17 (7.6%) in the iStent group and 14 (11.7%) in the Hydrus group ($p = 0.900$). Early hypotony (IOP <6 in the first postoperative month) occurred in 1 patient (1.3%) in the iStent inject group and 3 patients (4%) in the Hydrus group. All of these had recovered by 1 month, there was one case of late (3–24 months) hypotony in the Hydrus group. There were no cases of visually significant (≥2 lines BCVA loss) hyphema reported in the iStent inject group, 3 (2.5%) were reported in Hydrus cases.

There were no cases of endophthalmitis or significant anterior uveitis. Adverse events are summarised in Table 4.

TABLE 3 Subsequent procedures performed prior to completing 24 months of follow-up

	Hydrus	iStent inject
Deep sclerectomy	0	1
Iridoplasty	0	1
iStent inject	0	1
Other intraocular surgery excluding cataract	0	2
Posterior vitrectomy	0	1
SLT 180°	4	2
SLT 360°	0	1
Trabeculectomy	4	2
Xen implant	1	1

4 | DISCUSSION

This study uses real-world data from the FGB Registry to compare outcomes of cataract surgery combined with either the Hydrus Microstent or the iStent inject. Real-world data are influenced by clinical practice, not a research protocol, and this data set shows significant differences in the baseline characteristics of the two groups of interest.

Compared with the iStent inject group, the cataract with Hydrus group had a significantly higher preoperative IOP, more glaucoma medications, a greater visual field deficit, and worse BCVA. This suggests that in clinical practice in Australia, the Hydrus has been used in patients with more advanced disease. Accounting for these differences in important as preoperative characteristics influence the efficacy of glaucoma procedures.[14]

We found both devices investigated here provide modest IOP reduction at 2 years with no statistically significant difference in IOP reduction between them in either the crude, adjusted or propensity matched analysis. While no similar data have been published comparing the second generation iStent inject with Hydrus, data are available comparing the first-generation iStent with the Hydrus Microstent. Lee et al.,[15] reported 50 patients in each arm of study looking at cataract with first-generation iStent compared with cataract with Hydrus. They reported 12 months of follow-up using iCare tonometry rather than Goldmann and found no significant difference in IOP or medication reduction between the two groups.

The efficacy results presented here for each device are on the lower end of the range previously reported. The IOP reduction in iStent inject and Hydrus pivotal trials showed a 7.0 and 7.6 mmHg IOP reduction in association with cataract, respectively.[2,3] In these pivotal trials,

TABLE 4 Frequency and percentage of procedures with an adverse event recorded at any period up until the 24-month visit

	Hydrus	iStent inject	*p*-value
Subsequent procedure performed[a]	9 (7.5%)	12 (5.4%)	0.738[b]
Loss of BCVA ≥2 lines (0–1 month)	32 (26.7%)	24 (10.7%)	0.790[b]
Loss of BCVA ≥2 lines (1–3 months)	7 (5.8%)	4 (1.8%)	0.352[b]
Loss of BCVA ≥2 lines (3–24 months)	14 (11.7%)	17 (7.6%)	0.900[b]
Hypotony (0–1 month)	4 (3.3%)	1 (0.4%)	-
Hypotony (1–3 months)	0 (0%)	0 (0%)	-
Hypotony (3–24 months)	1 (0.8%)	0 (0%)	-
Device malposition	2 (1.7%)	1 (0.4%)	-
Hyphema with ≥2 line BCVA loss	3 (2.5%)	0 (0%)	-

Note: *p*-values were not calculated for events that had a frequency of ≤5 in each group.

[a]Prior to completing 24 months of follow-up.

[b]Logistic regression adjusted for baseline IOP, baseline medications, age, gender, visual field MD and nesting of outcomes within doctor and patient (for bilateral cases).

patients were only enrolled if they had an elevated IOP after medication washout, and the final IOP results similarly were also with medication washout. Other studies with a lower pretreatment IOP found more modest reductions: Guedes et al. reported a series of 58 cases of iStent inject with cataract with a baseline mean IOP of 16.1 mmHg. They found a 19.1% IOP reduction at 12 months.[16] A further study of 20 patients with pretreatment medicated IOP below 20 mmHg found a similar IOP reduction of 18.5% at 2 years.[17] Some other reports on iStent inject have also found persistent IOP reductions of over 30%, but in general, these had substantially higher pretreatment IOPs.[18–20] Similarly for the Hydrus Microstent, IOP reduction is smaller here than reported in other studies; Lee et al. found a 25.6% IOP reduction at 12 months with Fea et al. reporting a 19.6% reduction.[15,21]

The lower baseline IOPs of cases in this report may in part explain the smaller IOP reductions observed for each device. A further consideration is that most studies to date have tended to exclude cases that required secondary surgery, whereas this report has included these patients, carrying forward the last observation prior to reoperation, which invariably is an elevated IOP.[22]

After adjusting for baseline differences between the groups. The data presented here show that after 2 years, the cataract with iStent inject cohort had a greater reduction in glaucoma medication usage compared with the cataract and Hydrus cohort. After 2 years, the iStent inject group had an average reduction of 0.9 medications, while the Hydrus arm had an average reduction of 0.4 medications ($p = 0.025$). The magnitude of the medication reduction for each group was very similar (−1.0 medications vs. −0.5) after propensity score matching, but this was not statistically significant ($p = 0.081$) likely due to the reduced sample size in the propensity-matched cohort.

These findings are somewhat different to the COMPARE study, which was a prospective randomised trial of standalone Hydrus Microstent versus the first-generation iStent device (without concurrent cataract surgery).[23] The study randomised 152 eyes between the two groups. The study was initially designed to have medication washout at baseline and at the primary endpoint, but this did not occur and so there was a protocol variation to account for this. They found no significant difference between the groups in IOP reduction at any time point, but they did find that glaucoma medication use was significantly lower in the Hydrus group from the 3-month visit through to the final 12-month follow up. Relevant differences are that our presented data are of combination surgery with cataract, and it was involving the second-generation iStent inject rather than the first-generation iStent. It is not clear whether this difference in outcome, that is, medication reduction, is because of the concomitant cataract surgery, or because of different efficacy of the second-generation iStent inject over the first-generation device.

More generally, the reduction in glaucoma medications in this study is similar to existing literature. The iStent inject and Hydrus Pivotal trials reported a 1.2 and 1.0 medication reduction, respectively.[2,3] Similarly, Guedes et al. reported a reduction of 1.5 medications in combined iStent inject eyes,[16] while similar results have been reported for Hydrus with medications reductions of 1.2–1.4.[15,21]

Rates of adverse events were similar between the two groups. There was no difference in the percentage of eyes losing >2 lines of vision at any of the postoperative time periods, and in each arm of this study, the rate of vision loss is comparable with other studies.[21] Hydrus had a higher number of eyes developing early numerical hypotony (IOP < 6) (3.6% compared with 0%), but the absolute numbers were too small to compare statistically. None of the Hydrus patients developed associated choroidal effusions suggesting it is unlikely there was any significant visual impact from this finding. Both groups had low numbers of device malposition, which were not different between groups and consistent with other published literature.[24]

Rates of requiring further glaucoma surgeries were not significantly different with nine cases in the iStent inject arm and four cases in the Hydrus arm. Similarly, subsequent selective laser trabeculoplasty was performed in two eyes for iStent inject and three eyes in Hydrus. There were no cases of endophthalmitis or clinically significant uveitis in either group.

Real-world observational study of routine clinical practice inherently has a number of limitations. The choice of device may be influenced by patient characteristics leading to a selection bias. To account for this, we have undertaken adjusted analyses in our regression with additional analyses using propensity score matching taking into account differences in baseline characteristics.

Assessing the clinical significance of apparent medication reduction in MIGS studies can be challenging. The number of medications in use is influenced by individual practitioner practice patterns; whether all medications are washed out at surgery, or routinely continued and only withdrawn if there is a need such as local irritation or an IOP that is well below the patients' target pressure. There is also some evidence that stopping glaucoma medications does not always lead to an increase in IOP. In the Hydrus FDA pivotal trial, 587 patients were not randomised, and the most common reason for this was that the washed-out IOP did not rise above 22 mmHg.[2] This

could either be from a lack of efficacy of the glaucoma medications in that patient, poor adherence to the medications or that the IOP reading that led to commencing treatment was then affected by regression to the mean.

Differential adherence between patients is also a potential confounder in IOP measures in non-washed-out patients. Washing out medications is the gold standard as in the FDA pivotal trials, but not something that is routinely done in clinical practice. Therefore, the present study did not aim to identify the 'pure' effect of the individual glaucoma devices, but instead reflect what happens in real-world practice.

4.1 | Conclusion

The 24-month outcomes of combined phacoemulsification and either iStent inject or Hydrus confirm modest IOP and glaucoma medication reduction. The procedures are safe with minimal adverse events in either arm.

Surgeons should have confidence that either trabecular device has similar efficacy in reducing IOP and glaucoma medication use. There may be a small additional benefit of iStent inject over Hydrus in reducing glaucoma medication usage, however ongoing data collection and further studies will investigate whether this finding is robust.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

The FGB! Database has ongoing HREC ethics approval which was amended to include retrospective data entry for the purpose of this and future studies using the database. There are no investigations or measurements included in this study that are not part of routine clinical practice. There are therefore no material ethical considerations for this study.

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