JOJ Ophthalmology
ISSN: 2473-5477

Short Communication
Volume 14 Issue 2 - June 2026
DOI: 10.19080/JOJO.2026.14.555882

JOJ Ophthalmol

Rethinking Glaucoma Management: Integration of Innovative Technology and Consideration of Systemic Conditions

Andy Renschler[1]*, Coy Steel[2] and Barbara M Wirostko[3]

[1]*Intermountain Ocular Pathology Research Lab, John A Moran Eye Center SLC, UT, USA*

[2]*Spencer Fox Eccles School of Medicine at the University of Utah SLC, UT, USA*

[3]*John A Moran Eye Center SLC, UT, USA*

Submission: May 23, 2026; **Published:** June 01, 2026

***Corresponding author**: Andy Renschler, Intermountain Ocular Pathology Research Lab, John A Moran Eye Center SLC, UT, USA

Abstract

Progressive glaucoma management is evolving beyond isolated intraocular in clinic-based measurements towards a more continuous, systematic, and individualized care approach. We present a case of severe pigment dispersion glaucoma in which remote home tonometry, virtual reality visual field testing, recognition of obstructive sleep apnea, and observations related to glucagon-like peptide 1 receptor agonist therapy meaningfully influenced glaucoma management decisions, resulting in better care and eventually improved outcomes. Longitudinal physiologic data monitoring with remote tonometry and wearable perimetry helped identify clinically significant intraocular pressure (IOP) fluctuation and treatment response. This case highlights the potential value of integrating remote diagnostics, systemic disease evaluation, and emerging therapeutics into a more proactive, multidisciplinary approach resulting in better glaucoma care.

Keywords: Glaucoma; Tonometry; Perimetry; Intraocular pressure; GLP-1RA; Obstructive sleep apnea

Abbreviations: APAP: Automatic Positive Airway Pressure; GLP1RA: Glucagon-Like Peptide 1 Receptor Agonist; MD: Mean Deviation; OSA: Obstructive Sleep Apnea; SLT: Selective Laser Trabeculoplasty

Introduction

Glaucoma is a complex, progressive optic neuropathy that is often asymptomatic until irreversible damage occurs [1]. As the disease progresses, visual field defects and functional impairment worsen due to retinal ganglion cell loss and axonal degeneration [2-4]. Elevated intraocular pressure (IOP) remains the primary modifiable risk factor associated with glaucoma development and progression [2]. Proposed mechanisms regarding the pathophysiology associated with increased IOP include strain on the optic nerve head contributing to ischemia, impaired axonal transport, and cellular dysfunction [5].

Although glaucoma monitoring has historically relied upon routine in-office IOP measurements, our understanding of glaucoma pathophysiology continues to evolve beyond IOP magnitude alone. Advances in technology have expanded our ability to evaluate physiologic processes. This can be appreciated in several fields of medicine, as demonstrated with the use of continuous glucose monitors in diabetes, remote blood pressure monitoring for hypertension and home sleep studies monitoring apneic events in sleep apnea. Each have revolutionized the way their respective diseases are managed by generating longitudinal, real-world physiologic data where interventions can occur prior to systemic organ damage [6,7].

Additionally, these changes enable patients to actively participate in their care, empowering greater long-term patient engagement. Similarly in ophthalmology, the introduction of remote tonometry and virtual/wearable visual field platforms provide new opportunities to better characterize disease dynamics beyond isolated/infrequent office-based measurements enabling real time assessments and management change. Simultaneously, growing evidence suggests that glaucoma is influenced by a broader interplay of genetic, systemic, and physiologic factors than previously appreciated. Systemic comorbidities including diabetes, hypertension, and obstructive sleep apnea (OSA) are

associated with glaucoma development and progression [8,9]. Furthermore, medications used for managing these systemic conditions have also demonstrated an effect on glaucoma [10,11].

Case Example

To illustrate the value of these new methods of monitoring and managing glaucoma, we present the case of a 64-year-old white male with severe bilateral pigment dispersion glaucoma. His past medical history is notable for uncontrolled OSA and hypertension managed with medications. His clinical IOP measurements ranged in the mid-20s to high 30s mmHg at diagnosis and subsequent follow-up visits with a maximum IOP measurement of 48 mmHg in his left eye. Bilateral Durysta implantation was completed followed by bilateral selective laser trabeculoplasty (SLT) 1 month later due to severe allergic reactions to all topical medications. He was prescribed remote tonometry to monitor diurnal IOP due to his severe glaucoma status and remote residence outside the US.

Subsequently, 5 months after the device implantation, iCare HOME2 readings demonstrated IOPs of 10-15 mmHg OD and 10-23 mmHg OS with notable elevations in the early morning hours (between 4-6 am), suggesting decreased effectiveness of both Durysta and SLT. Later that month, for reasons unrelated to his glaucoma and due to cardiac disease with low ejection fraction, he initiated use of a GLP-1RA (Ozempic 0.25 mg weekly) and underwent repeat SLT bilaterally. Remote iCare tonometry revealed an immediate decline in IOP with measurements consistently below 15 mmHg OU. Six months later, the patient stopped using the GLP1-RA treatment. Subsequently, his IOP rose again without any other changes to systemic or ocular therapies. This prompted the provider to restart the GLP1-RA, which resulted in a similar marked reduction in IOP OU.

This patient also utilized virtual reality visual field perimetry throughout his treatment and monitoring course monthly with both 24-2 and 10-2 assessments. At a follow-up visit seven months after reinitiating the GLP-1RA, 24-2 visual field testing demonstrated a mean deviation of -12.22 dB OS with loss extending into the central 10 degrees, representing a decline of 1.91 dB compared to several months earlier (-10.31 dB) despite improvement in IOP spikes and flattening of his IOP curves. The treatment team was concerned, because the patient primarily resided in another country, which limited consistent in-person follow-up. To facilitate ongoing monitoring, virtual reality visual field perimetry was proposed. He was also advised to complete a formal sleep study for evaluation of his OSA status, where he was found to have over 30 apneic events an hour - consistent with severe OSA.

This prompted the initiation of automatic positive airway pressure (APAP) therapy, which further stabilized his IOP to below 20 mmHg in both eyes according to iCare home readings with concurrent stabilization of his virtual reality visual field testing delaying the need for surgical intervention at that time. Continued monthly monitoring with remote virtual reality perimetry ultimately demonstrated gradual worsening of the MD to -8.59dB on 10-2 assessment and -19.36 dB on 24-2 assessment prior to surgery. After discussion with the patient, additional surgical intervention with iStent and canaloplasty was pursued in March 2026 OS. Postoperatively, reliable virtual reality visual field-testing OS demonstrated MD improvement to -4.68 dB on 10-2 testing and -14.22 dB on 24-2 testing consistent with a favorable treatment response achieved by perhaps reducing the IOP spikes and reducing the stress on the ganglion cells.

Remote Tonometry

Remote tonometry played an incredibly useful role in this case, both in disease detection and assessment of treatment. Emerging as an effective diagnostic tool, remote tonometry has proven to be useful for disease management in several published reports [12,13]. The iCare HOME2 (iCare USA, Raleigh, NC) is a regulatory-cleared, validated prescription device that enables patients to monitor their IOP remotely and more frequently. Although IOP remains central to assessing glaucoma control, traditional office-based tonometry provides isolated measurements that are insufficient representations of true patient diurnal or nychthemeral IOP profiles that require patients to attend a clinic appointment.

In contrast, remote tonometry enables repeated measurements over days to months, offering a more comprehensive assessment of IOP dynamics that can substantially influence clinical management, especially enabling the ability to detect early am IOP spikes which would otherwise go undetected. These IOPs often go into the 20s and even 30s yet be within "normal" levels in the office during clinic hours [13,14]. It is well demonstrated that many patients with glaucoma experience peak IOP elevations during the early morning hours, often between 4:00 and 6:00 AM [15]. Notably, this is outside the timeframe of routine clinic visits. Prior research has also shown that greater diurnal IOP fluctuation is associated with progression of visual field loss regardless of mean IOP [16]. Remote tonometry enables patients and providers to identify vital details regarding each patient's diurnal IOP variation that is difficult to assess with clinic IOP measurements alone.

Virtual Reality Visual Field Testing

Virtual reality visual field perimetry was another useful diagnostic tool that provided vital information in this case. Using the VisuALL (Olleyes Summit, NJ) virtual reality platform allowed him to complete multiple regular assessments without attending an appointment. While living abroad, he easily completed visual fields monthly, which were then reviewed by his provider in the US. Assessment of his visual field means deviation (MD), particularly in his left eye, was monitored closely and enabled the ability to detect progression more rapidly and assess treatment response after surgical intervention. The American Academy of Ophthalmology (AAO) preferred practice guidelines recommend patients diagnosed with POAG complete at least one visual field

How to cite this article: Andy Renschler, Coy Steel, Barbara M Wirostko. Rethinking Glaucoma Management: Integration of Innovative Technology and Consideration of Systemic Conditions. JOJ Ophthalmol. 2026; 14(3): 555882. DOI: 10.19080/JOJO.2026.14.5558682

test per year; however, many patients complete fewer visual field tests than is recommended [17].

Traditional visual field perimetry requires an expensive, large piece of equipment with designated clinic space and technician time. A virtual reality platform for visual fields may help increase the frequency by reducing or minimizing obstacles patients and providers face when utilizing traditional visual field methods. In fact, increasing the frequency of visual field testing and clustering the exams has demonstrated reduced time to detect progression [18-21]. Unfortunately, increased testing utilizing in-clinic perimetry faces multiple significant obstacles [18,19]. Research to validate the use of virtual reality testing as an appropriate adjunct to Humphrey visual field testing is currently underway (manuscript pending).

Obstructive Sleep Apnea

Recognition and attention given to this patient's OSA status also significantly affected his intraocular pressure. There is an increasing appreciation that systemic comorbidities contribute significantly to the development and progression of glaucoma. Screening for these conditions may improve both glaucoma diagnosis and individualized management strategies. OSA is just one example of such conditions, as it has been identified as a significant risk factor for primary open-angle glaucoma with studies demonstrating odds ratios greater than 2.0 at 3-, 5-, and 10-year intervals following an OSA diagnosis [22].

Although OSA is primarily considered a respiratory disorder, it also produces substantial disruption of the body's circadian physiology [23]. The relationship between glaucoma, circadian dysregulation, and OSA remains unclear, but several vascular and mechanical mechanisms have been proposed. Vascular mechanisms include recurrent hypoxia resulting from apneic events leading to vascular dysregulation, increased vascular resistance, autonomic dysfunction, and oxidative stress from reperfusion injury [24-26]. Mechanical contributors may include nocturnal elevations in IOP related to supine positioning and obesity, increased intracranial pressure, and structural changes involving elastic fiber depletion within the lamina cribrosa and trabecular meshwork [24,27] Significantly higher ranges in daily IOP have also been observed in glaucomatous patients diagnosed with OSA when compared to glaucomatous patients without an OSA diagnosis [28]. Our group is currently investigating diurnal IOP characteristics in glaucomatous patients with OSA using iCare HOME2 tonometry. By characterizing IOP fluctuations in relation to sleep patterns and apneic events, this work aims to improve our understanding of the physiologic links among OSA, circadian disruptions, and glaucoma progression [28].

GLP1-RA:

Both emerging evidence and clinical observations suggest that glucagon-like peptide 1 receptor agonists (GLP-1RAs) and GLP-1/GIP dual agonists may have impacts on glaucoma [29-31]. Multiple IOP reducing mechanisms have been proposed, including cAMP- and nitric oxide-mediated pathways that reduce aqueous humor production and improve trabecular meshwork outflow, and neuroprotection via rescued retinal ganglion cells and downregulated neuroinflammatory markers like IL-1α, TNF-α, and C1q [32,33]. Clinical case series have documented IOP reductions in patients initiating these medications both as treatment adjuncts and monotherapy, though effect magnitude and consistency need further validation with controlled prospective trials (case series manuscript in review).

Additionally, one retrospective study reported statistically significant IOP reduction with GLP-1RA use in glaucoma patients, though multivariate analysis failed to maintain significance, likely due to confounding systemic and ocular factors [34]. At this point, there is not enough evidence to warrant their use as adjunct glaucoma/IOP lowering medications; however, we do believe that enough evidence has presented itself to warrant consideration of this drug class's effects when IOP changes are observed. The systemic risk profile and novelty of this medication's widespread use limit a deeper understanding of its potential role in glaucoma. Together, these findings support the need for further prospective studies that can definitively identify either the ability or inability of these medications to reduce IOP and offer neuroprotection in glaucoma.

Conclusion

This case illustrates how integrating modern diagnostics including remote tonometry and virtual reality visual field testing, while simultaneously addressing systemic comorbidities such as obstructive sleep apnea and considering emerging therapeutic insights (GLP-1 RA) meaningfully altered the course of severe glaucoma by delaying surgery in a high-risk patient. These tools provided longitudinal physiologic insight that extended beyond traditional clinic-based assessment and enabled more individualized treatment decision-making.

Although further prospective validation is needed to reduce confounding variables, this evolving holistic approach reflects a broader transition in glaucoma care toward proactive, data-rich, and patient centered disease management. As this frontier continues to evolve, implementing these strategies alongside conventional care may improve earlier progression detection, optimize treatment timing, and enhance long-term preservation of visual function.

Conflict of Interest Statement

B.M.W.: Medical Advisor MyEyes LLC. Consultant to Icare US and Finland. The remaining authors report no financial disclosures of conflicts of interest. All authors attest that they meet the current ICMJE criteria for authorship

How to cite this article: Andy Renschler, Coy Steel, Barbara M Wirostko. Rethinking Glaucoma Management: Integration of Innovative Technology and Consideration of Systemic Conditions. JOJ Ophthalmol. 2026; 14(3): 555882. DOI: 10.19080/JOJO.2026.14.5558682

Funding Acknowledgement

The Shiebler Family Foundation, Unrestricted grant to Moran Eye Center to support research in glaucoma.

References

1. Robert N Weinreb, David S Friedman, Robert D Fechtner, George A Cioffi, Anne L Coleman, et al. (2004) Risk assessment in the management of patients with ocular hypertension. Am J Ophthalmol 138(3): 458-467.
2. Nickells RW (2007) From ocular hypertension to ganglion cell death: a theoretical sequence of events leading to glaucoma. Can J Ophthalmol J Can Ophtalmol 42(2): 278-287.
3. Hirt J, Porter K, Dixon A, McKinnon S, Liton PB (2018) Contribution of autophagy to ocular hypertension and neurodegeneration in the DBA/2J spontaneous glaucoma mouse model. Cell Death Discov 4: 14.
4. Crish SD, Sappington RM, Inman DM, Horner PJ, Calkins DJ (2010) Distal axonopathy with structural persistence in glaucomatous neurodegeneration. Proc Natl Acad Sci 107(11): 5196-5201.
5. Rakic P, Riley KP (1983) Overproduction and elimination of retinal axons in the fetal rhesus monkey. Science 219(4591): 1441-1444.
6. Tan SY, Sumner J, Wang Y, Wenjun Yip A (2024) A systematic review of the impacts of remote patient monitoring (RPM) interventions on safety, adherence, quality-of-life and cost-related outcomes. Npj Digit Med 7(1): 192.
7. Babu M, Lautman Z, Lin X, Sobota MHB, Snyder MP (2024) Wearable Devices: Implications for Precision Medicine and the Future of Health Care. Annu Rev Med 75: 401-415.
8. Steven J Gedde, Kateki Vinod, Martha M Wright, Kelly W Muir, John T Lind, et al. (2021) Primary Open-Angle Glaucoma Preferred Practice Pattern®. Ophthalmology 128(1): P71-P150.
9. Yuan-Yao Fan, Wei-Wen Su, Chun-Hsiu Liu, Henry Shen-Lih Chen, Shiu-Chen Wu, et al. (2019) Correlation between structural progression in glaucoma and obstructive sleep apnea. Eye 33(9): 1459-1465.
10. Alan Kastner, Kelsey V Stuart, Giovanni Montesano, C Gustavo De Moraes, Jae H Kang, et al. (2023) Calcium Channel Blocker Use and Associated Glaucoma and Related Traits Among UK Biobank Participants. JAMA Ophthalmol 141(10): 956-964.
11. Retinopathy, Neuropathy, and Foot Care: Standards of Care in Diabetes—2026 | Diabetes Care | American Diabetes Association.
12. Laurence Quérat, Enping Chen (2023) Impact of self-tonometry on glaucoma treatment decision. Acta Ophthalmol (Copenh) 101(2): e246-e251.
13. Levin AM, McGlumphy EJ, Chaya CJ, Wirostko BM, Johnson TV (2022) The utility of home tonometry for peri-interventional decision-making in glaucoma surgery: Case series. Am J Ophthalmol Case Rep 28: 101689.
14. McGlumphy EJ, Mihailovic A, Ramulu PY, Johnson TV (2021) Home self-tonometry trials compared to clinic tonometry in patients with glaucoma. Ophthalmol Glaucoma 4(6): 569-580.
15. Perkins SW, Joo JH, Allan KC, et al. (2025) Home Tonometry Diurnal Intraocular Pressure Patterns, Patient Adherence, and Measurement Reliability in a Prospective Clinical Cohort. Clin Ophthalmol 19: 3547-3556.
16. Musch DC, Lichter PR, Guire KE, Standardi CL (1999) The Collaborative Initial Glaucoma Treatment Study: study design, methods, and baseline characteristics of enrolled patients. Ophthalmology 106(4): 653-662.
17. Brian C Stagg, Joshua D Stein, Felipe A Medeiros, Joshua Horns, M Elizabeth Hartnett, et al. (2022) The Frequency of Visual Field Testing in a US Nationwide Cohort of Individuals with Open-Angle Glaucoma. Ophthalmol Glaucoma 5(6): 587-593.
18. Wu Z, Saunders LJ, Daga FB, Diniz-Filho A, Medeiros FA (2017) Frequency of Testing to Detect Visual Field Progression Derived Using a Longitudinal Cohort of Glaucoma Patients. Ophthalmology 124(6): 786-792.
19. David P Crabb, Richard A Russell, Rizwan Malik, Nitin Anand, Helen Baker, et al. (2026) Frequency of Visual Field Testing When Monitoring Patients Newly Diagnosed with Glaucoma: Mixed Methods and Modelling. NIHR Journals Library.
20. Scott R Shuldiner, Michael V Boland, Pradeep Y Ramulu, C Gustavo De Moraes, Tobias Elze, et al. (2021) Predicting eyes at risk for rapid glaucoma progression based on an initial visual field test using machine learning. PloS One 16(4): e0249856.
21. Anderson AJ, Bedggood PA, George Kong YX, Martin KR, Vingrys AJ (2017) Can Home Monitoring Allow Earlier Detection of Rapid Visual Field Progression in Glaucoma? Ophthalmology 124(12): 1735-1742.
22. Pranav Vasu, Isabella V Wagner, Paul Connor Lentz, Priyanka Gumaste, Yazan Abubaker, et al. (2025) Obstructive Sleep Apnea as a Potentiator of Primary Open-Angle Glaucoma and Necessity for Interventional Therapy. Ophthalmol Glaucoma 8(6): 553-559.
23. Ramirez M, Kitayama K, Puran A, Tseng VL, Yu F, et al. (2025) The Associations Between Glaucoma and Circadian Rhythm Sleep Disorders in California Medicare Beneficiaries. Am J Ophthalmol 278: 250-256.
24. Pérez-Rico C, Gutiérrez-Díaz E, Mencía-Gutiérrez E, Díaz-de-Atauri MJ, Blanco R (2014) Obstructive sleep apnea-hypopnea syndrome (OSAHS) and glaucomatous optic neuropathy. Graefes Arch Clin Exp Ophthalmol Albrecht Von Graefes Arch Klin Exp Ophthalmol 252(9): 1345-1357.
25. García-Sánchez A, Villalaín I, Asencio M, García J, García-Rio F (2022) Sleep apnea and eye diseases: evidence of association and potential pathogenic mechanisms. J Clin Sleep Med JCSM Off Publ Am Acad Sleep Med 18(1): 265-278.
26. Faridi O, Park SC, Liebmann JM, Ritch R (2012) Glaucoma and obstructive sleep apnoea syndrome. Clin Experiment Ophthalmol 40(4): 408-419.
27. Fraser CL (2014) Obstructive sleep apnea and optic neuropathy: is there a link? Curr Neurol Neurosci Rep 14(8): 465.
28. Renschler A, Paulson C, Steel C, et al. (2026) Intraocular Pressure Characteristics in Primary Open-Angle Glaucoma with Obstructive Sleep Apnea. Poster presented at: ARVO, Denver, CO.
29. Sterling J, Hua P, Dunaief JL, Cui QN, VanderBeek BL (2023) Glucagon-like peptide 1 receptor agonist use is associated with reduced risk for glaucoma. Br J Ophthalmol 107(2): 215-220.
30. Emily C N Lawrence, Michelle Guo, Turner D Schwartz, Jie Wu, Jingwen Lu, et al. (2023) Topical and systemic GLP-1R agonist administration both rescue retinal ganglion cells in hypertensive glaucoma. Front Cell Neurosci 17: 1156829.
31. Johnson C, Pasquale LR, Wirostko B (2024) Glucagon-Like Peptide 1 Receptor Agonists: A Role in Glaucoma? Ophthalmol Glaucoma 7(5): 419-421.
32. James L Mitchell, Hannah S Lyons, Jessica K Walker, Andreas Yiangou, Olivia Grech, et al. (2023) The effect of GLP-1RA exenatide on idiopathic intracranial hypertension: a randomized clinical trial. Brain 146(5): 1821-1830.

How to cite this article: Andy Renschler, Coy Steel, Barbara M Wirostko. Rethinking Glaucoma Management: Integration of Innovative Technology and Consideration of Systemic Conditions. JOJ Ophthalmol. 2026; 14(3): 555882. DOI: 10.19080/JOJO.2026.14.5558682

33. Hannah F Botfield, Maria S Uldall, Connar S J Westgate, James L Mitchell, Snorre M Hagen, et al. (2017) A glucagon-like peptide-1 receptor agonist reduces intracranial pressure in a rat model of hydrocephalus. Sci Transl Med 9(404): eaan0972.

34. Hallaj S, Halfpenny W, Chuter BG, Weinreb RN, Baxter SL, et al. (2025) Association Between Glucagon-Like Peptide-1 Receptor Agonists Exposure and Intraocular Pressure Change: GLP-1 Receptor Agonists and Intraocular Pressure Change. Am J Ophthalmol 269: 255-265.

DOI: 10.19080/JOJO.2026.14.5558682

How to cite this article: Andy Renschler, Coy Steel, Barbara M Wirostko. Rethinking Glaucoma Management: Integration of Innovative Technology and Consideration of Systemic Conditions. JOJ Ophthalmol. 2026; 14(3): 555882. DOI: 10.19080/JOJO.2026.14.5558682