Correlation Between The White Matter Hyperintensities on MRI and Optical Coherence Tomography Angiography in Alzheimer's Disease Patients

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Introduction:

- Dementia is the irreversible deterioration of acquired cognitive abilities and is reportedly the 7th leading cause of death with Alzheimer's disease emerging as its most prevalent subtype.[1]
- Due to shared embryological origins of retinal and cerebral microcirculation, evaluation of retinal microcirculation using optical coherence tomography angiography (OCT-A) holds promise for unravelling cerebral microcirculation dynamics in Alzheimer's disease (AD).[2]
- This study aims to assess correlations between metrics derived from retinal OCT-A and white matter hyperintensity volumes (WMH) on magnetic resonance imaging (MRI) in AD patients.

Materials & Methods:

- Dementia patients were retrospectively recruited from the neurology and ophthalmology clinics of the Eskisehir Osmangazi University Hospital.
- Exclusion criteria were significant cataract, co-existing retinopathy and optic neuropathy, intraocular pressure >21mmHg, spherical equivalent ±4 D.
- Subjects underwent macular OCT-A imaging (Triton, Topcon Inc.).
- Foveal and average perifoveal vessel densities (VD) of the superficial and deep capillary plexus (SCP and DCP, respectively) were recorded from macular OCT-A scans (Triton, Topcon Inc.).
- T1 and T2 FLAIR MRI images within 3-year timeframe were used for quantifying WMH via fully automated toolbox (UBO-Detector, Jiang et al. 2018, **Figure 1**)[3]. Volume assessments were performed for periventricular-WMH (PVWMH), deep-WMH (DWMH) and whole brain-WMH (WBWMH) **(Figure 2)**.
- Pearson correlation was used, and statistical significance was set at $p<0.05$.

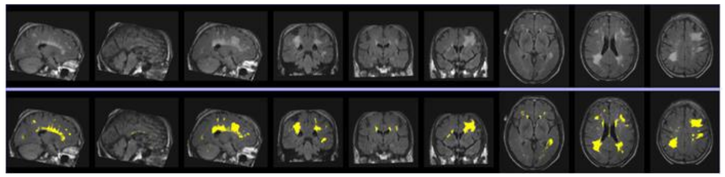


Figure 1. An example of extracted WMH. The first row is three slices of FLAIR on each plane, and the second row is extracted WMH overlain on FLAIR.[3]

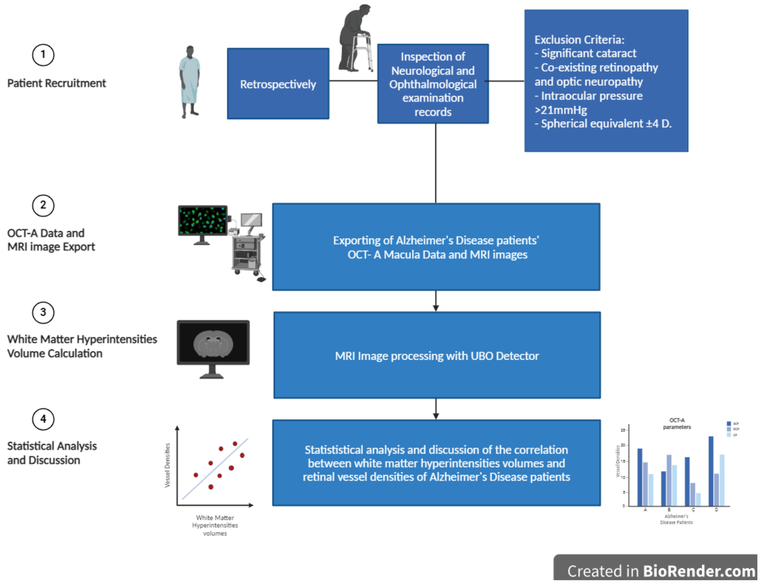


Figure 2. Study Flow Chart

Results:

- A total of 14 patients with mean age of 72.6 years (range: 65 – 82) were recruited.
- There was a moderate positive correlation between DWMH volume and foveal DCP ($p=0.029$, coefficient: 0.583) **(Figure 3)**.
- Although VD levels at the DCP layer showed similar correlation trends with WBWMH (foveal DCP coefficient: 0.49, $p=0.07$; perifoveal DCP coefficient: 0.48, $p=0.08$) and PVWMH (foveal DCP coefficient: 0.46, $p=0.09$; perifoveal DCP coefficient: 0.47, $p=0.09$), statistical significance was not reached **(Figure 3)**.

Correlations	SCP-F	SCP-P	DCP-F	DCP-P	CP-F	CP-P
WBWMH-v						
PVWMH-v						
DWMH-v			*			

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SCP_F: Superficial capillary Plexus-Foveal vessel density,SCP_P: Superficial capillary Plexus-Perifoveal vessel density, DCP_F: Deep capillary Plexus-Foveal vessel density, DCP_P: Deep capillary Plexus-Perifoveal vessel density, CP_F: Choriocapillaris Plexus-Foveal vessel density, CP_P: Choriocapillaris Plexus-Perifoveal vessel density, WBWMH-v: Whole Brain White matter hyperintensity volume, PVWMH-v: Periventricular White matter hyperintensity volume, DWMH-v: Deep White matter hyperintensity volume

Figure 3. Correlation matrix of the studied parameters

Conclusions:

- The volume occupied by WMH was positively correlated with VD at the DCP layer in patients with AD.
- This may have potential associations with the recent discovery of upregulated cerebrospinal fluid vascular endothelial growth factor levels in relation to cerebral amyloid angiopathy and WMH accumulation in AD.[4]

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References:
1. The Global Dementia Observatory Reference Guide. Geneva, Switzerland: World Health Organization; 2018.
2. Ceylan S, Özalp O & Atalay E., A peek at the window from the eye into the brain: potential use of OCT angiography in dementia, Expert Review of Ophthalmology, 2022
3. Jiang, J., Liu, T., Zhu, W., Koncz, R., Liu, H., Lee, T., Sachdev, P.S., Wen, W., UBO Detector – A cluster-based, fully automated pipeline for extracting white matter hyperintensities, NeuroImage (2018),
4. Meral A. Tubi, Koral Wheeler, Elizabeth Matsiyevskiy, Matthew Hapenney, Wendy J. Mack, Helena C. Chui, Kevin King, Paul M. Thompson, Meredith N. Braskie, White matter hyperintensity volume modifies the association between CSF vascular inflammatory biomarkers and regional FDG-PET along the Alzheimer's disease continuum, Neurobiology of Aging, 2023