EDITORIAL

Water drinking test: The second innings scorecard

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Introduction

Even though both intraocular pressure (IOP) fluctuation and peak IOP have been demonstrated to be significant risk factors for glaucoma progression, the latter has been shown to be a better predictor of disease progression. Peak IOP is also a more practical tool for guiding management protocols.[1-3]

Continuous 24 h IOP monitoring arguably provides the best measure of an individual's IOP, but is logistically not possible in clinical settings. A diurnal variation of IOP over 24 h provides a better understanding of an individual's IOP profile including mean and peak IOP, as well as IOP fluctuation.[4,5] All of the currently available methods of recording circadian IOP variations are resource and time intensive, and usually not feasible in routine glaucoma practice.

It is for bridging this lacuna that the water drinking test (WDT) has seen a resurgence in in glaucoma assessment and management. The WDT was initially used as a diagnostic test for glaucoma, and its use fell out of favor, understandably, because of its low sensitivity, specificity, and diagnostic value.[6,7]

However, given that the WDT measurements correlate well with diurnal tension curves, it may be considered as a more cost effective and efficient surrogate for the more time-consuming IOP phasing. The WDT, therefore, has seen a recent revival as a "*stress test*" to assess the capacitance of the aqueous outflow, an indirect tool to measure aqueous outflow facility, along with peak IOP and IOP fluctuation.[8]

How to Do the Test?

Ideally, the patient should not have any liquids for 2 h before the test is performed, to offset any effect of previous fluid intake on the IOP measurements.[9]

After measuring the patient's baseline IOP, the patient is asked to drink water over 5–10 min. Various authors have recommended various measures: Some use a fixed volume of water while others prefer to use a volume titrated to body weight.

Fixed volume WDT: 500 ml versus 1000 ml

Kerr *et al*. used 500 ml and 1000 ml of water for the WDT, and found that both fluid challenge volumes resulted in a statistically significant rise in IOP.[10] However, they also reported that the mean maximum increase in IOP was less in the 500 ml WDT compared with the 1000 ml WDT. Hence, while the 500 ml fluid challenge can be used in patients who are unable to drink a liter of water, it is not an accurate estimate of the peak diurnal IOP.

Susanna *et al*. have suggested that a fluid volume challenge of 800 ml WDT may be used instead.[8] The chief author (SB) also prefers to use 800 ml of water for routine WDTs.

Volume adjusted to body weight

Kumar *et al*. used 10 ml/kg body weight of water over 5 min and found that the peak IOP measured during diurnal IOP measurement showed a strong correlation with peak IOP during WDT.[11] They, however, also reported that the IOP fluctuation measured by the two tests did show a good correlation.

Proponents of body weight adjusted fluid volume challenge aim to compensate for the effect of body mass and the expected fluid shift between the intravascular, intracellular, and interstitial compartments. It stands to reason that a fluid challenge of 1000 ml would have a different physiological effect in a subject weighing 50 Kg, as compared with one who weighs a 100 Kg.

That said, this difference has not been validated, and most clinician scientists agree that a significant change from baseline IOP may be elicited on fluid challenge. This change is known to correlate with the diurnal IOP peak, but may or may not correlate well with fluctuation, in case of a challenge volume with 500 ml or less. However, in the absence of any consensus about the predictive value of WDT with various volumes used, most recent studies and clinics prefer to use either 800 ml or 10 ml/kg of body weight for the fluid challenge.

The IOP is measured three to 4 times at 15 min intervals, after drinking water. The maximum measured IOP is the peak IOP. This increase in IOP may be sustained or recover quickly. This may be considered as indicative of the outflow facility reserve.[12]

A word of caution before you decide for a WDT

The WDT is contraindicated in patients who are on fluid restriction because of systemic conditions such as cardiac and/or renal issues.

Mechanism of IOP Elevation During WDT

While the mechanism of IOP increase during the WDT is unclear, there are several postulates. Increase of episcleral venous pressure (EVP) and change in choroidal thickness probably contribute most to the change in IOP from baseline, but literature suggests that the decrease in outflow resistance and a centrally mediate increase in IOP may also contribute to the WDT response.

- Decrease in outflow resistance.[13]
- Potential centrally mediated mechanism.[14]
- Increased EVP (measured to be more than twice the baseline, within 10 min of the water drinking, and maintained for at least 90 min).[15]
- Choroidal expansion (measured increase of more than 20% in choroidal thickness during the WDT in eyes with open angles; may be more in eyes with angle closure).[16]

Evidence So Far

Medication versus medication

Antiglaucoma medications that increase outflow facility such as prostaglandin analogues result in better IOP control during the WDT than those that decrease aqueous humor inflow, namely, beta-blockers and carbonic anhydrase inhibitors.[8] Beta-blockers have been shown to have the worst profile managing IOP changes compared to the rest of medications tested.[17]

Another study showed that the combination therapy has the highest percentage of IOP fluctuations and positive WDT as compared to the other medications. This could be possibly due to the fact that the combination therapy is needed for patients with advanced glaucoma and extensive trabecular meshwork.[18]

Medication versus Surgery

Some glaucoma patients continue to deteriorate even after IOP reduction with antiglaucoma medications. Although medications lower the IOP and dampen the diurnal IOP fluctuations, they are not able to compensate for decreased outflow facility in glaucoma patients after a challenge of 1000 ml of water ingestion.[19] WDT can help detect such patients with compromised outflow facility and surgery can be offered to such patients as it has been shown that patients with medically controlled advanced glaucoma show greater IOP elevation and peak IOP after the WDT than eyes that have undergone trabeculectomy.[20]

Surgery versus surgery

Razeghinejad *et al*. studied effect of WDT after trabeculectomy and tube shunt (Ahmed glaucoma valve) surgery. They noted that IOP started to decline 30 min after the WDT in the trabeculectomy group, while it continued to increase up to 60 min in the tube shunt group.[21] This may have implications regarding the efficacy of tubes in some patients with advanced glaucoma.

Progression in unilateral versus bilateral glaucoma

De Moraes in a recent prospective study has shown that WDT peak is an independent predictor of progression whereas office-based IOP measurements fail to show a significant association with visual field progression.[22] They found that each mmHg higher WDT peak at baseline increased the risk of progression by 11%. In addition, in patients with bilateral glaucoma, eyes with higher IOP peaks during the WDT have worse visual field damage than their fellow eyes.

Angle closure versus open angle

Razeghinejad and Nowroozzadeh have shown that pharmacologic mydriasis and the WDT had similar IOP elevation before laser peripheral iridotomy (LPI), but after LPI, IOP elevation was much greater in the WDT group in primary angle-closure suspects. No changes in ocular biometric parameters were seen after LPI and/or pharmacologic mydriasis except for increments in anterior chamber volume after LPI.[23]

Arora *et al*. have shown a decrease in anterior chamber depth after WDT secondary to a significant increase in choroidal thickness in angle-closure eyes unlike open angle eyes.[24]

Test-Retest Reproducibility

Hatanaka *et al*. found that even though the IOP peaks showed excellent reproducibility, while the reproducibility of fluctuation was considered fair.[25] Medina *et al*., on the other hand, found low levels of agreement among WDTs performed at different times of the day, despite good correlation.[26] The use of WDT, therefore, like diurnal pressure curves, in the serial monitoring of glaucoma patients requires caution.[27]

The Final Verdict

The WDT, using either 800 ml or 10 ml/kg of body weight for fluid challenge, may be used as a surrogate to evaluate the aqueous outflow facility, predicting the diurnal IOP peak and the efficacy of surgical and medical management in selected cases of both, open and angle-closure glaucoma.

The second innings scorecard of the WDT is, of course, significantly better than its performance as a diagnostic tool for glaucoma. Like all other measures used in glaucoma practice, its relevance is also subject to clinical correlation and judicious interpretation. In the immortal words of Salvador Dali, as true for the WDT as for life itself: "*Have no fear of perfection – you'll never reach it.*"

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