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CASE REPORT

Radiofrequency catheter ablation guided by noncontact mapping of ventricular tachycardia originating from an idiopathic left ventricular aneurysm

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Abstract Idiopathic left ventricular aneurysm and diverticulum is known to be an arrhythmogenic substrate associated to ventricular tachyarrhythmias, generally based on a reentry mechanism. A case of a young woman affected by a monomorphic ventricular tachycardia, refractory to medical treatment, originating from an aneurysm of the membranous interventricular septum is reported. The left ventricular aneurysm was well characterized by multislice computed tomography and left ventricular angiography. Because of the nonsustained and poorly tolerated nature of the target arrhythmia, a noncontact mapping system was used to guide radiofrequency catheter ablation, allowing the elaboration of a three-dimensional activation map of the left ventricle on the basis of a ventricular tachycardia single beat. The procedure was acutely successful, and the patient remained free of ventricular tachycardia recurrences without antiarrhythmic drugs during a subsequent 6-month follow-up period. This is the first report of a successful radiofrequency catheter ablation guided by noncontact mapping system of a ventricular tachycardia originating from an idiopathic left ventricular aneurysm. This nonfluoroscopic mapping method allows a reliable reconstruction of the spatial relationships between the left ventricular main cavity and the aneurysm and can be safely and effectively used to map the ventricular tachycardia and guide the ablation procedure, particularly when conventional mapping is not indicated or not effective because of nonsustained or not-tolerated characters of ventricular tachycardia.

Keywords Idiopathic left ventricular aneurysm · Ventricular tachycardia · Radiofrequency catheter ablation · Noncontact mapping · Multislice computed tomography

1 Introduction

Left ventricular (LV) aneurysms of unknown etiology are defined as idiopathic; most of them are asymptomatic and often occasionally found during diagnostic procedures [1–4]. Symptomatic patients usually suffer from ventricular tachycardias (VT), generally based on a reentry mechanism; the first arrhythmic event may be sudden cardiac death [2–14]. The morphology of VT generally is the right bundle branch block (RBBB) according to LV origin. In this study, we describe the first case in which a noncontact mapping system was used to guide radiofrequency catheter ablation (RFCA) of a monomorphic VT originating from an idiopathic LV aneurysm, allowing the elaboration of a 3D activation map of the left ventricle on the basis of a VT single beat.

2 Case report

A 38-year-old woman suffered from palpitation and recurrent exercise-induced dizziness and fainting, with a history of premature ventricular complexes (PVCs) on rest electrocardiogram (ECG), and documented recurrent non-sustained monomorphic VT with RBBB morphology and superior axis. There was no family history of coronary heart

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disease or sudden death and no history of exposure to Chagas's disease or flu-like syndrome before the onset of symptoms or past history of systemic diseases. A single catheter mapping and ablation procedure had been unsuccessfully attempted 6 months before. Short runs of non-sustained VT could be induced leading to an inaccurate activation mapping and to an ineffective RFCA in the postero-septal region. In the next months, VTs recurred, always with the same morphology, despite of antiarrhythmic drug treatment (amiodarone and sotalol). At the admission to our institution, she was symptomatic for exercise-induced dizziness. The physical examination was completely normal. A baseline 12-lead ECG was normal except for frequent PVCs with RBBB morphology and superior axis. The chest X-ray and the results of laboratory tests were unremarkable. The transthoracic echocardiogram documented normal LV dimensions and function, and a wide aneurysm in the membranous portion of the interventricular septum, without evidence of interventricular shunts. The multislice computed tomography (MSCT) revealed normal coronary arteries and the presence of a large aneurysm (max. 24.3×32.1 mm) of the membranous portion of the interventricular septum, extending to the LV posterior wall (Fig. 1(a–c)); furthermore, the MSCT excluded the presence of thrombi in the aneurysm and other heart malformations. The coronary angiography confirmed the normality of the

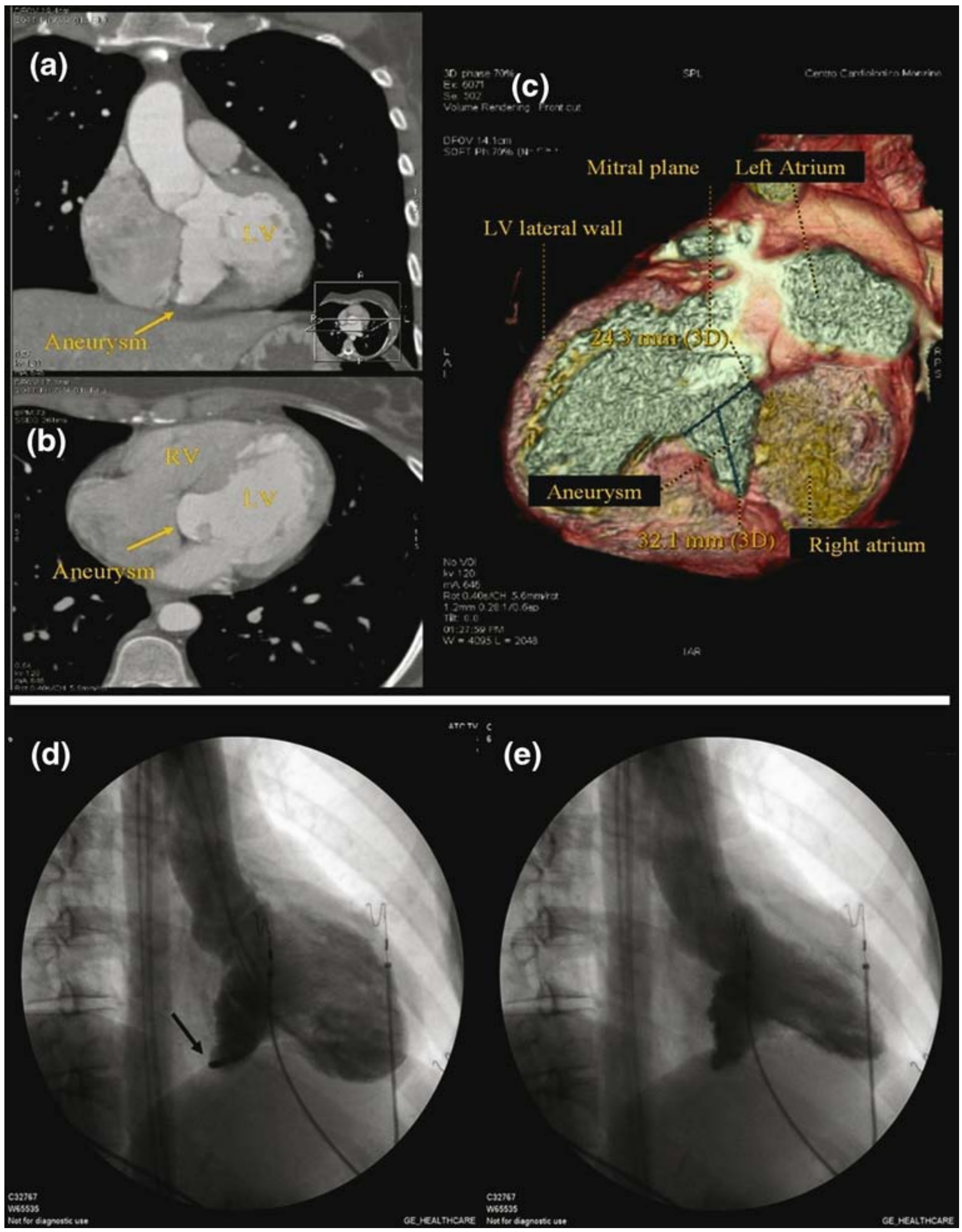

Fig. 1 Multislice computed tomography images showing the wide left ventricular aneurysm and its relationships to the heart chambers in a coronal phase (**a**), in an axial phase with a four-chamber view (**b**), and in a three-dimensional phase (**c**). Left ventriculography in right anterior oblique view showing the large postero-septal aneurysm with a wide connection to the main cavity (**d**, **e**). The aneurysm does not show contractility, maintaining the same shape during diastole (**d**) and systole (**e**) and remaining filled of contrast medium during systole. The ablation catheter tip is positioned inside the aneurysm (*black arrow*). *RV* Right ventricle, *LV* left ventricle

coronary tree; LV angiography documented a wide aneurysm localized in the postero-septal region, at a basal level, with a large connection to the LV main cavity; the aneurysm did not show contractility, maintaining the same shape during both systolic and diastolic phases (Fig. 1(d,e)). A repeat RFCA procedure was scheduled. Because of the nonsustained and poorly tolerated nature of the target arrhythmia, we felt that noncontact mapping might provide the information of the pattern of endocardial activation during even short runs of VT. Furthermore, the system allows reliable reconstruction of relevant anatomical details—in this case, the reconstruction of the LV aneurysm—that hypothetically might be involved in the origin of the arrhythmia.

3 Noncontact mapping system

Technical details of the commercially available system (St. Jude Medical ESI 3000) have been described elsewhere [15, 16]. Briefly, a 9F balloon multielectrode catheter is percutaneously introduced in the ventricular cavity and connected to a multichannel recorder to acquire more than

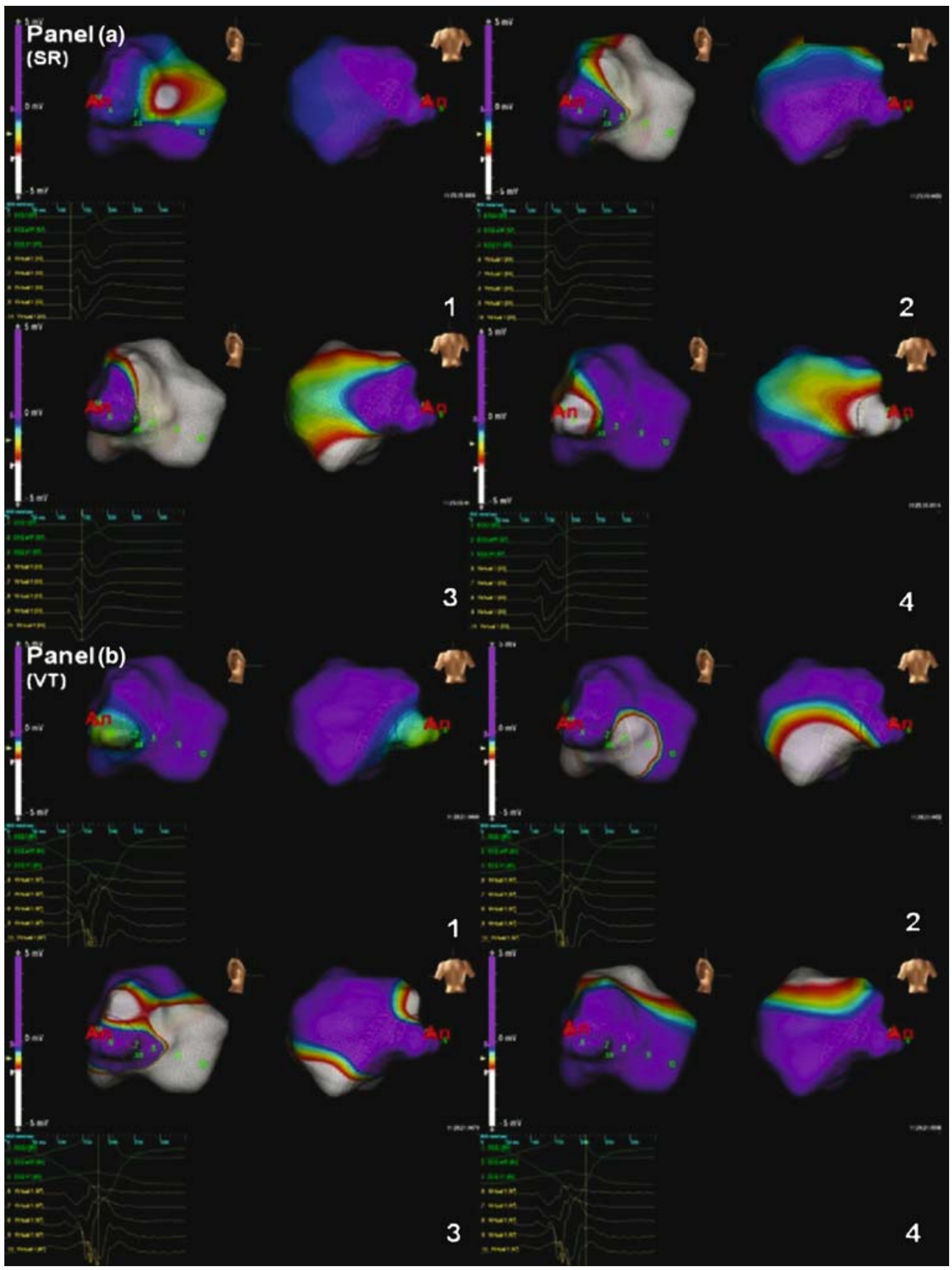

Fig. 2 Three-dimensional noncontact isopotential map showing left ventricular activation sequence during sinus rhythm (*SR*; (**a**), *1*, *2*, *3*, *4*) and ventricular tachycardia (*VT*; (**b**), *1*, *2*, *3*, *4*). The anatomical reconstruction of the endocardium is shown in *purple*; activated myocardium is shown in colors from *white* (depolarized) to *blue* (not yet depolarized). The aneurysm (*An*) originating from the interventricular septum may be clearly observed. The aneurysm is the site of latest activation during SR and earlier activation during VT

3,000 noncontact unipolar electrograms that are subsequently processed by a workstation generating a color-coded isopotential map that projects over the virtual endocardium the activation and repolarization wave front of the whole cycle. This system allows analysis of the most relevant parameters of the VT reentry circuit: the exit point, the diastolic pathway, and the diastolic interval [16].

4 Mapping and ablation procedure

A standard quadripolar catheter was advanced to the right ventricular apex and a standard, deflectable, 3.5-mm-tip saline-irrigated mapping/ablation catheter (Celsius Thermocool, Biosense Webster) was placed in the left ventricle by a retrograde transaortic route. Systemic anticoagulation was obtained with 10.000 IU heparin intravenous bolus followed by a continuous infusion to maintain an activated clotting time greater than 300 s. By a retrograde transaortic route, the balloon multielectrode catheter was advanced to the LV apex over a 0.032-in. J-tipped guidewire. The construction of the LV virtual endocardium was preliminarily obtained during sinus rhythm (SR). The reconstructed virtual 3D LV anatomical map confirmed the presence of a wide aneurysm originating from the postero-septal region. Programmed ventricular stimulation from the right ventricular apex reproducibly induced nonsustained runs of monomorphic VT with a cycle length of 360 ms and the same morphology as the clinical VT; a significant drop of the systemic arterial pressure occurred during the episodes of induced VT. The pattern of endocardial activation during SR revealed homogeneous and rapid activation throughout the LV endocardial surface, with the latest activation involving the aneurysm (Fig. 2(a), 1–4). During VT, the earliest diastolic activity could be traced on a discrete pathway at the anterior border of the aneurysm 50 ms before the QRS onset; once the activation front has emerged from the aneurysm, subsequent rapid activation spread to the posterior and anterior wall, and to the LV remaining surface (Fig. 2(b), 1–4). Pacemapping with a complete match of the 12 lead could be obtained within the aneurysm and near the anterior border. RFCA was performed by an irrigated tip catheter (30–35 W, 43°C, irrigation flow of 25 ml/min), delivering radiofrequency pulses around the neck of the LV aneurysm and also inside the aneurysm, on the basis of the diastolic pathway detected by noncontact mapping during VT and of the results of pacemapping during SR. At the end of the ablation procedure, a lack of pacing capture inside the aneurysm and the prevention of inducibility of any VT at the electrophysiological postablation study protocol (triple drive, four extrastimuli, during intravenous high-dose isoproterenol infusion) were documented. The total procedure time was 150 min, and the fluoroscopy time was 12 min. After RFCA, a transthoracic echocardiography excluded a pericardial effusion and aortic regurgitation; no periprocedural complications occurred. An exercise treadmill test performed 2 days after RFCA showed no VT episodes. The patient remained free of VT recurrences without any antiarrhythmic drugs therapy during a subsequent 6-month follow-up period.

5 Discussion

The association of idiopathic LV aneurysm with ventricular tachyarrhythmias was initially reported by Maloy et al. in 1971 [6], and confirmed by several next papers [3–5, 7–14]. The VTs associated to idiopathic LV aneurysm that may be induced by exercise [10] are based on a reentry mechanism [7] and generally are refractory to antiarrhythmic drugs, thus requiring nonpharmacological therapy [3, 8–10, 12–14]. Moreover, ventricular tachyarrhythmias may lead to sudden death, particularly in infancy [1]. To the best of our knowledge, the literature reports some cases of surgical treatment of the VTs (resection of the aneurysm/diverticulum with or without cryoablation) [3, 4, 6, 12–14] and few cases of RFCA guided by electroanatomical CARTO mapping (four nonsurgical transthoracic epicardial ablation [10], a percutaneous endocardial ablation [9], and an endocardial/nonsurgical epicardial ablation [11]). This is the first report of a successful RFCA guided by a noncontact mapping system in this clinical setting. Our case suggests that VTs originating from LV aneurysms may be amenable to RFCA and that a noncontact mapping system can be safely and effectively used to map these VTs and to guide the RFCA, particularly when conventional (entrainment) mapping is not indicated or not effective because of nonsustained or not-tolerated characters of VT. The noncontact mapping system allows an accurate tracing of the VT circuit on the basis of a single beat and a reliable reconstruction of the spatial relationships between the LV main cavity and the aneurysm, thus leading to a more safe and tailored ablation procedure. Finally, we confirm the usefulness of MSCT as an accurate noninvasive diagnostic modality for the detection and the morphologic evaluation of interventricular septum aneurysm [17] and suggest it also as a useful tool before an electroanatomical mapping-guided ablation procedure.

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