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Peripapillary capillary vessel density in normal tension glaucoma and primary open-angle glaucoma

Перипапиларни капиларни проток код нормотензивног и примарног глаукома отвореног угла

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SUMMARY

Introduction/Objective Primary open angle glaucoma (POAG) is a chronic, progressive, optic neuropathy with possible blindness and irreversible changes in the optic nerve head (ONH). Optical coherence tomography (OCT) is non-invasive method that provides structural glaucoma damage evaluation. OCT angiography (OCTA) provides qualitative and quantitative assessment of peripapillary microvasculature. The objective of this study was to determine whether there is a difference in peripapillary capillary vessel density in normal tension (NTG), POAG and healthy subjects.

Methods This prospective study included 120 eyes: 40 healthy eyes, 30 eyes with NTG and 50 eyes with POAG. Ophthalmological examination, central corneal thickness, OCT, OCT angiography (OCTA) also visual field were performed.

Results Vessel capillary density total (VCD total) is significantly higher in healthy compared to NTG and POAG (39.25 ± 0.94 vs. 36.79 ± 2.50 vs. 37.58 ± 1.53; $p<0,001$). Peripapillary capillary vessel density (VCD perip.) is lower significantly in NTG and POAG in comparison with healthy subjects (39.21 ± 2.62 vs. 40.18 ± 1.35 vs. 41.29 ± 0.81; $p<0.001$). VCD total is significantly lower in NTG compared to POAG (36.79 ± 2.50 vs. 37.58 ± 1.55; $p<0,001$). We found significantly positive correlation between OCT and OCTA parameters of ONH with mean deviation (MD) index in NTG between RNFL average with MD ($r=0.370$, $p<0.05$) also between VCD peripapillary inf. with MD ($r=0.395$, $p<0.05$). In POAG, we obtained a significantly positive correlation between VCD inf. with MD ($r=0.277$, $p<0.05$) also VCD inside disc with MD ($r=0.395$, $p<0.01$).

Conclusion Glaucoma patients have a significantly lower vessel density ONH and peripapillary capillary vessel density compared to healthy subjects. VCD total of ONH is significantly lower in NTG compared to POAG. We obtained a positive correlation between OCT and OCTA parameters with MD in NTG and POAG.

Keywords: optical coherence tomography angiography; optic nerve head; intraocular pressure

САЖЕТАК

Увод/Циљ Примарни глауком отвореног угла (ПОАГ) је хронична, прогресивна, оптичка неуропатија са могућим слепилом и иреверзибилним променама главе оптичког нерва (ГОН). Оптичка кохерентна томографија (ОКТ) је неинвазивна метода која пружа процену структурног оштећења код глаукома. ОКТ ангиографија (ОКТА) пружа квалитативну и квантитативну процену перипапиларне микроваскулатуре. Анализирали смо да ли постоји разлика у капиларном протоку перипапиларне регије код нормотензивног (НТГ), ПОАГ и здравих особа.

Методе У овој проспективној студији укључено је 120 очију: 40 здравих очију, 30 очију са НТГ и 50 очију са ПОАГ. Рађен је офталмолошки преглед, централна дебљина рожњаче, ОКТ, ОКТ ангиографија (ОКТА) и компјутеризовано видно поље.

Резултати Укупна густина капиларних крвних судова је значајно већа код здравих у поређењу са НТГ и ПОАГ ($39,25\pm0,94$; $36,79\pm2,50$; $37,58\pm1,53$; $p<0,001$). Укупни ПКП је значајно мањи код НТГ и ПОАГ у односу на здраве ($39,21\pm2,62$; $40,18 \pm 1,35$; $41,29\pm0,81$; $p<0,001$). Укупна густина капиларних крвних судова ГОН је значајно мања код НТГ у односу на ПОАГ ($36,79\pm2,50$; $37,58\pm1,55$; $p<0,001$). Укупни ПКП је значајно мањи код НТГ у поређењу са ПОАГ ($39,21\pm2,62$; $40,18\pm1,35$; $p < 0,001$). Значајну позитивну корелацију између ОКТ и ОКТА параметара ГОН са средњом девијацијом индекса видног поља (СДИВП) добили смо код НТГ између СНВП и СДВП ($r=0,370$, $p < 0,05$) и код радијалног перипапиларног капиларног плексуса (РПКП) у доњем сектору и СДИВП ($r=0,395$, $p<0,05$). Код ПОАГ значајну позитивну корелацију добили смо између густине капиларних крвних судова у доњем сектору и СДИВП ($r=0,277$, $p<0,05$) и густине капиларних крвних судова унутар диска са СДИВП ($r=0,395$, $p< 0,01$).

Закључак Пацијенти са глаукомом имају значајно мању густину капиларних крвних судова ГОН и ПКП у односу на здраве. Укупна густина капиларних крвних судова ГОН је значајно мања код НТГ у односу на ПОАГ. Позитивну корелацију добили смо између ОКТ и ОКТА параметара са средњом девијацијом индекса видног поља код НТГ и ПОАГ.

Кључне речи: оптичка кохерентна томографија ангиографија; глава оптичког нерва; интраокуларни притисак

INTRODUCTION

Primary open angle glaucoma (POAG) is a chronic, progressive, optic neuropathy with possible blindness and irreversible changes in the optic nerve. It causes a reduction of the neuroretinal rim and retinal nerve fiber layer (RNFL) with relative visual field (VF) defects. Changes in the VF are prevented with early diagnosis and treatment of glaucoma [1].

There are morphologically optic nerve head (ONH) changes in glaucoma as well as RNFL thickness decrease [2, 3, 4].

Usually used non-invasive method that provides structural glaucoma damage evaluation is optical coherence tomography (OCT) [5].

Optical coherence tomography angiography (OCTA) is non-invasive and high resolution method which provides peripapillary vessel density (angioflow vessel density) as well as superficial perifoveal vessel density quantification. Perfused area expressed as vessel density is a percentage of full examined of its limited sectors inside retinal layer [6,7]. Peripapillary vessel capillary density (VCD) is the most consistent OCTA parameter in the diagnosis and monitoring of glaucoma progression [6], and a useful predictor of visual field (VF) progression in intermediate and advanced glaucoma patients [8].

Jia et al. [9] were the first to describe vessel density reduced measurement by OCTA in glaucoma.

The aim of this study was to determine whether there is a difference in peripapillary capillary vessel density in normal tension (NTG) and primary open-angle glaucoma (POAG) patients as well as healthy subjects.

METHODS

This prospective research included 120 eyes: 40 healthy eyes, 30 eyes with NTG and 50 eyes with POAG. The study was performed in Practice of ophthalmology Family Čivčić, Belgrade, from April 2022 to March 2023.

Inclusion criteria were: open angle under gonioscopy, early (MD ≤ 6 dB) and middle (MD ≤ 12 dB) stage of glaucoma patients according to Hodapp´s classification [1], age ≥ 18 years. Different inclusion criteria were specified in:

-        healthy-control group: eyes without glaucoma with intraocular pressure (IOP) 10-21 mmHg, best corrected visual acuity (BCVA) ≥ 0,9, normal cup/disc ratio, RNFL thickness and peripapillary capillary vessel density (VCD perip.)

-        NTG group: eyes with early and middle stage (Hodapp´s classification) NTG, with characteristic change of the ONH and RNFL and MD ≤ 12 dB without elevated IOP. BCVA ≥ 0,5.

-        POAG group: eyes with early and middle stage (Hodapp´s classification) POAG, with typical damage of RNFL and ONH and MD ≤ 12 dB with elevated IOP. BCVA ≥ 0,5.

Exclusion criteria: advanced POAG glaucoma stage, secondary glaucoma, myopia ≥ - 6 D, optic nerve head drusen and other optic nerve head anomalies, trauma, other ocular diseases, previous laser treatment as well as ocular surgery (glaucoma or cataract), mean deviation (MD) > 12 dB, unreliable visual field patients (false-positive errors > 15%, false-negative errors > 15%, and fixation losses > 20%).

We examine in all patients: slit-lamp biomicroscopy, BCVA, Goldmann applanation tonometry, evaluation of dilated fundus, gonioscopy, CCT measurement using ultrasonic

pachymeter SP-100 Tomey (Tomey, Nagoya, Japan) and 24-2 threshold test with standard automated perimetry AP-1000 Tomey (Tomey, Nagoya, Japan). Spectral domain OCT (SOCT REVO 60, Optopol Technology, Zawiercie, Poland, software version 11.05) was performed in RNFL measurements and ONH analysis. OCTA examination was performed with SOCT REVO 60 with angio mode, software 11.05 (2021) axial resolution 5µm and 60 000 scan per second. The quality of the obtained recordings was QI ≥ 8.

Vessel capillary density is defined as the percentage of area occupied by capillaries with flow in the scanned region. Measurements were made and analyzed in the radial peripapillary capillaries (RPC) plexus from the inner limiting membrane (ILM) to the posterior boundary of the RNFL.

In research, there are considered statistical descriptive methods: arithmetic mean, standard deviation, median, minimum, maximum and percentage. The difference between the mean values of variables with normal distribution was analyzed by One Way ANOVA parametric test. For variables without a normal distribution, the non-parametric Kruskal-Wallis test was used. Additional analyzes were performed with the parametric t- test. Correlation between the investigated parameters was done with the Pearson′s correlation test and Spearman-R Order correlation test. Statistical analysis was done in SPSS software (version 26.0; IBM Corp., USA). Statistical significance is considered at level value of p<0.05.

Ethics: The study has approval of the Local Ethics Committee and the Medical Faculty University of Novi Sad, Novi Sad, Serbia (Number 01-39/237/1).

RESULTS

This prospective research included 120 eyes: 40 healthy eyes, 30 eyes with NTG and 50 eyes

with POAG. There were 39 (32.5%) male patients and 81 (67.5%) female patients. Demographic and clinical characteristics of patients are presented in Table 1. IOP values are significantly higher in POAG compared to NTG and healthy subjects ($p<0.05$). CCT is significantly smaller in NTG compared to POAG and healthy eyes ($p<0.001$). MD index of visual field (VF) is significantly higher in NTG and POAG patients compared to healthy eyes ($p<0.01$).

Table 2 shows the OCT parameters of ONH and the comparison between the groups. Cup/disc area ratio is significantly higher in NTG and POAG compared to healthy subjects ($p<0.001$). RNFL average thickness is significantly lower in NTG and POAG patients compared to healthy eyes ($p<0.01$).

OCTA parameters of ONH and comparison between groups are presented in Table 3. Vessel capillary density total (VCD total) is significantly higher in healthy compared to NTG and POAG patients (39.25 ± 0.94 vs. 36.79 ± 2.50 vs. 37.58 ± 1.53; $p<0.001$). Peripapillary capillary vessel density (VCD perip.) is significantly lower in NTG and POAG compared to healthy subjects (39.21 ± 2.62 vs. 40.18 ± 1.35 vs. 41.29 ± 0.81; $p<0.001$).

OCTA parameters of ONH and comparison between NTG and POAG groups are shown in Table 4. VCD total is significantly lower in NTG compared to POAG (36.79 ± 2.50 vs. 37.58 ± 1.55; $p<0.001$). VCD perip. is statistically highly significant lower in NTG compared to POAG (39.21 ± 2.62 vs. 40.18 ± 1.35; $p<0.001$).

Pearson's correlation coefficient between RNFL thickness and OCTA parameters of ONH are presented in Table 5. We obtained a positive correlation between RNFL average and RNFL inf. with VCD sup. ($p<0.05$) and RNFL nasalis with VCD total and VCD ins.d ($p<0.05$) in healthy subjects. We found significantly positive correlation in NTG between RNFL temp. and VCD inf. ($r=0.372$, $p<0.05$). In POAG, we obtained a significant negative correlation between

RNFL average and VCD ins.d (r = - 0.347, p<0.05) and RNFL inf. with VCD ins.d (r= - 0.388, p<0.01).

Spearman – R correlation OCT and OCTA parameters ONH with MD index visual field are shown in Table 6. We found significantly positive correlation between OCT and OCTA parameters of ONH with MD index in NTG among RNFL average and MD (r=0.370, p<0.05) and among VCD perip.inf. and MD (r=0.375, p<0.05). In POAG we obtained a significantly positive correlation between VCD inf. and MD (r=0.277, p<0.05) as well as VCD ins.d and MD (r=0.395, p<0.01).

DISCUSSION

OCTA provide qualitative and quantitative analysis of vessel capillary density of ONH and peripapillary region in glaucoma patients [6].

During aging in normal eyes there is a decrease in RNFL thickness, GCC thickness, peripapillary VCD density and superficial macular vessel density (mVD). Changes that occur with aging should be considered in the diagnosis and follow-up of glaucoma patients [10].

Bojikian KD et al. [11] analyzed 26 normally, 30 POAG and 31 NTG subjects. Normal eyes showed significantly higher RNFL thickness average compared to POAG and NTG (p<0.0001). Eyes with NTG also had significantly lower flux and vessel area density compared to normal eyes (p<0.0001).

In our study we found that VCD total is significantly higher in healthy compared to NTG and POAG patients (39.25±0,94 vs. 36.79±2.50 vs. 37.58±1.53; p<0.001). Peripapillary VCD is significantly lower in NTG and POAG compared to healthy subjects (39.21±2.62 vs.

40.18±1.35 vs. 41.29±0.81; p<0.001). Lee MN et al. [12] shows the results of peripapillary vessel density between patients with NTG and POAG compared to glaucoma suspect and control groups. Full vessel capillary density is significantly lower in NTG and POAG compared to control group (p<0.001). They did not find statistically significant VCD between NTG and POAG.

Onishi AC et al. [13] compared peripapillary VCD in healthy eyes (49.12±2.80) to POAG (37.63±7.19), p<0.001; but not statistically significant in NTG eyes (45.33±7.66; p=0.692). In the current study there was a significantly difference among peripapillary VCD in POAG and NTG eyes (p=0.030). Scripsema NK et al. [14] reported global perfused capillary density in POAG, NTG and normal eyes (33.13±6.23; 36.49±3.18; 41.32±1.96). A statistically significant difference between the groups was obtained (p<0.01).

Chen HS-L et al. [15] compared peripapillary vessel density in glaucoma to healthy eyes. In the present study, peripapillary vessel density total were significantly lower in glaucoma eyes than in healthy eyes (43.8%±5.7% vs. 53.3%±3.0%; p<0.001). Pearson's correlation coefficient showed that peripapillary vessel density total (r=0.74) and RNFL thickness (r=0.65) had strong positive correlation with MD (p<0.001).

In our study there is a significantly positive correlation in NTG among RNFL average and MD (r=0.370, p<0.05) and among VCD perip. inf. and MD (r=0.375, p<0.05). In POAG patients there are a significantly positive correlation between VCD inf. and MD (r=0.277, p<0.05) as well as VCD ins.d and MD (r=0.395, p<0.01). Kim DY et al. [16] analyzed peripapillary perfusion in NTG (71 eyes) and control group (71 eyes). Average RNFL thickness were significantly lower in NTG (78.45±12.66μm, p<0.001) compared to control group (92.39±9.40μm). MD index VF was significantly lower in NTG compared to control group (-4.84±5.34dB vs. -0.51±1.40dB; p<0.001). Peripapillary vessel capillary density average

decreased significantly in NTG compared to control group (42.77 ±2.67 vs. 45.15±1.74; p<0.001). The RNFL thickness average correlated positively with average perfusion density (r=0.610; p<0.001).

Petrovic M et al. [17] compared results of VCD and peripapillary VCD in healthy eyes and different stages of POAG. They discovered that all OCTA parameters are significantly higher in healthy eyes.

Ozturk B et al. [18] compared peripapillary VCD in a control group with different stages of POAG (early, moderate and severe stages). Peripapillary VCD parameters had the highest diagnostic performance in all POAG patients. Peripapillary VCD helps identify early stage glaucoma.

Lin Y-H et al. [19] analyzed peripapillary vessel density in NTG (74 eyes) and healthy eyes (24 eyes). They found that vessel capillary density total is statistically significant lower in NTG (43.9±6.14) than in healthy eyes (48.41±3.03), p<0.001. Peripapillary vessel density were significant lower in NTG (45.46±7.87) than in healthy eyes (50.73±3.31), p<0.002. RNFL thickness significant lower in NTG compared to healthy eyes (85.34±15.22 vs. 99.75±6.78; p<0.001).

Belbase U et al. [20] report on OCTA vessel density in healthy, glaucoma suspect and POAG eyes. They find significantly lower peripapillary VD in glaucoma compared to glaucoma suspected (GS) and healthy eyes (47.42±7.73 vs. 52.62±2,4 vs. 56.07±2.71, p<0.001). They obtained a significant positive correlation between peripapillary VD and MD of VF (R^2=0.32, p<0.001).

Elsalhy FMAE et al. [21] analyzed glaucoma suspected (GS) patients. They had significantly lower value of the mean radial peripapillary capillary plexus (RPC) compared to healthy

individuals (46.6±2.0 vs. 48.8±1.7, p<0.001).

The finding of peripapillary VCD reduction clearly separates healthy eyes from eyes with NTG and POAG, which is important for clinical practice [12,18].

CONCLUSION

Glaucoma patients have a significantly lower vessel density ONH and peripapillary capillary vessel density compared to healthy subjects. VCD total of ONH is significantly lower in NTG compared to POAG. We obtained a positive correlation between OCT and OCTA parameters with MD in NTG and POAG. OCTA is an important imaging method in the diagnosis and monitoring of glaucoma progression.

Note: The paper is part of a doctoral dissertation.

Conflicts of interest: None declared.

REFERENCES

1. European Glaucoma Society Terminology and Guidelines for Glaucoma. 6th Edition-Chapter 1: Terminology, classification and definitions. Savona, Italy: Platform Network;2025.

2. Angmo D, Kapoor A, Warjri GB, Azad SV, Chawla R, Gupta V, et al. Comparative evaluation of OCT with OCTA changes at the optic disc and macula in glaucoma suspect and early glaucoma. Indian J Ophthalmol. 2025;73(Suppl 2):S260-S266. [DOI: 10.4103/IJO.IJO_2575_23] [PMID:39446809]

3. Miljković A, Babić N, Davidović S, Barišić S, Brunet S, Tapavički B. Evaluation of peripapillary retinal nerve fiber layer thickness in patients with primary open-angle glaucoma. Srp Arh Celok Lek. 2022 May-Jun;150(5–6):325–9. [DOI: 10.2298/SARH200505020A]

4. Čivčić-Kalinić N, Stamenković M, Čivčić N, Brunet S. Relationship between optic nerve head topography and nerve fiber layer thickness in patients with primary open-angle glaucoma. Srp Arh Celok Lek. 2020;148(11–12):723–6. [DOI: 10.2298/SARH191126066C]

5. Sahoo B, Pegu J. A practical guide to clinical application of OCT in ophthalmology. Intech Open; 2019. [DOI: 10.5772/intechopen.84202]

6. Kancheva K, Radeva M, Resnick IB, Zlatarova Z. Evaluation of OCT Angiography Parameters as Biomarkers for Glaucoma Progression. Diagnostics.2025;16(1):35. [DOI: 10.3390/diagnostics16010035]

7. Marjanović I, Marić V, Božić M. Optical coherent tomography with angiography in glaucoma. Srp Arh Celok Lek.2023;151(11–12):725–9. [DOI: 10.2298/SARH230211096M]

8. Katarya K, de Vries VA, Barbosa-Breda J, Brea LS, De Jesus DA, Ramadas WD. Prognostic factors of optical coherence tomography angiography in intermediate and advanced primary open-angle glaucoma:A systematic review and meta-analysis. Acta Ophthalmol. 2026. [DOI: 10.1111/aos.70075] [PMID: 41615222]

9. Jia Y, Morrison JC, Tokayer J, Tan O, Lombardi L, Baumann B, et al. Quantitative OCT angiography of optic nerve head blood flow. Biomed Opt Express 2012;3(12):3127–37. [DOI: 10.1364/BOE.3.003127] [PMID: 23243564]

10. Pang R, Kolli A, Li R, Li M, Cao K, Ying GS, et al. Age-Related Optic Nerve Optical Coherence Tomography and Optical Coherence Tomography Angiography Changes in Subjects Without Glaucoma: A 5-Year Prospective Study. Am J Ophthalmol. 2026;282:396–404. [DOI: 10.1016/j.ajo.2025.11.028] [PMID: 41285266]

11. Bojikian KD, Chen C-L, Wen JC, Zhang Q, Xin C, Gupta D, et al. Optic disc perfusion in primary open angle and normal tension glaucoma eyes using optical coherence tomography-based micro angiography. PLoS ONE 2016;11(5):e0154691. [DOI: 10.1371/journal.pone.0154691] [PMID: 27149261]

12. Lee M-W, Yu H-Y, Park K-S, Jin S-Y, Kim J-S. A comparison of peripapillary vessel density between subjects with normal-tension glaucoma and primary open-angle glaucomawith similar extents of glaucomatous damage. Scientific Reports 2023;13:9258. [DOI: 10.1038/s41598-023-36369-w]

13. Onishi AC, Treister AD, Nesper PL, Fawzi AA, Anchala AR. Parafoveal vessel changes in primary open-angle glaucoma and normal-tension glaucoma using optical coherence tomography angiography. Clinical Ophthalmology 2019;13:1935–45. [DOI: 10.2147/OPTH.S206288] [PMID: 31579266]

14. Scripsema NK, Garcia PM, Bavier RD, Chui TYP, Krawitz BD, Mo S, et al. Optical coherence tomography angiography analysis of perfused peripapillary capillaries in primary open-angle glaucoma and normal-tension glaucoma. Invest Ophthalmol Vis Sci.2016;57(9):611–20. [DOI: 10.1167/iovs.15-18945] [PMID: 27742922]

15. Chen HS-L, Liu C-H, Wu W-C, Tseng H-J, Lee Y-S. Optical coherence tomography angiography of the superficial microvasculature in the macular and peripapillary areas in glaucomatous and healthy eyes. Invest Ophthalmol Vis Sci. 2017;58:3637-3645. [DOI: 10.1167/iovs.17-21846] [PMID: 28728171]

16. Kim DY, Kim S, Kim SA, Lee JM, Kim JH. Peripapillary perfusion analysis using optical coherence tomography angiography in patients with normal tension glaucoma. Korean J Ophthalmol 2024;38(1):51–63. [DOI: 10.3341/kjo.2023.0112] [PMID: 38110184]

17. Petrović M, Resan M, Stanković Babić G, Šarenac Vulović T, Radenković M, Veselinović A, et al. Analysis of structural and vascular changes of the optic disc and macula in different stages of primary open angle glaucoma. Vojnosanit Pregl 2022;79(2):142–9. [DOI: 10.2298/VSP200526084P]

18. Ozturk B, Erdem E, Harbiyeli II, Esen E, Sizmaz S, Sulanc B, et al. Effects of Glaucoma Stage on Optical Coherence Tomography Angiography Parameters in Patients With Primary Open-Angle Glaucoma. Cureus. 2025;17(3):e80583. [DOI: 10.7759/cureus.80583] [PMID: 40225535]

19. Lin Y-H, Huang S-M, Yeung L, Ku W-C, Chen HS-L, Lai C-C, et al. Correlation of visual field with peripapillary vessel density through optical coherence tomography angiography in normal-tension glaucoma. Trans Vis Sci Tech 2020;9(13):1–8. [DOI: 10.1167/tvist.9.13.26] [PMID: 33364080]

20. Belbase U, Maharjan IM, Subedi A. Optical Coherence Tomography Angiography Vessel Density in Healthy, Glaucoma Suspect and Glaucoma Eyes. J Curr Ophthalmol. 2024;36(1):31–6. [DOI: 10.4103/joco.joco_270_23] [PMID: 39553317]

21.   Elsalhy FMAE, Alshamarti SA, Alshamarti SA, Khattab AAA, Khalil MMAA, Morsy MFZ, et al. Evaluating the predictive value of optical coherence tomography angiography metrics and central corneal thickness among glaucoma suspect patients: a comparative cross-sectional study. Med Hypothesis Discov Innov Ophthalmol. 2025;14(4):183–93. [DOI: 10.51329/mehdiophthal1531] [PMID: 41608130]

Table 1. Demographic and clinical characteristics of patients

Parameters	Health (n = 40) $\overline{x} \pm$ SD	NTG (n = 30) $\overline{x} \pm$ SD	POAG (n = 50) $\overline{x} \pm$ SD	p
Age (years)	47 (18–74)	60.60 ± 14.16	62.36 ± 11.64	< 0.001
Gender (M/F), n	16/24	8/22	15/35	0.442
BCVA	0.98 ± 0.10	0.89 ± 0.18	0.94 ± 0.11	NS*
IOP (mmHg)	16.18 ± 2.73	15.47 ± 2.83	17.36 ± 3.74	< 0.05*
CCT (μm)	561.75 ± 36.45	498.73 ± 19.09	565.28 ± 28.98	< 0.0001*
MD (dB)	0.52(-3.06–3.45)	-1.57(-11-1.41)	-1.27(-4.57–3.61)	< 0.001**

M/F – male/female; BCVA – best corrected visual acuity; IOP – intraocular pressure; CCT – central corneal thickness; MD – mean deviation; NTG – normal tension; POAG – primary open angle glaucoma;
*One Way ANOVA;
**Kruskal–Wallis

Table 2. OCT parameters of optic nerve head

OCT parameters	Health (n = 40) $\bar{x} \pm SD$	NTG (n = 30) $\bar{x} \pm SD$	POAG (n = 50) $\bar{x} \pm SD$	p
RNFL aver. (μm)	123.45 ± 9.31	113.33 ± 18.42	114.26 ± 17.24	< 0.01*
RNFL sup. (μm)	139.38 ± 13	130.21 ± 23.06	127.36 ± 20.53	< 0.05*
RNFL inf. (μm)	144.58 ± 13.55	127 ± 26.54	129.42 ± 24.55	< 0.001*
C/D area ratio	0.29 (0.13–0.47)	0.425 (0.2–0.96)	0.49 ± 0.13	< 0.001**

OCT – optical coherence tomography; NTG – normal tension; POAG – primary open angle glaucoma; RNFL – retinal nerve fiber layer; C/D – cup/disc area ratio;
*One Way ANOVA;
**Kruskal–Wallis

Table 3. OCTA parameters of optic nerve head

OCTA parameters	Health (n = 40) $\overline{x} \pm$ SD	NTG (n = 30) $\overline{x} \pm$ SD	POAG (n = 50) $\overline{x} \pm$ SD	p
VCD total	39.25 ± 0.94	36.79 ± 2.5	37.58 ± 1.55	< 0.001*
VCD sup.	39 ± 1.92	36.64 ± 2.66	37.43 ± 1.91	< 0.001*
VCD inf.	39.19 ± 1.09	36.68 ± 3.03	37.45 ± 2.18	< 0.001*
VCD ins.d	31.53 ± 2.61	27.96 ± 4.17	27.33 ± 4.55	< 0.001*
VCD perip.	41.29 ± 0.81	39.21 ± 2.62	40.18 ± 1.35	< 0.001*
VCD perip.sup.	41.47 ± 1.1	39.62 ± 2.62	40.47 ± 1.31	< 0.001*
VCD perip.inf.	41.13 ± 0.85	38.74 ± 3.01	39.82 ± 2.07	< 0.001*

OCTA – optical coherence tomography angiography; VCD – vessel capillary density; VCD ins.d – vessel capillary density inside disc; VCD perip. – vessel capillary density peripapillary; NTG – normal tension; POAG – primary open angle glaucoma;
*One Way ANOVA

Table 4. OCTA parameters of optic nerve head in NTG and POAG

OCTA parameters	NTG (n = 30) $\bar{x} \pm$ SD	POAG (n = 50) $\bar{x} \pm$ SD	p
VCD total	36.79 ± 2.5	37.58 ± 1.55	< 0.001˚
VCD sup.	36.64 ± 2.66	37.43 ± 1.91	< 0.05˚
VCD inf.	36.68 ± 3.03	37.45 ± 2.18	< 0.01˚
VCD ins.d	27.96 ± 4.17	27.33 ± 4.55	NS
VCD perip.	39.21 ± 2.62	40.18 ± 1.35	< 0.001˚
VCD perip.sup.	39.62 ± 2.62	40.47 ± 1.31	< 0.001˚
VCD perip.inf.	38.74 ± 3.01	39.82 ± 2.07	< 0.001˚

OCTA – optical coherence tomography angiography; VCD – vessel capillary density; VCD ins.d – vessel capillary density inside disc; VCD perip. – vessel capillary density peripapillary; NTG – normal tension; POAG – primary open angle glaucoma;
˚t – Test

Table 5. Pearson՚s correlation coefficient between RNFL thickness and OCTA parameters of optic nerve head

OCT parameters	OCTA parameters	Health (n = 40)	NTG (n = 30)	POAG (n = 50)
RNFL average	VCD total	0.2960	0.1227	0.0056
	VCD sup.	0.3915*	0.1315	-0.0637
	VCD inf.	0.1149	0.2314	0.0077
	VCD ins.d	0.2189	0.0200	-0.3468*
	VCD perip.	0.0260	0.0742	0.1973
RNFL superior	VCD total	0.2493	0.0130	-0.0123
	VCD sup.	0.2384	0.1820	-0.0397
	VCD inf.	0.0913	0.0651	-0.0332
	VCD ins.d	0.1208	-0.1586	-0.2669
	VCD perip.	0.1177	-0.0353	0.1723
RNFL inferior	VCD total	0.1029	0.2055	0.0321
	VCD sup.	0.3727*	0.0102	-0.1129
	VCD inf.	0.0312	0.2655	0.0727
	VCD ins.d	0.0450	0.0403	-0.3883**
	VCD perip.	0.1879	0.1255	0.2436
RNFL temporalis	VCD total	0.0552	0.1199	-0.1955
	VCD sup.	0.0629	0.2676	-0.2325
	VCD inf.	0.0768	0.3723*	-0.1442
	VCD ins.d	0.1420	0.2727	-0.2228
	VCD perip.	0.0955	0.1252	-0.1248
RNFL nasalis	VCD total	0.3378*	0.0975	-0.0192
	VCD sup.	0.2301	0.2077	0.1023
	VCD inf.	0.2836	0.2855	-0.1036
	VCD ins.d	0.3158*	0.0848	-0.2049
	VCD perip.	0.2343	0.0934	0.1021

OCT – optical coherence tomography; OCTA – optical coherence tomography angiography; RNFL – retinal nerve fiber layer; VCD – vessel capillary density; VCD ins.d – vessel capillary density inside disc; VCD perip. – vessel capillary density peripapillary; NTG – normal tension; POAG – primary open angle glaucoma;
* $p < 0.05$;
** $p < 0.01$

Table 6. Spearman-R correlation OCT and OCTA parameters optic nerve head with mean deviation index visual field

OCT and OCTA parameters	Health (n=40)	NTG (n=30)	POAG (n=50)
RNFL average	-0.132	0.370*	-0.124
RNFL superior	-0.089	0.320	-0.155
RNFL inferior	-0.215	0.301	-0.110
VCD total	-0.024	0.357	0.235
VCD superior	-0.040	0.155	0.122
VCD inferior	0.049	0.316	0.277*
VCD ins.d	-0.125	-0.013	0.395**
VCD perip.	0.016	0.295	-0.015
VCD perip.sup.	-0.036	0.103	-0.092
VCD perip.inf.	0.033	0.395*	0.044

OCT – optical coherence tomography; OCTA – optical coherence tomography angiography; RNFL – retinal nerve fiber layer; VCD – vessel capillary density; VCD ins.d – vessel capillary density inside disc; VCD perip. – vessel capillary density peripapillary; NTG – normal tension; POAG – primary open angle glaucoma;
* $p < 0.05$;
** $p < 0.01$