Turkish Journal of Clinics and Laboratory

To cite this article: Ozen Y, Ozeke O, Ozbay MB, Acar B, Karakurt M, Kuyumcu MS, Gayretli KY, Yayla C, Ertem A, Aras D. Investigation of the relationship of coronary artery diameters with prediabetes and diabetes in patients with first diagnosis acute coronary syndrome. Turk J Clin Lab 2022; 2: 242-252.

Original Article

Investigation of the relationship of coronary artery diameters with prediabetes and diabetes in patients with first diagnosis acute coronary syndrome

İlk tanı akut koroner sendrom ile başvuran hastalarda koroner arter çaplarının prediyabet ve diyabet ile ilişkisinin incelenmesi

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ABSTRACT

Aim: Diabetic patients have a more severe and widespread coronary atherosclerosis, and their coronary artery diameters (CADs) are widely affected, but this has not been evaluated in prediabetics. This study investigated the effects of prediabetes on CADs in patients with acute coronary syndrome.

Material and Methods: Two hundred and sixty-six patients included in this study were divided into three groups as "normal", "prediabetic" and "diabetic". Patients' CADs were calculated via the quantitative coronary angiography technique. Coronary segments were measured from the designated regions.

Results: We found that both prediabetes and diabetes had similar adverse effects on vessels except the proximal RCA, unlike the normal group. We also found that the diameter of the LMCA was the most affected coronary segment, and the diameter of proximal LAD was second segment as affected mostly ($p < 0.001$ for both). When total CADs were analyzed, it was seen that distal coronary artery segments were more affected than proximal ($p < 0.001$).

Conclusion: This study showed that coronary artery diameters of prediabetic patients were affected similarly to patients with diabetes, and the narrowing of the distal coronary arteries was more affected than the proximal vessels. Early diagnosis and treatment of prediabetes is important to provide a more suitable coronary lesion for percutaneous or surgical revascularization.

Keywords: Acute coronary syndrome; diabetes; prediabetes; coronary artery diameter; HbA1c.

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Recevied: 08.05.2022 accepted: 13.06.2022
Doi: 10.18663/tjcl.1113964

ÖZ

Amaç: Diyabetik hastalarda daha yaygın ve şiddetli koroner ateroskleroz vardır ve koroner arter çapları (KAÇ) yaygın olarak etkilenir, ancak bu durum prediyabetiklerde değerlendirilmemiştir. Bu çalışma, akut koroner sendromlu hastalarda prediyabetin KAÇ' ları üzerindeki etkilerini araştırdı.

Gereç ve Yöntemler: Bu çalışmaya dahil edilen 266 hasta "normal", "prediyabetik" ve "diyabetik" olmak üzere üç gruba ayrıldı. Hastaların KAÇ' ları kantitatif koroner anjiyografi tekniği ile hesaplandı. Koroner segmentler belirlenen bölgelerden ölçüldü.

Bulgular: Normal gruptan farklı olarak hem prediyabetin hem de diyabetin proksimal RCA dışında damarlar üzerinde benzer etkileri olduğunu bulduk. Ayrıca LMCA çapının en çok etkilenen koroner segment olduğunu ve proksimal LAD çapının en çok etkilenen ikinci segment olduğunu bulduk (her ikisi için p<0,001). Total KAÇ' ları incelendiğinde distal koroner arter segmentlerinin proximal koronerlere göre daha fazla etkilendiği görüldü (p<0,001).

Sonuç: Bu çalışma, prediyabetik hastaların koroner arter çaplarının diyabet hastalarına benzer şekilde etkilendiğini ve distal koroner arterlerdeki daralmanın proksimal damarlara göre daha fazla etkilendiğini göstermiştir. Prediyabetin erken tanı ve tedavisinin, perkütan veya cerrahi revaskülarizasyon için daha uygun bir koroner lezyon sağlamak açısından önemlidir.

Anahtar kelimeler: Akut koroner sendrom; diyabet; prediyabet; koroner arter çapı; HbA1c.

Introduction

Diabetes mellitus (DM) is one of the most critical risk factors in the development of coronary artery disease (CAD), and it is responsible for 9.9% of the risk of having the first acute myocardial infarction (AMI) itself[1]. On the other hand, it has been reported that the frequency of cardiovascular disease (CVD)-related mortality in patients with DM is 2-4 times higher than in patients without DM, and 70-80% of the mortality in DM patients develops due to CVD[2, 3]. However, epidemiological evidence showed that this morbidity-mortality relationship begins in the early stage of normal glucose tolerance to overt diabetes[4]. Because both increased insulin resistance and impaired beta-cell function exhibits for the prolonged time before overt hyperglycemia became apparent, most diabetic patients manifest signs of CVD at diagnosis[1].

Conditions that plasma glucose levels are higher than normal but do not reach the diagnostic threshold of diabetes are called prediabetes. Prediabetes augments cardiovascular risk and mortality[5]. The rate of developing diabetes in prediabetic patients is about 70%[6]. Therefore, prevention of diabetes development and clinical complications associated with diabetes with early diagnosis increases the disease's clinical importance.

Coronary atherosclerosis in diabetic patients is more severe, extensive-diffuse, and rapidly progressive which, makes angiographic anatomy complex limiting the possibility to perform successful and complete revascularization[7-9]. The reasons for this trend are that diabetic patients have smaller-size vessels, an extensive disease that often progresses rapidly, a more significant burden of atherosclerotic disease, and exaggerated neointimal hyperplasia. Patients with smaller calibered vessels carry a higher risk of an adverse outcome for the percutaneous coronary intervention (PCI)[10, 11]. Because patients with small vessel diameter; have an increased incidence of restenosis and an increased risk of major cardiac events[12, 13]. This patient population had a higher risk after coronary artery bypass grafting (CABG) due to more technically challenging operative procedures and lower long-term patency rates[14-16] due to unaccommodating anastomoses between saphenous vein grafts or internal mammary conduits to small-caliber native coronary arteries, particularly in diabetics or women[17-20]. In the Coronary Artery Surgery Study, small body size and coronary artery caliber were found to be the strongest predictors for perioperative mortality[21].

In diabetic patients, the coronary artery and its branches have been shown to have smaller vessel diameters than normal individuals. Still, in prediabetic patients in a daily cardiology practice, vessel diameters appear narrower than normal individuals[22, 23]. Ertan et al[24] showed that prediabetes had a negative effect on coronary artery diameter in patients with normal coronary arteries. In the study of Kadi et al[25], it was shown that coronary collateral development was impaired in patients with prediabetes when compared to patients with coronary artery disease and normal fasting glucose levels. As a matter of fact, in a previous study, we found that prediabetes

affects coronary artery disease scores as much as diabetes[26].

This study aimed to evaluate whether there is a relationship between prediabetes and diffuse coronary stenosis and/or coronary artery size in patients with the first diagnosed acute coronary syndrome.

Material and Methods

Study design and patient selection

We analyzed 504 consecutive patients with acute coronary syndrome between November 2016 to November 2018. All the patients underwent coronary angiography (CA) in our institution. The patients with the previous CAD, structural heart disease, severe valve disease, chronic kidney disease (CKD), anemia, and ectatic CAD were excluded from the study. Two hundred sixty-six patients had an admission at the first occurrence of coronary artery disease and were included in the final analysis. Patients were classified according to HbA1c levels by ADA Guidelines into three groups: HbA1c lower than 5.7% (normal group), HbA1c: 5.7–6.4% (prediabetic group), and HbA1c higher than 6.4% (diabetic group)[27]. The patients previously diagnosed with diabetes were included in the diabetic group regardless of HbA1c levels. The study protocol was approved by the local institutional review board. A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data acquisition and assessment of coronary artery diameters

Demographic characteristics (age, gender, height, weight, background, family history, etc.), laboratory values (creatinine, GFR, total cholesterol, LDL, HDL, triglyceride, HbA1c, hemoglobin, thrombocyte), and (Left Ventricular Ejection Fraction) EF values of the patients were obtained from medical records. The coronary artery diameters were measured in diastole, and the largest dimension in each segment was used by two interventional cardiologists blinded to patients' clinical and laboratory data. Quantitative coronary angiographic analysis of all three coronary arteries was performed using the edge-detection method. After contrast filling, the catheter's diameter was used as a reference for calculating actual coronary vessel diameters. Measurements were taken in two orthogonal views of each of the major epicardial coronary arteries. The average of the two measurements was used for each coronary artery. The computer-assisted angiography analysis system was used for coronary diameter measurement (Syngo, artis floor angiography system, Siemens, Germany).

Available catheter tip diameter (2.0 mm for 6.0 F catheter, 2.3 mm for 7.0 F catheter) was used as a calibration object to evaluate the diameters of the coronary arteries. The diameters of the left main (LM), left anterior descending (LAD), and left circumflex (LCX) coronary arteries were evaluated in approximately 30 ° right anterior oblique projection, and right coronary artery (RCA) diameter was evaluated at approximately 60 ° left anterior oblique projection. The left main coronary artery (LMCA) was measured in its mid-region. The left anterior descending artery (LAD) was divided into three segments, the proximal LAD (pLAD) was measured at its midpoint between its origin and the first branch (first septal-1S or diagonal-1D) of the pLAD, the mid-LAD (mLAD) was measured between 1S and 1D, and the distal LAD (dLAD) was measured after the diagonal branch of the LAD, apical LAD was measured in its distal 1.0 cm before the distal bifurcation, commonly referred to as mustache. The circumflex (Cx) was also divided into two segments, the proximal Cx (pCx) was measured at its midpoint between its origin and the first obtuse marginal (1 M), the distal Cx (dCx) was measured at the origin of the second obtuse marginal branch (2 M), and finally, the 1 M was measured at its origin. The right coronary artery (RCA) was divided into two segments: the proximal RCA (pRCA) was measured 15 mm from the ostium, and the distal RCA (dRCA) was measured at the ostium of the posterior descending artery (PDA)[28]. The main measurement point was the most proximal disease-free part of each segment. Totally occluded coronary segments were not evaluated. Intracoronary nitrate is routinely administered to all patients during coronary angiography when systolic blood pressure was > 90 mmHg. The measurement locations of the coronary segments are shown (Figure 1).

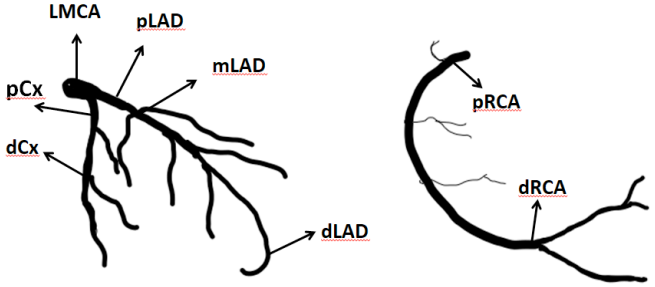

Figure 1. Measurement locations all of the coronary segments.

Statistical analysis

All statistical analyses were performed using SPSS for Windows version 21.0 (SPSS, Chicago, IL, USA). Since continuous variables did not show normal distribution, they were given a median and interquartile range (IQR). The Kolmogorov-Smirnov test was used to evaluate the distribution of continuous variables. Kruskall Wallis test was used to compare two groups that did not show normal distributin and bonferroni correction was used in the Post-Hoc analysis. The χ2 and Fisher Exact tests were used to compare categorical variables between groups. Multiple comparisons were evaluated with Bonferroni. The p-value below 0.05 was considered statistically significant. A multivariate analysis of variance (MANOVA) was used to compare HbA1c and gender on the coronary artery diameter. Body surface area (BSA) was added to the model as a covariate variable in the MANOVA test. Since the interaction of BSA with both HbA1c and gender and its main effect were not significant on the relevant parameters, it was removed from the model, and the analysis process was completed.

Results

Patients without a history of DM were divided into groups according to their HbA1c values. After all, there were 92 patients (34.5%) in the diabetes group (82 of them previously diagnosed with diabetes), 92 patients (34.5%) in the prediabetes group, and 82 (31%) patients in the normal group. In the study, the prevalence of prediabetes was 34.5%, and the prevalence of undiagnosed diabetes was 3.7%. The demographic characteristics of the patients are shown in Table 1. There was no difference between the groups regarding family history, smoking, hyperlipidemia, and type of acute coronary syndrome. Male gender was more common in the prediabetes group than diabetes group ($p<0.05$) and like the normal group. The diabetes ratio was significantly higher in female patients than the prediabetic subjects. Hypertension was more prevalent in patients with diabetes ($p<0.05$).

Low-density lipoprotein levels were significantly lower in diabetic patients than the prediabetic patients (116.6 ± 36.3 vs 136.5 ± 39.9, p=0.004) and HbA1c level was significantly higher in patients with diabetes [7.9 (6.5- 13.5) vs 6 (5.7-6.4), median (IQR)]. Gensini and Syntax scores were higher in diabetic and prediabetic patients than the normal patient group (p=0.001). However, there was no significant difference between diabetic and prediabetic patients in terms of Gensini and Syntax scores. There was no difference between the groups in total cholesterol, hemoglobin, creatinine, HDL, eGFR, platelet, AST, triglyceride, total cholesterol, Platelet, LVEF and body surface area (BSA) (Table 2).

Table 1. Demographic and clinical characteristics of the study groups

		Normal	Prediabetes	Diabetes	Test Statistic*	p
Gender	Male, (%)	63 (76.8)[ab]	78(84.8)[b]	58(63)[a]	11,793	0,003
	Female, (%)	19 (23.2)[ab]	14(15.2)[b]	34(37)[a]		
Family History	Yes, (%)	78(95.1)[a]	83(90,2)[a]	78(84,8)[a]	5.103	0,078
	No, (%)	4(4.9)[a]	9(9,8)[a]	14(15,2)[a]		
Smoking	No	27(32.9)[a]	17(18,5)[a]	27(29,3)[a]	5.133	0.077
	Yes	55(67.1)[a]	75(81,5)[a]	65(70,7)[a]		
Hyperlipidemia	No, (%)a	75(91.5)[a]	79(85,9)[a]	76(82,6)[a]	2.948	0,229
	Yes, (%)a	7(8.5)[a]	13(14,1)[a]	16(17,4)[a]		
Hypertension	No, (%)	59(72)[a]	57(62)[a]	35(38)[b]	21.855	<0.001
	Yes, (%)	23(28)[a]	35(38)[a]	57(62)[b]		
ACS type	NSTEMI, (%)	35(42.7)[a]	41(44.6)[a]	37(40.2)[a]	0.839	0.933
	STEMI, (%)	44(53.7)[a]	48(52.2)[a]	50 (54.3)[a]		
	USAP, (%)	3(3.7)[a]	3(3.3)[a]	5(5.4)[a]		
Sum	n, (%)	82(31)	92(34.5)	92(34.5)		

*Pearson χ^2, a-b: There is no difference between groups with the same letter for each line (Bonferroni).
ACS: Acute Coronary Syndrome

Table 2. Laboratory and angiographic variables according to study groups

	Normal	Prediabetes	DM	p
Age	58.5 (29 - 90)[a]	57 (40 - 89)[a]	59.5 (39 - 87)[a]	0.398
Creatinine	0.9 (0.5 - 1.5)[a]	1 (0.5 - 1.4)[a]	0.9 (0.6 - 1.5)[a]	0.746
Hdl	44.5 (24 - 82)[a]	41 (19 - 78)[a]	41 (3 - 81)[a]	0.079
Ldl	133.5 (55 - 216)[a]	136.5 ± 39.9[a]	116.6 ± 36.3[b]	0.042
Egfr	85 (22 - 172)[a]	86 (34 - 167)[a]	78 ± 27.5[a]	0.088
Triglyceride	78.5 (35 - 476)[a]	104 (33 - 409)[a]	114.5 (23 - 1061)[a]	0.051
Cholesterol	202 (111 - 313)[a]	204.3 ± 47.8[a]	188.4 ± 46.3[a]	0.062
Hemoglobin	14.3 (7.8 - 17.5)[a]	15 (8.8 - 17.5)[c]	13.7 (6.8 - 18.7)[a]	0.003
Platelet	230 (92 - 390)[a]	235.5 ± 70.2[a]	243.6 ± 66.7[a]	0.404
LVEF	47.5 (25 - 65)[a]	50 (20 - 70)[a]	50 (20 - 65)[a]	0.111
AST	39 (11 - 456)[a]	30 (11 - 445)[a]	35.5 (12 - 420)[a]	0.868
HbA1c	5.3 (4 - 5.6)[a]	6 (5.7 - 6.49)[b]	7.9 (6.5 - 13.5)[c]	<0.001
Gensini	40 (0 - 123)[a]	51 (2.5 - 116)[b]	53 (2 - 117)[b]	0.001
Syntax Score	15.5 (0 - 46)[a]	21.5 ± 9.5[b]	22.5 ± 8[b]	0.001
BSA	1.9 (1.5 - 2.4)[a]	1.9 (0.5 - 2.3)[a]	1.9 (1.6 - 2.3)[a]	0.389

*Kruskal Wallis test[Post- hoc Bonferoni correction, Adj. Sig.; median (min-max)], a-c: There is no difference between groups with the same letter for each parameter. HDL: High-density lipoprotein, Ldl: Low-density lipoprotein, Egfr: Estimated glomerular filtration rate, LVEF: Left ventricular ejection fraction; AST: Aspartate aminotransferase

Multiple comparison of coronary artery diameters of each coronary segment between the groups and gender are shown in Table 3 and Figure 2. The diameter of each coronary artery segments in patients with diabetes and prediabetes were significantly lower than the normal group (p <0.001). The diameter of coronary segments was similar between the diabetic and prediabetic groups.

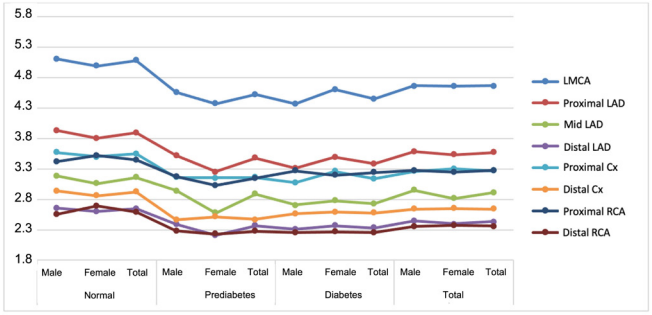

Figure 2. Comparison of coronary artery diameters of each coronary segments between the study groups and gender

In the model consisting of HbA1c, gender, and BSA, HbA1c and gender were effective on coronary artery diameter. BSA had no effect, so it was removed from the model. HbA1c was found to be effective on the diameter of the left main coronary, proximal LAD, mid LAD, distal LAD, proximal Cx, distal Cx, distal RCA (p-value, respectively <0.001 / 0.001 / 0.001 / 0.006 / 0.010 / 0.005 / 0.006). Among these, it was determined with partial eta square that it affects the LMCA the most and then the proximal LAD secondly (ŋLMCA=0.060, ŋproximal LAD=0.056) (Table 4). HbA1c did not affect proximal RCA. It was determined that gender alone did not affect diameters. HbA1c and gender interaction were not found to be effective on diameter. HbA1c was found to be the most effective parameter on coronary artery diameter.

Proximal total coronary artery diameter was obtained by summing the proximal diameters of three epicardial coronary arteries. Descriptive analysis of proximal and distal total coronary artery diameters by HbA1c and gender are shown in Table 5.

HbA1c was effective on both proximal and distal total coronary artery diameter (p <0.001 for both) (Table 6). The partial eta square showed that HbA1c affected mostly the distal total coronary artery diameter (ŋDTCAD=0.092). It was determined that gender alone does not affect total diameter. HbA1c and gender interaction were not found to be effective on total diameter.

Table 3. Multiple comparison of coronary artery diameters of each coronary segments between the groups and gender

	Gender	Left Main Coronary	Proximal Lad	Mid Lad	Distal Lad	Proximal Cx	Distal Cx	Proximal Rca	Distal Rca
Normal	Male	5.11 ± 1.14	3.93 ± 1.17	3.19 ± 1.19	2.66 ± 1.22	3.57 ± 1.18	2.94 ± 1.21	3.42 ± 1.36	2.56 ± 1.41
	Female	4.99 ± 1.15	3.8 ± 1.15	3.06 ± 1.2	2.6 ± 1.22	3.5 ± 1.25	2.86 ± 1.25	3.52 ± 1.24	2.69 ± 1.22
	Sum	5.08 ± 1.14[a]	3.9 ± 1.17[a]	3.16 ± 1.19[a]	2.64 ± 1.22[a]	3.55 ± 1.19[a]	2.92 ± 1.22[a]	3.45 ± 1.33[a]	2.59 ± 1.37[a]
Prediabetes	Male	4.56 ± 1.27	3,52 ± 1.29	2.94 ± 1.27	2.39 ± 1.31	3.16 ± 1.32	2.47 ± 1.4	3.17 ± 1.26	2.29 ± 1.34
	Female	4.37 ± 1.22	3,25 ± 1.25	2.58 ± 1.27	2.21 ± 1.23	3.15 ± 1.27	2.51 ± 1.27	3.03 ± 1.18	2.23 ± 1.29
	Sum	4.53 ± 1.26[b]	3,48 ± 1.29[b]	2.88 ± 1.27[b]	2.36 ± 1.3[b]	3.16 ± 1.31[b]	2.47 ± 1.38[b]	3.15 ± 1.25[a]	2.28 ± 1.34[b]
DM	Male	4.37 ± 1.19	3,32 ± 1,24	2.71 ± 1.29	2.31 ± 1.31	3.08 ± 1.26	2.57 ± 1,26	3.27 ± 1.23	2.25 ± 1.33
	Female	4.6 ± 1.2	3,5 ± 1,21	2.78 ± 1,26	2.37 ± 1.28	3.26 ± 1.24	2.59 ± 1.27	3.2 ± 1.33	2.27 ± 1.33
	Sum	4.45 ± 1.2[b]	3,38 ± 1,23[b]	2.73 ± 1.28[b]	2.33 ± 1.3[b]	3.14 ± 1.25[b]	2.58 ± 1.26[b]	3.24 ± 1.27[a]	2.26 ± 1.33[b]
Sum	Male	4.67 ± 1.22	3.58 ± 1.25	2.95 ± 1.26	2.45 ± 1.29	3.26 ± 1.27	2.64 ± 1.32	3.28 ± 1.29	2.36 ± 1.37
	Female	4.66 ± 1.19	3.53 ± 1.21	2.81 ± 1.25	2.4 ± 1.26	3.3 ± 1.25	2.65 ± 1.26	3.25 ± 1.28	2.37 ± 1.3
		4.67 ± 1.22	3.57 ± 1.24	2.91 ± 1.26	2.43 ± 1.28	3.27 ± 1.27	2.64 ± 1.3	3.27 ± 1.28	2.36 ± 1.35

a-b: There is no difference between groups with the same letter for each measurement value (Bonferroni).

Table 4. Comparison of coronary artery diameters according to HbA1c and gender with Multivariate ANOVA

		Test Statistic	p	Partial Eta square
HbA1c	Left Main Coronary	8.342	<0,001	0.06
	Proximal LAD	7.673	0.001	0.056
	Mid LAD	6.741	0.001	0.049
	Distal LAD	5.22	0.006	0.039
	Proximal Cx	4.714	0.01	0.035
	Distal Cx	5.411	0.005	0.04
	Proximal RCA	2.838	0.06	0.021
	Distal RCA	5.166	0.006	0.038
Gender	Left Main Coronary	0.023	0.88	0
	Proximal LAD	0.375	0.541	0.001
	Mid LAD	2.19	0.14	0.008
	Distal LAD	0.454	0.501	0.002
	Proximal Cx	0.133	0.715	0.001
	Distal Cx	0	0.997	0
	Proximal RCA	0.139	0.71	0.001
	Distal RCA	0.054	0.816	0
HbA1c*Gender	Left Main Coronary	1.194	0.305	0.009
	Proximal LAD	1.678	0.189	0.013
	Mid LAD	1.943	0.145	0.015
	Distal LAD	0.685	0.505	0.005
	Proximal Cx	0.548	0.579	0.004
	Distal Cx	0.12	0.887	0.001
	Proximal RCA	0.307	0.736	0.002
	Distal RCA	0.22	0.803	0.002

LAD: left anterior descending artery, Cx: circumflex artery, RCA: right coronary artery

Table 5. The proximal and total coronary artery diameters between the groups and gender

		Proximal Total CAD	Distal Total CAD
Normal	Male	11.14 ± 1.27	8.37 ± 1.09
	Female	11.01 ± 1.28	8.31 ± 1.13
	Sum	11.11 ± 1.27	8.36 ± 1.09
Prediabetes	Male	10.16 ± 2.09	7.44 ± 1.41
	Female	9.63 ± 1.39	7.13 ± 1.06
	Sum	10.08 ± 2	7.4 ± 1.37
DM	Male	9.87 ± 1.22	7.36 ± 1.09
	Female	10.21 ± 1.59	7.45 ± 1.29
	Sum	10 ± 1.37	7.39 ± 1.16
Sum	Male	10.39 ± 1.71	7.71 ± 1.3
	Female	10.31 ± 1.53	7.63 ± 1.27
		10.37 ± 1.66	7.69 ± 1.29

DM:Diabetes Mellitus, CAS: Coronary Artery Diameter

Table 6. Evaluation of Proximal Total Coronary Artery Diameter and Distal Coronary Artery Diameter values with two-way MANOVA

		Test statistics	p	Partial Eta square
HbA1c	PTCAD	9.591	<0.001	0.069
	DTCAD	13.178	<0.001	0.092
Gender	PTCAD	0.208	0.649	0.001
	DTCAD	0.268	0.605	0.001
HbA1c*Gender	PTCAD	1.173	0.311	0.009
	DTCAD	0.424	0.655	0.003

PTCAD: Proksimal Total Coronary Artery Diameter ,DTCAD: Distal total Coronary Artery Diameter

Discussion

The critical findings of our study included the following: The severity of coronary artery disease is similar between prediabetes and diabetes. Coronary artery diameters of the patients with prediabetes and diabetes were also similar, and smaller than normal patients. HbA1c levels had influence in most of the coronary segment's diameters except proximal RCA. Furthermore, elevated HbA1c levels affected distal total coronary artery diameters more.

The stage before DM develops is the prediabetic stage. Prediabetes has been shown to be associated with increased cardiovascular risk and mortality[29, 30]. It has been reported that 35% of patients admitted to hospital with AMI are prediabetic[28, 31]. It is stated in some publications that the rate of developing diabetes in prediabetic patients is 70%. Therefore, early diagnosis and prevention of diabetes development and clinical complications due to diabetes increase the disease's clinical importance[32]. The interaction between prediabetes and CVD was investigated in a cross-sectional study by Ford et al [30], and as a result, it was found that the CVD risk value increased in patients with FBG 110 mg/dl and above[33]. IFG increased CVD risk by 1.28-fold in patients with glucose 100-125 mg / dL and 1.20-fold in patients with 110-125 mg / dL[34]. In the Hoorn study , it was reported that an increase of 1.4% in HbA1c in a non-diabetic population between the ages of 50-75 led to a 51% increase in CVD rate[32]. In the CV outcome study conducted by Kim et al. in approximately 3,000 patients with ACS, prediabetes showed similar outcomes with diabetes[35]. Our previous study reported that coronary atherosclerosis in prediabetic patients was higher in patients with normoglycemia and similar in patients with diabetes[26].

It has been found that prediabetes is associated with widespread coronary stenosis and small vessel disease in both genders, particularly LAD and distal coronary arteries, in a study conducted by Ertan et al[24]. They also showed that gender affected coronary artery diameter. This study found that the most affected vessels in the prediabetic and diabetic groups were LMCA and proximal LAD. Our study is consistent with this study in this respect. In our study, we found that HbA1c affects proximal total CAD and distal total CAD. Besides, in comparing the groups according to HbA1c, it was determined that the distal coronary artery diameter was mainly affected among other total coronary arteries. Indeed, in the study of Cicek et al. found that HbA1c was an independent predictor of in-hospital mortality in STEMI treated with primary PCI[36]. In this respect, our study sheds light on the effect of HbA1c. However, we found that gender alone did not affect the diameters, and our study did not correlate with this aspect of that study. We attributed this to male dominance in all three groups in our study. It has been determined that male gender dominance was present in all three groups, and in many studies, most of the patients were male[33]. However, this could be explained by the fact that male patients had additional risk factors, such as high smoking rates

In the previous study we found no difference in terms of mean age between groups [26]. In the study conducted by AbuShady et al[33] sought the prevalence of prediabetes in patients with ACS, it was reported that there was no significant difference in age between the groups. It has been determined that the average age of NSTEMI patients in ACS patients admitted to the emergency department is higher than STEMI [37]. In our study, we found that the average age of patients with ACS was not different between the groups, however, we found that the average age of patients presenting with NSTEMI was higher than the other ACS groups.

A study previously conducted in patients with normal coronary arteries; could not determine the relationship of BSA with coronary artery diameters[38].Our study determined that BSA was similar between HbA1c groups, and BSA had no effect on the coronary artery diameters. The reason could be similar characteristics of the patients in the present study. We also found that gender did not affect diameters as a single.

It is stated that there is a close relationship between prediabetes and heart failure[39]. Previous studies reported that heart failure was more common in the prediabetic group than in the non-diabetic group[40, 41]. Contrary to the literature, ejection fraction was found similar between the groups in our study. Since all patients were newly diagnosed with ACS, the absence of EF difference between the groups could be attributed to the fact that diabetes had not yet affected the ejection fraction.

A decrease in GFR is an independent risk factor for CVD. An increased prevalence of chronic renal failure (CRF) has been reported in prediabetics[42]. In our study, the group's GFR value with DM was lower than the prediabetic and normal groups, but it did not gain statistical significance. Hemoglobin levels were significantly lower in the DM group than in the other groups. Diabetic nephropathy developing in patients with DM may cause impairment of kidney functions and low Hgb.

In the Diabetes Insulin Glucose and Myocardial Infarction (DIGAMI) study, it was stated that 34% of the patients admitted to the hospital with AMI had newly diagnosed prediabetes, and 31% had newly diagnosed DM[43]. It has been observed that HbA1c is associated with increased mortality even in the non-diabetic range. In the DECODE study conducted in patients with type 2 DM, it was stated that the relationship between glycemia and CVD started and increased in the normal blood glucose range[44]. In the meta-analysis of Ford et al[30] reported that there is a significant increase in the risk of developing CVD in prediabetic patients compared to those with normoglycemia. In our study, the prevalence of prediabetes was 34.5%, and the prevalence of undiagnosed DM was 3.7%. In our study, we found a negative association between HbA1c levels and coronary artery diameters. The relationship between HbA1c and CADs could be explained by the relationship between glucose level and development of endothelial dysfunction, microvascular and macrovascular complications. Vascular changes may develop in the patient before diabetes becomes evident or clinical findings appear.

In our study, the HbA1c level was the highest in the DM group and the lowest in the normal group. HbA1c had most effect on left main coronary, proximal LAD, mid LAD, distal LAD, proximal Cx, distal Cx, distal RCA, and it had been determined that it affected the LMCA the most and then the proximal LAD among them. HbA1c did not affect proximal RCA. This difference may be related to the dominance of the right and left coronary arteries. There were 72 % right dominance, 10% left dominance, and 18 % codominance in humans [45].

Conclusion

The severity of stenosis and diameter of coronary arteries were similar between prediabetes and diabetes. HbA1c levels had an influence in most of the coronary segment's diameters except proximal RCA. Furthermore, elevated HbA1c levels affected distal total coronary artery diameters more.

Authors' Note

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, and final approval of the version to be published. This paper was presented at the 17th International Update in Cardiology and Cardiovascular Surgery (UCCVS) Congress, November 5-7, 2021. The data about the patients who were enrolled in the present study were also introduced in the master thesis of Yasin Ozen.

Declaration of conflict of interest

The authors received no financial support for the research and/or authorship of this article. There is no conflict of interest

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