Optic Disc Area and Diameter of the Central Retinal Vein Occlusion Fellow Eyes, Determined by Optical Coherence Tomography

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Objective: *To investigate the diameters and disc area of central retinal vein occlusion fellow eyes (CRVO fellow eyes), whether there is any small diameter of the particular axis, which predisposing to central retinal vein occlusion (CRVO), or not.*
Material and Method: *A prospective analytic study between 78 CRVO fellow eye patients and 102 healthy control subjects was evaluated. Fast optic disc scan with Stratus OCT was obtained.*
Results: *Six axes of disc diameters, and disc area were not different between the groups. Analysis of the model excluding glaucoma within the study group (n = 59) revealed the similar outcome.*
Conclusion: *Optic disc diameters and size in the CRVO fellow eyes were not different from normal subjects. Optic disc size appears not to be the pathogenesis of CRVO.*

Keywords: *Central Retinal Vein Occlusion, Optic disc size, Optical Coherence Tomography, Pathogenesis and Glaucoma*

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Optic disc size is an important parameter in pathogenesis of optic nerve diseases. Large optic disc size has been reported in normal-tension glaucoma, optic pit, and morning glory syndrome. Small optic disc has been reported in the two classic diseases of nonarteritic anterior ischemic optic neuropathy (NAION)[1-4] and optic disc drusen (ODD)[5,6]. In NAION, small optic disc size or "disc at risk" predisposes to compartment syndrome of the blood supply to the optic disc. In ODD, the small scleral canal compresses optic nerve fibers, retinal ganglion cells damage, leading to calcified hyaline deposits anterior to lamina cribosa[5].

However, by using a technology of optical coherence tomography (OCT), conflicting outcomes to the previous studies have been determined. Contreras et al[7] reported that the optic disc area and vertical disc diameter of NAION-affected eyes, and fellow eyes were not significantly different to controls. Floyd et al[8] reported that ODD-affected eyes, ODD-fellow eyes, and their first-degree relatives had a larger optic disc size than controls. Those outcomes may change the explanation of pathogenesis of the diseases.

OCT, a retina imaging device, has been widely used in clinical research. It determines the morphologic measurement of the optic disc and retinal nerve fiber layer. Optic disc diameter is automatically determined by the termination of retinal pigment epithelium and Bruch's membrane. Six axes of 0°, 30°, 60°, 90°, 120°, and 150° of the disc diameters are interpolated to be disc area (Fig. 1).

Regarding to central retinal vein occlusion (CRVO), Mansour et al[9] proposed that small disc might be the risk of the disease. However they found that horizontal optic disc diameter was not different among CRVO, CRVO fellow eye, and control subjects. Beaver Dam Eye Study reported that optic disc size was not related to CRVO occurrence, neither[10].

Despite the reports of Mansour and Beaver Dam Eye Study, we speculated that the optic disc might be smaller in some particular axis which never been

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studied and lead to constriction of the retinal vein. Central retinal vessels trunk is usually located in the superonasal part of lamina cribosa. We, thus, speculated that the axis of superonasal (axes 30° and 60°, right eye orientation) was constrict in CRVO eye, and would be the risk of the vein occlusion. By using OCT, we could investigate whether or not the particular axis of the optic disc was smaller than control subjects.

Material and Method

The present report is a companion article of "Central Corneal Thickness in the Central Retinal Vein Occlusion Fellow Eye". The study design was described elsewhere[11]. In brief, it was a prospective analytic study of the optic disc diameter between CRVO fellow eyes and healthy controls. Institute review board approved the protocol to study. Informed consent was read and signed by all participants.

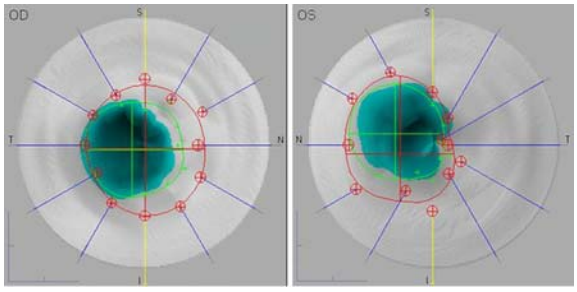

Fig. 1 Fast optic disc scanned by Stratus OCT. Optic disc diameter is determined by the termination of retinal pigment epithelium and Bruch's membrane (the 12 small red target circles). Six axes of 0°, 30°, 60°, 90°, 120° and 150° of the disc diameters are connected to create a disc area (the red circle)

Ninety-seven CRVO fellow eyes and one hundred-twelve controls underwent complete ocular examination, including slit-lamp examination, autorefraction, intraocular pressure measurement, gonioscopy and dilated ophthalmoscopy. Humphrey visual field test would be tested if glaucoma was suspected. Fast optic disc was scanned with Stratus OCT (Carl Zeiss Meditec Inc, Dublin, California, USA).

We excluded 19 eyes of CRVO fellow eye and 10 eyes of the control, because the signal strength of vertical disc diameter was less than 6 (as the manufacture recommended). Data was recorded and analyzed with SPSS 17.0 (SPSS Inc, Chicago, IL). Descriptive statistics: number, percent, mean $\pm$ standard deviation (SD) were used for demographic data and baseline characteristics. Student t-test and Chi-square test were applied for analysis. Significant difference was set at $p < 0.05$.

Results

Total numbers of 78 eyes of CRVO fellow eye and 102 controls were analyzed. Glaucoma was diagnosed in 19 of 78 eyes (24.4%) of CRVO fellow eye. Baseline characteristic of CRVO fellow eye subjects and controls are shown in Table 1. Mean age of CRVO fellow eye was older than the control ($p < 0.001$). Male, systemic diseases (diabetes, hypertension), smokers and glaucoma were predominated in the study group ($p < 0.05$). There were the exception for ischemic heart disease and aspirin usage that were not different between the groups ($p = 0.083$ and 0.070, respectively). Mean 6 axes of optic disc diameters were not different between the groups. in either models of inclusion or exclusion of glaucoma ($p > 0.05$),as shown in Table 2.

Table 1. Demographic data and baseline characteristic of CRVO-fellow eye subjects and controls

	CRVO-fellow eye (n = 78)	Controls (n = 102)	p-value
Age [Mean (years) $\pm$ SD]	59.39 $\pm$ 10.70	46.10 $\pm$ 5.58	<0.001*
Sex: Male (%)	40 (51.3%)	28 (27.5%)	0.001*
Diabetic mellitus	27 (34.6%)	0	<0.001*
Hypertension	13 (16.7%)	2 (1.9%)	<0.001*
Ischemic heart disease	3 (3.8%)	0	0.083
Smoking	8 (10.3%)	0	0.004*
Aspirin	5 (6.4%)	1 (0.9%)	0.070
Glaucoma	19 (24.4%)	0	<0.001*

Values are represented as means $\pm$ SD and n (%)
* significant at $p < 0.05$
CRVO = Central retinal vein occlusion

Cup-to-disc ratios in CRVO fellow eyes were significantly larger than in the controls ($p < 0.05$). In addition, we analyzed the optic disc parameters using the model excluded 19 glaucoma patients within the study group (n = 59). Optic disc diameters, optic disc area and cup area were not significantly different ($p > 0.05$), as shown in Table 3.

Discussion

CRVO is multifactorial disease. Pathogenesis of CRVO relates to the compartment syndrome of the central retinal vessels. Extra-luminal and intra-luminal factors of CRV can be the causes of CRVO. Thrombophilic from underlying of diabetes and hypertension relate to CRVO as an intra-luminal cause, and glaucoma may indicate the extra-luminal cause of CRVO[12-15].

Optic disc area and diameter appear to be within normal range in CRVO fellow eyes. The present study was aimed to elucidate the details of the 6 axes of disc diameters, which automatically determined by OCT. There is no specific axis is smaller than controls. Glaucoma is common in the present study (24.0%). In addition, we had analyzed the disc area and diameters in the model excluding 19 glaucoma patients. Still, the optic disc size was not different to the controls. Large cup-to-disc ratio by glaucoma is common in the study.

The mechanism of association between CRVO

Table 2. Comparative optic disc area and diameters of CRVO-fellow eye subjects and controls

Optic disc parameters	Total		p-value	Excluded case with glaucoma		p-value
	CRVO-fellow eye (n = 78)	Controls (n = 102)		CRVO-fellow eye (n = 59)	Controls (n = 102)	
Disc area (mm^2)	2.54 ± 0.46	2.55 ± 0.51	0.883	2.47 ± 0.37	2.55 ± 0.51	0.289
Disc diameter (mm)						
Horizontal (0°)	1.63 ± 0.24	1.65 ± 0.24	0.587	1.60 ± 0.22	1.65 ± 0.24	0.123
Axis 30°	1.69 ± 0.28	1.71 ± 0.36	0.666	1.66 ± 0.28	1.71 ± 0.36	0.264
Axis 60°	1.78 ± 0.49	1.89 ± 0.29	0.069	1.78 ± 0.48	1.89 ± 0.29	0.128
Vertical (90°)	1.97 ± 0.43	1.94 ± 0.37	0.597	2.00 ± 0.39	1.94 ± 0.37	0.338
Axis 120°	1.80 ± 0.40	1.85 ± 0.32	0.306	1.74 ± 0.40	1.85 ± 0.32	0.069
Axis 150°	1.66 ± 0.23	1.70 ± 0.23	0.288	1.64 ± 0.20	1.70 ± 0.22	0.099

Values are represented as means ± SD * Significant at $p < 0.05$
CRVO = Central retinal vein occlusion

Table 3. Comparative optic disc configuration of CRVO-fellow eye subjects and controls

Optic disc parameters	Total		p-value	Excluded case with glaucoma		p-value
	CRVO-fellow eye (n = 78)	Controls (n = 102)		CRVO-fellow eye (n = 59)	Controls (n = 102)	
Disc area (mm^2)	2.54 ± 0.46	2.55 ± 0.51	0.883	2.47 ± 0.37	2.55 ± 0.51	0.289
Cup area (mm^2)	1.06 ± 0.69	0.81 ± 0.51	0.010*	0.85 ± 0.49	0.81 ± 0.51	0.641
Rim area (mm^2)	1.51 ± 0.58	1.73 ± 0.49	0.006*	1.64 ± 0.53	1.73 ± 0.49	0.267
Cup/disc area	0.40 ± 0.23	0.31 ± 0.16	0.004*	0.34 ± 0.15	0.31 ± 0.16	0.321
Cup/disc (horizontal)	0.64 ± 0.18	0.58 ± 0.17	0.013*	0.60 ± 0.15	0.58 ± 0.17	0.416
Cup/disc (vertical)	0.57 ± 0.18	0.50 ± 0.14	0.006*	0.53 ± 0.16	0.50 ± 0.14	0.339

Values are represented as means ± SD * Significant at $p < 0.05$
CRVO = Central retinal vein occlusion

and glaucoma is unclear. In Beaver Dam Eye Study, an incident CRVO increased 29.0 % for each 0.1 increment in cup-to-disc ratio[10]. The common mechanism may be related to lamina cribosa (LC) compression. LC is displaced backward by increased IOP, and it will compress and collapse the retinal vein, and will lead tosssssssss subsequent intimal proliferation; then CRVO occurs[16-18].

There are some surgical treatments to relieve the compression of CRV, such as optic nerve sheath decompression[19] and lamina puncture[20] or radial optic neurotomy (RON)[21-23]. RON is to cut the lamina of ONH for relaxing the peri-vascular constriction of CRV. CRV is usually located in the superonasal of LC, it is thought that cutting LC at nasal part could be the most effective. However, both procedures are still controversy for CRVO management. The present study outcome does not indicate the specific part of the optic disc for the procedures.

Limitations of the present study included baseline characters between the groups are not matched. CRVO fellow eye group are 15-year older than controls. Male is more prevalent in the study group than controls. Underlying diseases in the study group are higher. In such asymmetry disease, CRVO fellow eye may not indicate the CRVO eye.

In conclusion, by using OCT determined the optic disc configuration, no specific axis diameter is small. Pathogenesis of CRVO appears not relate to the optic disc size. In addition, glaucoma is common in CRVO fellow eye, clinician should be aware of glaucoma management for such patients.

Potential conflicts of interest

None.

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ขนาดของขั้วประสาทตาในตาอีกข้างหนึ่งของผู้ป่วยหลอดเลือดดำอุดตันในตา วัดด้วยเครื่อง optical coherence tomography (OCT)

บุญส่ง วนิชเวชารุ่งเรือง, พรพิมล จักสถาพร, กนกวรรณ ยุตติธรรม, สุเมธ วาณิชวรานนท์, กิติพงษ์ หาญเจริญ

วัตถุประสงค์*: เพื่อศึกษาขนาดและความกว้างของ 6 แกนของขั้วประสาทตาในตาอีกข้างหนึ่ง (fellow eye) ของผู้ที่เป็นโรคหลอดเลือดดำอุดตันในตา*

วัสดุและวิธีการ*: เป็นการวัดค่าดังกล่าวด้วยการใช้ OCT ใน 78 ตาของกลุ่มศึกษาเทียบกับ 102 ตา ของกลุ่มควบคุมที่เป็นปกติ*

ผลการศึกษา*: ไม่มีความแตกต่างกันของขนาดและความกว้างของขั้วประสาทตาในระหว่างกลุ่ม อีกทั้งการวิเคราะห์โดยคัดผู้ที่เป็นต้อหินออกไปแล้ว จำนวนที่เหลือ 59 ราย ก็พบว่ายังไม่มีความแตกต่างเช่นเดียวกัน*

สรุป*: การศึกษานี้พบว่าขนาดของขั้วประสาทตาไม่มีความแตกต่างกันระหว่างกลุ่ม ซึ่งอาจจะบ่งบอกว่าขนาดของขั้วประสาทตาไม่มีผลต่อการเกิดโรคหลอดเลือดดำอุดตันในตา*