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Clinical Importance of Late Potential in Patients With Angina Pectoris

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Abstract

Angina pectoris, especially vasospastic angina, is associated with lethal ventricular tachycardia. The clinical importance of late potential in angina pectoris was assessed in 171 patients with angina-like pain. Patients were categorized into three groups based on coronary angiography. Patients in the exertional angina pectoris (AP) group exhibited at least 75% organic stenosis of a major coronary artery after intracoronary injection of a nitrate drug (82 patients). Patients in the chest pain syndrome (CPS) group had no significant organic stenosis of the coronary artery and the acetylcholine-loading test produced negative results (39 patients). Patients in the vasospastic angina (VSA) group had a positive acetylcholine-loading test (50 patients). When the filtered QRS duration was prolonged to above 130 msec and/or the root-mean-square voltage in the last 40 msec was below 15 μV in VCM-3000, the late potential was judged to be positive.

The incidence of late potential was higher in the AP group (23.2%) and the VSA group (38.0%) than in the CPS group (7.7%) ($p<0.05$, $p<0.01$). Comparison of late potential incidence between patients with coronary vasospasm below 90% (group 1) and patients with above 90% (group 2) induced by the acetylcholine-loading test in the VSA group showed more late potential in group 2 than in group 1 (84.2% vs 15.8%). Late potential was present in 19 (23.2%) patients in the AP group, but only 2 (10.5%) had under 90% degree of coronary stenosis and the other 17 (89.5%) had greater than 90% degree of stenosis. Thus, late potential was mainly observed in patients with severe organic stenosis.

These results suggest that the origin of late potential is associated with inhomogeneous electrical excitation induced by frequent angina attack and the duration of total or near total occlusion. Strict clinical management is required for patients with VSA or AP associated with late potential.

Key Words

Angina pectoris, Coronary vasospasm, Signal averaging, Late potential

INTRODUCTION

Late potential is detected by signal averaged electrocardiography in patients with ventricular tachycardia[1–4], and is useful to predict the occurrence of this arrhythmia. Previously, we studied the incidence of late potential in patients with vasospastic angina and found that it was significantly more frequent in patients with vasospastic angina, especially in those with severe spasm during the attack, than in normal controls[5]. This study examined the incidence of late potential in patients with angina pectoris and both vasospasm and organic stenosis of the coronary artery to assess the clinical importance of late potential.

METHODS

This study included 171 patients referred to Dokkyo University Hospital between May 1989 and September 1994. All patients presented with an-

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Selected abbreviations and acronyms

AP=angina pectoris
CPS=chest pain syndrome
f-QRS=filtered QRS
LP=late potential
RMS40=root-mean-square voltage for the last 40 msec
VSA=vasospastic angina

Table 1 Clinical characteristics of the three groups

	CPS group	VSA group	AP group
Patients (*n*)	39	50	82
Age (yr)	53±11	56±9	59±10
Gender (M:F)	23:16	* 39:11	69:13

*$p<0.05$.
M=male; F=female.

gina-like pain. Patients with myocardial infarction (abnormal Q wave in the 12-lead electrocardiogram), past history of sustained ventricular fibrillation and tachycardia, carditis, cardiomyopathy, valvular heart disease, bundle branch block, atrial fibrillation or flutter were excluded.

Patients were categorized into three groups based on coronary angiography. The angina pectoris (AP) group contained 82 patients (69 men and 13 women; mean age [±SD] 59±10 years) with at least 75% organic stenosis of a major coronary artery after intracoronary injection of nitrate drug. The chest pain syndrome (CPS) group comprised 39 patients (23 men and 16 women; mean age [±SD] 53±11 years) with no significant organic stenosis of the coronary artery and the acetylcholine-loading test[6,7] produced negative results. The vasospastic angina (VSA) group was composed of 50 patients (39 men and 11 women; mean age [±SD] 56±9 years) in whom the acetylcholine-loading test produced positive results. The clinical characteristics are shown in **Table 1**. Acetylcholine chloride (Daiichi Seiyaku, Tokyo, Japan) was dissolved in 0.9% saline (5 m*l*) in incremental doses of 25, 50 and 100 μg and injected into the left coronary artery. Left coronary angiography was performed when the ST-segment changed and/or chest pain occurred, or 1 to 3 min after each injection. Acetylcholine in incremental doses of 25 and 50 μg was injected into the right coronary artery and a right coronary arteriography was performed as above. If more than 75% coronary spasm was induced by these procedures, the acetylcholine-loading test was defined as positive. Patients with less than 90% coronary vasospasm were defined as group 1, and patients with more than 90% coronary vasospasm were defined as group 2.

After a 24-hour medication wash-out period, signal averaged electrocardiograms were recorded in patients at rest in the supine position without chest pain using a vectorcardiograph (VCM-3000, Fukuda Denshi, Tokyo, Japan). The frequency was 40–300 Hz, and the filtered QRS (f-QRS) waves were averaged 200 times. The time at which the f-QRS wave exceeded three times the noise level in the PQ-segments was defined as the starting point of the f-QRS wave. The endpoint of the f-QRS wave was also defined as the point falling below three times the noise level of the f-QRS wave in the ST-segment. If the f-QRS duration was over 130 msec and/or the root-mean-square voltage for the last 40 msec (RMS40) was below 15 μV, late potential was defined as positive according to Ozawa *et al.*[8]

All calculated data are expressed as mean ±SD. One-way analysis of variance was performed to determine the statistical significance of differences. The χ^2 test was used for comparison of discrete variables. Statistical significance was accepted at the 95% confidence level.

RESULTS

Degree of coronary stenosis

Coronary organic stenosis was greater than 90% by coronary angiography in 54 of the 82 patients in the AP group. Group 1 contained 23 patients and group 2 contained 27 patients in the VSA group.

Comparison of RMS40 and f-QRS between the chest pain, vasospastic angina and angina pectoris groups

The RMS40 and f-QRS are shown for one patient in the CPS group and one patient in the VSA group 2 in **Fig. 1**.

RMS40 was smaller in the AP and the VSA groups than in the CPS group (25.1±11.7, 22.3±13.3 and 26.6±9.7 μV, respectively), but not statistically significant (**Fig. 2**). f-QRS was significantly longer in the VSA and the AP groups than in the CPS group (114.2±14.5, 113.6±11.0 and 109.0±6.9 msec, $p<0.05$, respectively; **Fig. 3**).

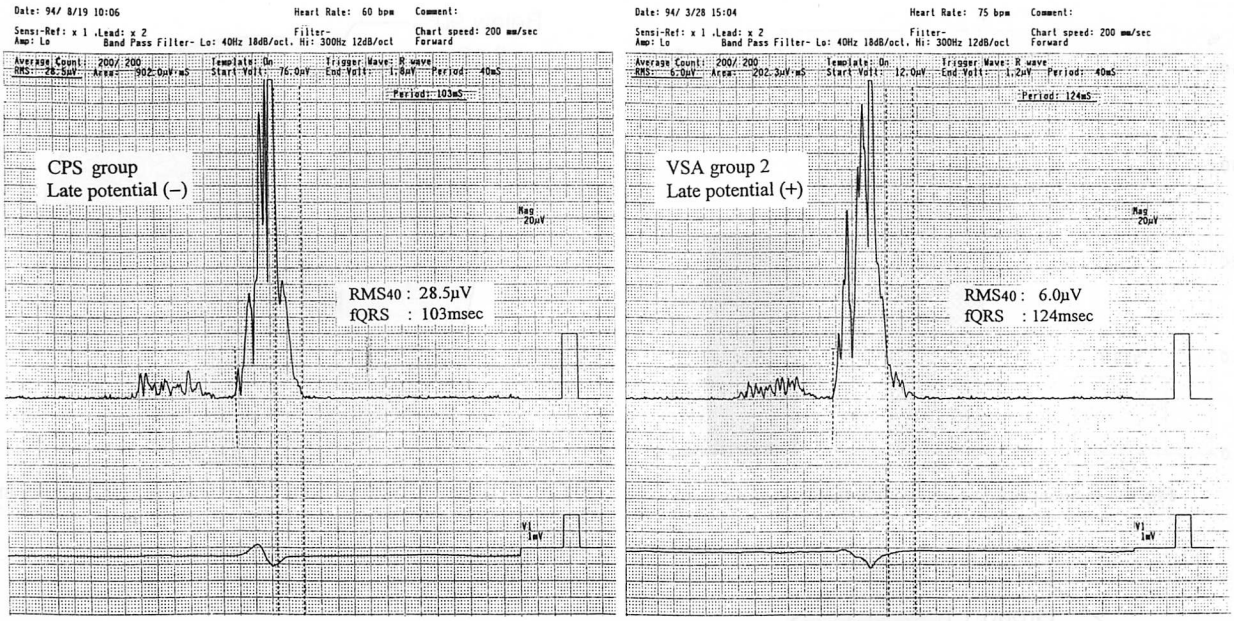

Fig. 1 RMS40 and f-QRS in one patient of the CPS group (*left*) and one patient of the VSA group 2 (*right*)

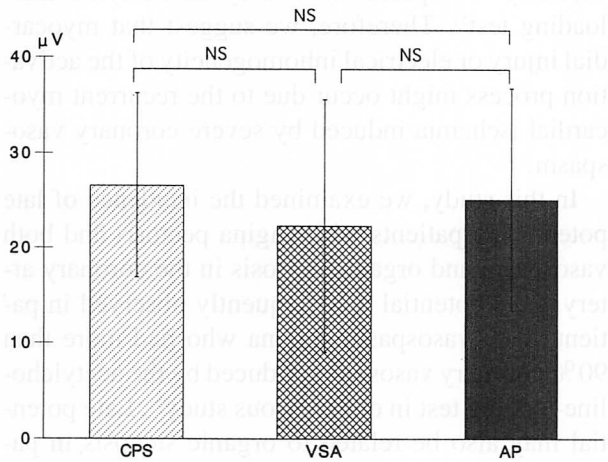

Fig. 2 Root-mean-square voltage for the last 40 msec

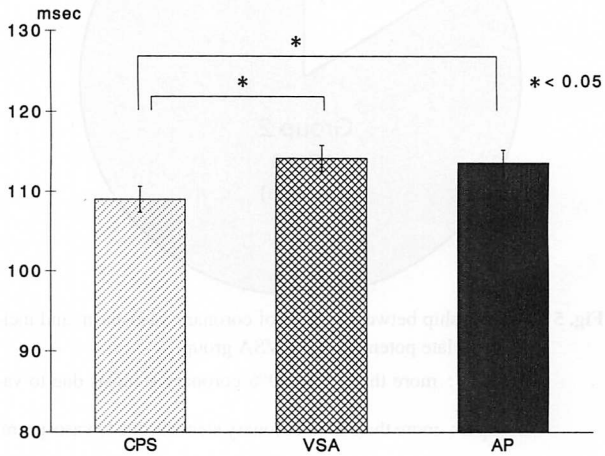

Fig. 3 Filtered QRS duration

Incidence of late potential in the three groups

The incidence of late potential was significantly higher in the VSA group (38.0%) and the AP group (23.2%) than in the CPS group (7.7%) (χ^2 test, $p<0.01$, $p<0.05$, respectively; **Fig. 4**). Although the incidence of late potential was not significantly different between the VSA group and the AP group, it tended to be higher in the VSA group ($p=0.07$, NS).

Relationship between degree of coronary vasospasm and incidence of late potential in the vasospastic angina group

Late potential was positive in 19 patients in the VSA group. Three of these patients (15.8%) were in group 1 and 16 patients (84.2%) in group 2. The incidence of late potential in group 2 with severe coronary vasospasm was higher than in group 1 (**Fig. 5**).

Relationship between degree of coronary organic stenosis and incidence of late potential in the angina pectoris group

Late potential was positive in 19 patients in the AP group. Two of these patients (10.5%) had less than 90% coronary stenosis and 17 patients (89.5%) had more than 90% coronary stenosis. Thus, the incidence of late potential was higher in

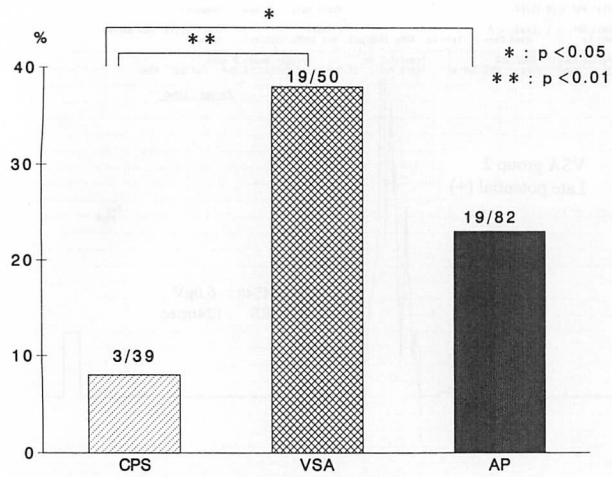

Fig. 4 Incidence of late potential in the three groups

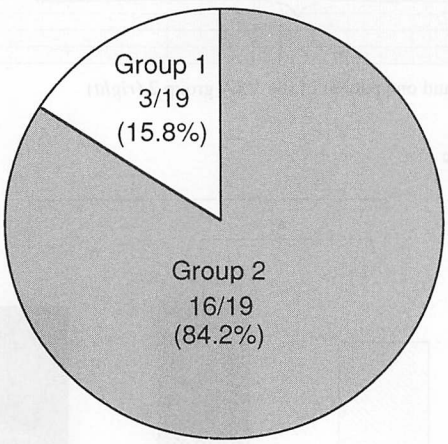

Fig. 5 Relationship between degree of coronary vasospasm and incidence of late potential in the VSA group

Group 1 : more than 75 to 90% coronary stenosis due to vasospasm.
Group 2 : more than 90% coronary stenosis due to vasospasm.

patients with severe organic stenosis than in patients with moderate stenosis (**Fig. 6**).

DISCUSSION

Several reports have indicated that late potential is useful to predict the occurrence of fatal ventricular tachycardia and sudden death in patients with ischemic heart disease, especially in patients with old myocardial infarction[9–11]. Further, fatal ventricular arrhythmia, such as ventricular tachycardia, frequently occurs in patients with vasospastic angina[12–16]. However, few studies of the relationship between late potential and vasospastic angina have been reported. Recently, we studied the relationship between vasospastic angina and late potential and found that late potential was frequently observed in

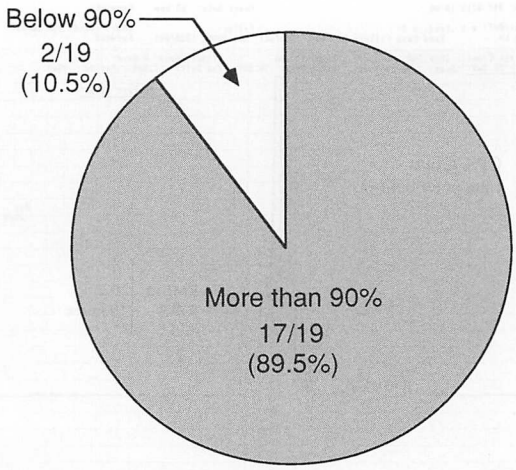

Fig. 6 Relationship between degree of coronary organic stenosis and incidence of late potential in the AP group

Below 90% : <90% coronary stenosis.
More than 90% : ≧90% coronary stenosis.

patients with vasospastic angina who had severe coronary vasospasm induced by the acetylcholine-loading test[5]. Therefore, we suggest that myocardial injury or electrical inhomogeneity of the activation process might occur due to the recurrent myocardial ischemia induced by severe coronary vasospasm.

In this study, we examined the incidence of late potential in patients with angina pectoris and both vasospasm and organic stenosis in the coronary artery. Late potential was frequently observed in patients with vasospastic angina who had more than 90% coronary vasospasm induced by the acetylcholine-loading test in our previous study[5]. Late potential may also be related to organic stenosis in patients with angina pectoris. The incidence of late potential was higher in both the AP and the VSA groups than in the CPS group in this study. The incidence of late potential in the CPS group in this study was almost the same as that reported in normal subjects[1,17,18]. Thus, the incidences of late potential in the AP and the VSA groups in this study were obviously high. Moreover, patients with more than 90% vasospastic stenosis induced by the acetylcholine-loading test in the VSA group and more than 90% stenosis due to organic lesion in the AP group had higher incidences of late potential.

The high incidence of late potential may be caused by myocardial damage produced by recurrent transient myocardial ischemia. Slow conduction due to myocardial injury induced by recurrent myocardial ischemia is a possible mechanism.

Miura[19] also reported that recurrent coronary occlusion induced accumulative metabolic myocardial damage. Clinically, Nakajima *et al.*[20] reported that such myocardial damage could be detected by iodine-123-betamethyl-*p*-iodophenyl-pentadecanoic acid in patients with vasospastic angina. The incidence of late potential was higher in the AP and the VSA groups than in the CPS group, but not significantly different between the AP and the VSA groups. Different grades of myocardial damage due to the mechanism of occurrence and duration of myocardial ischemia may exist between the AP group and the VSA group.

Myocardial blood flow remained constant without vasospastic attack in the VSA group, but total occlusion occurs suddenly during vasospastic attack and the duration of total or near total occlusion may be longer than effort angina. In contrast, chronic ischemia induced by organic coronary stenosis is always present in the AP group. Recurrent transient short time myocardial ischemia may occur frequently in the AP group compared to the VSA group. Therefore, the adaptation for myocardial ischemia in terms of preconditioning reported by Murry *et al.*[21] might be progressive in the AP group compared to the VSA group, so slow conduction based on late potential would tend to occur, especially in the VSA group. Further studies are necessary to evaluate these explanations.

We conclude that patients with vasospastic angina or angina who have organic stenosis with late potential suffer severe vasospasm during the attack, so strict clinical management is required in these patients.

要　約

狭心症における心室遅延電位の臨床的意義

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狭心症患者における遅延電位 (late potential) の臨床的意義を検討した．対象は狭心症様症状を有する 171 例で，冠動脈造影および acetylcholine 負荷試験により，冠攣縮性狭心症群 50 例 (冠攣縮群)，胸痛症群 39 例 (胸痛症群) および労作性狭心症群 82 例 (狭心症群) に分類した．フクダ電子製 VCM-3000 を用いて遅延電位の測定を行った．

遅延電位陽性率は胸痛症群 (7.7%) に比し，冠攣縮群 (38.0%)，狭心症群 (23.2%) において有意に高かった (χ^2 test, $p<0.01$, $p<0.05$)．冠攣縮群で遅延電位陽性を示した 19 例中 16 例 (84.2%) は高度攣縮性狭窄を認めた群であった．狭心症群においても，遅延電位陽性を示した 19 例中 17 例 (89.5%) は 90% 以上の高度狭窄例であった．心筋梗塞既往のない狭心症においても，高度の器質的または攣縮性狭窄を示す症例では遅延電位陽性率が高いことから，これらの症例では，何らかの心筋伝導障害の存在が示唆される．

遅延電位陽性を示す狭心症症例は高度の器質的または攣縮性狭窄を認める頻度が高く，臨床上慎重な対応が必要と考えられる．

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