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Evaluation of Electrocardiogram Changes in Patients with Slow Coronary Flow

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Abstract

Background: Slow coronary flow (SCF) is defined as a condition in which in spite of no evidence of coronary occlusion or stenosis in angiography, there is delayed pacification of the vessels after the injection of a contrast agent. There are several studies about electrocardiogram (ECG) changes in these patients, but changes like OLD MI, RBBB, LBBB, LVH and ST-T wave have not been evaluated in them and sample sizes in these studies have been also small. The aim of this study was to evaluate electrocardiogram changes in patients with slow coronary flow referred to Shafa Hospital affiliated to Kerman University of Medical Sciences, Kerman, Iran.

Methods: In this descriptive-analytical study, 3000 patients with probable diagnosis of coronary occlusion referred to Shafa hospital affiliated to Kerman University of Medical Sciences were screened. Elective coronary angiography was performed for all patients using Judkinz standard method and the findings were analyzed by two cardiologists. Also, standard 12-lead electrocardiogram was recorded for the patients. Finally, 57 patients with normal coronary flow and 105 patients with slow coronary flow were included in this study.

Results: Frequency of SCF was 3.5%. The electrocardiogram (ECG) changes in patients with SCF were evaluated and it was revealed that greatest changes were related to T wave and the most frequent form was inverted T wave (57.1%). There was no significant difference in these changes between SCF group and NCF group (P=0.279). The other electrocardiogram changes in the two groups did not reveal any statistically significant difference.

Conclusion: According to the findings of this study, CSF can be diagnosed on the basis of angiographic findings, while electrocardiogram changes are non- specific findings in these patients.

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Introduction

Slow coronary flow (SCF) is an angiographic phenomenon characterized by delayed pacification of epicardial coronary artery without any occlusion or stenosis or other problems such as coronary artery ectasia, coronary spasm or valvular disease or heart muscle disease (1-3). This phenomenon was reported for the first time in 1972 by assessing the angiographic results of 6 patients with chest pain (4). Overall, SCF has been observed in almost 1% of the patients undergoing coronary angiography (5). In the recent

angiographic studies, the frequency of SCF has been reported 5.5 percent (6). Pathogenesis of CSF is not well known, but a number of histopathological theories have suggested reduced intraluminal diameter and functional obstruction, as the basis of pathogenesis (7).

Recent studies have showed that endothelial dysfunction, atherosclerosis, and inflammation can play an important role in the pathogenesis of SCF (7-12). This phenomenon is clinically more common in young male smokers with acute coronary syndrome (8). SCF is diagnosed with chest pain, which cannot be classified as any coronary artery diseases like stable angina or cardiac syndrome X (13). Electrocardiogram (ECG) is widely accepted as a noninvasive diagnostic test, which is available and useful in the diagnosis of cardiac ischemia, but its diagnostic value in patients with SCF has not been studied extensively.

In a study by Natalie et al (2011), ST-T wave changes in patients with SCF during the presentation of the disease with acute coronary syndrome were evaluated (14). Turkmen M, et al (2007) in their study evaluated P-wave duration and dispersion (PWD) in patients with SCF (15) and Bicerglu St et al (2007) investigated the relationship between left Bundle Block Branch (LBBB) and SCF (16). But in these studies, the prevalence of electrocardiographic changes such as Old Myocardial Infarction (MI), right Bundle Block Branch (RBBB), left Bundle Block Branch (LBBB), left ventricular hypertrophy (LVH), and ST-T wave changes have not been evaluated. Moreover, the relationship between the involved artery and ECG changes has not been evaluated in these studies and most of these studies had a small sample size of just 30-40 patients.

Materials and Methods

This cross- sectional study was performed on patients with frequent chest pain and in some cases, with history of hospitalization in CCU who underwent angiography in Shafa hospital affiliated to Kerman University of Medical Sciences during 2014-2015. Elective coronary angiography was performed for all patients using Judkinz standard method and through femoral artery by manual injection of a contrast agent (Visipaque, 6-8 cc for each view) using F6 (Judkins) catheter. During angiography, certain drugs that could have an impact on vascular resistance were inhibited.

Afterwards, angiograms which showed SCF according to diagnostic criteria of Timi Frame Count (17), were coded, analyzed and confirmed by two cardiologists on a daily basis.

A group of patients with normal coronary flow, as control group, were also selected and their angiograms were coded and analyzed by the two cardiologists. Exclusion criteria for both groups were the same. After 10 minutes lying on the bed in a quiet room, standard 12-lead electrocardiogram was recorded for the patients. According to the codes of angiograms, electrocardiograms were also coded and read by scholars under the supervision of a cardiologist and relevant information was collected.

Exclusion Criteria

Patients with coronary artery diseases (spasm, plaque, ectasia, and obstructive lesions), cardiomyopathies, valvular heart diseases and congestive heart failure, were excluded from the study because these conditions can affect coronary blood flow. Finally, 57 patients with normal coronary arteries (NCF) and 105 patients with SCF were selected and included.

Data Analysis

Data analysis was done through SPSS19 and using Chi-square test for qualitative and t-test for quantitative data. Statistical significant level was considered at $P<0.05$.

Diagnostic Criteria for SCF

In angiographic films, the number of frames, after the injection of contrast agent, from vessels opacification to its complete pacification, called as Timi Frame Count, was used as an accurate measure of blood flow in arteries. In other words, more frame count indicates longer period of complete vessel pacification that is the ratio of blood flow to the vessel length. According to the study of Gibson et al (18), the left anterior descending artery (LAD) compared with the left circumflex artery (LCX) and the right coronary artery (RCA) is about 1.7 times longer; therefore, to determine the SCF group, based on the frame count in normal arteries, cut off point values were considered as 22.5 for RCA, 26 for LAD and 28 for LCX (sensitivity and specificity= 100%). Finally, 105 patients with SCF and 57 patients with NCF were included in this study.

Results

The prevalence of SCF was 3.5 percent. Mean age of patients with NCF and SCF was respectively 54.39 years (39-70 years) and 51.85 years (29-79 years). Mean age of patients with SCF was lower than that of those with NCF. In SCF patients, 48.6% had history of hospitalization, while in NCF patients 43.9% had history hospitalization. There was no significant difference between the two groups in regard to the demographic characteristics such as sex, prevalence of hypertension and smoking (table 1). The prevalence rates of electrocardiogram changes in the two groups were not significantly different (Table 2).

Table 1. Comparison of demographic characteristics of patients with SCF and NCF

Variables		SCF	NCF	P-value
mean age (+ SD)		51.85 (+SD)	54.39 (+S)	0.106
Gender	Male	57 (54.3%)	24 (42.1%)	0.139
	Female	48 (45.7%)	33 (57.9%)	
History of Hospitalization	No	54 (51.4%)	32 (56.1%)	0.342
	Yes	51 (48.6%)	25 (43.9%)	
Opium consumption	No	81 (77.1%)	38 (66.7%)	0.105
	Yes	24 (22.9%)	19 (33.3%)	
Smoking	No	85 (81.0%)	51(89.5%)	0.158
	Yes	20 (19.0%)	6 (10.5%)	
Diabetes	No	87 (82.9%)	42 (73.7%)	0.166
	Yes	18 (17.1%)	15 (26.3%)	
High Blood Pressure	No	62 (59.0%)	32 (56.1%)	0.72
	Yes	43 (41.0%)	25 (43.9%)	
High Blood Cholesterol	No	90 (85.7%)	47 (82.5%)	0.584
	Yes	15 (14.3%)	10 (17.5%)	

Table 2. Comparison of the frequency of electrocardiographic changes in patients with SCF and NCF

ECG Changes		NCF	SCF	P-value
RHYTM	NL	104(99.0%)	57(100%)	0.46
	AF	1(1%)	0	
AXIS	NL	94(89.5%)	52(91.2%)	0.432
	LEFT	8(7.6%)	1(1.8%)	
	RIGHT	3(2.9%)	4(7.0%)	
PR.INTER	Mean	0.172	0.169	0.406
QRS DURA	mean	0.071	0.072	0.511
OLD MI	NO	94(89.5%)	55(96.5%)	0.002
	YES	11(10.5%)	2(3.5%)	
RBBB	NO	104(99.0%)	56(98.2%)	0.659
	YES	1(1%)	1(1.8%)	
LBBB	NO	102(97.1%)	56(98.2%)	0.666
	YES	3(2.9%)	1(1.8%)	
LVH	NO	0	0	1
	YES	0	0	
P CHANGE	NO	67(63.8%)	32(56.1%)	0.274
	Biphasic	10(9.5%)	5(8.8%)	
	BI.NEG	4(3.8%)	4(7%)	
	NEG	23(21.9%)	16(28.1%)	
LONG PR	NO	104(99.0%)	55(96.5%)	0.283
	YES	1(1%)	2(3.5%)	
WIDE QRS	NO	101(96.2%)	55(96.5%)	1
	YES	4(3.8%)	2(3.5%)	
ST CHANG	NO	85(81.0%)	52(91.2%)	0.06
	ELEVATIO	11(10.5%)	3(5.3%)	
	DEPRESS	9(8.6%)	2(3.5%)	
T CHANG	NO	29(27.6%)	25(43.9%)	0.279
	TALL	1(1%)	1(1.8%)	
	BIP NEG	13(12.4%)	5(8.8%)	
	BI.NEG.TA	2(2%)	0	
	NEG	60(57.1%)	26(45.6%)	

BIP. NEG: Biphasic-Negative T, NEG: Negative

Discussion

Although in previous studies, the frequency of SCF has been low, it has been raised (5.5%) in recent studies. Despite high frequency of this disease, there is lack of evidence on its etiology and underlying causes (6). SCF is a clinically important condition because it might cause angina at rest or during exercise or results in myocardial infarction and hypertension (19). Despite good prognosis of patients with SCF, chronic chest pain in these patients clearly affects their quality of life (4).

Clinical course of the disease is very debilitating and 80% of the patients frequently experience angina and more than 20%, require hospitalization in cardiac intensive care unit (8). Electrocardiogram as a diagnostic test that is non-invasive, accessible, and useful method for diagnosis of cardiac ischemia, is widely accepted, but its diagnostic value in patients with SCF has not been extensively studied. In this study, ECG cahnges observed in patients with SCF were not consistent with the results of other studies.

In the study by Bicerglu St et al (2007) with a sample size of 40 patients, LBBB frequency in patients with SCF was 6.1%, which was higher than its frequency in the present study(16. In the study by Muhammad Ali Sadr-Ameli et al (2015), the frequency of LBBB and RBBB was 7.3%, which is consistent with the results of our study (20).

In this study, ECG of 11 patients (10.5%) showed ST-segment elevation and those of 9 patients (8.6%) showed ST-segment depression. In the study of Sadr-Ameli et al (2015) on the prognosis of SCF, ECG changes and ST-segment depression has been reported as 39.6% in patients with SCF, which is inconsistent with the results of our study; however, the condition of ECG recording was not described in the mentioned study (20). Natalie Cutler et al (2015) have reported resting ST change (ST elevation) with a frequency of 39%, which is inconsistent with the results of our study (14). It is worth mentioning that they have recorded ECG changes in patients with SCF and acute coronary syndrome (ACS), but in the present study, ECG changes were recorded in patients without chest pain.

In Natalie Cutler study, the frequency of T-wave changes has been reported as 15% (14), which is inconsistent with the results of the present study (72.4%). Ali Sadr-Ameli et al reported negative T-wave in 29.3% of the patients (20), which is inconsistent with the results of our study.

Other ECG changes have not been reported in previous studies. In this study, the frequency of ECG changes in patients with SCF based on the blocked artery (LAD, RCA, or LCX) was also investigated and of 105 patients with SCF, 88 patients with three blocked arteries were reported. The LAD was involved in 11 cases, RCA in 2 cases, LAD and LCX in 3 cases, and RCA and LAD in one case. Of the eleven cases with involved LAD, 8 cases with T-wave inversion in the precordial leads were observed. And of 2 cases with involved RCA, one case with T-wave inversion in the AVF and III leads and the other one with T-wave inversion in the V1,4,5,6, and II leads were observed. In 3 cases with involved LAD and LCX, 2 cases with normal ECG and one case with T-wave inversion in III leads were reported.

In one case with involved LAD and RCA, T biphasic in V3,4, and 5 was observed. According to the obtained results, it can be concluded that involvement of LAD was consistent with ECG changes, but it was not the same for other arteries.

Limitations and Suggestions

There was no statistically significant difference between the two studied groups in the present study and it might be due to the fact that patients who underwent coronary angiography with complaint of chest pain or shortness of breath were candidates for angiography due to some pathological problems in their electrocardiogram, exercise tolerance test (ETT) or echocardiogram, while healthy people who had no problem did not undergo angiography. In addition, since the frequency of demographic characteristics, history of diabetes, hypertension, and high blood cholesterol in NCF group was higher than that in SCF group, the presence of underlying

disease is indicated in this group that can be categorized in syndrome X category.

Patients might have microvascular pathology that cannot be diagnosed through angiography and therefore, they might be classified in NCF group. In evaluation of intravascular lumen by intravascular ultrasound (IVUS), despite the normal coronary angiography, atherosclerosis plaques can be seen in the vessel wall. For comparison, a group of healthy people without cardiovascular complaints and pathological problems in exercise tolerance test (ETT) or echocardiography should undergo angiography for comparison with SCF group. But, it is not clinically possible because healthy people without any indication cannot undergo angiography due to its side effects, and it was the main limitation of this study.

According to the obtained results, since the frequency of hospitalization was the same in both groups indicating microvascular involvement in NCF group, it is suggested that ECG of patients in both groups be compared with that of healthy people.

Conclusion

According to the results of this study, SCF diagnosis is merely possible based on the angiographic results and electrocardiogram changes are not specific findings in these patients.

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