Intraocular Pressure Peaks After Suprachoroidal Stent Implantation

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Précis: Retrospective analysis of 38 suprachoroidal glaucoma stent implantations showed sudden intraocular pressure (IOP) elevations to > 30 mm Hg in 37% of eyes, 39% needing additional glaucoma surgery, and a success rate at 12 months of 24%.

Purpose: To study the efficacy and safety of suprachoroidal stent in everyday clinical practice at a tertiary glaucoma center.

Materials and Methods: This retrospective single-center consecutive case series involved patients treated at Helsinki University Hospital with the CyPass Micro-Stent. Preoperative IOP was ≥ 18 mm Hg. Success was IOP between 6 and 18 mm Hg and lowering of IOP at least 20% from baseline without an increase in glaucoma medications over baseline or use of oral acetazolamide, and no subsequent glaucoma surgery.

Results: Of the total 38 eyes of 33 patients, 17 had primary open-angle glaucoma, 16 had exfoliative glaucoma, 2 each had uveitic glaucoma or steroid-induced glaucoma, and 1 had pigmentary glaucoma. Median preoperative IOP was 25.8 [interquartile range (IQR), 9.7] mm Hg with a median of 3 (IQR, 2) glaucoma medications. Kaplan-Meier estimate of median survival time was 79 days (95% confidence interval, 37-121 d). Success rate at 12-month follow-up was 24%. Sudden IOP elevation to over 30 mm Hg occurred in 14 eyes (37%). Highest IOP was 68 mm Hg. IOP peaks occurred between 1 week and 8 months after the surgery. In total, 43% of those with IOP elevation to > 30 mm Hg had no symptoms. After the CyPass implantation, 15 eyes (39%) needed additional glaucoma surgery within a median of 167 (IQR, 109) days.

Conclusions: Suprachoroidal stenting in a heterogenous clinical population resulted in a high incidence of sudden IOP peaks with a low success rate.

Key Words: suprachoroidal, supraciliary, CyPass, MIGS, glaucoma (J Glaucoma 2020;29:1050–1055)

The number of glaucoma patients increases worldwide, so simple, fast, and predictable surgical options with little postoperative after-care are greatly sought after.1,2 As a result of this need and with technical and surgical advancements, a surge of various new minimally invasive glaucoma surgery (MIGS) devices has struck the market in recent years. MIGS currently aims to enhance aqueous outflow from the anterior chamber to the subconjunctival or to the suprachoroidal space, or to the episcleral veins using Schlemm canal and collector channels. Of these 3 pathways, the suprachoroidal space has the inherent advantage of a lower pressure gradient than that of episcleral veins (4 mm Hg vs. 8 to 10 mm Hg) and its use also avoids problems associated with subconjunctival drainage such as excess scarring of a filtering bleb, lifelong risk of infection, and other conjunctival bleb-related problems.3-5

One of the stents using the suprachoroidal route is the CyPass Micro-Stent (Alcon, Geneva, Switzerland). It was, however, withdrawn from the market by the manufacturer in August 2018 after a long-term safety study showing significant corneal endothelial cell loss.6 However, interest is continuing in the potential benefits of the suprachoroidal pathway, and various other new suprachoroidal stents and surgical techniques are currently in use and under investigation.7-16

In this retrospective single-center study, we analyzed the efficacy and adverse events related to the use of a suprachoroidal micro-stent in an everyday clinical setting at a tertiary-care facility.

MATERIALS AND METHODS

This retrospective single-center consecutive case series study used data collected with permission from the institutional review board in accordance with the Declaration of Helsinki. Patients treated at Helsinki University Hospital with the CyPass Micro-Stent implantation between November 2017 and August 2018 were identified from medical records by procedure code, with all data collected in March 2020.

Patients

The study comprised consecutive eyes with glaucoma that had undergone a CyPass Micro-Stent implantation. Inclusion criteria were preoperatively treated intraocular pressure (IOP) ≥ 18 mm Hg. Criteria for the CyPass operations and reoperations were not uniformly defined, and each decision to operate was at each individual surgeon’s discretion. Similarly, no predefined criteria existed for any postoperative medication decrease or increase, with those decisions on the basis of the clinical judgment of individual surgeons.

Outcome Measures

The definition of success conformed to the World Glaucoma Association guidelines and was lowering of IOP by at least 20% from the preoperative medicated value (the baseline). IOP between 6 and 18 mm Hg, and no increase in glaucoma medications over the baseline.17 Failure was...
defined as 2 consecutive visits not fulfilling these criteria (excluding the first postoperative day visit) or any additional glaucoma surgery or continuous use of oral acetazolamide. The date of failure were considered to be the midpoint between the last day of success and the first day of failure. Baseline IOP was the mean Goldmann applanation tonometry (GAT) reading of the 3 visits preceding surgery.

CyPass Micro-Stent Implantation

Three experienced glaucoma surgeons certified for CyPass Micro-Stent implantation performed the operations and followed the same standard technique. The study includes all CyPass implantations performed in our clinic, also the first cases. In procedures combined with phacoemulsification cataract surgery, the CyPass Micro-Stent was inserted at the completion of cataract surgery.

All patients were instructed to use prednisolone acetate 10 mg/mL drops q.i.d. for 1 month and levofloxacin hemihydrate 5 mg/mL drops q.i.d. for 2 weeks. Preoperative IOP medication was paused after the surgery and was stepwise reintroduced during postoperative visits if necessary.

Study Measures

We collected all clinical data from preoperative visits including age, sex, glaucoma diagnosis, time since diagnosis, IOP at diagnosis, laterality, prior surgical procedures and ocular diseases, best-corrected visual acuity, GAT IOP, optic nerve-head cup-disc ratio, and number and type of glaucoma medications in use.

Data collected from postoperative visits included GAT IOP, best-corrected visual acuity, clinical findings, and number of glaucoma medications. Procedure-related data included complications during and after surgery. Postoperative data were collected at the following time points if available: 1 day, 1 week, 1 month, and 2, 3, 6, 12, 18, and 24 months after surgery. Data were also collected on all additional visits related to hypotensive or hypertensive episodes.

Statistics

Results are median and interquartile range (IQR). These were calculated with Microsoft Excel software (Microsoft Corporation, Redmond, WA). Kaplan-Meier product limit estimate of survival was calculated with an open source software RStudio (RStudio, Boston, MA).

RESULTS

The inclusion criteria were met for 38 eyes of 33 patients (Supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/IJG/A424). Of these, 17 eyes had primary open-angle glaucoma (POAG), 16 had exfoliative glaucoma (EXG), 2 each had uveitic glaucoma or steroid-induced glaucoma, and 1 had pigmentary glaucoma.

Four eyes (11%) had undergone previous incisional glaucoma surgery; 1 trabeculectomy, 1 deep sclerectomy, 1 ab interno trabeculotomy, and 1 eye had deep sclerectomy followed by Ahmed valve implant. Selective laser trabeculoplasty had been performed on 24 (65%) eyes; 7 had transscleral cyclophotocoagulation, and 6 laser peripheral iridotomy (LPI). One eye had LPI because of pigment dispersion syndrome. Four eyes with POAG and 1 eye with EXG had developed narrow angles after 4 to 22 years of glaucoma treatment, because of natural lens growth.

In total, 15 (39%) of the CyPass implantations were combined with phacoemulsification. Of the 23 (61%) eyes with a stand-alone CyPass procedure, 16 (70%) were pseudophakic.

The median preoperative (baseline) IOP was 25.8 (IQR 9.7) mm Hg and the median number of glaucoma medications in use was 3 (2). Baseline IOP was 23.7 (8.5) mm Hg in POAG eyes, 27.4 (8.4) mm Hg in EXG eyes, and 29.0 (7.7) mm Hg in secondary glaucomas.

IOP was lower than baseline in 38 eyes on the first postoperative day except for 1 eye with a blood clot inside the lumen of the implant (see below). Median IOP was on the first postoperative day 13.5 (IQR, 7.6) mm Hg (all eyes without glaucoma medication), at 1 week 13.0 (9.5) mm Hg (6 eyes on medication), and at 1 month 15.5 (12.5) mm Hg (12 eyes on medication).

One eye of each patient (the first operated eye) was included in a Kaplan-Meier survival plot of 33 eyes (Fig. 1). Estimated median survival time was 79 days (95% confidence interval, 37-121 d). At 12 months of follow-up, success was 24%.

Of all 38 eyes, 15 (39%) needed additional glaucoma surgery that was performed a median of 167 (109) days after CyPass implantation. Trabeculectomy was performed on 3 eyes, deep sclerectomy on 6 eyes, endocyclophotocoagulation on 3 eyes, and Baerveldt glaucoma implant on 3 eyes.

IOP Elevations

An IOP rise of 10 mm Hg or more from the previous measurement to over 21 mm Hg occurred in 23 eyes (61%) without any abnormal findings in slit-lamp examination, one such as iris incarceration, blood inside the stent, or abnormal stent position (Fig. 2). Of these 23 eyes, in 9, IOP rose to a range of 22 to 30 mm Hg, and in 14 eyes (of 13 patients) to over 30 mm Hg. The highest peak IOP was 68 mm Hg. IOP peaks occurred between 1 week and 8 months after the surgery, and the median time was 63 days after the surgery. At the end of follow-up, 4 (17%) of these 23 eyes were considered successful.

Eight (57%) of the eyes with IOP elevation over 30 mm Hg presented with symptoms of high IOP, but the other 43% were symptomless. The range of highest measured IOP of symptomatic eyes (35 to 68 mm Hg) was similar to IOP in those without symptoms (33 to 65 mm Hg).

The most common symptoms were localized scotomas in 5 eyes. One patient had only a transient 15 minutes blurring of vision a week before having an IOP of 65 mm Hg during a routine follow-up visit. Only 1 of these 14 eyes had IOP-lowering medication at the time of the peak IOP; this eye was on a fixed combination dorzolamide-timolol drops, but IOP increased from 17 to 60 mm Hg.

In those eyes with an IOP rise to values above 30 mm Hg, a routine IOP measurement had been taken a median of 27 (IQR 10) days before the IOP elevation (range, 5 to 88 d). Median IOP on those visits was 13.5 (7.8) mm Hg. In 1 patient, the IOP was 17 mm Hg on postoperative day 7. Five days later, the eye had become painful, and its IOP was 60 mm Hg.

Of the 14 eyes with a sudden IOP rise ⩾ 30 mm Hg, none was considered successful at the end of follow-up and 11 (79%) underwent additional glaucoma surgery. One eye had central retinal vein occlusion during high IOP and loss of vision to a level of light perception before additional surgical intervention.
Other Adverse Events

Intraoperative and immediate postoperative complications were rare (Table 1). One vitreous loss happened during phacoemulsification with a ruptured posterior capsule. Implants were appropriately positioned at the first postoperative day, except for 1 stent that was not deep enough and had to be pushed deeper. One eye had a corneal erosion on the first day.

Four eyes had hyphema large enough to be visible without gonioscopy. Three of the 4 hyphemas resolved without sequelae, but in 1 eye there was blood clot inside the micro-stent 1 week after the surgery, and although it cleared during the second week, the IOP remained at a preoperative level until deep sclerectomy was performed 3 months later. One stent was blocked by a blood clot inside the stent without a larger hyphema, and IOP was 58 mm Hg on the first day. However, after the blood cleared, IOP fell and the eye remained at the target IOP without medication until the end of follow-up.

Iris incarceration of the stent occurred in 1 pseudo-phakic eye 2 weeks postoperatively. It was at first successfully liberated with local argon laser iridoplasty. At the next

![CyPass Micro-Stent Survival Function](image)

**FIGURE 1.** Kaplan-Meier survival plot of CyPass Micro-Stent eyes. Only 1 eye of each patient was included. Survival after CyPass was defined as intraocular pressure (IOP) between 6 and 18 mm Hg and lowering of IOP at least 20% from baseline without an increase in glaucoma medications over baseline or use of oral acetazolamide, and no subsequent glaucoma surgery. The gray area represents 95% confidence intervals.

![Intraocular pressures of all CyPass Micro-Stent implanted eyes](image)

**FIGURE 2.** Preoperative and postoperative intraocular pressures (IOP). Each line represents 1 eye. All eyes are included whether or not they were considered successful during the follow-up. Lines ending before 12 months of follow-up had undergone additional glaucoma surgery except for 2 patients who died during the follow-up (dotted lines). No IOPs after additional glaucoma surgery are shown.
visits, no iris adhesion to the stent was visible, but the stent was buried so deep inside the suprachoroidal space that it could be seen only with anterior segment optical coherence tomography imaging.

Three eyes presented with hypotony (IOP <6 mm Hg). All were pseudophakic and had a stand-alone CyPass procedure. The hypotony lasted for postoperative days 1 to 31, 10 to 134, and 36 to 74. No eye had hypotony-related complications (shallow anterior chamber, choroidal effusion, hypotony maculopathy). However, even with the very low initial IOP up to 6 months, 1 of these eyes experienced a sudden IOP elevation from 6 to 65 mm Hg 8 months after the operation.

**DISCUSSION**

Treating glaucoma by surgically increasing aqueous drainage to the suprachoroidal space is theoretically appealing and has awakened considerable interest. This retrospective analysis of the efficacy and safety of the suprachoroidal CyPass Micro-Stent procedure showed a high incidence of sudden postoperative IOP elevations with unfavorable prognosis. An IOP rise to over 30 mm Hg was evident in 37% eyes without any abnormal findings in slit-lamp examination, and at the end of follow-up, only 14% of these were considered successful.

The same 37% of our eyes had high IOP by the criteria of the DUETTE trial, in which 27% of eyes experienced an IOP rise of >10 mm Hg from baseline or to over 30 mm Hg. In the DUETTE trial, 50% of these eyes underwent an additional glaucoma procedure in contrast to 79% of eyes in our study.

IOP rises over 30 mm Hg from baseline in 8.9% of eyes, and 31.6% of eyes needed additional glaucoma surgery. In the CyCLE study with combined Cypass and cataract surgery, 10.5% had an IOP increase of > 10 mm Hg from baseline, and 5% needed additional surgery. In the COMPASS study, 4.3% of eyes had an IOP over 10 mm Hg above baseline in 2 years, and 5.5% of that study’s eyes needed secondary glaucoma surgery. By the criterion of the CyCLE and COMPASS studies, of our 37 eyes, 9 (24%) had an IOP elevation. Our study thus showed the highest reported incidence of elevated IOPs and the highest rate of additional glaucoma surgery.

The number of complex cases does not explain this difference, since 29% of eyes in our study had earlier glaucoma surgery (excluding selective laser trabeculoplasty and LPI) compared with eyes in the study of Kerr and colleagues in which all eyes had glaucoma surgery. However, the eyes in our study had higher baseline IOP (mean ± SD, 27.1 ± 7.5 mm Hg), and were treated with more medications (3.1 ± 1.4) compared with eyes in the DUETTE (24.5 ± 2.8 mm Hg, 2.2 ± 1.1 medications), CyCLE CyPass with cataract surgery (21.1 ± 5.9 mm Hg, 2.1 ± 1.1 medications), COMPASS (24.4 ± 2.8 mm Hg, 1.4 ± 0.9 medications), and the Kerr and colleagues (22.5 ± 8.0 mm Hg, 2.7 ± 1.0) studies. The higher baseline IOP with more baseline medications may explain our higher incidence of high IOPs and reoperations.

Our IOP peaks occurred between 1 week and 8 months postoperatively, at a median length of time of 63 days. This is in line with the findings in the DUETTE study with its essentially little if any device failure during its second year of follow-up. In a recent case report, McCartney and Phagurni describe an acute ocular hypertensive crisis in both eyes of a patient with IOPs of 83 and 56 mm Hg occurring 2 months postoperatively.

The CyPass Micro-Stent is not the only suprachoroidal glaucoma device associated with IOP elevations. Regarding a new surgical technique of suprachoroidal drainage with collagen-sheet implantation, Szurman et al reported that 9.2% of their 65 eyes showed early postoperative IOP peaks and about half of those required reoperation within the first 12 months. A report of a novel MINIject suprachoroidal device (STAR Medical, Wavre, Belgium) stated that of 26 eyes, 6 (23%) had IOP elevations during the first 3 months after surgery. In 5 eyes, the elevations were deemed mild to moderate and 1 had a severe IOP peak of 60 mm Hg at 2 months. None of these eyes required additional surgery.

Several hypotheses for IOP elevations exist. Sudden closure of the cyclodialysis cleft combined with a possible underlying long-term increase in trabecular meshwork resistance may explain the very high IOPs. One ultrasound study after CyPass insertion demonstrated a gradual reduction in the area of suprachoroidal fluid diffusion. Agnifili et al showed that the main cause of suprachoroidal gold micro shunt failure in refractory uncontrollable glaucoma was an intense fibrosis of the inner spaces and outer surfaces of the shunt. From past work, we know that the cyclodialysis procedure has been associated with severe IOP spikes in many patients as the cleft closes.

According to Hoeh et al, the cyclodialysis cleft formed during CyPass implantation often contracts around the stent 4 to 6 weeks following surgery. The exact reason for the sudden IOP elevations with CyPass is unknown, but such elevations in IOP seem characteristic of most if not all forms of suprachoroidal glaucoma surgery.

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**TABLE 1. Adverse Events**

| Event                          | Count (%) |
|-------------------------------|-----------|
| Hyphema                       | 4 (11%)   |
| Hypotony (IOP <6 mm Hg)       | 3 (8%)    |
| Cystic macular edema          | 1         |
| Corneal erosion               | 1         |
| Vitreous loss                 | 1         |
| Iris incarceration             | 1         |
| Repositioning of the stent    | 1†        |
| Additional glaucoma surgery   | 15 (39%)  |
| Time after CyPass procedure   | 167 (109) |

**IOP peaks**

- >30 mm Hg: 14
- >40 mm Hg: 10
- >50 mm Hg: 9

**Symptomatic‡**

- 8/14 (57%)§

**Time after surgery (d) [range]**

- 56 (83) [14-238]

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Numbers represent eyes and are presented as median (interquartile range); unless otherwise stated.

*Local argon laser iridoplasty restored flow and pressure dropped from 58 to 6 mm Hg. At the next visit the stent was, however, migrated further inside the suprachoroidal space (confirmed with OCT) and this led to IOP rise again and additional glaucoma surgery was scheduled.

†All 3 retention rings were visible on the first postoperative day and the stent was pushed to a proper position.

‡For example pain or blurring of vision.

§IOP range of symptomatic patients (35 to 68 mm Hg) was similar to those without symptoms (33 to 65 mm Hg).

IOP indicates intraocular pressure; OCT, optical coherence tomography.
IOP elevations do occur in other types of glaucoma surgery as well. Early postoperative weeks after trabeculectomy are characterized by fluctuations in IOP.3,32 After deep sclerectomy, IOP can rise significantly months and years after surgery before a goniopuncture is performed.33 Miletto and Baerveldt glaucoma implants often present with a hypertensive phase a few weeks after the procedure.34 One of the main reasons for choosing MIGS surgery is safety. Adverse events such as IOP peaks may be less acceptable than in surgical techniques with more IOP-lowering capacity. We noted IOP peaks after CyPass during the first 8 months after the surgery. Almost half of the eyes with high IOPs did not present any symptoms. This makes a difficult combination for everyday clinical practice; how to watch for a significant and frequent, but often symptomless complication for 8 months after suprachoroidal stent implantation?

Three of our study eyes (8%) had hypotony, close to the figures in other studies. The reported incidence of hypotony was 2.9% in the COMPASS study, 0.4% in the CyCLE stand-alone, 13.8% in the CyCLE group of combined caretact surgery, and 0% in the DUETTE.20,22,24 Szurman and colleagues reported transient hypotony in 6.2% of eyes undergoing collagen-sheet implantation, 3.8% of eyes with the MINIject implant had hypotony, and 13.9% of eyes with the STARFlo implant.7,12,13 No hypotony has been reported with the gold micro shunt.8,10,16

This study shows a very high incidence of sudden high IOPs and a relatively poor prognosis in CyPass Micro-Stent implanted eyes. These high IOPs are vision-threatening in glaucomatous and ageing eyes. They can lead to vision loss as occurred in 1 of our study eyes with very high IOP followed by central retinal vein occlusion, ruberosis, and loss of vision to light perception. Severe glaucomatous damage can occur during episodes of high IOP.35–38 It is also important to note that hypertensive medication may not prevent such pikes as in 1 of our study patients with considerable IOP elevation up to 60 mm Hg while on dorzolamide-timolol medication.

Limitations of this study include the possibility of a selection bias, its retrospective nature, its limited sample size, relatively short follow-up, and the heterogeneity of its diagnoses. The results found are not necessarily generalizable because of possible extreme subgroup results. The study does not have a control group and therefore the results may not be directly related to the intervention. It is possible that more eyes had IOP peaks than were observed, because nearly half (43%) of the high IOPs caused no symptoms and were discovered on a routine follow-up visit. Because of the small sample size of the study we did not perform any statistics regarding group differences or the effects of preoperative characteristics on the results. However, it is important to add that IOP peaks occurred in all diagnostic groups and did not seem to concentrate on POAG or EXG eyes. As the study included also the very first CyPass implantations in our hospital, it is possible that the results would have been better after a learning phase. However, the CyPass implantation technique proved to be easy to learn for an experienced glaucoma surgeon and all implants except for 1 were in a correct position on the first postoperative day, and initial unmedicated postoperative IOPs were low (except for 1 case with blood clot).

Although the CyPass Micro-Stent is currently unavailable for clinical use, many other suprachoroidal procedures and devices are in use or under development.7–16 On the basis of our results here, we suggest careful adoption of new suprachoroidal procedures into everyday clinical practice with frequent IOP measurements during the first postoperative year. IOP monitoring should be systematic, because of the high incidence of symptomless IOP elevations.

REFERENCES
1. Tham Y-C, Li X, Wong TY, et al. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology. 2014;121:2081–2090.
2. Shah M. Micro-invasive glaucoma surgery—an interventional glaucoma revolution. Eye Vis (Lond). 2019;6:29.
3. Emi K, Pederson JE, Toris CB. Hydrostatic pressure of the suprachoroidal space. Invest Ophthalmol Vis Sci. 1989;30:233–238.
4. Azaiza-Blanco A, Katz LJ. Dysfunctional filtering blebs. Surv Ophthalmol. 1998;43:93–126.
5. Kim E-A, Law SK, Coleman AL, et al. Long-term bleb-related infections after trabeculectomy: incidence, risk factors, and influence of bleb revision. Am J Ophthalmol. 2015;159:1082–1091.
6. Reiss G, Clifford B, Vold S, et al. Safety and effectiveness of CyPass supraciliary micro-stent in primary open-angle glaucoma: 5-year results from the COMPASS XT study. Am J Ophthalmol. 2019;208:219–225.
7. Denis P, Hirneiß C, Reddy KP, et al. A first-in-human study of the efficacy and safety of MINIject in patients with medically uncontrolled open-angle glaucoma (STAR-I). Ophthalmol Glaucoma. 2019;2:290–297.
8. Tanto M, Chihara E. Safety and effectiveness of gold glaucoma micro shunt for reducing intraocular pressure in Japanese patients with open angle glaucoma. Jpn J Ophthalmol. 2017;61:388–394.
9. Figus M, Lazzi S, Fogagnolo P, et al. Supraciliary shunt in refractory glaucoma. Br J Ophthalmol. 2011;95:1537–1541.
10. Hueber A, Roters S, Jordan JF, et al. Retrospective analysis of the success and safety of gold micro shunt implantation in glaucoma. BMC Ophthalmol. 2013;13:35.
11. Cseke I, Vamosi P, Bausz M. Starflo glaucoma implant: early experience in Hungary. Rom J Ophthalmol. 2016;60:14–17.
12. Fili S, Wölfelschneider P, Kohlhass M. The STARFlo glaucoma implant: preliminary 12 months results. Graefes Arch Clin Exp Ophthalmol. 2018;256:773–781.
13. Myers JS, Massod A, Herbstak DM, et al. Prospective evaluation of two iStent® trabecular stents, one iStent Supra®, and postoperative prostaglandin in refractory glaucoma: 4-year outcomes. Adv Ther. 2018;35:395–407.
14. Laroche D, Anugo D, Ng C, et al. Intra-scleral ciliary sulcus suprachoroidal microstent surgery affordable. J Natl Med Assoc. 2019;111:427–435.
15. Szurman P, Januschowski K, Boden KT, et al. Suprachoroidal drainage with collagen sheet implant - a novel technique for non-penetrating glaucoma surgery. Graefes Arch Clin Exp Ophthalmol. 2018;256:381–385.
16. Skaat A, Sagiv O, Kinori M, et al. Gold micro-shunt implants versus Ahmed glaucoma valve: long-term outcomes of a prospective randomized clinical trial. J Glaucoma. 2016;25:155–161.
17. Shaarawy T. World Glaucoma Association. Guidelines on Design and Reporting of Glaucoma Surgical Trials. Amsterdam: Kugler; 2009.
18. Hosmer DW, Lemeshow S, May S. Applied Survival Analysis: Regression Modeling of Time-to-Event Data. 2nd ed. Hoboken, NJ: Wiley-Interscience; 2008.
19. Tarkkanen A, Kivelä T. Cumulative incidence of converting versus Ahmed glaucoma valve: long-term outcomes of a prospective randomized clinical trial. J Glaucoma. 2016;25:155–161.
20. Hoeh H, Ahmed IIK, Grisanti S, et al. Early postoperative safety and surgical outcomes after implantation of a suprachoroidal micro-stent for the treatment of open-angle glaucoma concomitant with cataract surgery. *J Cataract Refract Surg*. 2013;39:431–437.

21. García-Feijoo J, Höh H, Uzunov R, et al. Supraciliary microstent in refractory open-angle glaucoma: two-year outcomes from the DUETTE trial. *J Ocul Pharmacol Ther*. 2018;34:538–542.

22. Kerr NM, Wang J, Peruchó L, et al. The safety and efficacy of supraciliary stenting following failed glaucoma surgery. *Am J Ophthalmol*. 2018;190:191–196.

23. Grisanti S, Grisanti S, García-Feijoo J, et al. Supraciliary microstent implantation for open-angle glaucoma: multicentre 3-year outcomes. *BMJ Open Ophthalmol*. 2018;3:e000183.

24. Vold S, Ahmed IIK, Craven ER, et al. Two-year COMPASS trial results: supraciliary microstenting with phacoemulsification in patients with open-angle glaucoma and cataracts. *Ophthalmology*. 2016;123:2103–2112.

25. McCartney M, Phagura RS. Delayed bilateral hypertensive crisis with CyPass Micro-Stent – the highs and lows. *Am J Ophthalmol Case Rep*. 2020;18:100635.

26. Ioannidis AS, Bunce C, Barton K. The evaluation and surgical management of cyclodialysis clefts that have failed to respond to conservative management. *Br J Ophthalmol*. 2014;98:544–549.

27. Küchle M, Naumann GO. Direct cyclopexy for traumatic cyclodialysis with persisting hypotony. Report in 29 consecutive patients. *Ophthalmology*. 1995;102:322–333.

28. Pastor E, Bermúdez M, Moralez-Fernandez L, et al. Ultrasound biomicroscopy findings after suprachoroidal cypass implant for glaucoma: one year follow-up. *Invest Ophthalmol Vis Sci*. 2013;54:4773.

29. Agnifili L, Costagliola C, Figus M, et al. Histological findings of failed gold micro shunts in primary open-angle glaucoma. *Graefes Arch Clin Exp Ophthalmol*. 2012;250:143–149.

30. Chandler PA, Grant WM, Epstein DL, et al. Cyclodialysis. In: Chandler PA, Grant WM, Epstein DL, eds. *Chandler and Grant’s Glaucoma*. Baltimore, MD: Williams & Wilkins; 1997: 573–579.

31. Hoeh H, Vold SD, Ahmed IK, et al. Initial clinical experience with the CyPass Micro-Stent: safety and surgical outcomes of a novel supraciliary microstent. *J Glaucoma*. 2016;25:106–112.

32. Vijaya L, Manish P, Ronnie G, et al. Management of complications in glaucoma surgery. *Indian J Ophthalmol*. 2011;59(suppl):S131–S140.

33. Anand N, Pilling R. Nd:YAG laser goniopuncture after deep sclerectomy: outcomes. *Acta Ophthalmol*. 2010;88:110–115.

34. Chansangpetch S, Surukrattanaskul S, Tapaneeyangkul P, et al. Hypertensive phase and its association with surgical outcomes in Baerveldt implantation. *Int Ophthalmol*. 2018;38:1717–1725.

35. Costa VP, Smith M, Spaeth GL, et al. Loss of visual acuity after trabeculectomy. *Ophthalmologica*. 1993;100:599–612.

36. Kolker AE. Visual prognosis in advanced glaucoma: a comparison of medical and surgical therapy for retention of vision in 101 eyes with advanced glaucoma. *Trans Am Ophthalmol Soc*. 1977;75:539–555.

37. Aggarwal SP, Hendeles S. Risk of sudden visual loss following trabeculectomy in advanced primary open-angle glaucoma. *Br J Ophthalmol*. 1986;70:97–99.

38. Otto J. Loss of point of fixation after glaucoma surgery. *Klin Monbl Augenheilkd Augenarzt Ftibild*. 1957;131:178–195.