AJMB
eISSN: 2600-8173
https://doi.org/10.37231/ajmb.2025.9.S1.736
https://journal.unisza.edu.my/ajmb

PENERBIT
Universiti Sultan Zainal Abidin

Asian Journal of Medicine and Biomedicine

Choroidal Modulations Following Water Drinking Test (WDT) as Measured Using Swept-source Optical Coherence Tomography (SS-OCT)

Aina Afiqah Ayob, Nur Diyana Mohamad Ares, Nur Syahirah Abdul Rahman, Ilyanoon Zahari, Muhammad Afzam Shah Abdul Rahim, Firdaus Yusof*

Department of Optometry and Visual Science, Kulliyyah of Allied Health Sciences, International Islamic University Malaysia, Kuantan Campus, Malaysia.

*Corresponding author: yfirdaus@iium.edu.my

Received: 2nd January 2024 Accepted: 4th August 2024 Published: 11th January 2025

Abstract

The ocular choroidal layer was previously difficult to study due to its location sandwiched between the sclera and retina. Advancements in imaging technology, particularly the Swept-source Optical Coherence Tomography (SS-OCT) enabled the in vivo measurement of deep-ocular structures such as the choroid[1]. The choroid is the most vascularized tissue in the eye which mainly functions to supply oxygen to the retina[2]. The water drinking test (WDT) compares the intraocular pressure (IOP) before and after a certain amount of water is consumed, allowing for the estimation of peak circadian IOP[3]. The physiology behind the WDT is not fully understood, however, the choroidal volume's abrupt expansion was the reason for the reported IOP elevations[4, 5]. Additionally, a prospective investigation examining the alterations in choroidal circulation and structure came to the conclusion that the dilatation of the choroidal arteries was directly responsible for the increase in thickness following the WDT[8]. The purpose of this study was to use SS-OCT to investigate changes in choroidal thickness (CT) following the WDT.

This study evaluated the effect of water drinking on CT using the SS-OCT in healthy young adults. Eighteen young adults (22.61±0.78 years; 9 females) were recruited into the study, after obtaining their written consent. Participants ingested 1000ml of water within 5 minutes as per the WDT protocol[6, 7]. The macular and peripapillary (area around the optic disc, OD) CTs were measured using the Deep Range Imaging (DRI) Topcon SS-OCT Triton Series system (Topcon Inc., Tokyo, Japan) at baseline and after 5, 10, 15, 30, 45, 60, 75, and 90 minutes of WDT. Intraocular pressure (IOP) was measured at the various time points using a non-contact tonometer (Keeler, United Kingdom). A 3D macula protocol imaging of 7.0×7.0mm raster scan was used for macular CT measurement while a 3D 12x12mm radial scan centered on OD was used for peripapillary CT measurement. Only scans with a signal strength index ≥60 were included. The distance between the Bruch's membrane and the choroid-scleral interface was taken as CT. The CTs were compared between the time points to evaluate the choroidal modulations using repeated measures of analysis of variance (RM-ANOVA). Post-hoc analyses were conducted using the Bonferroni correction.

The IOP peaked from 15.56±3.28mmHg at baseline to 17.56±3.29mmHg at 10 minutes post water ingestion (Bonferroni correction, p=0.02), before reducing to a plateau of 14.72±2.85mmHg after 75 minutes post-WDT. This observation was similar to other studies[4, 8, 9]. The average baseline CTs were 247.79±55.07μm and 299.50±102.46μm in the macular and peripapillary, respectively. No significant choroidal modulations

were evident in any macular zones (RM-ANOVA, p>0.05) (Table 1). The temporal peripapillary zone showed choroidal modulations (RM-ANOVA, p=0.001) (Table 2), where the 60-minute CT recorded a significant increment relative to the baseline (Bonferroni correction, p=0.05).

Table 1: Macular choroidal thickness analysis following water drinking test (WDT) at different macular zones. The Ø sign reflects the diameter of the measured zone.

Time points	Choroidal Thickness (µm) N=18				
	Foveal – 1mm Ø	Superior foveal – 3mm Ø	Inferior foveal – 3mm Ø	Nasal foveal – 3mm Ø	Temporal foveal – 3mm Ø
Baseline	274.39 ± 54.02	282.58 ± 62.53	267.72 ± 54.61	240.00 ± 64.15	272.81 ± 48.00
0-minute post-WDT	270.44 ± 53.60	284.00 ± 63.03	270.36 ± 55.54	236.53 ± 54.08	276.44 ± 45.96
15 minutes post-WDT	275.00 ± 54.38	287.67 ± 62.49	270.47 ± 52.64	236.19 ± 52.22	276.00 ± 44.81
30 minutes post-WDT	277.56 ± 53.77	289.75 ± 63.29	270.17 ± 54.75	237.44 ± 54.47	275.97 ± 45.60
45 minutes post-WDT	270.39 ± 53.38	283.17 ± 62.93	270.00 ± 56.38	235.17 ± 53.26	273.14 ± 47.14
60 minutes post-WDT	271.50 ± 57.33	286.67 ± 64.69	268.86 ± 57.48	236.11 ± 54.64	274.83 ± 48.09
RM-ANOVA (p)	0.193	0.143	0.407	0.421	0.450

Table 2: Peripapillary choroidal thickness analysis following water drinking test (WDT) at different zones around the optic disc (OD).

Time points	Choroidal Thickness (µm) N=18			
	Superior of OD	Inferior of OD	Nasal of OD	Temporal of OD
Baseline	159.17±40.45	128.64±42.03	162.78±62.40	140.78±44.36*
0-minute post-WDT	164.92±44.64	127.06±44.00	164.22±61.72	148.81±42.97
15 minutes post-WDT	165.50±47.89	128.22±40.74	158.33±58.82	155.11±43.39
30 minutes post-WDT	160.72±43.56	131.33±43.74	160.42±55.70	156.64±48.56
45 minutes post-WDT	168.67±45.27	130.42±40.41	165.42±58.27	149.86±42.55
60 minutes post-WDT	164.36±39.88	130.06±39.91	163.94±54.81	155.22±48.37*
RM-ANOVA (p)	0.214	0.782	0.607	0.001*

The choroid at the macular zones showed no modulations upon WDT, despite the increase in IOP. The peripapillary choroid at the temporal zone of OD showed modulations following WDT, with its CT retained swollen even after 60 minutes post-WDT. The choroidal vasculature of healthy young adults exhibits an autoregulatory mechanism over the changes in perfusion and ocular pressure. Sectoral modulations in the peripapillary choroid, concerning WDT, necessitate further testing such as on different refractive groups to rule out the possibility of a refractive effect on CT changes.

Keywords
Choroidal thickness, water drinking test, swept-source OCT, young adults

References

1. Xie, R., Qiu, B., Chhablani, J., & Zhang, X. (2021). Evaluation of choroidal thickness using optical coherent tomography: a review. Frontiers in Medicine, 8, 783519.
2. Spaide, R. F. (2020). Choroidal blood flow: review and potential explanation for the choroidal venous anatomy including the vortex vein system. Retina, 40(10), 1851-1864.

3. Goldberg I, Clement CI. The water drinking test. Am J Ophthalmol. 2010 Oct;150(4):447-9.
4. Mansouri, K., Medeiros, F. A., Marchase, N., Tatham, A. J., Auerbach, D., & Weinreb, R. N. (2013). Assessment of choroidal thickness and volume during the water drinking test by swept-source optical coherence tomography. Ophthalmology, 120(12), 2508-2516.
5. De Moraes C.G., Reis A.S., Cavalcante A.F., Sano M.E., Susanna R., Jr. Choroidal expansion during the water drinking test. Graefes Arch. Clin. Exp. Ophthalmol. 2009;247:385–389.
6. Khoo, P. Y., Cheng, T. C., & Din, N. M. (2022). Water drinking test in glaucoma management: a review of the literature. Malaysian Journal of Ophthalmology, 4(3), 252-261.
7. Bhartiya, S., & Ichhpujani, P. (2020). Water drinking test: the second innings scorecard. Clin Exp Vis Eye Res, 3, 1-3.
8. Nagasato, D., Mitamura, Y., Egawa, M., Kameoka, M., Nagasawa, T., Tabuchi, H., ... & Sakamoto, T. (2019). Changes of choroidal structure and circulation after water drinking test in normal eyes. Graefe's Archive for Clinical and Experimental Ophthalmology, 257, 2391-2399.
9. Nongpiur, M. E., Foo, V. H., de Leon, J. M., Baskaran, M., Tun, T. A., Husain, R., ... & Aung, T. (2015). Evaluation of choroidal thickness, intraocular pressure, and serum osmolality after the water drinking test in eyes with primary angle closure. Investigative Ophthalmology & Visual Science, 56(4), 2135-2143.