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Original Investigation

Comparison of Coronary Artery Calcium Scores with Platelet Volume and Uric Acid Levels in Patients Who Underwent Coronary Artery Imaging with Computed Tomography

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Abstract

Objective: The aim of this study is to evaluate the association of coronary artery calcium score and the increased risk of coronary artery disease with mean platelet volume (MPV) and uric acid.

Methods: For this retrospective study, patients with a preliminary diagnosis of chronic ischemic heart disease were taken from our hospital with patients from the clinic with laboratory tests and multidetector computed tomography (MDCT) performed. In total, there were 190 patients. Radiology reports and MDCT reports, clinical features, and values from the laboratory were obtained from the data system. The patients were divided into three groups according to the risk of coronary event, which was identified by coronary artery calcium score, age, and gender: low (105), medium (45), and high (40). The correlation between MPV and uric acid values was examined within these three groups. In addition, the patients with and without type 2 DM had the correlation with actual values examined. A p value <0.05 was considered statistically significant.

Results: According to this study, the comparison of coronary artery calcium score and the coronary event risk of the group with MPV and uric acid values showed that there was no statistical significance. In the study, in the diabetic patient group, MPV, coronary artery calcium score, risk of coronary event, and plaque volume were significantly higher.

Conclusion: Although coronary artery calcium score is seen as an independent risk factor for the prediction of coronary artery disease, in our study, there was no relation between MPV and uric acid values and coronary artery score, which indicates atherosclerosis in the coronary artery.

Keywords: Coronary artery disease, coronary artery calcium score, mean platelet volume (MPV), uric acid, multidetector computed tomography (MDCT)

Introduction

Deaths due to cardiovascular diseases are the primary cause of mortality worldwide (1). While decreasing important risk factors can effectively reduce the rate of deaths associated with cardiovascular diseases, hospital treatment can help few patients (2). The calcification of coronary arteries is an important and precise marker for indicating coronary atherosclerosis (3). The coronary artery calcium score (CACS) can give significant information about coronary artery disease without the development of a cardiac event. It shows calcification in coronary arteries and heart valves and complications that may occur depending on them. In light of these data, a physician can closely follow-up risky patients.

In the determination of possible cardiac event risks, the detection of atherosclerosis in coronary arteries has an important role. Therefore, the detection of coronary artery calcification, which is an important indicator of atherosclerosis, was essential for previously identifying the risk of cardiovascular disease. Many studies revealed that the presence of calcium in coronary arteries has a high predictive value for demonstrating serious cardiac events that may develop in asymptomatic individuals in subsequent years (4). Electron beam tomography and multidetector computed tomography (CT) were used as non-invasive, practical, reliable, and sensitive techniques for determining calcification in coronary arteries (5-7). Because the procedure is performed with multidetector CT, other pathologies in the sectional area can be detected and diagnosed earlier.

Uric acid is the last product of purine metabolism in humans and it a minor risk factor for coronary artery disease. In many studies, a relationship between high levels of uric acid and coronary artery disease has been found, and various results have been obtained. Research has revealed that hyperuricemia is an independent risk factor for coronary artery disease (8).

Platelets play an important role in the development of acute complications associated with atherosclerosis. The adhesion of platelets to the endothelium is the first stage in atherosclerosis. Acute coronary syndromes develop as a result of rupture in the atherosclerotic plaque, activation of the coagulation cascade appearing after that, and a common pathophysiological mechanism formed by the adhesion, activation, and aggregation of platelets (9, 10). Because

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large volume platelets are metabolically more active, the volume of platelets is one of the important determinants of platelet functions. Increased mean platelet volume (MPV) is considered as an indicator of platelet functions and activation and also of increased risk of cardiovascular disease (11-13). Platelet volume increases in the presence of atherosclerotic diseases including coronary artery disease, peripheral artery disease, renal artery stenosis, and cerebrovascular diseases, as well as in the presence of factors posing a risk for atherosclerosis, such as hypertension, hyperlipidemia, diabetes mellitus, chronic renal failure, and obesity (14, 15).

In this study, we evaluated the relationship between multidetector CT, which is a good non-invasive imaging technique for revealing coronary artery disease, and CACS obtained in this imaging technique and coronary event risk predicted based on the evaluation of this score according to age, gender, platelet volume, and uric acid level, which are reported to be independent risk factors for coronary artery disease in recent studies.

Methods

The files of patients who were admitted to our hospital between June 2007 and January 2013 and who requested to undergo multidetector CT and coronary artery imaging due to the pre-diagnosis of chronic ischemic heart disease were retrospectively evaluated. MPV and levels of HbA1c and uric acid were taken from their recordings. Age, gender, and the diabetic state of the patients were recorded. Coronary CT angiography reports were examined, and parameters on coronary event risk obtained according to the table formed considering CACS, plaque volume, age, and gender of the patients were assessed.

The patients excluded from the study were those in the age range of 35–70 years and those who underwent known coronary artery bypass surgery or placement of stents because their risk of cardiovascular disease was not calculated according to CACS.

The patients' CACS calculation technique and risk table are presented below (Table 1).

Technique: Non-contrast volumetric axial sections synchronized with 16-detector CT and ECG were taken in 1-mm section thickness, 0.75-mm collimation, and 0.5-mm reconstruction space. Calcium scoring was evaluated according to the Agatston scoring system using "Siemens Calcium Scoring Software" in the left main coronary artery, left anterior descending coronary artery, circumflex artery, and right main coronary artery.

In the patients included in the study, CACS and coronary event risk and the relationship between the levels of uric acid and MPV were evaluated. The existent data of patients with and without the diagnosis of diabetes were compared.

Statistical analysis

The characteristics of the patients were summarized with basic statistics. Mean, median, standard deviation, and minimum and maximum values were used for expressing quantitative variables, and number and percentage were used for categorical variables. The statistical significance value (p) was accepted as 0.05. Statistical analyses were performed using SPSS version 12.0 software.

For numerical parameters displaying normal distribution, one-way analysis of variance with post hoc Tukey's honest significant difference test was used for comparing three groups. In comparisons of the three groups in terms of numerical parameters with abnormal distribution, Kruskal–Wallis test was used. For dual comparisons, Mann–Whitney U test was employed. Crosstab statistics were used for comparing categorical variables (chi-square test, Mantel–Haenszel test). Moreover, for evaluating the relationship between numerical variables showing ordinal or asymmetrical distribution, Spearman correlation was used. In comparisons, parametric or non-parametric statistical techniques were used considering whether a variable displayed normal distribution or not. Student t-test was employed for comparing two groups with regard to numerical parameters with normal distribution. For abnormal numerical parameters, Mann–Whitney U test was used.

Results

A total of 190 patients (104 male and 86 female) were included in the study. Of the patients, 54.7% were males and 45.3% were females (Table 2). Fifty percent of patients had type 2 diabetes mellitus (DM). Of these patients with type 2 DM, 57% were males and 38% were females. No statistically significant difference was found in gender with regard to the presence of DM (p=0.145) (Table 3). Patients were divided into three groups according to the risk of coronary event. In the group of coronary event risk, the low-risk group included 105 patients, the moderate-risk group included 45 patients, and the high-risk group included 40 patients. No statistically significant difference was detected in terms of gender in the coronary event risk group (p=0.234) (Table 4). In the evaluation of coronary event risk group according to the diagnosis of type 2 DM, coronary event risk was found to be high in patients with a diagnosis of type 2 DM (p=0.038) (Table 5). The levels of uric acid were compared in terms of gender, the presence of type 2 DM diagnosis, and coronary event risk group and was found to be higher in male patients (p=0.041) (Table 6). In the comparison of MPV with gen-

Table 1. Risk determination according to age and gender

	Male				Female			
SCORE	Age<40	40–50	50–60	60<	Age<50	50–60	60–70	>70
0	L	L	L	L	L	L	L	L
1–10	M	L	L	L	M	L	L	L
11–100	M-H	M	M	M	M-H	M	M	L
101–400	H	H	M-H	M	H	H	M-H	M
>400	H	H	H	H	H	H	H	H

Atherosclerosis and heart attack risk: L: low risk; M: moderate risk; H: high risk

Table 2. Gender distribution of all patients

	Number	Percentage
Male	104	54.7
Female	86	45.3
Total	190	100.0

der, the presence of type 2 DM diagnosis, and coronary event risk group, MPV was found to be higher in patients diagnosed with type 2 DM ($p<0.001$) (Table 7). When CACS was compared with gender, type 2 DM diagnosis, and coronary event risk group, it was higher in patients with the diagnosis of type 2 DM ($p=0.004$) (Table 8). On the other hand, no statistically significant difference was found in the comparison of CACS with MPV and uric acid levels (Table 9). In addition, according to coronary event risk group, MPV, uric acid levels, and CACS values were compared, and no statistically significant difference was detected (Table 10).

Discussion

Coronary artery disease is one of the main causes of deaths in developed countries. The fact that a great number of patients have acute myocardial infarction and cardiac-dependent sudden death without presenting any sign demonstrates the significance of the early diagnosis and treatment of coronary artery disease. The detection of risk factors and initiation of appropriate protection programs are very important for cardiovascular diseases. At present, conventional risk factors such as smoking, age, and hyperlipidemia are insufficient for determining the risk profile of an individual. Recently, the use of imaging techniques for finding atherosclerosis developing in coronary arteries is overemphasized (16).

CACS with multidetector CT is the most commonly used technique that monitors the presence of coronary atherosclerosis in a non-invasive way. There is a significant relationship between calcification occurring in coronary arteries and coronary artery disease. It was stated in various studies that coronary artery calcium load, which is an important indicator of coronary atherosclerosis, provides prognostic data for determining cardiovascular risk, independently from traditional risk factors. However, some points such as how to use CACS and its applicability as a screening method in asymptomatic individuals are still controversial (16).

Considering all studies that have been conducted, the detection of coronary artery calcium load gives prognostic data in addition to traditional risk factors in asymptomatic patients. The absence of calcium deposition in the wall of coronary arteries is an indicator of low risk for cardiovascular event development in various risk groups. Besides that, increasing coronary artery calcium load shows an increased cardiovascular event risk. In patients having CACS of 0, ischemia is not generally observed in functional stress tests, and occlusive coronary artery disease is not expected in conventional coronary angiography (16).

In this study, we evaluated the relationship between multidetector CT, which is accepted to be a good non-invasive imaging technique for detecting coronary artery disease, and CACS obtained in this imaging technique and coronary event risk predicted based on the evaluation of this score according to age, gender, MPV, and uric acid levels, which are reported to be independent risk factors for coronary artery disease in recent studies.

Uric acid is the last product of purine metabolism in humans and is a minor risk factor for coronary artery disease. In many studies conducted, a relationship between high levels of uric acid and coronary artery disease has been found, and various results have been obtained. It has been revealed in some studies that hyperuricemia is an independent risk factor for coronary artery disease (8).

In our study, uric acid levels were found to be higher in men, but no statistically significant relationship was observed between uric acid levels and CACS and coronary event risk.

Atherosclerotic plaque rupture developing in coronary arteries and platelet activation following that are among the most important causes of acute ischemic events. Increased MPV is accepted to be an indicator of platelet functions and activation and is evaluated to be a marker of an increased cardiovascular disease risk (11, 12).

In our study, MPV was higher in patients diagnosed with DM. However, no statistically significant relationship was found between the levels of platelet volume and CACS and coronary event risk.

Table 3. DM distribution according to gender

		DM		
		Non-existing	Existing	Total
Male	Number	47	57	104
	Percentage	45.2	54.8	100.0
Female	Number	48	38	86
	Percentage	55.8	44.2	100.0
Total	Number	95	95	190
	Percentage	50.0	50.0	100.0

DM: diabetes mellitus

Table 4. Coronary event risk group according to gender

		Coronary event risk			
		Low	Moderate	High	Total
Male	Number	53	27	24	104
	Percentage	51.0	26.0	23.1	100.0
Female	Number	52	18	16	86
	Percentage	60.5	20.9	18.6	100.0
Total	Number	105	45	40	190
	Percentage	55.3	23.7	21.1	100.0

Table 5. Coronary artery risk according to DM

		Coronary event risk			
		Low	Moderate	High	Total
Non-existing	Number	60	19	16	95
	Percentage	63.2	20.0	16.8	100.0
Existing	Number	45	26	24	95
	Percentage	47.4	27.4	25.3	100.0
Non-existing	Number	105	45	40	190
	Percentage	55.3	23.7	21.1	100.0
Total					

DM: diabetes mellitus

Table 6. Uric acid levels

	Number	Mean	Median	Standard deviation	Minimum	Maximum
Whole group	190	5.4	5.3	1.4	2.6	9.7
Male	104	5.6	5.55	1.4	2.6	9.2
Female	86	5.2	5.2	1.2	3	9.7
DM non- existing	95	5.4	5.3	1.2	3	9.2
DM existing	95	5.4	5.2	1.5	2.6	9.7
Low	105	5.3	5.2	1.2	3.1	9.7
Moderate	45	5.6	5.3	1.4	2.9	8.9
High	40	5.5	5.4	1.7	2.6	9.2

DM: diabetes mellitus

Table 7. MPV

	Number	Mean	Median	Standard deviation	Minimum	Maximum
Whole group	190	8.5	8.35	1.2	5.8	15.1
Male	104	8.4	8.25	1.2	5.8	15.1
Female	86	8.7	8.4	1.1	6.7	12.3
DM non- existing	95	8.1	8.1	0.9	5.8	11
DM existing	95	8.9	8.8	1.3	6.9	15.1
Low	105	8.5	8.4	1.0	6.7	11
Moderate	45	8.8	8.2	1.6	7.1	15.1
High	40	8.4	8.45	1.0	5.8	10.9

MPV: mean platelet volume; DM: diabetes mellitus

Table 8. CACS

	Number	Mean	Median	Standard deviation	Minimum	Maximum
Whole group	190	139.5	6.5	358.2	0	3569
Male	104	170.3	12.5	429.7	0	3569
Female	86	102.2	3	243.0	0	1763
DM non- existing	95	91.5	0	222.1	0	1322
DM existing	95	187.5	20	451.7	0	3569
Low	105	3.6	0	11.9	0	73
Moderate	45	90.6	68	85.1	6	380
High	40	551.3	371.5	621.9	69	3569

CACS: coronary artery calcium score; MPV: mean platelet volume; DM: diabetes mellitus

In a considerable number of patients with the diagnosis of diabetes mellitus, various micro- and macro-vascular complications develop over time. The degree and duration of hyperglycemia are important risk factors for the occurrence of micro- and macrovascular complications (15).

Hyperglycemia developing in patients with diabetes mellitus causes remarkable changes in platelet morphology and functions (15).

Platelets are significant targets for hyperglycemic damage, but the pathophysiology of this damage has not been completely explained. In various studies, it has been revealed that platelet sensitivity and increased platelet production in patients with DM can lead to some changes in platelet morphology. Larger and oversensitive platelets were found in patients diagnosed with diabetes mellitus (15).

Table 9. The correlation between CACS and uric acid levels and MPV

Spearman		CACS	Uric acid	MPV
CACS	r	1.000	0.068	0.017
	p	-	0.351	0.814
	N	190	190	190
Uric acid levels	r	0.068	1.000	-0.091
	p	0.351	-	0.211
	N	190	190	190
MPV	r	0.017	-0.091	1.000
	p	0.814	0.211	-
	N	190	190	190

MPV: mean platelet volume; CACS: coronary artery calcium score

Table 10. Correlations of CACS and uric acid levels and MPV according to coronary event risk

	Spearman		CACS	Uric acid	MPV
Low	CACS	r	1.000	-0.025	-0.023
		p	-	0.798	0.812
		N	105	105	105
	Uric acid levels	r	-0.025	1.000	-0.182
		p	0.798	-	0.064
		N	105	105	105
	MPV	r	-0.023	-0.182	1.000
		p	0.812	0.064	-
		N	105	105	105
Moderate	CACS	r	1.000	-0.008	0.128
		p	-	0.961	0.402
		N	45	45	45
	Uric acid levels	r	-0.008	1.000	0.112
		p	0.961	-	0.464
		N	45	45	45
	MPV	r	0.128	0.112	1.000
		p	0.402	0.464	-
		N	45	45	45
High	CACS	r	1.000	-0.045	-0.165
		p	-	0.785	0.310
		N	40	40	40
	Uric acid levels	r	-0.045	1.000	-0.032
		p	0.785	-	0.847
		N	40	40	40
	MPV	r	-0.165	-0.032	1.000
		p	0.310	0.847	-
		N	40	40	40

MPV: mean platelet volume; CACS: coronary artery calcium score

Conclusion

Some studies have revealed that uric acid levels and MPV are important laboratory values for demonstrating myocardial ischemia and atherosclerosis process. On the other hand, CACS is accepted to be a certain indicator of coronary atherosclerosis. In our study, the relationship between MPV and uric acid level, despite it being demonstrated as an independent risk factor for the prediction of coronary artery disease, and CACS, which is an indicator of atherosclerosis in coronary arteries, could not be showed. Considering that MPV and uric acid levels are affected by various drugs and comorbid diseases, further studies on this issue, which will be longer term, provide more detailed patient data, and have a larger population, are needed.

Ethics Committee Approval: Ethics committee approval was received for this study.

Informed Consent: Due to the retrospective nature of this study, informed consent was waived.

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