American Journal of Ophthalmology Case Reports 29 (2023) 101786

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: www.ajocasereports.com/

Elevated IOP following a bladder filling protocol: A case report

Vivian L. Qin [a], Brian J. Nguyen [a], Patrick Tripp [b], Amanda Lehman [b], Victoria M. Addis [a], Qi N. Cui [a,*]

[a] Scheie Eye Institute, University of Pennsylvania, Philadelphia, PA, 19104, USA
[b] Corporal Michael J. Crescenz Philadelphia VA Medical Center, Philadelphia, PA, 19104, USA

ARTICLE INFO

Keywords:
Glaucoma
Provocative testing
Water-drinking test
Intraocular pressure

ABSTRACT

Purpose: We describe a patient with elevated intraocular pressure (IOP) secondary to an oral water bolus and examine the utility of the water-drinking test.
Observations: A 66-year-old male with a history of hypertension presented with headache, bilateral retro-orbital ache, and blurry vision. Symptoms began shortly after his radiation treatment for prostate cancer, for which he consumed a water bolus to fill his bladder 30 minutes prior to treatment initiation. On exam, he had bilateral elevated IOP that responded to topical IOP-lowering medications. Gonioscopy demonstrated open angles and fundus exam showed non-glaucomatous optic nerves with pronounced retinal venous tortuosity. The water-drinking test showed a peak intraocular pressure of 20 mmHg in the right eye (5 mmHg increase from baseline) and 23 mmHg in the left eye (8 mmHg increase from baseline), suggesting impairment of the outflow system in the left compared to the right eye. He was started on topical IOP-lowering therapy and followed in our clinic as a glaucoma suspect.
Conclusions: Consumption of a water bolus can be associated with IOP elevation and may be a risk factor in patients with otherwise normal IOPs at risk for glaucoma. The water-drinking test was historically used as provocative testing for open-angle glaucoma and may have an updated role in evaluating at-risk patients without ocular hypertension.

1. Introduction

Elevated intraocular pressure (IOP) is an important risk factor for the development and progression of glaucoma, as well as the primary target for medical and surgical treatments. Single in-office IOP measurements do not fully capture the variability in IOP within and between days.[1] Further, IOP fluctuations are larger and peak diurnal IOP is higher in patients with glaucoma than those without.[1–3] Different methods and devices including modified diurnal tension curve and sensors for continuous IOP monitoring have been explored to capture IOP fluctuations over a 24-h span, however none have achieved widespread popularity.[4] Provocative tests have also been developed for the evaluation of patients at high risk for glaucoma. The water drinking test (WDT) is a provocative test that was first described in the early 20th century[5] and was predominantly used in the 1950s and 1960s as a test to detect and diagnose glaucoma. More recently, its use in diagnosis has been largely abandoned due to low specificity and sensitivity.[6] Nevertheless, peak IOP values obtained from WDT have been shown to correlate with diurnal tension curves as well as with progression on visual field testing.[7–9] We describe here a patient who developed elevated IOP and related symptoms shortly after undergoing radiotherapy with a bladder filling protocol to treat his prostate cancer, and whose symptoms were reproduced with the WDT in the clinic.

2. Case report

A 66-year-old male with a history of hypertension and prostate cancer was referred for symptoms of headache, bilateral retroorbital ache, and bilaterally decreased vision. His symptoms began during a radiation treatment session for his prostate cancer. He reported a similar episode during a prior radiation session. Prior to these sessions, he was required to drink at least 250 mL of water without urinating as part of the 'bladder filling protocol,' the purpose of which is to displace the bladder and small intestines away from the prostate to prevent iatrogenic radiation toxicity.[10] Upon presentation, best corrected visual acuity was 20/30 in the right eye and 20/40 in the left eye. Intraocular

* Corresponding author. 51 N 39th Street, Philadelphia, PA, 19104, USA.
E-mail address: Qi.cui@pennmedicine.upenn.edu (Q.N. Cui).

https://doi.org/10.1016/j.ajoc.2022.101786
Received 29 September 2022; Received in revised form 7 December 2022; Accepted 21 December 2022
Available online 23 December 2022

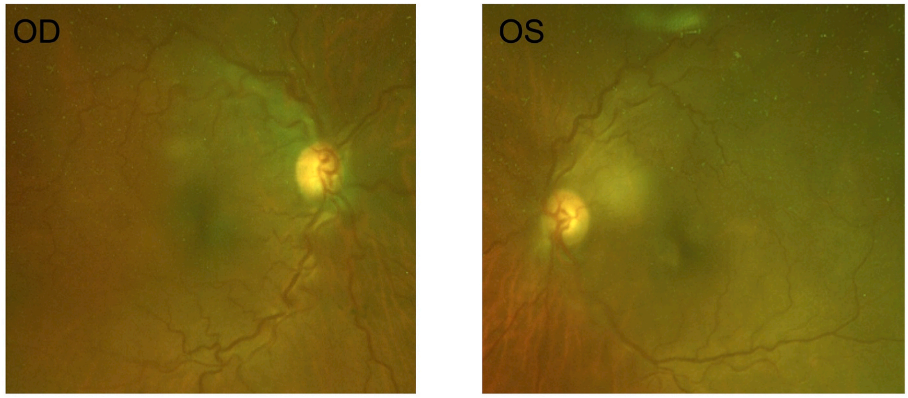

Fig. 1. Fundus photos showed optic nerves without significant cupping and intact disc rims in both eyes.

pressure by Goldmann applanation was 28 mmHg in the right eye and 42 mmHg in the left eye. In comparison, prior IOP from 2016 was 19 mmHg in the right eye and 21 mmHg in the left eye. Gonioscopy revealed anterior chamber angles that were open 360° to ciliary body band without any peripheral anterior synechiae in both eyes. Slit lamp exam revealed bilateral cataracts graded as 2+ nuclear and cortical. Dilated fundus exam demonstrated optic nerves with a cup to disc ratio of 0.4 and bilateral healthy-appearing rims, in addition to retinal venous tortuosity (Fig. 1). OCT showed retinal nerve fiber layer thickness that was within normal limits in the right eye, and borderline thinning of the superotemporal quadrant in the left eye (Fig. 2).

Patient was given 2 rounds of dorzolamide/timolol 2%/0.5% and brimonidine 0.2%, and his IOP improved to 15 in the right eye and 21 in the left eye after 45 minutes. Patient was asked to initiate treatment with latanoprost daily before bed and brimonidine 0.2% twice a day in both eyes. One week after initial presentation, the patient remained asymptomatic with IOPs of 15 mmHg in both eyes.

Three months after presentation and following a 2-week washout period when all IOP medications were held, the patient returned to clinic for the WDT to assess the cause of his IOP elevation. In this test, IOP was measured before drinking 1L of water within a span of 5 minutes, and then once every 15 minutes for an hour. Of note, post-washout baseline IOPs were not elevated (15 mmHg in both eyes) prior to water ingestion. In the Collaborative Glaucoma Study, a rise in IOP of 5 mmHg was found to be associated with six fold higher risk of glaucomatous field loss.[8] In our patient, IOP increased by 5 mmHg in the right eye and 8 mmHg in the left eye (Table 1). During this visit, Humphrey visual field testing showed global decrease of sensitivity related to cataracts, non-glaucomatous-appearing scattered temporal losses in both eyes, and a possible inferior defect in the left eye that was marred by low test reliability (Fig. 3A). A repeat field 5 months later showed improved reliability and did not reproduce the inferior defect in the left eye (Fig. 3B).

3. Discussion

Our patient presented with bilaterally elevated IOP resulting in headache and retroorbital ache in the setting of significant water intake over a short period of time. In effect, he had unwittingly participated in provocative testing for glaucoma. The association between water intake and IOP elevation was confirmed after a water-drinking test demonstrated bilateral IOP elevation. While this patient had not been previously followed for glaucoma or as a glaucoma suspect, his examination and testing results were consistent with ocular hypertension/open angle glaucoma suspect or pre-parametric glaucoma. He is now being followed as a glaucoma suspect in our clinic, and his radiation oncology team was made aware of this side effect of the bladder-filling protocol for radiation treatments. He continued his treatments under the same protocol after starting his topical medications without recurrence of his symptoms.

Although water intake has been associated with increased IOP, the physiological cause of this phenomenon is not entirely clear. Proposed etiologies are numerous and include increased episcleral venous pressure, reduction in outflow facility, autonomic nervous stimulation, and choroidal expansion,[11,12] with all of these factors likely contributing in a multifactorial fashion. The WDT may be informative about a patient's true peak IOP and the amount of IOP fluctuation they experience on a daily basis, particularly in patients with "normal" baseline IOP, thereby helping to identify patients at higher risk for disease progression.[13] Additionally, the rate of IOP recovery after WDT could be used to indirectly assess aqueous outflow facility.[14] A study using hemoglobin video imaging demonstrated increased aqueous outflow in response to the WDT for both glaucomatous and non-glaucomatous subjects.[15] In glaucomatous eyes, however, the increase in outflow was not sustained, contributing to sustained IOP elevation at the 1-h conclusion of the WDT.

Finally, the WDT may have an updated role in predicting treatment response. Topical treatments that increase outflow have been shown to be more effective than aqueous suppressants in stabilizing diurnal IOP in those with a positive WDT.[16] Further, peak IOP and IOP fluctuations during the WDT were both reduced following SLT,[17] while trabeculectomy was more effective than non-penetrating glaucoma surgeries and medical treatments at reducing IOP fluctuations during testing.[18,19] Compared to post-trabeculectomy eyes, eyes post-tube shunt placement experienced prolonged IOP elevation during the WDT.[20] These studies suggest that the WDT may play a role in quantifying treatment-induced changes to IOP dynamics.

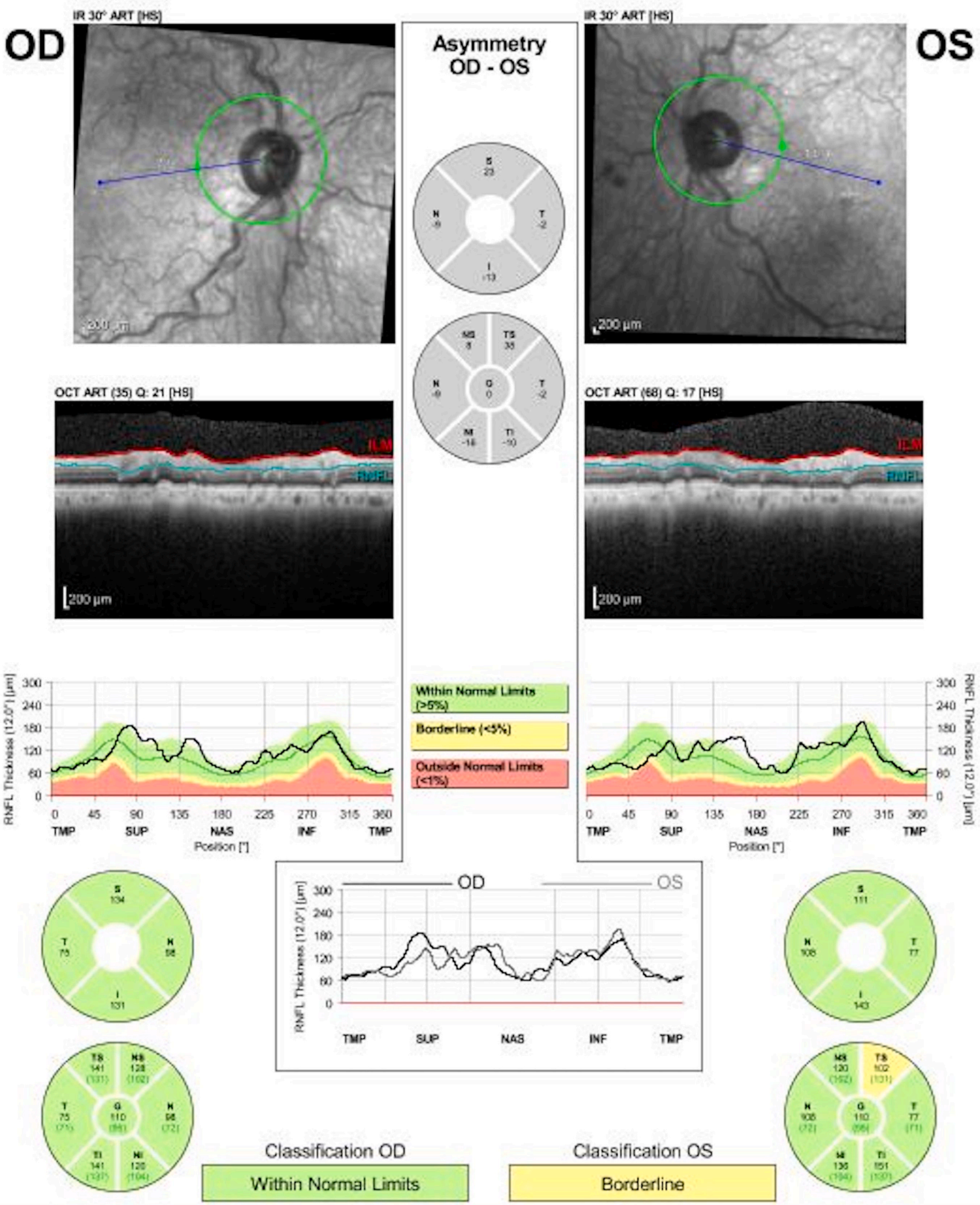

Fig. 2. Optical Coherence Tomography showed retinal nerve fiber layer thickness that was within normal limits in the right eye, and borderline thinning of the superotemporal quadrant in the left eye.

Table 1
Intraocular pressures were elevated in both eyes during the Water Drinking Test.

Time	IOP by Goldmann Applanation (OD/OS)
12:35PM (Baseline)	15/15
12:50PM	18/18
1:05PM	16/18
1:20PM	17/21
1:35PM	20/23

4. Conclusions

A water bolus can be associated with elevated IOP and should be considered a risk factor in patients with a known history of increased fluid intake. This may result from an assortment of etiologies ranging from pre-hydration for oncological treatments to conditions like psychogenic polydipsia. Even if IOP elevation is not observed at baseline in these patients, WDT followed by increased surveillance may be indicated to evaluate for IOP peak, the degree of IOP fluctuations, and asymmetry of response between eyes. Ultimately, the WDT may identify relevant risk factors in select populations of glaucoma suspects.

Patient consent

The patient consented to publication of the case via telephone consent.

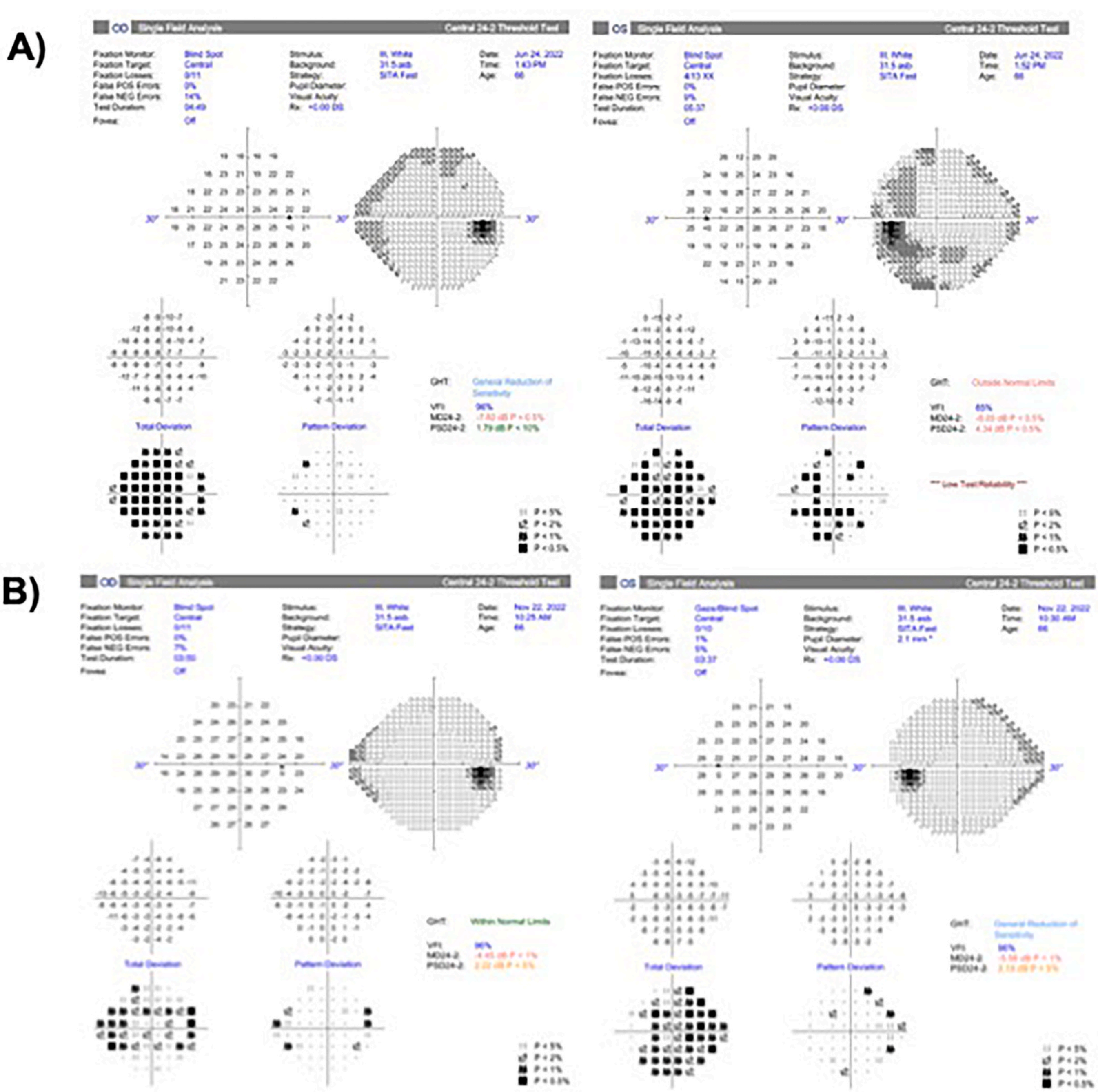

Fig. 3. A) An initial Humphrey visual field 24-2 demonstrated global decrease of sensitivity related to cataracts in both eyes, non-specific scattered temporal changes, and concern for an inferior defect in the left eye. B) A repeat field with improved reliability 5 months later failed to reproduce the same inferior defect.

Acknowledgments and Disclosures

This study was supported by a RPB Unrestricted Grant (University of Pennsylvania School of Medicine). None of the authors have any financial disclosures. All authors attest that they meet the current ICMJE criteria for Authorship. We would like to acknowledge Krystal Jean-Louis for technical assistance during the administration of the Water Drinking Test.

References

1. Wilensky JT. The role of diurnal pressure measurements in the management of open angle glaucoma. *Curr Opin Ophthalmol*. 2004;15(2):90–92. https://doi.org/10.1097/00055735-200404000-00005.
2. Asrani S, Zeimer R, Wilensky J, Gieser D, Vitale S, Lindenmuth K. Large diurnal fluctuations in intraocular pressure are an independent risk factor in patients with glaucoma. *J Glaucoma*. 2000;9(2):134–142.
3. Tojo N, Abe S, Ishida M, Yagou T, Hayashi A. The fluctuation of intraocular pressure measured by a contact lens sensor in normal-tension glaucoma patients and nonglaucoma subjects. *J Glaucoma*. 2017;26(3):195–200. https://doi.org/10.1097/IJG.0000000000000517.
4. Da Silva F, Lira M. Intraocular pressure measurement: a review. *Surv Ophthalmol*. 2022;67(5):1319–1331. https://doi.org/10.1016/j.survophthal.2022.03.001.
5. Nørskov K. The water provocative test. *Acta Ophthalmol*. 1967;45(1):57–67. https://doi.org/10.1111/j.1755-3768.1967.tb06477.x.
6. Roth JA. Inadequate diagnostic value of the water drinking test. *Br J Ophthalmol*. 1974;58(1):55–61. https://doi.org/10.1136/bjo.58.1.55.
7. Olatunji OP, Olawoye O, Ajayi BGK. Correlation and agreement between water drinking test and modified diurnal tension curve in untreated glaucoma patients in Nigeria. *J Glaucoma*. 2020;29(6):498–503. https://doi.org/10.1097/IJG.0000000000001493.
8. Armaly MF, Krueger DE, Maunder L, et al. Biostatistical analysis of the collaborative glaucoma study: I. Summary report of the risk factors for glaucomatous visual-field defects. *Arch Ophthalmol*. 1980;98(12):2163–2171. https://doi.org/10.1001/archopht.1980.01020041015002.
9. Susanna R, Hatanaka M, Vessani RM, Pinheiro A, Morita C. Correlation of asymmetric glaucomatous visual field damage and water-drinking test response. *Investig Ophthalmol Vis Sci*. 2006;47(2):641–644. https://doi.org/10.1167/iovs.04-0268.
10. O'Doherty ÚM, McNair HA, Norman AR, et al. Variability of bladder filling in patients receiving radical radiotherapy to the prostate. *Radiother Oncol*. 2006;79(3):335–340. https://doi.org/10.1016/j.radonc.2006.05.007.
11. Diestelhorst M, Krieglstein GK, Diestelhorst M, Krieglstein GK. The effect of the water-drinking test on aqueous humor dynamics in healthy volunteers. *Arch Clin Exp Ophthalmol*. 1994;232:145–147.
12. Gustavo Vasconcelos De Moraes C, Soares Castro Reis A, Furlani de Sá Cavalcante A, Eimi Sano M, Susanna Jr R. Choroidal Expansion during the Water Drinking Test. doi:10.1007/s00417-008-0969-2.
13. De Moraes CG, Susanna R, Sakata LM, Hatanaka M. Predictive value of the water drinking test and the risk of glaucomatous visual field progression. *J Glaucoma*. 2017;26(9):767–773. https://doi.org/10.1097/IJG.0000000000000725.
14. Waisbourd M, Savant SV, Sun Y, Martinez P, Myers JS. Water-drinking test in primary angle-closure suspect before and after laser peripheral iridotomy. *Clin Exp Ophthalmol*. 2016;44(2):89–94. https://doi.org/10.1111/CEO.12639.
15. Lusthaus JA, Meyer PAR, McCluskey PJ, Martin KR. Hemoglobin video imaging detects differences in aqueous outflow between eyes with and without glaucoma during the water drinking test. *J Glaucoma*. 2022;(7):511–522. https://doi.org/10.1097/ijg.0000000000002029. Publish Ah.
16. Vetrugno M, Sisto D, Trabucco T, Balducci F, Delle Noci N, Sborgia C. Water-drinking test in patients with primary open-angle glaucoma while treated with different topical medications. *J Ocul Pharmacol Therapeut*. 2005;21(3):250–257. https://doi.org/10.1089/JOP.2005.21.250.
17. Kerr NM, Lew HR, Skalicky SE. Selective laser trabeculoplasty reduces intraocular pressure peak in response to the water drinking test. *J Glaucoma*. 2016;25(9):727–731. https://doi.org/10.1097/IJG.0000000000000512.
18. Danesh-Meyer HV, Papchenko T, Tan Y whee, Gamble GD. Medically controlled glaucoma patients show greater increase in intraocular pressure than surgically controlled patients with the water drinking test. *Ophthalmology*. 2008;115(9):1566–1570. https://doi.org/10.1016/j.ophtha.2008.01.023.
19. Mansouri K, Orguel S, Mermoud A, et al. Quality of diurnal intraocular pressure control in primary open-angle patients treated with latanoprost compared with surgically treated glaucoma patients: a prospective trial. *Br J Ophthalmol*. 2008;92(3):332–336. https://doi.org/10.1136/bjo.2007.123042.
20. Razeghinejad MR, Tajbakhsh Z, Nowroozzadeh MH, Masoumpour M. Water drinking test: intraocular pressure changes after tube surgery and trabeculectomy. *J Ophthalmic Vis Res*. 2017;12(4):390. https://doi.org/10.4103/JOVR.JOVR_204_16.