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Case Report

Reduction in Intraocular Pressure Fluctuation after Trabecular Micro-Bypass Implantation: Case Report

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Abstract

Introduction: To present a case of a patient with advanced glaucoma and documented intraocular pressure (IOP) fluctuations who underwent iStent *inject*® implantation, resulting in reduced pressure variability and stabilization of visual field progression.

Symptoms and Clinical Findings: A 65-year-old female with a single functional eye and progressive glaucomatous damage despite apparently well-controlled IOP on dual therapy underwent a water drinking test (WDT), revealing significant IOP fluctuations as a probable cause of the glaucomatous progression.

Therapeutic Interventions and Outcomes: Given the patient's monocular state and the surgical risks associated with filtering procedures, it was decided, in agreement with the patient, to perform an iStent *inject* implantation in an attempt to control the IOP fluctuations. Following surgery, the patient demonstrated a significant flattening of IOP fluctuations on repeat WDT, from a range of 10-19 mmHg preoperatively to 10-13 mmHg postoperatively. Hypotensive therapy was reduced, and serial 24-2 visual fields have shown stabilization during the 22 months since her surgery.

Conclusion: This case suggests that iStent *inject*® may be a valuable treatment option to reduce IOP fluctuations in carefully selected patients at high surgical risk. Further studies are needed to explore the potential role of minimally invasive glaucoma surgery (MIGS) in the management of IOP variability.

Keywords: Glaucoma, fluctuation, intraocular pressure, iStent, MIGS, trabecular micro-bypass

Introduction

Glaucoma is a chronic, progressive optic neuropathy and a leading cause of irreversible blindness worldwide. The primary modifiable risk factor for the development and progression of glaucoma is elevated intraocular pressure (IOP) [1]. Numerous studies have demonstrated that both mean IOP and IOP fluctuations play critical roles in determining the rate of glaucomatous progression [2,3]. Long-term IOP variability has been independently associated with visual field deterioration, even in patients whose office-based IOP measurements are within the target range [4].

In clinical practice, standard IOP measurements may fail to capture peak pressures and diurnal fluctuations, particularly in patients with progressive damage despite apparently adequate IOP control. Provocative tests, such as the water drinking test (WDT), can help reveal these hidden fluctuations and assess outflow facility, offering valuable insights into the adequacy of treatment [5]. Identifying and addressing IOP variability is especially relevant in patients with advanced glaucoma, where even small fluctuations

may contribute to further optic nerve damage.

Although filtering surgeries such as trabeculectomy traditionally have been recommended to achieve low target IOP and minimize IOP fluctuations, their potential complications including hypotony, infection, and bleb-related issues may pose unacceptable risks in some patients, particularly those with a single functional eye [6]. In this context, minimally invasive glaucoma surgeries (MIGS) have emerged as an alternative, offering a favorable safety profile, rapid recovery, and preservation of conjunctival integrity [7].

However, MIGS procedures such as trabecular micro-bypass stents are primarily used in mild to moderate glaucoma, and their efficacy in controlling IOP fluctuations is not fully understood. Here, we present the case of a patient with advanced glaucomatous damage and documented IOP fluctuations who underwent iStent *inject*® implantation with successful flattening of pressure variability and stabilization of visual field progression. This case highlights a potential role for MIGS in selected high-risk patients, where safety is a primary concern and IOP fluctuation control is essential.

Case Presentation

We present the case of a 72-year-old female patient referred in October 2023 by her treating physician for evaluation due to progression noted in her last visual field tests with the Visual Field Index (VFI) worsening from 70% to 63% and mean deviation (MD) worsening from -11.77 to -14.22 dB over a 10-month period (November 2022 to September-2023.

Her medical history includes systemic arterial hypertension, controlled with telmisartan and hydrochlorothiazide, and a history of penetrating ocular trauma in the right eye during adolescence, which required surgical repair. Currently, the right eye has no light perception and exhibits extensive synechiae, making adequate posterior segment evaluation impossible.

In the left eye, her history includes primary open-angle glaucoma (POAG), selective laser trabeculoplasty (SLT) performed in October 2022, and phacoemulsification cataract surgery with intraocular lens implantation in September 2023. Two weeks after cataract surgery, she presented with suspected endophthalmitis, for which intravitreal antibiotics were administered. The vitreous humor culture was negative for any microorganisms.

At the time of ophthalmologic evaluation in October 2023, the patient was using a fixed combination of latanoprost and timolol. Best-corrected visual acuity in the left eye was 20/25, and IOP was 10 mmHg. Slit-lamp examination showed a clear cornea, a deep and quiet anterior chamber, focal iris atrophy, and an intraocular lens well-positioned in the capsular bag. Fundus examination revealed an attached retina, optic nerve head cupping of 85-90% with a pale neuroretinal rim (1+), concentric rim thinning, and a macula with preserved foveal reflex. Serial 24-2 visual fields demonstrated advanced glaucomatous damage with further progression, now with VFI 53% and MD -17.60 dB.

Given the IOP was within the target range (10 mmHg), a WDT was performed using 1 liter of water. This test may be indicated in patients with apparently well-controlled IOP but documented visual field progression, to unmask pressure fluctuations that may contribute to continued optic nerve damage. It helps assess the eye's outflow facility and detect peak IOP elevations not captured during routine measurements. In the context of this patient, it was decided to perform this test prior to requesting a 24-hour tension curve. The following IOP measurements were obtained:

- 0 minutes: 10 mmHg
- 15 minutes: 19 mmHg
- 30 minutes: 15 mmHg
- 45 minutes: 15 mmHg
- 60 minutes: 13 mmHg

The WDT is considered positive if fluctuations greater than 6 mmHg are detected or if IOP peaks exceed the target pressure established for the patient. In this case, the WDT was classified as positive, and the decision was made to proceed with iStent *inject* implantation in the single functional left eye. The rationale for offering this minimally invasive option was the monocular status of the patient, wanting to maintain high safety profile and preserve precious ocular tissue in case a filtering procedure was needed at a later stage.

The iStent *inject* device (including two stents) was implanted uneventfully on October 25, 2023. At the time of surgery, timolol was discontinued, and latanoprost was continued as monotherapy. Postoperative evaluations on days 1 and 7 showed good clinical evolution with IOP of 10 mmHg at both visits. At postoperative week 4, a repeat WDT was performed with the following IOP measurements:

- 0 minutes: 10 mmHg
- 15 minutes: 13 mmHg
- 30 minutes: 13 mmHg
- 45 minutes: 13 mmHg
- 60 minutes: 13 mmHg

Given the improved WDT results (less IOP variability and lower IOP readings), the established treatment was maintained and the surgery was classified as succesful. Visual fields were ordered, and the patient has been followed every 4 months since, with stable IOP (ranging from 9-12 mmHg) and visual field findings (VFI ranging from 64% to 54% and MD ranging from -13.32 to -13.61 dB). Her most recent follow-up was in July 2025, at which time

IOP was 9 mmHg on topical latanoprost, VFI was 54%, and MD was -13.61 dB.

Discussion

Intraocular pressure remains the primary modifiable risk factor in the management of glaucoma, and both elevated IOP and IOP fluctuations have been independently associated with disease progression, particularly in advanced stages of glaucoma [2,3]. Although the therapeutic goal is to maintain IOP within a target range individualized for each patient, there is increasing evidence that long-term IOP variability despite apparently controlled office measurements can contribute significantly to optic nerve damage and visual field loss [4,8].

The WDT is a well-known provocative method to unmask IOP peaks and assess outflow facility, especially in patients with suspected progression despite IOP measurements within target [9]. In the presented case, the WDT revealed IOP fluctuations exceeding the therapeutic threshold, which were not evident in routine clinical measurements, thus providing a likely explanation for the patient's continued visual field deterioration.

Filtering surgeries such as trabeculectomy traditionally have been recommended for achieving low target IOP and controlling IOP fluctuation in patients with advanced glaucoma [10]. However, they carry significant risks, including hypotony, bleb-related infections, and vision-threatening complications, which are especially concerning in monocular patients [11]. In such cases, the risk–benefit ratio of surgery must be carefully considered, and less invasive options may be more appropriate.

Minimally invasive glaucoma surgeries (MIGS), including trabecular meshwork stents like the iStent *inject*, have been primarily indicated for patients with mild to moderate glaucoma, often in combination with cataract surgery, due to their more favorable safety profile and more moderate IOP-lowering efficacy compared to filtering surgery [12,13]. Their role in advanced glaucoma, particularly for controlling IOP fluctuations, is not well established in the current literature.

This case demonstrates that iStent *inject* implantation resulted in a marked flattening of the IOP curve as assessed by repeat WDT, along with stabilization of the patient's visual fields over time. This favorable response suggests that in well-selected Patients particularly those with monocular status, advanced disease, and surgical risk factors MIGS devices could be a viable alternative to more invasive filtering procedures.

This case highlights the potential utility of iStent *inject* not only for IOP reduction, but also for dampening pressure variability, which may be an important contributor to progression. Although generalization is limited by the single-case design, the findings warrant further investigation through prospective studies evaluating the effect of MIGS on IOP fluctuations and long-term functional outcomes.

In conclusion, while trabecular stents are not specifically indicated for the control of IOP fluctuations, their use in carefully selected patients may offer a safer alternative in situations where filtering surgery poses high risk. The present case supports considering iStent *inject* implantation as part of the surgical armamentarium in patients with advanced glaucoma and documented pressure variability.

Conclusion

This case illustrates the potential benefit of using trabecular micro-bypass stents (iStent *inject*) in a patient with advanced glaucoma and documented IOP fluctuations who was at high risk for complications from traditional filtering surgery. While the role of MIGS in controlling IOP variability remains to be defined, the documented flattening of IOP curves and functional stabilization in this case highlight its possible utility in selected clinical scenarios. Until more robust data become available, MIGS should be considered an option in the therapeutic arsenal, particularly when patient safety and preservation of residual visual function are paramount.

Informed Consent

Written informed consent for the publication of the patient's clinical details was obtained, and a copy of the consent form is available for review by the Editor.

Disclosures

Dr. Arriozola Disclosures: Speaker for Glaukos Corporation Mexico.

Dr. Dana M. Hornbeak: Employee and shareholder, Glaukos Corporation (Aliso Viejo, CA, USA).

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