e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(12); 357-364

Original Research Article

Significance of Axial Length in Retinal Venous Occlusions

Kondam Swetha[1], K. Bharathi[2], Y. Rajarajeshwari[3]

[1]Assistant Professor, Department of Ophthalmology, Government Medical College, Mahabubnagar District, Telangana State

[2]Senior Resident, Department of Ophthalmology, Government Medical College, Mahabubnagar District, Telangana State

[3]Senior Resident, Department of Ophthalmology, Government Medical College, Mahabubnagar District, Telangana State

Received: 05-11-2023 Revised: 25-11-2023 / Accepted: 15-12-2023

Corresponding author: Dr. Kondam Swetha

Conflict of interest: Nil

Abstract

Introduction: Association between hyperopic refractive error and retinal venous occlusion has been demonstrated. In most of the studies, hyperopia was measured in terms of refractive errors.

Aims: Present study is conducted to know whether any significance of axial length is there in retinal vein occlusions.

Materials and Methods: This is a prospective, case control study in Patients attending Ophthalmology department, diagnosed as CRVO/ BRVO. 60 patients [30 CRVO patients and 30 BRVO patients] diagnosed as CRVO or BRVO in 24 months were included in the study.

Results: The mean axial length of affected eyes of CRVO patients is 22.16mm [SD 0.98] that of unaffected eyes is 22.44mm [SD 0.87]. The p-value is 0.0002. The difference between the 2 groups is statistically significant the mean axial length of right eye of the control group is 23.03 mm [SD 0.76]. The mean axial length of affected eyes of CRVO patients is 22.16mm [SD 0.98]. The p-value is 0.0004. The difference between in the CRVO affected eye and the control group is statistically significant. The mean axial length of affected eyes of BRVO patients is 22.49mm [SD 0.70] that of unaffected eyes is 22.63mm [SD 0.73]. The p-value is 0.0661. The difference between the 2 groups is not statistically significant. The mean axial length of right eye of the control group is 23.03 mm [SD 0.76]. The mean axial length of affected eyes of BRVO patients is22.49mm [SD 0.70]. The p-value is 0.0063. The difference between in the BRVO affected eye and the control group is statistically significant. The present study demonstrates that significantly shorter axial lengths in the CRVO and BRVO affected eyes than the control eyes.

Conclusions: It is concluded that shorter axial length could be an additional risk factor in the pathogenesis of CRVO and BRVO. The reason could be in eyes with shorter axial lengths, the retinal vein and artery are more tightly confined as they pass through the lamina cribrosa, which may impair blood flow in the vein.

Keywords: Central retinal vein obstruction [CRVO], Branch retinal vein obstruction [BRVO], axial length and Lamina cribrosa.

Introduction

Venous obstructive disease of the retina is a common retinal vascular disorder, second only to diabetic retinopathy in incidence. [1] Incidence of CRVO is 0.8 per 1000 persons and 4.4 per 1000 persons for BRVO in general population. The estimated prevalence of RVO was 0.52%, BRVO was 0.442% and CRVO was 0.08% [2].

RVO most commonly affects the venous blood supply of entire retina [CRVO] or a quadrant drained by one of the branches [BRVO] less commonly superior or inferior half of retina alone is affected. [HRVO] Central retinal vein obstruction [CRVO] and branch retinal vein obstruction [BRVO] differ with respect to pathophysiology, underlying systemic associations, average age of onset, clinical course and therapy. [3]

CRVO most commonly occurs in the elderly usually above 50 years [4,5].Many systemic and local factors that contribute to the thrombus formation can predispose to the development of central retinal vein occlusion, including hypertension, diabetes mellitus, hyperviscosity, hyperlipidemia, POAG and hyperopia[6,7].Branch retinal vein occlusions occur three times more common than central retinal vein occlusion. Men and women affected equally, usual age of onset is 60- 70 years [3]. BRVO almost always occur at an arterio-venous crossing, where the artery and vein share a common adventitial sheath [3, 8]. Most BRVO's occur Superotemporally, probably due to the highest concentration of arteriovenous crossings lied there [9, 10]. Most common risk factors associated with BRVO are systemic hypertension, diabetes, hyperlipidemia, glaucoma, smoking and age related atherosclerosis. Antiphospholipid antibodies, elevated plasma homocysteine levels and low serum folate levels have been associated with increased risk of vein occlusion. [11, 12, 13]

Role of axial length and refractive status in RVO

The association between hyperopic refractive error and retinal venous occlusion has been demonstrated [7, 14-17]. In most of the studies, hyperopia was measured in terms of refractive errors. As age related lens changes may interfere with refractive error, recent studies have focused on the relation of axial length as a measurement of hyperopia with retinal venous occlusion [18-21]. Axial hypermetropia may be predisposed to greater crowding of the central retinal artery and central retinal vein at lamina cribrosa, more likely to develop central retinal vein occlusion [20]. Some studies have suggested an increased risk of BRVO in eyes with shorter axial lengths [20-25]. At present the efforts to improve visual acuity in central vein occlusion and branch retinal vein occlusion have been disappointing and a better understanding of various predisposing factors and patho-physiology of retinal vein occlusions assumes a lot of importance in the development of newer treatment modalities [26]. Present study is conducted to know whether any significance of axial length is there in retinal vein occlusions.

Patients and Methods

This is a prospective, case control study in Patients attending Department of Ophthalmology at Government General Hospital, Mahaboobnagarand diagnosed as CRVO / BRVO are included in the study.60 patients, [30 CRVO patients and 30 BRVO patients]diagnosed as CRVO or BRVO in24 months [December 2019 to November 2021] were included in the study.

Inclusion Criteria

Cases attending or referred to Department of Ophthalmology at Government General Hospital, Mahaboobnagarand diagnosed as CRVO / BRVO are included.

Exclusion Criteria

Any history of previous ocular trauma or previous ocular surgery.

Control Group

30 patients attending Government General Hospital, Mahaboobnagarwith early cataracts with visible fundus details who are matched with the cases in relation to age, sex, HTN, diabetes status, without any retinal vein occlusions and without any history of previous ocular trauma or previous ocular surgery were included. Patients with early cataracts without any RVO chosen as control group because there is no known or suspected association between axial length and cataracts. Therefore the choice of control group should not confound examination of the relationship between axial length and retinal vein occlusion in any way.The control group in most reported studies of axial length in retinal vein occlusion consists of cataract patients without RVO.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of Government Medical College, Mahabubnagar.Informed consent was obtained from patients andcontrols.

Examination and Statistical Analysis

A complete ophthalmic examination of all patients was done including visual acuity, anterior segment evaluation by slitlampbiomicroscopy, post dilated examination of fundus using indirect ophthlamoloscopy. Fundus fluorescein angiography was done as and when required.

Every patient who was included in the study was subjected to axial length measurement of both the eyes using A-Scan ultrasonography by using contact method. Post dilated AR readings were taken using Auto refractometer. Every patient who was included in the study group was subjected to investigations like blood pressure, random blood sugar levels, complete blood picture, ESR, lipid profile, cardiac evaluation. [2 dimensional echo cardiography and carotid doppler].

The axial lengths of right eyes of the control group were taken using A-scan ultrasonography by using contact method in the same manner of cases. The A-Scan machine is well calibrated periodically. The measurements of both cases and controls taken by a single person. The data thus collected was analyzed. The axial lengths of patients affected and unaffected eyes compared using paired T-test.

The axial lengths of the patients and that of the controls compared by using unpaired T-test. Thus mean of the axial lengths and standard deviation and standard error of mean was calculated by using a computer software, p-value is drawn, p-value is set <0.005 for statistical significance. The means were given with their standard error (SEM) and difference between the two means were compared within the 95% confidence interval.

Results

The total number of patients included in the study group are 60.

These patients are divided into two groups.

1. 30 cases central retinal vein occlusion
2. 30 cases branch retinal vein occlusion

Control group includes 30 patients attending Department of Ophthalmology in Government General Hospital, Mahaboobnagarwith early cataracts who are matched with the cases in relation to age, sex, hypertension, diabetes mellitus status and without any Retinal vein occlusions and without any previous ocular trauma or surgery are included. Our study included 22 males and 8 females in central retinal vein occlusion group and 15 males and 15 females in branch retinal vein occlusion group. 16 males and 14 females in control group.

Table 1: Distribution of age group in the study population

Age group	No. of patients of CRVO	Percentage	No. of patients of BRVO	Percentage	No. of controls
20-25	1	3.3%	-	-	1
26-30	1	3.3%	-	-	1
31-35	-	-	2	6.66%	1
36-40	2	6.66%	3	10%	3
41-45	2	6.66%	5	16.66%	3
46-50	2	6.66%	1	3.3%	2
51-55	6	20%	6	20%	3
56-60	5	16.66%	9	30%	7
61-65	4	13.33%	2	6.66%	4
66-70	4	13.33%	1	3.3%	2
71-75	-	-	1	3.3%	2
76-80	2	6.66%	-	-	-
81-85	1	3.3%	-	-	1
Total	30		30		30

In our study group of CRVO >73.31% are above 50 years with a mean age of 53.94 years. Their ages ranged from 24 to 81 years.

Table 2: Distribution of gender group in the study population

Type of RVO	Males	Percentage	Females	Percentage	Total
CRVO	22	73%	8	27%	30
BRVO	15	50%	15	50%	30
No of controls	16	53.33%	14	46.66%	30

Out of 30 patients 22 are men and 8 are women.

Table 3: Distribution of axial length in the study population

Axial length range in mm	CRVO affected eye		CRVO fellow eye		BRVO affected eye		BRVO fellow eye	
	RE	LE	RE	LE	RE	LE	RE	LE
19.00- 19.99	0	1	0	0	0	0	0	0
20.00- 20.99	1	0	1	1	0	1	0	0
21.00- 21.99	4	7	5	2	2	2	3	3
22.00- 22.99	4	8	8	5	14	5	5	11
23.00- 23.99	3	1	3	4	4	2	1	5
24.00- 24.99	1	0	0	1	0	0	1	1

Table 4: Distribution of axial length in the study population of CRVO

Range of axial length in mm	19.00 to 19.99	20.00 to 20.99	21.00 to 21.99	22.00 to 22.99	23.00 to 23.99	24.00 to 24.99
CRVO affected eye	1	1	11	12	4	1
CRVO unaffected eye	0	2	7	11	7	1
Control right eye	0	0	4	8	16	2

The mean axial length of right eye of the control group is 23.03 mm [SD 0.76] the mean axial length of the affected eye of CRVO is 22.16mm [SD 0.98]. 95% of confidence interval is -1.33 to -0.41. The p-value is 0.0004.The difference between CRVO affected eye and control group is statistically significant.

Table 5: Distribution of axial length in the study population of BRVO

Range of axial length in mm	19.00 to 19.99	20.00 to 20.99	21.00 to 21.99	22.00 to 22.99	23.00 to 23.99	24.00 to 24.99
BRVO affected eye	0	1	4	19	6	0
BRVO unaffected eye	0	0	6	16	6	2
Control right eye	0	0	4	8	16	2

The mean axial length of the BRVO group affected eye is 22.49mm [SD 0.70] [SEM 0.12], the range is 20.95mm to 23.90mm. The mean axial length of the unaffected eye was 22.63mm [SD 0.73] [SEM 0.13], and range is [21.14mm to 24.28mm], the p-value is 0.0661. The difference between the 2 groups is not statistically significant.

Table 6: Laterality of the affected eye in CRVO group

Affected eye in CRVO	
RE	13
LE	16
BE	1
Affected eye in BRVO	
RE	19
LE	10
BE	1
Territory in BRVO	
Superiotemporal	12
Inferiotemporal	18

Most of the patients affected uniocularly 13 patients affected in the right eye [43.33%], 16 patients affected in left eye [53.33%] one patient affected in both eyes [3.33%].

Table 7: Distribution of other risk factors in study population

Risk factors	CRVO	BRVO	Control group
Hypertension	6	15	6
Diabetes mellitus	5	2	2
HTN+DM	7	2	3
Hyperlipidemia	2	1	-
HTN+DM+ Cardiac disease	2	-	-
Cardiac disease	1	1	1
Glaucoma	3	1	1

In CRVO group 6 patients had hypertension [20%] 7 patients had diabetes mellitus and hypertension [23.33%]. In BRVO group 15 patients had hypertension [50%] 2 patients had diabetes mellitus and hypertension [6.66%].

Discussion

In our study we did not group CRVO and BRVO together because the sites of blockage in each are anatomically different. They differ with respect to pathophysiology, underlying systemic associations, average age of onset, clinical course and therapy. [3].

CRVO most commonly occurs in elderly usually above 50 years. Hayreh et al [6] have observed that the most prevalent ages for CRVO development are 65 years and older, and it is more common in men than in women, and more predominant in right eye than in left. [4, 5]. However BRVO is more common in women. Gutman [7], reported that 90% of retinal vein obstructions occur in the 50 year age group or older. In our study group of CRVO >73.31% are above 50 years with a mean age of 53.94 years. Their ages ranged from 24 to 81 years. Out of 30 patients 22 are men and 8 are women. Most of the patients affected uniocularly 13 patients affected in the right eye [43.33%], 16 patients affected in left eye [53.33%] one patient affected in both eyes [3.33%]. BRVO's occur 3 times more common than CRVO's, men and women affected equally, usual age of onset is 60-70 years. [3]. in our study group of BRVO >62.72% are above 50 years of age. Their ages ranged from 32 years to 72 years with a mean age of 52.56 years. Out of 30 patients 15 are women and 15 are men. Most of the patients affected uniocularly, 19 patients affected in the right eye [63.33%] and 10 patients affected in the left eye. [33.33%] and 1 patient affected in both eyes. [3.33%].

In the study group of BRVO out of 30 patients, 12 patients affected in the superotemporal region [40%] ,18 patients affected in the inferiotemporal region [60%].As mentioned earlier there are so many risk factors for RVO, including hypertension, diabetes mellitus, arteriosclerosis, primary open angle glaucoma, hyperlipidemia, hyperviscosity, increase in fibrinogen and coagulation factors and deficiencies in protein C and S, hyperopiaand some studies have suggested an increased risk of RVO's in eyes with short axial length.

Previous studies have shown systemic hypertension to be a risk factor for both CRVO and BRVO [30]. Our study also demonstrated a similar trend. In CRVO group 6 patients had hypertension [20%] 7 patients had diabetes mellitus and hypertension [23.33%]. In BRVO group 15 patients had hypertension [50%] 2 patients had diabetes mellitus and hypertension [6.66%]. In previous studies where retinal circulation is evaluated by using rheology, the science of deformation and flow of matter, it was observed that retina and choroid have relatively high blood flow rate for their tissue mass. Also retinal vein in the arteriovenous junctions and in the scleral canal can be compressed by arteries and lamina cribrosa respectively. This way retinal vascular structures are different from other vascular structures. Further high metabolic requirements of the retina are prone to the effects of blood flow changes. The pathogenesis of thrombus formation is a multifactorial process. In a histopathological evaluation of eyes affected with CRVO, a thrombus was demonstrated at or near the lamina cribrosa. There are some anatomical factors predisposing to this localization including the common adventitial sheath that surrounds CRV and CRA within the optic nerve. The sieve like structure of the lamina cribrosa which is formed from interweaving fascicles of collagen bundles with no elasticity restricts the expansion of vessels passing through it. There is an increased prevalence of arteriosclerotic diseases in patients with CRVO. The arteriosclerotic changes affect the media and intima and the involved arteries become more rigid with narrowed lumen and scleral canal. Green [31, 32] and coworkers were able to demonstrate histopathologically a thrombus in the CRV at or near the lamina cribrosa in each of 29 enucleated eyes with CRVO. They hypothesized that within the lamina cribrosa, the vessel is in close proximity to the central retinal artery and a thickened artery in this region can impinge upon the vein and lead to turbulent blood flow in that vein with subsequent endothelial damage, platelet aggregation and thrombus formation.

BRVO has a better visual outcome than CRVO. According to anatomical, Histopathological and fundus fluorescein angiography studies BRVO generally occurs at arteriovenous junctions. Arteries and vein share common adventitial sheath at these sites. Frangieh [33] et al Histopathological study observed that in BRVO venous thrombosis is secondary to capillary and arterial changes.

Arteriosclerosis causes stenosis of both the artery and vein decreasing the arterial perfusion pressure which leads to venous stasis. The changes in the vessel endothelium cause platelet aggregation and that leads to thrombus formation.

Previous Studies did not find that the frequency of diabetes was significantly increased in patients with RVO compared to normal subjects. Five patients of CRVO group [16%] and two patients of BRVO group [6%] had diabetes mellitus. The results of our study were consistent with previous studies of CRVO and BRVO.

It has been reported POAG or elevated IOP is significant for RVO in some studies but not in others. The reason for these conflicting results is not clear but possibly arises from the methodologic differences in the selection of control groups. It is not evaluated in present study. Other possible systemic risk factors such as hyperlipidemia, blood hyperviscosity, increase in erythrocyte aggregation and coagulation factors are not evaluated in our study.

It has been reported that incidence of hypermetropia is higher in CRVO and BRVO than in the normal population. In axial hypermetropia the ocular axial length is short, the scleral canal is smaller and the lamina cribrosa fenestrations are narrow. This creates crowding at the optic nerve fibres and CRV and CRA in the optic canal. In our study group of CRVO, the mean axial length of the affected eye is 22.16mm [SD 0.98] [SEM is 0.17 mm] and the range is 19.89mm to 24.38mm. The mean axial length of unaffected eye is 22.44mm [SD 0.87] standard error of mean [SEM is 0.16] and the range is 20.15 mm to 24.12 mm. p-value is 0.0002 the difference is between the two groups is statistically significant.

The mean axial length of right eye of the control group is 23.03 mm [SD 0.76] the mean axial length of the affected eye of CRVO is 22.16mm [SD 0.98]. 95% of confidence interval is -1.33 to -0.41. The p-value is 0.0004.The difference between CRVO affected eye and control group is statistically significant.The mean axial length of the BRVO group affected eye is 22.49mm [SD 0.70] [SEM 0.12], the range is 20.95mm to 23.90mm. The mean axial length of the unaffected eye was

22.63mm [SD 0.73] [SEM 0.13], and range is [21.14mm to 24.28mm], the p-value is 0.0661. The difference between the 2 groups is not statistically significant.

The mean axial length of right eye of the control group is 23.03 mm [SD 0.76] and the mean axial length of the affected eye of BRVO group is 22.49 mm [SD 0.12] 95% confidence interval of this group is -0.932 to -.016.p-value is 0.0063.The difference between BRVO affected eye and control group is statistically significant.

The fact that BRVO generally occurs at the AV crossings has been known since Leber, [27] first observed and suggested the vulnerability of arteriovenous crossing in BRVO. It was indicated later by Gass [28] that a common adventitial sheath between a branch retinal artery and vein at the AV crossing was an important contributing factor in BRVO.

Klein [29] also suggested that local anatomical factors such as multiple AV crossings in the presence of systemic factors including hypertension or diabetes to increase the possibility of BRVO. The narrowing of the venous lumen at the crossings established as well. This is probably due to the mechanical compression of overlying hypertensive arteriosclerotic artery. The subsequent narrowing of the venous lumen lead to turbulence, reduced flow and venous stasis, which may result in thrombus formation.

Although the association of hyperopia with increased risk of BRVO has been well- established, the exact role of shorter axial length as measure of hypermetropia in BRVO is not clear.

It is possible that in a shorter eye the retinal vein and artery are more tightly confined as they pass through the lamina cribrosa and this may impair the flow in the vein which could be reduced further at the arteriovenous crossing. Reduced blood flow may eventually cause thrombus formation at the crossing. Another explanation might be smaller caliber vessels in hyperopic eyes than in the myopic eyes that may predispose to venous occlusion in a complex manner.

In a study conducted by Nursen Ariturk et al [20] showed relation between retinal vein occlusions and axial lengths. Ocular axial lengths were measured by A-Scan ultrasonography in 17 patients with CRVO and 41 patients with BRVO and compared with those of contralateral unaffected eyes and 66 age matched controls.

In the CRVO group the mean axial length of involved eyes was 22.25mm [SD 0.19] the mean axial length of uninvolved eyes was 22.61 mm [SD 0.13] p-value was s <0.05. The difference was statistically significant [mean difference was 0.36mm] 95% confidence interval -0.62; -0.09.The mean axial length of control group was 23.22 mm [SD 0.09]. The mean axial length of affected eye of CRVO group was 22.25 mm [SD 0.19]. The mean difference between the affected eye of CRVO and the control eyes [0.97mm] was also statistically significant. [p-value<0.001] 95% CI -1.26;-0.40].

In the BRVO group the mean axial length of involved eyes was 22.89 mm [SD 0.11] the mean axial length of uninvolved eyes was 22.99 mm [SD 0.12] p-value was >0.05. The difference was not statistically significant [mean difference was 0.14 mm] the mean axial length of control group was 23.22 mm [SD 0.09]. The mean axial length of affected eye of BRVO group was 22.89 mm [SD 0.11]. The mean difference between the affected eye of BRVO and the control eyes [0.33mm] was statistically significant. [p-value<0.05] 95% CI -0.63;-0.04]. The results ae correlating with results of present study.

In a study conducted by Osman Cekic et al, [23] on the role of axial length in central and branch retinal vein occlusion. The axial lengths of affected and fellow eyes of 19 patients with CRVO and 27 with BRVO and of their controls were measured with A-Scan ultrasonography. The control group consisted of 17 individuals for CRVO and 25 for BRVO matched in age, sex and the prevalence of hypertension and diabetes. The results of measurements in affected, unaffected and control eyes were compared.

The mean axial length of CRVO affected eyes was 22.36mm [SD 0.87]. The mean axial length of CRVO unaffected eyes was 22.98mm [SD 0.96]. The mean axial lengths of control eyes was 23.31mm [SD 0.73]. p-value is <0.05. The difference between the two groups was statistically significant.

In mean axial lengths of BRVO affected eyes was 22.89mm [SD 0.70]. The mean axial length of BRVO unaffected eyes was 23.02mm [SD 0.84]. The mean axial length of control eyes was 23.26 mm [SD 0.91]. p-value is >0.05. The difference was not statistically significant. In BRVO group, the mean axial length did not differ among affected, unaffected and control eyes (p>0.05).The fact that the role of a shorter axial length in the development of CRVO and BRVO may vary in accordance with degree of shortness could be due to the anatomically different sites of blockage and relatively different etiological and systemic factors. The results of CRVO group are correlating with the present study and that of BRVO group are not correlating with the present study.

In a study conducted by San-Chang Tsai, Hsin-YiChen, and Chiu-Ying Chen [24] on Relation between Retinal Vein Occlusion and Axial Length, the study group consisted of 40 patients with unilateral CRVO and 77 patients with unilateral BRVO. The control group included 67 individuals who matched the study group patients in age, systemic hypertension and diabetes mellitus status. The axial lengths of affected and fellow eyes of patients and controls were measured using A-scan ultrasonography.

In the CRVO group the mean axial length of affected eyes was 23.22mm [SD 1.14].The mean axial length of unaffected eyes was 23.48mm [SD 1.01]. p value=0.05. The difference between two groups was not statistically significant mean axial length of control eyes was 23.98mm [SD 0.84]. The mean axial length of affected of CRVO group was 23.22 mm [SD 1.14]. p-value is <0.05. The difference between the two groups was statistically significant.

In the BRVO group the mean axial length of affected eyes was 23.13mm [SD 0.86].The mean axial length of unaffected eyes was 23.32mm [SD 1.02]. p value<0.05. The difference was statistically significant. The mean axial length of control eyes was 23.98mm [SD 0.84]. The mean axial length of affected of BRVO group was 23.13 mm [SD 0.86] p-value is <0.05. The difference was statistically significant.

The results of BRVO group are correlating with the present study. The results of CRVO affected and unaffected eyes are not correlating with the present study. The results of CRVO affected and control eyes are correlating with the present study. There is inconsistency in the results of different studies. This may be partly attributed to the different demographic characteristics of the patients with BRVO and CRVO and normal subjects, and partly to the use of different statistical methods for comparison among studies. In addition statistical methods vary depending on the sample size and study design. However there is general agreement among most of these studies including present one that axial lengths of eyes with either CRVO or BRVO are generally shorter than those of eyes in control subjects.

The exact role of shorter axial length in the development of retinal vein occlusion is also unknown. It is possible that in eyes with shorter axial length the retinal vein and artery are more tightly confined as they pass through the lamina cribrosa, which may impair blood flow in the vein. The flow could be reduced further at the level of the arteriovenous crossing. When the blood flow decreases, viscosity increases as a result of erythrocyte aggregation. Reduced blood flow at these two levels, in conjunction with increased blood viscosity and turbulence in the narrowed lumen of the vein, could cause thrombosis.

Conclusions

The retinal vein occlusions are more common in elderly population with mean age of CRVO group is 53.94 years and that of BRVO group is 52.56 years. CRVO is more common in males (22) than in females (8). But equal in both males (15) and females (15) in BRVO.

There is increased prevalence of hypertension patients with RVO. There is no increased prevalence of Diabetes Mellitus in patients RVO.

It is concluded that shorter axial length could be an additional risk factor in the pathogenesis of CRVO and BRVO. The reason could be in eyes with shorter axial lengths, the retinal vein and artery are more tightly confined as they pass through the lamina cribrosa, which may impair blood flow in the vein. The flow could be reduced further at the level of AV crossings. When the blood flow decreases viscosity increases as a result of erythrocyte aggregation. Reduced blood flow at these two levels, in conjunction with increased blood viscosity and turbulence in the narrowed lumen of the vein, could cause thrombosis which could lead to retinal vein occlusion.

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