

Pseudonormalization: clinical, electrocardiographic, echocardiographic, and angiographic characteristics

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ABSTRACT

Objective: Spontaneous pseudonormalization (PN) is a unique 12-lead electrocardiography (ECG) finding which has been reported to be associated with severe, transmural myocardial ischemia. To date, a paucity of data exists about the incidence and clinical characteristics of patients with PN. Therefore the aim of this study was to investigate the incidence and the electrocardiographic, echocardiographic, and angiographic characteristics of patients with PN.

Methods: Clinical, laboratory, electrocardiographic, echocardiographic, and angiographic characteristics of 12 consecutive patients with PN on 12-lead ECG (Group 1) were compared with patients (Group 2, n=28) presenting with acute coronary syndrome (ACS) associated with ST-T wave changes without PN.

Results: All patients presented with chest pain. The incidence of PN among patients presenting with ACS was 1%. Pseudonormalization was present in precordial leads in 11 and in inferior leads in 1 patient. Nine out of 12 (75%) patients in Group 1, 16 out of 28 (57%) patients in Group 2 had elevation of cardiac enzymes compatible with acute myocardial infarction. Severely narrowed or totally occluded ischemia and/or infarction-related coronary arteries were present in all patients in Group 1, in 20 (71%) patients in Group 2. Three patients in Group 1 and one patient in Group 2 had coronary artery thrombus formation. Group 1 patients had worse coronary collateral grading in comparison to Group 2 patients.

Conclusion: Pseudonormalization is a rare entity and it is typically associated with severely narrowed or totally occluded coronary arteries along with thrombus formation, and poor coronary collateral development. (*Anadolu Kardiyol Derg 2007; 7 Suppl 1; 175-7*)

Key words: pseudonormalization, electrocardiography, acute coronary syndrome, echocardiography, coronary angiography

Introduction

Spontaneous pseudonormalization (PN) is a unique 12-lead electrocardiography (ECG) finding which has been reported to be associated with severe, transmural myocardial ischemia (1-4). To date, a paucity of data exists about the incidence and clinical characteristics of patients with PN (1). Therefore, the aim of this study was to investigate the incidence and the electrocardiographic, echocardiographic, and angiographic characteristics of patients with PN.

Methods

Study population

Patients presenting with acute coronary syndrome (ACS) with PN on 12-lead electrocardiogram (ECG) (Group 1) were prospectively included in the study, between July 2003 and July 2006. Clinical, laboratory, electrocardiographic, echocardiographic, and angiographic characteristics of this group was compared with patients presenting with ACS associated with ST-T wave changes without PN (Group 2). Patients with completely normal coronary arteries were excluded from the study.

Data acquisition

Every patient had serial 12-lead ECGs, serial serum creatine kinase (CK)-MB, serum cardiac troponin I measurements, transthoracic echocardiography, and coronary angiography.

12-lead surface ECG

Every patient had 12-lead ECG on admission, and during and after an each episode of chest pain. Pseudonormalization was considered positive in the presence of following three criteria: 1-Presence of ischemic T wave inversion (>0.2 mV) on the baseline ECG of the index patient, 2-"Normalization" of the T wave inversion (isoelectric ST segment and upright T wave) during an episode of ischemic chest pain, and 3-Reversion of the T wave inversion to their baseline appearance, following resolution of the chest pain (5).

Transthoracic echocardiography

All patients underwent transthoracic echocardiography (within 48-hours of admission) for the evaluation of valvular function and morphology, left ventricular (LV) wall motion abnormalities and LV ejection fraction. Left ventricular wall motion abnormalities were assessed by using regional wall

motion index (16-segment model) (6) and LV ejection fraction was calculated by semiquantitative two-dimensional visual estimate method (7).

Coronary angiography

Selective coronary angiographies were performed in all patients. Atherosclerotic burden was measured by the modified Gensini score once the patient was diagnosed with coronary artery disease (8). Development of coronary collaterals (collateral grading) was assessed by Rentrop classification (9).

Statistical analysis

Values were expressed as mean±SD. Characteristics of groups were compared using the unpaired Student’s t-test and p <0.05 was considered statistically significant. Categorical variables were compared using Chi-square analysis.

Results

Group 1 consisted of 12 patients (10 men/2 women; mean age 61±8 years, range 43 to 76 years). Group 2 consisted of 28 patients (23 men/5 women; mean age 57±11 years, range 40 to 84 years).

All patients presented with chest pain. The incidence of PN among patients presenting with ACS was approximately 1% (12 out of 1284). Pseudonormalization was present in precordial leads in 11 and in inferior leads in 1 patient of Group 1.

All patients underwent coronary angiography±percutaneous coronary intervention within 24-hours of their presentation. Use of beta-blockers, aspirin, statins, angiotensin converting enzyme inhibitors, heparin and IV nitrates were similar between the two groups. Group 1 patients received glycoprotein IIb/IIIa inhibitors more often than Group 2 patients (33% versus 3%).

The prevalence of risk factors for coronary artery disease was similar between Group 1 and 2. History of acute myocardial infarction was more common among patients in Group 2 than in Group 1 patients (32% versus 8%, p>0.05). Elevation of cardiac enzymes compatible with acute myocardial infarction was present in 9 out of 12 patients in Group 1, and in 16 out of 28 patients in Group 2 (p>0.05). Severely narrowed (90% to 99%, n=10) or totally occluded (n=2) ischemia and/or infarction-related coronary arteries were present in all patients in Group 1, and in 20 patients (71%) in Group 2 (p>0.05). Three patients (25%) in Group 1 and 1 patient (3%) in Group 2 had coronary artery thrombus formation. Group 1 patients tended to have better LV ejection fractions (52±13% versus 47±12%, p=0.25), better wall motion index (0.16±0.29 versus 0.5±0.74, p=0.12), and less atherosclerotic burden (91±83 versus 144±105, p=0.1) in comparison to Group 2 patients. Group 1 patients had less coronary collateral development (0.25±0.6 versus 1.04±1.3, p=0.015) in comparison to Group 2 patients (Table 1).

Discussion

The cellular, electrocardiographic, and electrophysiological mechanisms of PN are unknown. Previous studies have shown that early negative T waves in patients with ST segment elevation myocardial infarction are due to a recent transmural myocardial ischemia rather than active ischemia which is consistent with the data that recurrences of spontaneous ischemia can result in

transient ST segment re-elevation or pseudonormalization of T waves (10, 11). It is quite possible that the T wave inversions seen on the baseline 12-lead ECGs (taken in the absence of active chest pain) in patients with ACS represent “myocardial stunning” rather than active ischemia. Angiographically, patients with PN typically have severely narrowed or totally occluded ischemia/infarction-related coronary arteries with unstable plaques and thrombus formation. Furthermore, patients with PN may have larger thrombus load and severely reduced coronary blood flow. In addition, underdeveloped coronary collaterals, as shown in our study population, can be a contributing factor for myocardial ischemia. As a result, the mechanism for normalization may be the algebraic sum of the extent of ST segment elevation and the amplitude of the T waves of acute myocardial ischemia plus the extent of preexisting ST segment depression and the degree of T wave inversion, to result in isoelectric ST segment and upright T wave (1, 12, 13).

Pseudonormalization of T waves can be spontaneous or non-spontaneous. Non-spontaneous PN of T waves have been frequently described in certain clinical conditions such as during coronary angioplasty, exercise stress testing, and dobutamine echocardiography (14-19). These studies reported that the PN of T waves predicts recovery of regional contractile function after anterior wall myocardial infarction. However, the specificity and the sensitivity of this finding for the presence or absence of myocardial ischemia are low. On the other hand, spontaneous PN is a relatively rare but a very specific finding for severe myocardial ischemia among patients with ACS.

Table 1. Clinical, echocardiographic and angiographic characteristics of patients

Variables	Group 1	Group 2	p
Age, years	61±8	57±11	0.24
Gender (Male/Female)	10/2	23/5	NS
History of CAD, n (%)			
History of AMI	1(8)	9(32)	NS
History of CABG	1(8)	2(7)	NS
History of PCI	1(8)	4(14)	NS
Risk factors for CAD, n (%)			
Hypertension	6(50)	15(54)	NS
Diabetes mellitus	2(17)	5(18)	NS
Smoking	5(41)	15(54)	NS
Hyperlipidemia	4(33)	15(54)	NS
Peak serum CK-MB, ng/mL	55±65	72±102	NS
Peak serum Troponin I, ng/mL	30±41	28±42	NS
LVEF,%	52±13	47±12	0.25
Wall motion index	0.16±0.29	0.5±0.74	0.12
Collateral grading	0.25±0.6	1.04±1.3	0.015
Gensini score	91±83	144±105	0.1

Data are given as mean±SD, number of patients, and percentages. p<0.05 considered to be significant. AMI- acute myocardial infarction, CABG- coronary artery bypass surgery, CAD- coronary artery disease, CK-MB- creatine kinase MB fraction, LVEF- left ventricular ejection fraction, NS- non significant, PCI- percutaneous coronary intervention

In agreement with prior studies, we showed that spontaneous PN of T waves indicate severe myocardial ischemia (1-5). Therefore, these patients should be treated on an urgent basis with aggressive medical treatment and percutaneous coronary intervention.

Study Limitations

The number of patients in Group 1 were limited due to the rarity of PN. The plaque structure and the thrombus load can be better delineated by using intravascular ultrasound and coronary angiography.

Conclusions

Pseudonormalization is a rare entity and it is typically associated with severely narrowed or totally occluded coronary arteries along with thrombus formation and poor coronary collateral development. Patients with PN tend to have better left ventricular function, wall motion index and less atherosclerotic burden in comparison to patients with ACS but without PN.

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