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Electrocardiographic evolution in patients with hypertrophic cardiomyopathy who develop a left ventricular apical aneurysm

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Abstract

Introduction: Hypertrophic cardiomyopathy (HCM) patients with apical aneurysm have a largely unfavourable clinical course, and are often unrecognised because echocardiography is limited in the assessment of the left ventricular (LV) apex. The aim of this study is the identification of electrocardiographic (ECG) abnormalities associated with the development of apical aneurysm in HCM patients.

Materials and methods: Electrocardiographic features were assessed in 14 HCM patients who had a good-quality baseline ECG recorded before and after the diagnosis of apical aneurysm.

Results: During follow-up (8.8 ± 7.5 years), the following ECG changes were observed: increase in QRS-complex duration (87 ± 12 ms to 118 ± 34 ms, p = 0.006), QRS-complex fragmentation, decrease in QRS-complex amplitude (SV_1 + RV_{5-6}, from 41 ± 18 mm to 26 ± 11 mm, p = 0.015), ST-segment elevation in V_4–V_6 (J-point in V_5, from −0.9 ± 1.3 mm to +0.7 ± 1.3, p = 0.003), positivisation of negative T waves in V_3-V_6 (T-wave depth in V_5, from −3.4 ± 6.6 to +3.1 ± 4.1, p = 0.005).

Conclusions: HCM patients who develop LV apical aneurysm exhibit distinctive ECG changes along with apical remodelling. Suggestive ECGs should lead the physician to study LV apex by nonstandard echocardiographic views, and perform MRI.

Keywords: Hypertrophic cardiomyopathy; Apical aneurysm; Electrocardiography

Introduction

Hypertrophic cardiomyopathy (HCM) is a genetic cardiac disease, characterised by a marked variability in natural history and phenotypic expression [1,2]. HCM patients with left ventricular (LV) apical aneurysm represent a unique subgroup at high risk for adverse clinical events largely related to sudden death, embolic stroke, and heart failure [3–6]. The reported prevalence of apical aneurysms in the HCM population is 2% [5].

Patients are often unrecognized because echocardiography is limited in the assessment of the ventricular apex. Cardiac magnetic resonance has a higher spatial resolution and detection capability, but still is not widely available, and cannot be performed in patients with implantable cardioverter-defibrillators [5,7]. Diagnosis of an apical aneurysm in HCM patients has important prognostic and therapeutic implications. The potential role of electrocardiogram (ECG) in the detection of apical aneurysms has not yet been defined in HCM patients. Previous descriptions of electrocardiographic alterations in this subgroup have been confined to case reports [3,8,9] or small patients series with incomplete electrocardiographic follow-up [4,10,11].

We describe the electrocardiographic features of HCM patients who developed LV apical aneurysm, in order to define whether specific electrocardiographic alterations may lead to the clinical suspicion of ventricular aneurysm.

Materials and methods

Selection of patients

Twenty-three patients with clinically diagnosed HCM and LV apical aneurysm, were consecutively enrolled and evaluated from 1984 to 2013 in 4 centres: Division of Cardiology, Sapienza University (Rome, Italy, n = 11), Azienda Ospedaliera Ordine Mauriziano di Torino (Turin,

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Italy, n = 8), Ente Ospedaliero Ospedali Galliera (Genoa, Italy, n = 2), Krankenanstalt Rudolfstiftung (Vienna, Austria, n = 2). Of the 23 patients, 14 (60.9%) were selected for the study group because they had a good-quality baseline ECG recorded before the diagnosis of apical aneurysm, and a good-quality ECG recorded after the diagnosis of apical aneurysm. Diagnosis of apical aneurysm was made by echocardiography in 8 patients (57.1%), and by magnetic resonance imaging (MRI) in 6. Initial evaluation was the first visit to a participating institution, during which the first ECG was recorded. Most recent evaluation was the last visit to a participating institution, during which the last ECG was recorded. Thirteen patients (92.9%) developed the apical aneurysm during the time interval between first evaluation in a participating institution, and last clinical evaluation. One patient had already developed an apical aneurysm at initial evaluation but previous ECGs performed in an external institution were available. Obstructive atherosclerotic coronary artery disease was excluded as a cause of LV aneurysm formation in 13 of the 14 selected patients (92.9%) by (1) the absence of significant coronary arterial narrowing in the left anterior descending (LAD) artery by conventional arteriography (n = 4) or cardiac computed tomography angiogram (n = 1) and (2) absent history of chest pain, coronary risk factors, and acute coronary syndrome in the other 8 patients. Significant coronary arterial narrowing (≥50%) in the LAD artery was demonstrated by coronary angiography in 1 patient (7.1%). The 8 patients without coronary angiography or computed tomography angiogram were 55 ± 21 years old at apical aneurysm diagnosis (four of them were <40 years old).

Electrocardiography

Standard resting 12-lead ECGs were performed in all 14 patients at each clinical evaluation (once a year) with commercially available instruments. All patients had a good-quality ECG recorded before and after the diagnosis of LV apical aneurysm. The time interval between the ECG recorded before and that recorded after the aneurysm development was 8.8 ± 7.5 years (range, 1.4–28.4). All ECGs were recorded at 25 mm/s, 10 mm/mV, and analysed by the same investigator (E.P.). Several parameters were examined: rhythm, P waves, PR interval, electrical axis, Q waves, QRS complex, QTc interval, ST segment, T wave, signs of left ventricular hypertrophy (LVH). The electrocardiograms were interpreted using criteria previously described in detail, but with certain modifications [12,13]. Q-waves were considered pathological if ≥0.04 s in duration or ≥25% of the height of the ensuing R-wave. Q waves present only in V_1 or only in lead III were not considered as abnormal. ST segment elevation was considered significant if the J point was shifted ≥1.5 mm, using the preceding PQ segment as the isoelectric point. Fragmentation of narrow QRS was defined by the presence of ≥1 R′ or notching of the R wave or S wave present on at least 2 contiguous leads, corresponding to a major coronary artery territory on the resting 12-lead ECG [14]. Fragmentation of wide complex QRS was defined by the presence of >2 R waves or more than 2 notches in the R wave or the S wave, in 2 contiguous leads corresponding to a major coronary artery territory [15].

Echocardiography

HCM was defined as echocardiographic demonstration of a hypertrophied and nondilated left ventricle in the absence of another cardiac or systemic disease capable of producing the observed degree of wall thickening. Two-dimensional echocardiograms were performed in all 14 patients at each clinical evaluation with commercially available instruments. The magnitude and distribution of LVH were assessed in all cross-sectional planes [16,17]. Maximum LV wall thickness was defined as the greatest dimension measured at any site within the LV chamber [17]. Peak instantaneous outflow gradient and peak instantaneous mid-ventricular gradient were estimated under basal conditions, with continuous-wave Doppler echocardiography. Obstruction was defined as a peak instantaneous gradient ≥30 mmHg [18,19]. Apical aneurysm was defined as a discrete thin-walled dyskinetic or akinetic segment in the most distal portion of the LV chamber, with a relatively wide communication to the LV cavity [5].

Cardiovascular magnetic resonance

Cardiovascular magnetic resonance (CMR) was performed in 11 of the 14 study patients with a 1.5-T whole-body scanner (Siemens Sonata-Avanto, Erlangen, Germany; or Signa Hdx, General Electrics Healthcare, Milwaukee, WI) with dedicated cardiac coils. Breath-hold cine steady-state free precession images were acquired in 3 long-axis orientations and multiple short-axis slices from the atrio-ventricular ring to the LV apex. Late gadolinium enhancement (LGE) images were acquired 15 minutes after intravenous administration of 0.2 mmol/kg gadolinium-DTPA (Gadovist, Schering, Berlin Germany) with breath-hold segmented inversion-recovery sequence acquired in the same views as the cine images. Inversion time was optimised to null normal myocardial signal.

Statistical analysis

Descriptive statistics are expressed as mean ± standard deviation for continuous variables and as proportions for categorical variables. Subgroups were compared by Student *t* test for continuous variables, and by standard chi-square tests for categorical variables (Fisher's exact test). Statistical analyses were performed using the SPSS version 19.0 statistical software, and statistical significance was defined as $p < 0.05$.

Results

Patients' characteristics

The 14 HCM patients who developed an apical aneurysm were 56 ± 20 years old at initial evaluation and 63 ± 20 years old at the most recent evaluation. First detection of apical aneurysm was at age 60 ± 20 (range, 25–88). Nine patients (64.3%) were female. Eight (57.1%) of the 14 patients had the