

Anger and Coronary Calcification in Individuals with and without Risk Factors of Coronary Artery Disease

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The authors investigated the relationship between anger and the calcification of the coronary artery in individuals with and without risk factors for coronary artery disease in Korea. Sixty-one subjects with risk factors of coronary artery disease and 31 subjects without risk factors were enrolled in this study. Electron Beam Computed Tomography was used to measure the calcium level of coronary artery. The anger expression scale was used to measure the anger levels. The anxiety, depression, hostility, and somatization subscales of the symptom checklist-90-revised (SCL-90-R) and the global assessment of recent stress (GARS) scale were used to assess the psychopathology and perceived stress. The logistic regression analysis results showed that only the anger-total score was significantly associated with the coronary calcification regardless of the risk factors. These results suggest that anger plays an important role in the calcification of the coronary artery.

Key Words: Coronary calcification, electron beam computed tomography, risk factor, anger

INTRODUCTION

According to recent estimates, coronary heart disease (CHD) is the third leading cause of death in Korea with a mortality rate that continues to rapidly increase. For example, today it is nearly twice as high as it was 10 years ago.¹ Many of these deaths occur suddenly and often without any prior warning signs or previously known coronary disease.² CHD is not normally suspected

until the symptoms occur or a positive stress test result is documented.³

Coronary artery disease commonly occurs in association with atherosclerosis.⁴ During the past few decades, considerable progress has been made in identifying the risk factors associated with coronary heart disease (CHD). Among the major factors are age, gender, elevated plasma cholesterol levels, hypertension, smoking, and obesity.⁵

Psychological factors are also known to affect the biological processes involved in the progression of coronary artery disease,⁶ and psychological risk factors may have a direct physiological effect on the progression to CHD. Moreover, they may add additional risk in association with adverse health behaviors, such as smoking,⁷ and the other traditional CHD risk factors, such as hyperlipidemia.⁸ It has been suggested that the magnitude of these psychological risks is similar to those reported for the traditional cardiovascular risk factors.⁶

Research has demonstrated that mental stress can result in a transient reduction in the coronary artery diameter, particularly in more severely diseased arteries.⁹ It was reported that most patients who had at least one occlusion that was greater or equal to 75% also scored highest on type A behavior and hostility.¹⁰ Laboratory studies have demonstrated that myocardial ischemia can be triggered by mental stress and emotions such as anger.^{11,12} Anger might contribute to the atherosclerotic process by elevating the triglycerides and LDL (low-density lipoprotein)/HDL (high-density lipoprotein) ratio.¹³ Research suggests that anger is a potent short-term trigger of a myocardial infarction¹⁴ and that anger is more

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strongly associated with ischemia than any other emotional state.¹⁵ In addition, it was reported that a high level of anger expression and low social support is likely to increase the risk of disease progression in patients with coronary artery disease.¹⁶

In asymptomatic individuals, the risk is normally estimated based on the family history of a premature CHD and the risk factors present. However, this information alone is of limited prognostic value.¹⁷ For example, it is known that most coronary patients have only average or moderately elevated cholesterol levels.^{18,19} This suggests the need for improved prediction, possibly aided by the detection of preclinical coronary artery disease in asymptomatic individuals.³

Coronary artery calcium, unlike peripheral arterial calcium, is observed only in the presence of calcified atherosclerotic plaque.^{20,21} Coronary electron beam computed tomography (EBCT) is a noninvasive tool, which was developed to detect atherosclerotic coronary artery disease by measuring the amount of calcium deposition in the walls of the coronary arteries. The EBCT-derived coronary artery calcium (CAC) scores correlate with the severity of the underlying coronary artery disease.²² Therefore, the EBCT calcium score may be taken as an effective predictor of coronary artery disease. In addition, EBCT might be a useful screening tool for asymptomatic persons with coronary artery disease.⁴

Ethnic differences have been found in terms of the coronary calcium prevalence in a cohort study of high risk asymptomatic adults.²³ To date, few studies have reported a relationship between anger and coronary calcification, using EBCT. One study showed a positive association between hostility and coronary artery calcification.²⁴ However, another study found no such association between hostility and subclinical coronary artery disease.²⁵ No reports showing a relationship between the psychological factors, such as anger and coronary calcification, using EBCT are available in Korea.

The aim of this study was to determine the relationship between anger and calcification of the coronary arteries in individuals with and without the risk factors for coronary artery disease among a sample of middle or older aged

people.

MATERIALS AND METHODS

Subjects

The subjects were self-referred or referred by their physicians to a radiologist for EBCT screening, or recruited through advertisements among hospital staff and university personnel. Informed consent was obtained from all subjects after the nature of the procedure had been fully explained. They were selected consecutively and were asked to complete a questionnaire, covering their medical and risk factor history, their history of hypertension, diabetes, hypercholesterolemia, tobacco use, current weight and height, a family history of premature myocardial infarction, chest pain suggestive of angina pectoris, and a reported previous myocardial infarction. However, from the self-report questionnaire, none of these subjects reported being treated for psychiatric disorders or having any symptoms of such disorders. Only those aged between 40 and 60 were included. After reviewing the completed questionnaire and the results of the study, the subjects were divided into those with risk factors and those without. In addition to those with a family history of premature CHD and smoking, those with a serum cholesterol level of 240 mg/dl or more, obesity (determined by BMI higher than 25.0 kg/m²), diabetes mellitus (determined by fasting blood glucose level of 140 mg/dl or more), and hypertension (140/90 mmHg or higher) were grouped as being subjects with the risk factors (risk group). Among them, 2 patients with diabetes mellitus and 16 patients with hypertension were included in the study. The others were grouped as being subjects without the risk factors (non-risk group). In this case, the completed questionnaire was reviewed and the above biological measurements were also made to confirm the non-risk group.

However, those subjects with a history of psychiatric disorders, chest pain or previous coronary disease and those with diseases other than hypertension and diabetes mellitus were excluded from the study. The scan results were scored by

a radiologist.

Electron beam computed tomography (EBCT)

The studies were performed using an Imatron C-100 Ultrafast (Imatron, South San Francisco, CA) CT scanner, as previously described in the protocol.²⁴ Briefly, this protocol required the subjects lie in the supine position head first into the scanning aperture with no couch angulation. They were instructed to take three deep breaths and to hold them at end-expiration while a preview scan was performed. The patients' positioning was checked and adjusted, so that the scanning began from near the lower margin of the bifurcation of the main pulmonary artery. Coronary visualization was achieved without contrast using a single slice mode of the ultrafast CT scanner in conjunction with a 100 msec scan time, a 3 mm slice thickness, electrocardiographic triggering (to 80% of the R-R interval), and breath holding for approximately 45 seconds. Twenty to 30 contiguous slices were acquired with no interslice gaps. Each of the levels, which encompassed the proximal portions of the coronary arteries where almost all the calcium is present, was evaluated sequentially to determine the presence and quantity of the CAC deposits. From the protocol,²⁶ the threshold for a calcified lesion was set at a CT density of 130 Hounsfield units (HU) in at least 1 pixel (an area $\geq 0.51 \text{ mm}^2$). At each level, all the pixels with a CT density $\geq 130 \text{ HU}$ were displayed. A region of interest was manually encircled around each visible lesion within each coronary artery, and the computer-acquired measurements of the lesion area in square millimeters along with the maximum Hounsfield number of each region of interest were recorded. A density score was determined on the basis of the maximum Hounsfield number in the following manner: 1=130 through 199, 2=200 through 299, 3=300 through 399, and 4 \geq 400 HU. The score for each region of interest was calculated by multiplying the density score by the area. A total calcium score was determined by summing each of these scores for all 20 slices from the following major coronary arteries: (1) the left main, (2) the left anterior descending, (3) the left circumplex, and (4) the right coronary

artery.

Procedures for other biological studies and psychological factors

The lipid assessment involved determining the total serum, low-density lipoprotein (LDL), high-density lipoprotein (HDL) cholesterol, and serum triglyceride levels. These lipid levels were all determined shortly after the EBT. All the subjects were consecutively selected and interviewed, and were given a verbal and written explanation of the study. Only those patients that consented to the study completed the questionnaires, and all but 35 responded. The subjects were asked to respond to the questionnaire just before the EBT. The questionnaire included the Korean version²⁷ of the Anger Expression Scale,²⁸ the anxiety, depression, somatization, and hostility subscales of the Korean version²⁹ of the Symptom Checklist-90-Revised (SCL-90-R),³⁰ and the Korean version³¹ of the GARS scale.³² The anger expression scale is a 22-item self-rating instrument designed to assess the levels of anger expression (anger-out) and anger suppression (anger-in). The SCL-90-R is a 98-item self-rating instrument designed to assess the psychopathology during the previous week, and constitutes 9 subscales. The GARS is a self-rating instrument developed for assessing the severity of recent stressors in seven areas during the previous week.

Data analysis

Comparisons of the biological variables and the psychological measures between the risk group and the non-risk group were made using a Student's *t*-test. Group comparisons based on the demographic data such as, gender, marital status (married vs. widowed) were made using the χ^2 test. Logistic regression analyses were undertaken to determine the relationship between the level of anger and presence or absence of calcification. No comparison between the risk and the non-risk groups was made on total calcium level, because there was only a small number of subjects with calcification compared to those without calcification.

RESULTS

Sociodemographic data

The sociodemographic characteristics of the risk and non-risk groups are described in Table 1. No significant differences were found in terms of gender, age, the level of education, income, or marital status (married vs. widowed) between the two groups (Table 1).

Sixty-one subjects with the risk factors for coronary heart disease and 31 subjects without the risk factors were enrolled in this study. Twenty-six had 1 and 35 had ≥ 2 of the following risk factors: past or current smoking (70.5%), diabetes (3.3%), hypercholesterolemia (31.1%), hypertension (26.2%), a family history of premature CHD (11.5%), or obesity (40.0%).

Comparison of the level of anger and the other psychological factors between the risk group and the non-risk group

The risk group and the non-risk group showed no significant differences in anger expression levels. In addition, no significant differences were found in the anxiety, depression, somatization, and hostility subscales of the SCL-90-R or in the total GARS scores between the two groups

(Table 2).

Comparison of calcification between the risk group and the non-risk group

Calcification, as evidenced by the presence of CAC deposits, was found in 23 subjects with the risk factors, and in 10 subjects without the risk factors. No significant difference was found in the proportion of those with calcification between the risk and the non-risk groups ($\chi^2=.27$ $p=.61$).

Correlation between the level of anger expression and calcification

In the logistic regression analyses, only the anger-total subscale score was significantly associated with calcification. The other variables such as gender, age, presence or absence of risk factors were not significantly associated with calcification. In contrast, either the anger-in or anger-out subscale score was not significantly associated with calcification (Table 3).

However, there was no significant correlations between the level of anger expression and the total cholesterol ($r=-.14$ -.01 $p>.05$), LDL-cholesterol ($r=-.23$ -.10 $p>.05$), HDL-cholesterol ($r=-.37$ -.11 $p>.05$), or triglyceride ($r=-.07$ -.20 $p>.05$) levels in the risk or in the non-risk groups.

Table 1. Comparison of the Sociodemographic Characteristics

	Risk group (N=61) N (%)	Non-risk group(N=31) N (%)	Statistics	df	p
Sex					
Male	44 (72.1)	17 (54.8)	$\chi^2=2.75$	1	.10
Female	17 (27.9)	14 (45.2)			
Age (years)					
Mean \pm S.D.	53.5 \pm 6.1	53.1 \pm 7.2	t=.29	90	.77
Education (years)					
Mean \pm S.D.	14.3 \pm 2.5	14.6 \pm 2.1	t=-.58	90	.57
Marital status					
Married	59 (96.7)	27 (87.1)	$\chi^2=3.12$	1	.08
Widowed	2 (3.3)	4 (12.9)			
Income (1,000 dollars per month)					
Mean \pm S.D.	2.46 \pm .88	2.44 \pm .90	t=.01	90	.99

Table 2. Psychological Factors in the Risk Group and Non-risk Group

	Risk group (N=61) Mean \pm S.D.	Non-risk group (N=31) Mean \pm S.D.	t	df	p
Anger Expression Scale					
Anger-in	11.1 \pm 5.1	11.0 \pm 3.9	.17	90	.86
Anger-out	6.4 \pm 3.6	6.5 \pm 2.8	-.03	90	.97
Anger-total	17.6 \pm 6.4	17.4 \pm 5.0	.12	90	.91
SCL-90-R					
Anxiety	5.0 \pm 5.0	4.9 \pm 4.1	.05	90	.96
Depression	9.2 \pm 7.0	8.2 \pm 5.4	.72	90	.47
Hostility	2.4 \pm 2.7	2.0 \pm 2.0	.63	90	.53
Somatization	7.6 \pm 6.3	7.1 \pm 5.3	.37	90	.71
GARS					
Total	18.5 \pm 6.6	18.8 \pm 7.8	-.16	90	.87

SCL-90-R, Symptom checklist-90-revised; GARS, Global assessment of recent stress.

Table 3. Logistic Regression Results for the Level of Anger Expression and Calcification of the Coronary Artery

Variables	Beta	SE	OR	95%CI	p
Gender	-0.20	0.50	0.82	0.30-2.20	.69
Age	0.05	0.04	1.05	0.98-1.12	.21
Presence or absence of risk factor	0.18	0.49	1.19	0.46-3.10	.72
Anger-total	0.08	0.04	1.08	1.001-1.17	.04
Gender	-0.27	0.50	0.76	0.29-2.03	.59
Age	0.04	0.04	1.04	0.97-1.12	.23
Presence or absence of risk factor	0.17	0.48	1.19	0.46-3.06	.73
Anger-in	0.07	0.05	1.07	0.97-1.18	.18
Gender	-0.35	0.49	0.70	0.27-1.85	.48
Age	0.04	0.04	1.05	0.97-1.12	.22
Presence or absence of risk factor	0.17	0.48	1.18	0.46-3.05	.73
Anger-out	0.11	0.07	1.12	0.98-1.28	.11

SE, Standard error; OR, Odds ratio; CI, Confidence interval.

DISCUSSION

There were no significant differences in psychological measures such as the levels of anger expression, hostility, depression, anxiety, and somatization between the risk group and the non-risk group. This suggests that the risk group was biologically but not psychologically different from the non-risk group.

Calcification in the coronary artery, as evidenced by the presence of CAC deposits, was found in 23 subjects with risk factors, whereas it was found in 10 subjects without risk factors. However, the proportion of those with coronary calcification was similar in the two groups. These results suggest that calcification in the coronary artery does not occur only in association with the known risk factors.

The logistic regression analyses showed that, the anger-total subscale score was significantly associated with coronary calcification regardless of the presence or absence of the risk factors, whereas either the anger-in or anger-out subscale score was not significantly associated with coronary calcification. These results suggest that anger plays an important role in the calcification of the coronary artery.

Based on past research, the serum lipid concentrations are associated with the psychosocial factors. For example, elevations in the total serum cholesterol level have been found in persons exposed to a variety of psychological stressors³³ and among the individuals scoring high on the self-reports or the observational measures of type A behavior and hostility.^{34,35} A moderate association was also reported between the anger and cholesterol concentrations.^{34,35} However, men who had a higher tendency to express anger outwardly had a significantly higher HDL-cholesterol level than men with a lower tendency to express anger.³⁶ In this study, no significant associations were found between the anger levels and the serum lipids or between the perceived stressors (as determined by the total GARS score) and serum lipids in the non-risk group and risk group. Such differences might be related to the small number of subjects as well as heterogeneity of the risk factors in this study. However, further study will be needed to clarify the relationship between either anger or stress and the serum lipid levels.

This study had some methodological limitations. First, the data is based on a relatively small number of subjects. Second, the risk group consisted of subjects with heterogeneous risk factors. Third, only the self-reported questionnaires were used to identify those subjects without psychiatric disorders. Finally, definitive conclusions as to whether anger precedes or is a consequence of coronary calcification could not be drawn because of the cross-sectional nature of the data.

An additional study using a large number of subjects and a homogeneous group with the same risk factors will be needed. On the other hand, a longitudinal study should also be conducted in order to determine the causal relationship between anger and coronary calcification.

In conclusion, these results suggest that anger

can play an important role in the calcification of the coronary artery.

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