Original Article

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Assessment of Serum Atherogenic Indices and Insulin Resistance in Retinal Vein Occlusion

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Abstract

Objectives: This study aimed to investigate serum atherogenic indices as novel cardiovascular risk factors associated with retinal vein occlusion (RVO).

Materials and Methods: This retrospective case-control study included 57 patients with newly diagnosed RVO whose plasma lipid profile (low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], total cholesterol [TC], and triglycerides [TG]) and insulin resistance were examined. Serum atherogenic indices (LDL-C/HDL-C, TC/HDL-C, TG/HDL-C, and non-HDL-C/HDL-C ratios) and presence of insulin resistance were compared between the patients and 63 healthy subjects. Cut-off values were determined by receiver operating characteristic curve analysis.

Results: The mean age of the RVO patients was 63.7±9.4 years. Plasma levels of LDL-C, HDL-C, TC, and TG showed no significant difference between the patient and control groups (p>0.05). However, LDL-C/HDL-C, non-HDL-C/HDL-C, and TC/HDL-C ratios were higher in the RVO group compared to healthy subjects (p=0.015, p=0.036, and p=0.015, respectively). Fasting insulin concentrations, plasma insulin, and homeostasis model assessment of insulin resistance (HOMA-IR) index were higher in the RVO patients compared to controls (p=0.003, p=0.001, and p=0.001, respectively).

Conclusion: LDL-C/HDL-C, TC/HDL-C, and non-HDL-C/HDL-C ratios were found to be increased in RVO. Compared to the traditional plasma lipid profile, serum atherogenic indices were found to be superior predictors of RVO development. Measurement of HOMA-IR index should be taken into consideration in the evaluation of insulin resistance. High serum atherogenic indexes in RVO patients reveal the need to take precautions against the risk of cardiovascular disease and stroke.

Keywords: Retinal vein occlusion, serum atherogenic index, serum lipid profile, insulin resistance, HOMA-IR

Introduction

Retinal vein occlusion (RVO) is a common retinal vascular disease that can lead to visual impairment.[1] The prevalence of RVO has been reported as between 0.3% and 1.6%.[1,2] Its relatively high prevalence warrants attention to the prevention and management of the disease. Although there is still uncertainty regarding the pathogenesis of RVO, comprehensive studies have found an increased risk in patients with cardiovascular diseases such as arterial hypertension, hypercholesterolemia, atherosclerosis, and diabetes mellitus (DM).[3] Other identified risk factors for RVO development include aging, smoking, obesity, insulin resistance, trauma, open-angle glaucoma, thrombophilia, and hyperviscosity.[4,5,6]

The clinical signs of RVO include disseminated superficial and deep retinal hemorrhages, retinal edema, venous dilation, venous sheathing, anastomotic vessels, intraretinal microvascular disturbances, optic disc hyperemia, and optic disc edema. According to the location and findings of the affected vein, RVO is divided into the subtypes of branch retinal vein occlusion (BRVO) and central retinal vein occlusion (CRVO).[7,8] Visual symptoms and prognosis rely on the subtype of RVO and the degree of macular involvement.

The significant relationship with cardiovascular risk factors necessitates a systemic evaluation including assessment of blood pressure, complete blood count, lipid profile, glucose metabolism, and insulin resistance for all patients with RVO

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during the diagnosis and treatment process. Regarding the traditional fasting plasma lipid profile (triglycerides [TG], total cholesterol [TC], low-density lipoprotein cholesterol [LDL-C], and high-density lipoprotein cholesterol [HDL-C]), the relationship between these parameters and RVO is well-established in the literature.[2,5,7,9,10,11,12] The use of lipid ratios allows assessment of both antiatherogenic and atherogenic lipid parameters.[13] There are previous studies evaluating these ratios as novel biomarkers in cardiovascular diseases. However, according to our knowledge based on a review of the literature, no comprehensive study has evaluated TG/HDL-C, LDL-C/HDL-C, TC/HDL-C, and non-HDL-C/HDL-C ratios in patients with RVO. The purpose of this study was to investigate serum atherogenic indices as novel cardiovascular risk factors associated with RVO and contribute to the overall health status of patients with RVO.

Materials and Methods

Subjects and Clinical Data

This retrospective case-control research included 57 patients with newly diagnosed RVO who underwent detailed examination in the ophthalmology department of Selçuk University Faculty of Medicine from January to December 2019 and had their plasma lipid concentrations and insulin resistance assessed. The study conformed to the guidelines of the Declaration of Helsinki and was authorized by the Selçuk University Institutional Review Board and Ethics Committee (decision no: 2021/104, date: 24.02.2021). Informed consent was obtained from each participant.

The diagnosis of RVO was determined by an experienced retina specialist (Ş.G.) based on ophthalmoscopic examination of the fundus demonstrating typical clinical findings (e.g., retinal hemorrhages, retinal edema, venous dilation, venous sheathing, optic disc hyperemia, and optic disc edema) and was objectively confirmed by fundus fluorescein angiography. Based on the findings, the patients were classified into subgroups as CRVO (diffuse vascular findings in all retinal quadrants) or BRVO (vascular findings only in a wedge-shaped area). In addition, autorefractometer results (Tonoref III, Nidec Co. Ltd, Aichi, Japan), intraocular pressure measured by Goldmann applanation tonometry, best corrected visual acuity as determined on the standard Snellen eye chart, demographic data, and medical and ocular history were collected from the records of Selçuk University Faculty of Medicine. We only included patients with onset of symptoms within the last 72 hours, because the onset of the RVO could not be ascertained exactly.

Exclusion criteria were having additional notable systemic disease such as renal abnormalities, liver dysfunction, chronic infections, blood dyscrasias, collagen disease, or neoplastic disease; history of a surgical intervention within the last 3 months; current treatment with anticoagulant drugs, insulin for DM, postmenopausal hormone replacement, or antihyperlipidemic drugs; and any comorbid ocular disease (e.g., ocular trauma, uveitis, or retinal condition other than RVO).

After the evaluation of inclusion and exclusion criteria, 57 patients diagnosed with RVO were enrolled in this study. The healthy control group comprised 63 age- and sex-matched subjects who presented with symptoms of presbyopia and had normal findings on ophthalmological examination. Serum atherogenic indices and presence of insulin resistance were compared between patients and controls.

Laboratory Analysis

Blood samples were drawn into plain tubes without anticoagulant for analyses of serum lipids, hemoglobin A_{1c} (HbA1c), plasma glucose, and insulin. All samples were obtained after a 12-hour overnight fast by cubital venipuncture between 8:30 and 10:30 a.m. TC, HDL-C, and TG serum concentrations were examined on an ARCHITECT C16000 chemistry analyzer (Abbott Diagnostics, IL, USA) by enzymatic colorimetric methods according to the manufacturer's instructions. The Friedewald formula was used to determine LDL-C levels.[14] Non-HDL-C was computed as TC minus HDL-C.

HbA1c was calculated by standard laboratory techniques. Fasting plasma glucose (FPG) was detected using the glucose oxidase method. Concentrations of fasting insulin were measured by radioimmunoassay.

The lipid ratios TG/HDL-C, TC/HDL-C, LDL-C/HDL-C, and non-HDL-C/HDL-C were calculated using lipid profile data. In addition, Framingham risk score for coronary heart disease was used to estimate the 10-year risk of myocardial infarction or death for all subjects. Comparisons were made using the standardized Framingham risk formula including age, sex, systolic blood pressure, TC, HDL-C, and smoking status.[15,16] Scores were calculated according to the values and categories, and the 10-year risk percentage was determined. The risk of coronary events in the next 10 years was classified as low (<10%), intermediate (10-20%), or high (>20%).[16]

Definitions of Diabetes Mellitus, Hypertension, and Insulin Resistance

DM was defined as a self-declared history of a previous diagnosis of diabetes and the use of antidiabetic medications. HT was defined as being treated with any antihypertensive drug. Insulin resistance was determined through the homeostasis model assessment of insulin resistance (HOMA-IR) according to the method of Matthews et al.[17]: HOMA-IR = plasma insulin (mIU/mL) × FPG (mg/dL)/22.5. Using a cut-off of 2.5, the participants were classified as those with insulin resistance (HOMA-IR ≥2.5) and those without insulin resistance (HOMA-IR <2.5).[18]

Statistical Analysis

Data were analyzed with SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Measurements are expressed as the mean ± standard deviation. The normality of each variable in the groups was measured using the Kolmogorov-Smirnov test. Comparisons of categorical data between groups were made using Pearson's chi-square test. For comparisons of continuous data, independent samples t-test was applied for variables with normal distribution

and the Mann-Whitney U test was performed for variables with abnormal distribution. We used the Spearman correlation coefficient to detect correlations between parameters. Receiver operating characteristic (ROC) curve analysis was utilized to show the sensitivity and specificity of serum lipid ratios and their cut-off values for predicting RVO, BRVO, and CRVO. The predictive validities were measured as area under the ROC curve. $p<0.05$ was regarded as statistically significant.

Results

There were 57 RVO patients with a mean age of 63.7±9.4 years. The healthy control group included 63 individuals with a mean age of 62.2±5.7 years. The age and sex distribution of the individuals in the groups did not differ significantly ($p>0.05$). While the frequency of HT differed significantly between the patient group and the control group ($p=0.011$), there was no difference in the frequency of DM ($p>0.05$). The demographic data of the subjects are summarized in Table 1.

Serum TG, TC, LDL-C, and HDL-C showed no statistical differences between the groups ($p>0.05$). Non-HDL-C was higher in the RVO group ($p=0.042$). In addition, LDL-C/HDL-C, TC/HDL-C, and non-HDL-C/HDL-C ratios were also higher in RVO patients compared to healthy subjects ($p=0.036$, $p=0.015$, and $p=0.015$, respectively). On the other hand, TG/HDL-C ratio showed no significant difference ($p>0.05$). Correlation analysis revealed that TG/HDL-C was correlated with FPG ($r=0.211$, $p=0.021$), insulin ($r=0.308$, $p=0.001$), HbA1c ($r=0.299$, $p=0.001$), and HOMA-IR ($r=0.317$, $p=0.0001$). Details are given in Table 2.

Regarding glucose metabolism, the RVO group had higher fasting insulin concentrations, plasma insulin, and HOMA-IR index ($p=0.003$, $p=0.001$, and $p=0.001$, respectively). The proportion of subjects with insulin resistance (HOMA-IR ≥2.5) was significantly higher in RVO compared to controls ($p=0.0001$). However, mean HbA1c values did not differ significantly between the groups ($p>0.05$) (Table 2).

Table 1. Demographic data of study subjects

	RVO group (n=57)	Control group (n=63)	p value
Mean age ± SD (years)	63.7±9.4	62.2±5.7	0.275*
Male/female ratio (n)	25/32	26/37	0.774**
Hypertension (n)	24	13	**0.011****
Diabetes mellitus (n)	22	17	0.175**

Statistically significant values ($p<0.05$) shown in bold. *Independent samples t-test, **Chi-square test
SD: Standard deviation, RVO: Retinal vein occlusion

Table 2. Parameters of all RVO patients and healthy participants

	RVO group (n=57)		Control group (n=63)		p value
	Mean ± SD	Median	Mean ± SD	Median	
TC (mg/dL)	211.2±46.3	210	198.1±40.1	129	0.101*
LDL-C (mg/dL)	133.2±32.3	139	122±35.2	129	0.1**
HDL-C (mg/dL)	47.5±12.3	46	49.5±10	48	0.129**
TG (mg/dL)	162.5±91.1	125	132±38.1	129	0.378**
Non-HDL-C (mg/dL)	163.6±41.3	163	148.6±38.3	148	**0.042***
TC/HDL-C	4.5±1	4.6	4.11±1	4.1	**0.015***
TG/HDL-C	3.6±2.2	2.9	2.81±1	2.6	0.092**
LDL-C/HDL-C	2.9±0.7	3	2.55±0.8	2.6	**0.036****
Non-HDL-C/HDL-C	3.5±1	3.6	3.11±1	3.1	**0.015***
FPG (mg/dL)	116.5±41.4	107	96.9±13.8	95	**0.003****
HbA1c (%)	6.4±1.3	6	6.1±0.6	5.9	0.410**
Insulin (mIU/mL)	10±5.2	9.7	6.2±2	6	**0.001****
HOMA-IR	3.13±2.48	2.3	1.5±0.6	1.6	**0.001****
HOMA-IR ≥2.5, n (%)	27 (52.6)		5 (7.9)		**0.0001*****

Statistically significant values ($p<0.05$) shown in bold. *Independent samples t-test, **Mann-Whitney U test, ***Chi-square test, RVO: Retinal vein occlusion, SD: Standard deviation, TC: Total cholesterol, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, TG: Triglycerides, FPG: Fasting plasma glucose, HbA1c: Glycated hemoglobin, HOMA-IR: Homeostatic model assessment for insulin resistance

In subgroup analysis, 68.4% (n=39) of patients with RVO showed characteristics of BRVO, while 31.6% (n=18) of them had the presentation of CRVO. Of all the lipid and glucose metabolism parameters, only LDL-C differed significantly between subgroups. The frequency of HT was higher in CRVO (p=0.011). The characteristics of the CRVO and BRVO subgroups are shown in Table 3.

The Framingham 10-year risk in subjects with RVO was 10.8%, which was significantly greater than in the control group (p<0.05). Men in particular had significantly higher Framingham risk scores than women in the RVO group (p=0.0001). The mean score was 10.48% in BRVO patients and 11.75% in the CRVO group. Although patients with CRVO had higher Framingham 10-year risk, there was no significant difference between BRVO and CRVO subjects in analysis (p>0.05).

ROC curve analysis was performed to determine the specificity and sensitivity of atherogenic indices in differentiating RVO patients from controls, as well as cut-off values for predicting RVO, BRVO, and CRVO. According to our results, values higher than the following cut-off values were significant in terms of RVO risk: 4.44 for TC/HDL-C values (64% sensitivity, 65% specificity), 3.41 for non-HDL-C/HDL-C (64% sensitivity, 63% specificity), 2.64 for TG/HDL-C (68% sensitivity, 50% specificity), and 2.89 for LDL-C/HDL-C (63% sensitivity, 65% specificity). In addition, TC/HDL-C values >4.52 (72% sensitivity, 68% specificity) and LDL-C/HDL-C values greater than >2.9 (66% sensitivity, 68% specificity) were found to be significant in predicting CRVO. ROC curve analysis and the cut-off values for RVO, BRVO, and CRVO are shown in Table 4.

Discussion

RVO is the most common retinal vasculopathy following diabetic retinopathy and occurs due to disturbances of the retinal venous circulation.[8] The most common known risk factors for cardiovascular comorbidities are also strongly associated with RVO. Previously, studies have investigated parameters associated with cardiovascular health in RVO.[2,5,7,10,11,12,19] Khan et al.[20] stated that patients with RVO have an elevated 10-year Framingham risk score for cardiovascular disease. Furthermore, it has been emphasized that therapy aimed at controlling risk factors should be planned in these patients. Therefore, patients diagnosed with RVO should be examined in terms of cardiovascular health.

Dyslipidemia, presenting as elevated levels of TG, LDL-C, and TC and a low level of HDL-C, is a well-defined traditional risk factor for RVO.[5,11,12,20] However, it has been reported that lipoproteins and some of their ratios (TG/HDL-C, TC/HDL-C, LDL-C/HDL-C, and non-HDL-C/HDL-C) show a stronger statistical relationship with the severity and prevalence of coronary artery disease in determining the risk of atherosclerosis compared to measurements of lipid levels alone.[21] The current

Table 3. Details of the BRVO and CRVO patient subgroups

	BRVO Group (n=39)		**CRVO Group (n=18)**		**p value**
Sex (male/female), n (%)	15 (38.5)/24 (61.5)		10 (55.6)/8 (44.4)		0.227*
	Mean ± SD	**Median**	**Mean ± SD**	**Median**	
Age	64.6±6.9	64	61.7±13.3	64.5	0.692**
TC (mg/dL)	205±46.8	210	224.6±43.3	225.5	0.140***
LDL-C (mg/dL)	128.4±33.3	132	143.6±28	145.5	**0.032****
HDL-C (mg/dL)	46.8±11.6	45	49.2±14	46.5	0.513**
TG (mg/dL)	157.5±87.2	125.0	173.3±100.8	143.5	0.778**
Non-HDL-C (mg/dL)	158.2±43.2	156	175.3±35.1	177	0.147***
TC/HDL-C	4.5±1.1	4.4	4.74±0.9	4.9	0.497***
TG/HDL-C	3.5±2.2	2.7	3.81±2.32	3.2	0.830**
LDL-C/HDL-C	2.8±0.8	2.9	3±0.5	3	0.152**
Non-HDL-C/HDL-C	3.5±1.1	3.4	3.7±0.9	3.9	0.497***
FPG (mg/dL)	118.2±44.9	108	112.8±33.4	97	0.486**
HbA1c (%)	6.3±1.2	6	6.4±1.48	5.9	0.730**
Insulin (mIU/mL)	10.1±5.04	9.7	9.9±5.8	9.3	0.624**
HOMA-IR	3.1±2.4	2.7	3±2.5	2	0.643**
HOMA-IR ≥2.5, n (%)	20 (51.3)		7 (38.9)		0.384*
Diabetes mellitus, n (%)	16 (41.0)		6 (33.3)		0.579*
Hypertension, n (%)	12 (30.8)		12 (66.7)		**0.011***

Statistically significant values (p<0.05) shown in bold. *Chi-square test, **Mann-Whitney U test, ***Independent samples t-test, BRVO: Branch retinal vein occlusion, CRVO: Central retinal vein occlusion, SD: Standard deviation, TC: Total cholesterol, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, TG: Triglycerides, FPG: Fasting plasma glucose, HbA1c: Glycated hemoglobin, HOMA-IR: Homeostatic model assessment for insulin resistance

Table 4. Receiver operating characteristic curve analysis for atherogenic indices in predicting retinal vascular occlusion						
	Index	**AUC (95% CI)**	**Cut-off value**	**p value**	**Sensitivity (%)**	**Specificity (%)**
RVO	TC/HDL-C	0.626 (0.526-0.727)	4.44	**0.017**	64	65
	LDL-C/HDL-C	0.611 (0.509-0.713)	2.89	**0.036**	63	65
	TG/HDL-C	0.589 (0.485-0.694)	2.64	0.092	68	50
	Non-HDL-C/HDL-C	0.626 (0.526-0.727)	3.41	**0.017**	64	63
BRVO	TC/HDL-C	0.603 (0.492-0.714)	4.37	0.081	61	63
	LDL-C/HDL-C	0.582 (0.471-0.693)	2.67	0.165	59	54
	TG/HDL-C	0.58 (0.461-0.699)	2.78	0.176	51	52
	Non-HDL-C/HDL-C	0.603 (0.492-0.714)	0.61	0.081	61	63
CRVO	TC/HDL-C	0.676 (0.544-0.809)	4.52	**0.023**	72	68
	LDL-C/HDL-C	0.675 (0.548-0.801)	2.9	**0.024**	66	68
	TG/HDL-C	0.609 (0.431-0.788)	2.86	0.159	55	57
	Non-HDL-C/HDL-C	0.676 (0.544-0.809)	3.52	0.544	72	68

Statistically significant values ($p<0.05$) shown in bold. AUC: Area under the curve, CI: Confidence interval, TC: Total cholesterol, HDL-C: High-density lipoprotein cholesterol, LDL-C: Low-density lipoprotein cholesterol, TG: Triglycerides

study aimed to evaluate the serum lipid ratios and insulin resistance status of newly diagnosed RVO patients.

It is known that a high TG/HDL-C ratio is associated with abdominal obesity and insulin resistance, even with no change in LDL-C levels, as well as high BMI and hyperinsulinemia.[22,23,24] Furthermore, the TG/HDL-C ratio was reported to be a strong predictor of mortality and cardiovascular health in women with presumed myocardial ischemia.[25] In another large population survey of participants aged 20-90 years, an association was demonstrated between the TG/HDL-C ratio and cardiovascular disease.[26] Çelik and Gökçe[27] reported that RVO patients had a significantly higher atherogenic index of plasma (log [TG/HDL-C]) than the control group. This parameter was also reported to be related with metabolic-associated fatty liver disease and unfavorable prognosis of percutaneous coronary intervention.[28,29] In our study, the TG/HDL-C ratio was higher in the RVO group. However, no statistically significant difference was determined. Moreover, we observed that the TG/HDL-C ratio was correlated positively with HOMA-IR, insulin, HbA1c, and FPG. Therefore, this ratio should be evaluated together with glucose metabolism and insulin resistance markers. FPG, insulin, and HOMA-IR index were found to be increased in RVO patients compared to the control group. The average HbA1c value of the patients and healthy group was above 6%, and no statistical difference was found between the groups. In our study of RVO patients, TG/HDL-C ratio and HbA1c were not good indicators for the evaluation of insulin resistance. However, HOMA-IR index calculated with insulin level and FPG was found to be markedly higher in the RVO group. Therefore, we believe this is a crucial parameter that should be used in the evaluation of insulin resistance in subjects with RVO. In the literature, FPG with insulin level and HbA1c ratio have been previously evaluated in RVO patients.[9,30,31] As far as we know, the current study is the first in which the HOMA-IR index was applied in the assessment of insulin resistance in RVO patients.

Ratios of cholesterol ester-rich lipoprotein levels (LDL-C/HDL-C and TC/HDL-C) are among the well-known markers of ischemic heart disease, and elevated ratios indicate a disorder in cholesterol metabolism.[32,33] TC/HDL-C ratio is a parameter of coronary heart disease and includes both an atherogenic and an antiatherogenic lipid parameter.[34] Since the LDL-C level is determined based on TG, TC, and HDL-C concentrations, it cannot be calculated with traditional formulas in patients with a TG level of more than 399.[14] In this case, direct evaluation of the TC/HDL-C ratio can provide information in terms of atherogenic lipid components. Earlier studies regarding serum lipid profiles in coronary heart disease patients indicated that TC/HDL-C ratios were high when compared to controls.[23,35,36] Stampfer et al.[33] demonstrated that a higher LDL/HDL ratio was associated with an elevated risk of myocardial infarction. In a 20-year prospective study of 3914 patients with stroke, low HDL-C and high TC/HDL-C ratio were emphasized to be related to the risk of total and ischemic stroke in male and female patients.[37] In our study, the TC/HDL-C ratio was higher in RVO patients than the healthy subjects. In their biochemical analysis of 60 patients with ischemic heart disease, Ghosh et al.[36] reported a TC/HDL-C ratio of 4.9±1.2, which was notably higher than the control group. We think that the high TC/HDL-C and LDL-C/HDL-C ratios in RVO patients suggest that these parameters may be associated with worse cardiovascular health status and clinical outcomes.

As is known, atherosclerosis is a crucial risk factor for RVO, and abnormalities in cholesterol metabolism also pose a threat.[3] Previously, non-HDL-C has been reported to be a superior predictive marker of arterial vessel wall stiffness compared to LDL-C.[38] Therefore, the ratio of non-HDL-C/HDL-C is easy,

convenient, and better for the assessment of coronary artery disease and arterial stiffness risk than lipid parameters alone.[39,40] In the current study, non-HDL-C levels and non-HDL-C/HDL-C ratios were observed to be increased in the RVO patients compared to the healthy subjects. This result undoubtedly reveals the necessity of further cardiovascular examination of patients diagnosed with RVO. Moreover, it demonstrates the importance of vascular health both in protecting the health of the fellow eye and in the recovery of the eye affected by RVO.

In subgroup analysis, the frequency of hypertension was higher in the group with CRVO, consistent with the literature.[5] In terms of serum lipids, however, only LDL-C levels were found to be increased in the CRVO group. ROC analysis revealed that TC/HDL-C and LDL-C/HDL-C ratios were significant for predicting CRVO, while none of the ratios were significant for BRVO. The fact that TC/HDL-C and LDL-C/HDL-C ratios are indicative of CRVO may demonstrate a higher risk of cardiovascular disease. More comprehensive studies should be done on serum lipids and atherogenic indices to reveal the differences between CRVO and BRVO.

The Framingham risk score has been used for many years to estimate the 10-year risk of myocardial infarction or death in various populations.[20] In our study, the Framingham risk score was higher in RVO patients (10.8%), and especially in men. Similarly, a meta-analysis showed the 10-year Framingham risk score in subjects with RVO to be 10.1%.[20] In the current study, no significant difference was seen in the Framingham risk score between CRVO and BRVO patients. We attributed the slightly higher Framingham risk score in CRVO cases to the higher frequency of hypertension. In another study, higher 10-year risk of coronary heart disease was reported in BRVO patients due to the frequency of hypertension and other cardiovascular risk factors.[41] In our study, there was intermediate risk of coronary events in both BRVO and CRVO. Although the Framingham risk score was not found to differ in CRVO cases, TC/HDL-C and LDL-C/HDL-C ratios were predictive of CRVO. As can be seen from these results, it is necessary to evaluate cardiovascular health status in RVO patients.

Study Limitations

To the best of our knowledge, the current study is the first to evaluate serum lipid ratios as serum atherogenic indices and the HOMA-IR index in patients with RVO. However, the study had some limitations. The small sample size and single-center design are the most important of them. Additionally, the study may have biased because the sample consisted of subjects presenting for care. Finally, causality between dyslipidemia and RVO cannot be established because of the cross-sectional study design. Future research should focus on the effect of changes in serum lipid ratios on the recovery process by examining the outcomes of RVO treatment in prospective cohort studies.

Conclusion

The current study showed that RVO was associated with increased ratios of TC/HDL-C, LDL-C/HDL-C and non-HDL-C/HDL-C compared to healthy subjects. The results suggest that measurement of HOMA-IR index should be considered in the evaluation of insulin resistance in RVO cases. These abnormalities may contribute to the pathogenesis of RVO and the associated risk of cardiovascular disease and stroke in these patients.

Ethics

Ethics Committee Approval: Selçuk University Institutional Review Board and Ethics Committee (decision no: 2021/104, date: 24.02.2021).

Informed Consent: Obtained.

Authorship Contributions

Surgical and Medical Practices: Ş.G., Concept: Ş.G., S.E., Design: Ş.G., S.E., Data Collection or Processing: S.E., Analysis or Interpretation: Ş.G., S.E., Literature Search: Ş.G., S.E., Writing: Ş.G., S.E.

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Data Availability: The data that support the findings of this study are available from the corresponding author (S.E.) upon reasonable request.

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