Radiofrequency Catheter Ablation of Life-Threatening Ventricular Arrhythmias Caused by Left Ventricular Metastatic Infiltration

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Metastases to the cardiac ventricles are rare and, unfortunately, often follow a rapidly fatal course.\(^1,2\) Occasionally, they cause symptomatic ventricular arrhythmias (VAs) for which limited therapeutic options exist, such as antiarrhythmic drugs, whereas the use of catheter ablation, to our knowledge, has never been reported to date.

We present the case of a 27-year-old man with a metastatic tumor in the left ventricle and intractable malignant VAs. In February 2009, the patient had been diagnosed with a gluteal sarcoma and initially treated with combined chemotherapy (including anthracyclines) and radiation. Since December 2009, a mild reduction in left ventricular ejection fraction (45%) was detected, and since January 2010, frequent monomorphic premature ventricular contractions (PVCs) and nonsustained ventricular tachycardias (VTs) were documented. Treatment with amiodarone proved helpful, and no life-threatening VAs could be induced on standard electrophysiological study.\(^3\) Since April 2010, however, the patient suffered from multiple drug-refractory episodes of sustained VT and ventricular fibrillation, requiring several direct current shocks (Figure 1). His left ventricular ejection fraction had remained stable. Electrical storm resulted in immediate hemodynamic instability and dramatically affected his quality of life. The patient was referred to our institution, where multiple antiarrhythmic drug combinations were tested, both orally and intravenously, allowing a relative stabilization of cardiac rhythm. Cardiac MRI showed a T2-hyperintense, weakly gadolinium-enhanced area at the basis of the anterior papillary muscle, compatible with metastatic infiltration (Figure 2, online-only Data Supplement Movie 1). An oncology consultation hypothesized a life expectancy of \(<6\) months. After about 2 weeks, the recurrence of multiple episodes of VT and ventricular fibrillation required intensive care treatment with deep sedation and assisted ventilation, but still VAs could not be controlled. Thus, a repeat electrophysiological evaluation and radiofrequency catheter ablation were planned. Informed consent was obtained for all invasive procedures throughout the patient’s clinical course.

Figure 1. A, Sinus rhythm with PVC with right bundle branch block morphology, inferior axis, and positive concordance in precordial leads. The QRS morphology suggested an origin localized at the left ventricle anterolateral wall in its middle portion, a site that was compatible with the basis of the anterior papillary muscle.\(^4\) B, Clinical VT (heart rate, 220 beats/min; same QRS morphology as PVCs). C, Clinical PVC triggering ventricular fibrillation.

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Electrophysiological Examination and Ablation

The procedure was performed under general anesthesia. Because VT caused hemodynamic instability, the mapping procedure was focused on identification of the arrhythmogenic substrate. First, a 3D shell of cardiac anatomy was created on an electroanatomic mapping system (CartoSOUND; Biosense Webster Inc) integrated with intracardiac echocardiography (ICE). Then
left ventricular bipolar voltage mapping was performed during sinus rhythm to further evaluate the arrhythmogenic substrate. A low-voltage area (≤0.5 mV) was found near the basis of the anterior papillary muscle, where ICE visualized an endocardial hyperechogenic area (Figure 2, online-only Data Supplement Movies 2 and 3). Pace mapping was performed in that specific area, identifying a site where the paced ventricular beat morphology matched in all 12 ECG leads the patient’s clinical PVC, as confirmed by automatic algorithm software (PaSo; Biosense Webster) implemented in the mapping system (Figure 3). Finally, the clinical VT was easily induced by right ventricular programmed stimulation, and the earliest prematurity during VT activation mapping (~35 ms) was recorded at the site of best pace mapping (Figure 4). Therefore, radiofrequency ablation was performed, delivering energy from 30 W up to 40 W with an irrigated-tip catheter initially by a retrograde aortic approach and then by a transseptal approach to achieve greater catheter stability. After multiple radiofrequency pulses at that site and surrounding areas, VT could no longer be induced by ventricular programmed stimulation and burst pacing, not even under isoprenaline infusion. Additionally, no PVCs were observed for the subsequent 30 minutes of intraprocedural time as well as for the rest of the hospital stay. The patient remained symptom free for 2 months after the procedure, but as his overall clinical conditions deteriorated, the decision was ultimately made to discontinue chemotherapy. He died in July 2010. His parents opted not to have an autopsy performed.

**Discussion**

Since the introduction of bidimensional echocardiography, multislice CT, and MRI, cardiac metastases have been more frequently diagnosed in vivo. Clinical manifestations are extremely variable. Some common presentations include atrial and ventricular tachyarrhythmias or premature beats, conduction disorders, and blocks, especially in the presence of myocardial dysfunction. Patients with malignant cardiac tumors, whether primary or secondary, have a guarded prognosis. Current treatment options do little to encourage a positive outlook and are particularly limited in cases of cardiac metastases. Because cardiac tissue involvement is frequently diffuse, the usefulness of chemotherapy or surgical intervention is questionable. It appears reasonable that an ICD is not indicated in

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**Figure 4.** A, Activation map of the left ventricle during tachycardia. Best local activation is shown in red. B, The local intracardiac electrogram anticipates by 35 ms the surface ECG QRS onset. C, Activation map in right anterior oblique view showing the radiofrequency lesion points (red dots). Ablation pulses were extended from the best activation point to the whole pathological area pointed out by the bipolar voltage map and by ICE. D, Fluoroscopy in right anterior oblique view with the mapping catheter at the ablation site. In this picture, it is possible to appreciate the ablation catheter inserted by a transseptal approach, as satisfactory stability could not be achieved using a retrograde aortic approach.
patients with a short life expectancy and frequent VA burden, as electrical storm becomes likely. To date, a pharmacological approach is the only established weapon in the physician’s hands. Palliative treatment of VA with amiodarone in patients with ventricular tumors may well suppress their symptoms and improve the quality of the few remaining months of their lives.2 In the present case, MRI allowed a noninvasive in vivo visualization of the left ventricular metastatic infiltration, whose arrhythmogenic potential was subsequently demonstrated with mapping techniques and visualized by real-time ICE. This report is the first of radiofrequency ablation for the treatment of VAs related to cardiac metastases and refractory to antiarrhythmic drugs. In this case, the ablation procedure was successfully performed with an endocardial approach, but epicardial access should be taken into consideration because approximately one third of cardiac metastases involve the epicardium.2 In any case, an ablative approach relies on multimodality imaging and should be taken into account as an effective alternative to drug therapy to improve a patient’s quality of life.

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Disclosures
Dr Tondo serves as a member of the advisory board of Biosense Webster Inc and serves as a consultant and receives lecture fees from St Jude Medical. Dr Carbucicchio is a consultant for Biotronik. Drs Casella, Dello Russo, Tondo, Bartoletti, Monti, Marana, and Giraldi report no competing interests.

References

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SUPPLEMENTAL MATERIAL

1) Movie Caption

Movie 1
Cine-MRI

Movie 2
Intracardiac echo fan intersecting the low-voltage area, showing intramyocardial vacuolization in the lateral wall of the left ventricle.

Movie 3
Intracardiac echo fan intersecting the low-voltage area, showing the endocardial hyperechogenic area (empty arrow) at the basis of the anterior papillary muscle.

2) Acknowledgment permissions

Eng. Daniela Gravina allows to be mentioned in Acknowledgments Section of paper: “CIRCAE/2010/961193-Radiofrequency catheter ablation of life-threatening ventricular arrhythmias caused by left ventricular metastatic infiltration” that will be published on Circulation: Arrhythmia and Electrophysiology

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