

The Macular Choriocapillaris and the Superficial Vascular Plexus in Glaucoma. An OCT-Angiography Study and Review of the Literature



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- ❑ Does primary open-angle glaucoma affect the Macular Choriocapillaris (CC) and the Macular Superficial Capillary Plexus (SCP-VD) as assessed by OCTA ?
- ❑ Are there diurnal fluctuations in measurements ?
- ❑ Same findings by similar studies ?
- ❑ Coss-sectional study in Istituto Auxologico Italiano, Milan, Italy:
 - ❑ 39 eyes (24 individuals) with open angle glaucoma (mean age = 58.79 ± 6 years)
 - ❑ 43 eyes (27 individuals) with ocular hypertension (59.19 ± 6 years)
 - ❑ 54 eyes (35 controls) (58.27 ± 6 years)



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□ RESULTS:

- The mean CC perfusion area values were not significantly different among the three groups ($P \geq 0.47$)
- In contrast, SCP-VD, retinal thickness, and GCC thickness were statistically different among the groups ($P \leq 0.016$), except for the foveal SCP-VD ($P \geq 0.19$)
- Systemic hypertension, sex, age and axial length were not significantly associated with parameters measurements ($P \geq 0.07$)
- Neither the CC nor the other parameters investigated exhibited any statistically significant morning to evening variation ($P \geq 0.16$).



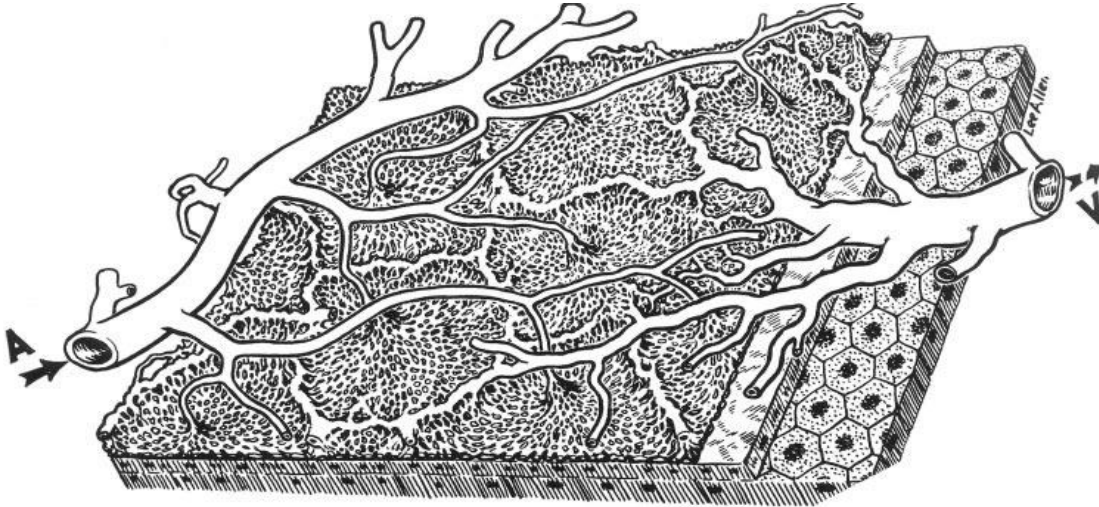
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	Morning				Evening			
	Normal Control Mean (SD)	Hypertension Mean (SD)	Glaucoma Mean (SD)	FDR Adjusted P Value	Normal Control Mean (SD)	Hypertension Mean (SD)	Glaucoma Mean (SD)	FDR Adjusted P Value
Macular CC perfusion area flow, mm ² SCP-VD (%)	2.110 (0.110)	2.117 (0.111)	2.125 (0.110)	0.4745	2.137 (0.099)	2.103 (0.103)	2.120 (0.103)	0.5471
Whole-SCP-VD	51.337 (2.602)	50.781 (2.783)	45.726 (4.669)	<0.0001	51.504 (2.073)	50.812 (2.907)	46.069 (4.889)	<0.0001
Fovea-SCP-VD	21.674 (7.753)	23.063 (6.792)	18.210 (9.034)	0.1902	21.609 (7.887)	22.721 (6.228)	18.774 (8.681)	0.5855
Para-fovea-SCP-VD	54.052 (3.801)	53.472 (2.786)	49.687 (4.582)	0.0005	54.037 (2.498)	53.300 (3.609)	50.154 (4.692)	0.0022
Macular thickness, µm								
Whole thickness	282.074 (9.491)	282.86 (12.813)	266.923 (14.516)	0.0006	281.685 (9.453)	282.767 (13.25)	266.282 (14.907)	0.0002
Fovea thickness	257.611 (20.137)	264.628 (30.236)	247.897 (20.758)	0.0165	258.333 (19.527)	262.744 (23.044)	248.128 (21.942)	0.5769
Para fovea thickness	322.296 (11.424)	324.512 (14.023)	308.564 (18.519)	0.0108	321.63 (11.42)	324.14 (14.669)	307.923 (18.987)	0.0059
GCC thickness, µm								
Whole GCC	95.333 (4.911)	94.000 (5.831)	81.667 (12.244)	<0.0001	95.259 (4.938)	93.791 (6.205)	81.821 (12.314)	<0.0001
Hemi inferior GCC	94.796 (5.360)	93.186 (6.013)	81.59 (13.226)	<0.0001	94.704 (5.417)	93.326 (6.232)	81.564 (13.143)	<0.0001
Hemi superior GCC	96.056 (4.854)	94.744 (6.184)	82.128 (12.842)	<0.0001	95.704 (4.924)	94.395 (6.329)	81.641 (13.496)	<0.0001



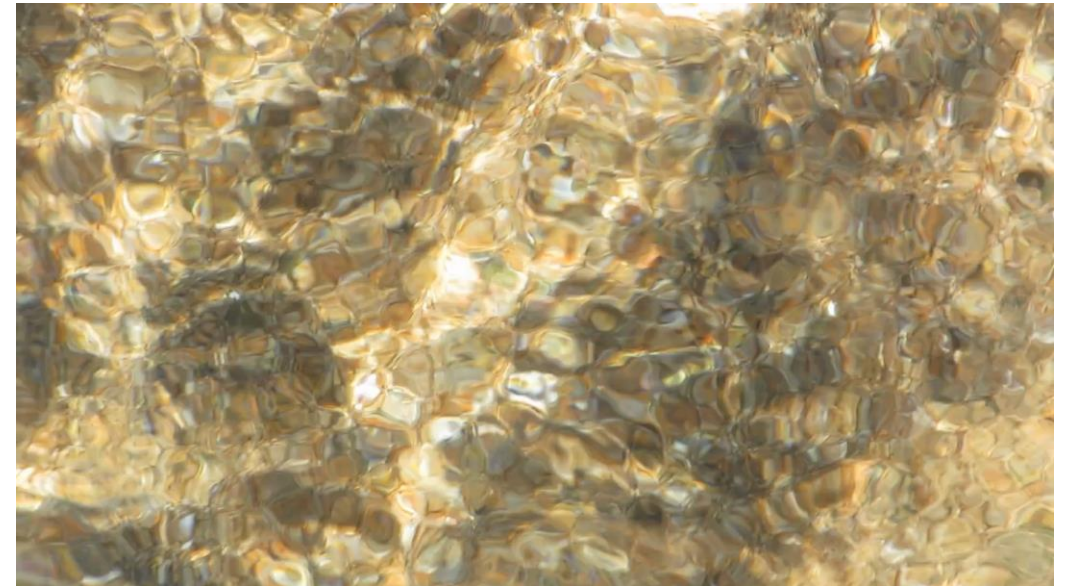
Why the Choriocapillaris is NOT affected in Glaucoma ?

- ❑ It is a meshwork of densely packed and interconnected capillaries that functions in a lobular mode in terms of blood flow
- ❑ Probably it remains a stable and independent vascular district within the choroid, whereas the outer portions of the choroid are mostly sensible to systemic pressure changes, diurnal fluctuations, and pathological alterations
- ❑ If the macular CC perfusion remains intact in glaucoma regardless alterations in the overlying retina and the peripapillary area, probably does not have a vascular role in the pathogenesis since both areas (macular and peripapillary) are nourished by the same arteries (short posterior ciliary arteries, distinct from that of the superficial retina, supplied by the central retinal artery)



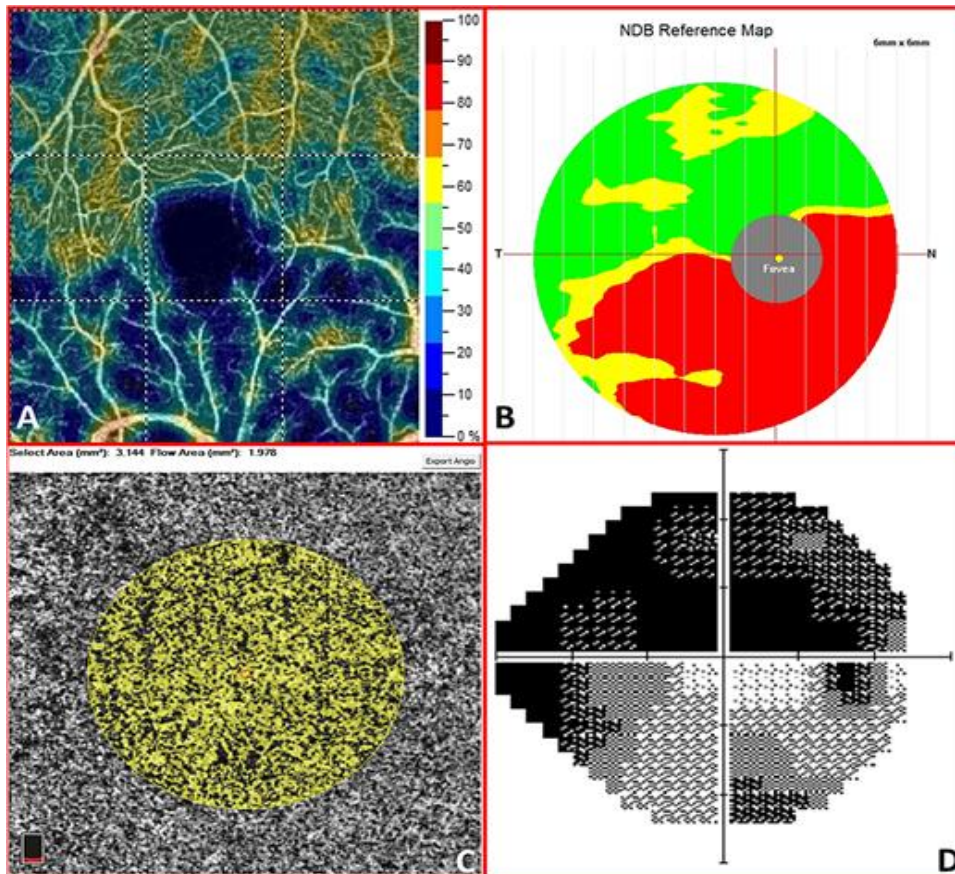
A, choroidal arterioles; V, choroidal vein

(Hayreh SS. Segmental nature of the choroidal vasculature. *Br J Ophthalmol.* 1975;59:631–648)



Why the Superficial Capillary Plexus is affected in Glaucoma ?

- ❑ Elevated intraocular pressure damages the GCC and as these cells die the SCP perfusion in this area decline. This has been strongly demonstrated by many studies
- ❑ It is also possible that poor vascular supply may even contribute to the initial damage or that a feedback loop occurs: GCC damage reduces vascular supply, and reduced supply leads to more GCC damage



The hemi-inferior parafovea superficial capillary plexus vessel density map and the hemi-inferior ganglion cell complex thickness (A and B, respectively) are reduced in a 52-year-old man with advanced glaucoma. This reduction corresponds to a superior scotoma in the computed visual field (D). On the contrary, no vascular dropout is detectable on the macular choriocapillaris vascular perfusion area map (C)



Review of the Literature

The Macular Choriocapillaris unaffected by Primary Open Angle Glaucoma:

Few reports yet but basically concordant

- ❑ Lun K, Sim YC, Chong R, Wong D, Tan B, Husain R, Aung T, Sng CCA, Schmetterer L, Chua J. Investigating the macular choriocapillaris in early primary open-angle glaucoma using swept-source optical coherence tomography angiography. *Front Med (Lausanne)*. 2022 Sep 21;9:999167.
- ❑ Shin JD, Wolf AT, Harris A, Verticchio Vercellin A, Siesky B, Rowe LW, Packles M, Oddone F. Vascular biomarkers from optical coherence tomography angiography and glaucoma: where do we stand in 2021? *Acta Ophthalmol*. 2022 Mar;100(2):e377-e385
- ❑ Chao SC, Yang SJ, Chen HC, Sun CC, Liu CH, Lee CY. Early macular angiography among patients with glaucoma, ocular hypertension, and normal subjects. *J Ophthalmol*. 2019; 2019: 7419470

To be noted that, on the contrary, the choriocapillaris vascularity is affected in normal tension glaucoma, suggesting a different and direct involvement in the pathogenesis of this disease

- ❑ Tepelus TC, Song S, Borrelli E, et al. Quantitative analysis of retinal and choroidal vascular parameters in patients with low tension glaucoma. *J Glaucoma*. 2019
- ❑ Wang YM, Hui VWK, Shi J, Wong MOM, Chan PP, Chan N, Lai I, Cheung CY, Tham CC. Characterization of macular choroid in normal-tension glaucoma: a swept-source optical coherence tomography study. *Acta Ophthalmol*. 2021

The Macular Superficial Capillary Plexus is affected in Primary Open Angle :

Many reports and all concordant

- ❑ Lommatzsch C, Rothaus K, Koch JM, Heinz C, Grisanti S. OCTA vessel density changes in the macular zone in glaucomatous eyes. *Graefes Arch Clin Exp Ophthalmol*. 2018
- ❑ Kromer R, Glusa P, Framme C, Pielen A, Junker B. Optical coherence tomography angiography analysis of macular flow density in glaucoma. *Acta Ophthalmol*. 2019
- ❑ Yip VCH, Wong HT, Yong VKY, et al. Optical coherence tomography angiography of optic disc and macula vessel density in glaucoma and healthy eyes. *J Glaucoma*. 2019
- ❑ Verticchio Vercellin A, Siesky B, Antman G, Oddone F, Chang M, Eckert G, Arciero J, Kellner RL, Fry B, Coleman-Belin J, Carnevale C, Harris A. Regional Vessel Density Reduction in the Macula and Optic Nerve Head of Patients With Pre-Perimetric Primary Open Angle Glaucoma. *J Glaucoma*. 2023
- ❑ Choi J, Kwon J, Shin JW, Lee J, Lee S & Kook MS (2017): Quantitative optical coherence tomography angiography of macularvascular structure and foveal avascular zone in glaucoma. *PLoS One* 12: e0184948
- ❑ Verticchio Vercellin A, Harris A, Oddone F, Carnevale C, Siesky BA, Arciero J, Fry B, Eckert G, Sidoti PA, Antman G, Alabi D, Coleman-Belin JC, Pasquale LR. Diagnostic Capability of OCTA-Derived Macular Biomarkers for Early to Moderate Primary Open Angle Glaucoma. *J Clin Med*. 2024
- ❑ Braun M, Saini C, Sun JA, Shen LQ. The Role of Optical Coherence Tomography Angiography in Glaucoma. *Semin Ophthalmol*. 2024.
- ❑ Lu P, Xiao H, Liang C, Xu Y, Ye D, Huang J. Quantitative Analysis of Microvasculature in Macular and Peripapillary Regions in Early Primary Open-Angle Glaucoma. *Curr Eye Res*. 2020.
- ❑ Takusagawa HL, Liu L, Ma KN et al. (2017): Projection-resolved optical coherence tomography angiography of macular retinal circulation in glaucoma. *Ophthalmology*



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