CASE REPORT

Radiofrequency Catheter Ablation of Ventricular Tachycardia after Repair of Tetralogy of Fallot

ALEJANDRO VENTURA, LISANDRO SORIANO, MARISA LÓPEZ, ELIZABETH ENCISO

Received: 12/09/2010
Accepted: 02/15/2011

Address for reprints:
Dr. Alejandro Ventura
Cordis - Instituto del Corazón
Pellegrini 677
(3500) Resistencia - Pcia. del Chaco, Argentina
e-mail: aleventura@arnet.com.ar

SUMMARY

Sustained monomorphic ventricular tachycardia (SMVT) is a late complication of corrective surgery for tetralogy of Fallot. The success rate of conventional radiofrequency ablation is <50% due to patients' characteristics. Three-dimensional electroanatomic mapping system is associated with favorable outcomes.
We describe the case of a 53 year-old male patient with a history of previous corrective surgery for tetralogy of Fallot and an implantable cardioverter defibrillator due to syncope secondary to SMTV. Despite being treated with amiodarone, radiofrequency catheter ablation was indicated due to recurrences. In addition, we describe three-dimensional electroanatomic mapping system as a complement to conventional electrophysiology for an adequate characterization of the arrhythmogenic circuits undergoing radiofrequency catheter ablation.
To our understanding, this is the first case published in Argentina of radiofrequency catheter ablation of a SMVT in patients with corrective surgery for tetralogy of Fallot.

Rev Argent Cardiol 2012;80:58-61.

Key words > Tetralogy of Fallot - Ventricular Tachycardia - Catheter Ablation

Abbreviations >

AVA	Implantable Cardioverter Defibrillator	**SMVT**	Sustained Monomorphic Ventricular Tachycardia
ECG	Electrocardiogram	**RV**	Ritght Ventricle
Eg	Electrograms	**PV**	Pulmonary Valve
TF	Tetralogy de Fallot	**TV**	Tricuspid Valve

BACKGROUND

Sustained monomorphic ventricular tachycardia (SMVT) is a late complication of surgical repair of tetralogy of Fallot (TF), its incidence is 11.9%, with 8.3% risk of sudden cardiac death at 35 years follow-up . (1, 2)

In this presentation is described the case of a patient with SMVT after previous surgical repair of TF, in which the use of three-dimensional electroanatomic mapping system, complemented by conventional electrophysiological techniques, was critical to achieve a successful ablation.

CASE REPORT

A 53 year-old male patient, who at 11 years of age underwent surgical repair of TF. In 1999 he was placed an automatic implantable cardioverter defibrillator (ICD) for symptomatic SMVT with syncope. The ECG of base showed sinus rhythm, with right bundle branch block (Figure 1A). The echocardiogram reported severe dilatation of the right chambers, moderate tricuspid regurgitation and severe pulmonary insufficiency.

In the last 3 months the patient showed several episodes of SMVT with a cycle of 480 msec, lower axis, QR in V1 and dominant R wave from V2 to V6, consistent with origin in the outflow tract of the right ventricle (RV) (Fig. 1 B) , it was recurrent despite treatment with amiodarone, for what it was indicated a radiofrequency ablation.

Description of Procedure

The procedure was carried out under sedation-analgesia with midazolam / fentanyl. By via the right femoral vein was introduced a 6 Fr quadripolar catheter, which was positioned at level of the bundle of His, another 6 Fr octupole catheter was placed in the coronary sinus and was used as reference for the NavX and a deflectable tip catheter of 8mm (Blazer II, Boston Scientific) in the RV through the tricuspid valve (TV), with which was carried out the mapping and radiofrequency application. For the

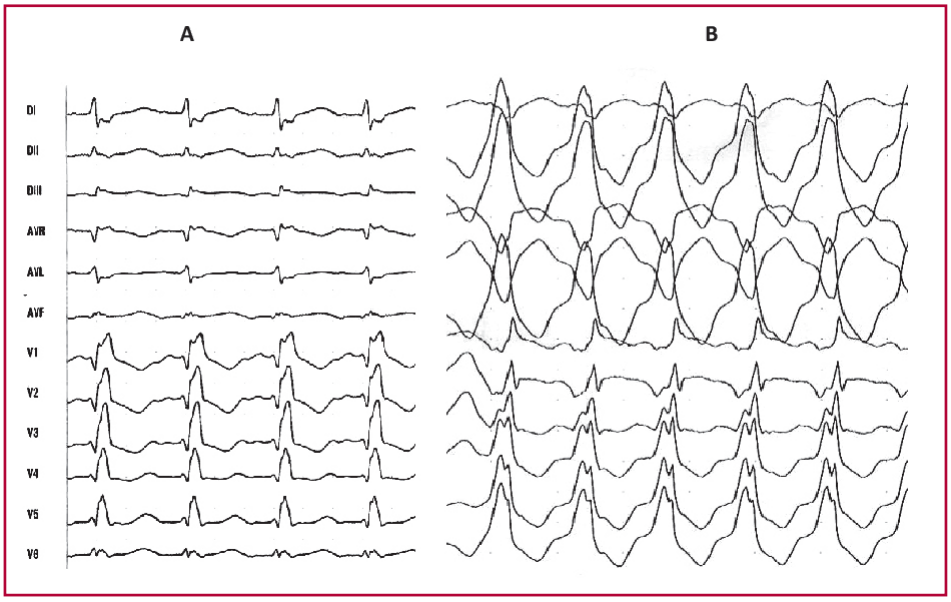

Fig. 1. A. ECG with sinus rhythm. **B.** Sustained monomorphic ventricular tachycardia.

electroanatomic mapping system was used EnSite NavX version 8 system (St Jude Medical, St Paul, Mn, USA).

First it was carried out a RV volumetric **anatomical mapping** to identify the TV and the pulmonary valve (PV). Then it was made a **voltage map** in sinus rhythm, with particular attention to identifying scabs and surgical scars. It was used a colour scale based on the voltage of the intracavitary bipolar electrograms (Eg) of each analysis point for the definition of cicatricial tissue (Eg ≤ 0.5 mV, gray) and healthy tissue (Eg ≥ 1.5 mV, lilac), the areas with intermediate voltage (0.5-1.5 mV) were defined as bordering areas of diseased tissue (range of colours from red to green). (3, 4) This scale was modified by corrections in their lower and upper limits, with the aim of better definition of the interest areas. (Figure 2).

The clinical SMVT was induced reproducibly and was well tolerated hemodynamically. We proceeded to make an **activation map** (Figure 3A), after which guidance techniques were applied to define, according to the methodology described in previous publications, the different circuit components and the critical isthmus of slow conduction (Figure 3 B1 and B2). (5, 6)

For ablation was used an Osypka Hat-300 Smart radiofrequency generator, configuring a maximum power of 70 W and 65 ° C (temperature control). It was carried out a line of RF applications (eight applications of 60 seconds each) at level of critical isthmus of tachycardia, with which was achieved to interrupt the arrhythmia, which subsequently did not return to be inducible (Fig. 3 C).

DISCUSSION

Surgical scars or patches located in the anterior face of RV outflow tract and the pulmonary infundibular septal face in patients undergoing surgical repair of TF are barriers to the conduction of cardiac stimulus and leave as consequences anatomic isthmuses, which added with the presence of slow conduction areas favour the development of ventricular arrhythmias by macro-reentrant circuits. (7-9)

The SMVT may be treated by conventional radiofrequency ablation techniques, however, in these patients, the complexity of the anatomy, the presence of hypertrophic myocardium, the amplitude of the isthmuses, hemodynamic instability or non-inducibility of arrhythmia make that the use of these techniques have offered a success rate no greater than 50%. (10)

The advent of three-dimensional electroanatomical mapping methods, complementing conventional electrophysiology, favours the correct characterization of arrhythmogenic circuits, allowing the definition of block areas, the activation sequence, areas of slow conduction and critical isthmuses and making possible the rescission of arrhythmia by radiofrequency.

Applying a range of colours to the voltages of the intracavitary bipolar electrograms, we make a **voltage map**, by which we were able to make a three-dimensional anatomical reconstruction of the RV and identify a scab corresponding to ventriculotomy in the anterior face of infundibulum (see Figure 2).

Once induced SMVT, the next step was the realization of an **activation map**, which again uses a colour scale, but this time related to the precocity of activation. The main purpose of the activation map is in the focal arrhythmias, whether automatic or micro-reentrant, since it allows us to identify the precise site of origin of arrhythmias. In macro-reentrant circuits, the site of earliest activation is associated with the output of the stimulus and not with the critical area of slow conduction, which is, as we already mentioned,

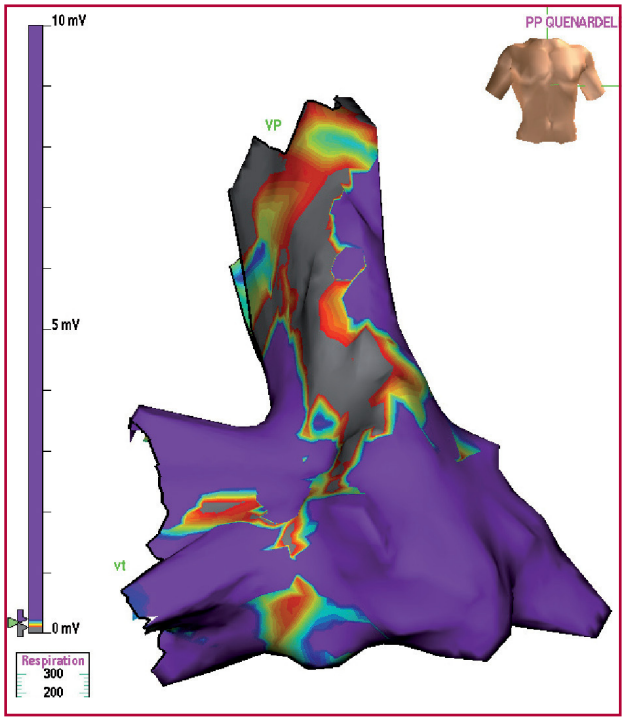

Fig. 2. Voltage map image in anteroposterior incidence. Cicatricial tissue areas may be observed (gray) and healthy tissue (lilac). Areas with intermediate voltages were defined as bordering areas of diseased tissue (range of colours from red to green). The colour scale was modified by corrections in their lower and upper limits, with the aim of better definition of interest areas. PV: Pulmonary valve. TV: Tricuspid valve.

the accurate target for radiofrequency application. However, in this case it was useful, since it allowed us to clearly objectify clockwise rotation of circuit around the scar, where the later areas (lilac) are carried on with the early ones (white) (see Figure 3A). The coloured areas, in turn, represent a series of isochronous lines, which may indicate us the speed of propagation of the stimulus. As shown in Figure 3, the passage from white to red and then to orange is made slowly , downward on the anterior edge of the scar, for next spread more quickly through the rest of the RV and reunit in the upper anterior face below the PV. Figure 4 shows a sequence of images corresponding to the **propagation map** of reentrant circuit around the scar.

In the region where the area of slow conduction was found, guidance techniques of ventricular tachycardia showed coincident characteristics with the critical isthmus, as concealed fusion, posestimulación return cycle similar to the cycle length of tachycardia (500 msec vs. 485 msec), presence of presystolic fractionated potentials, and low voltage and spike-QRS interval (100 msec) similar to the local Eg-QRS interval (95 msec) (see Figure 3 B1). The application of a radiofrequency line in that place achieved the abolition of the arrhythmia (see Figure 3 C). A 6-month follow-up, the patient did not have recurrences in the absence of antiarrhythmic drug therapy.

To our knowledge, this is the first reported case in Argentina of SMVT ablation in patients with surgical repair of TF. It represents a good example of

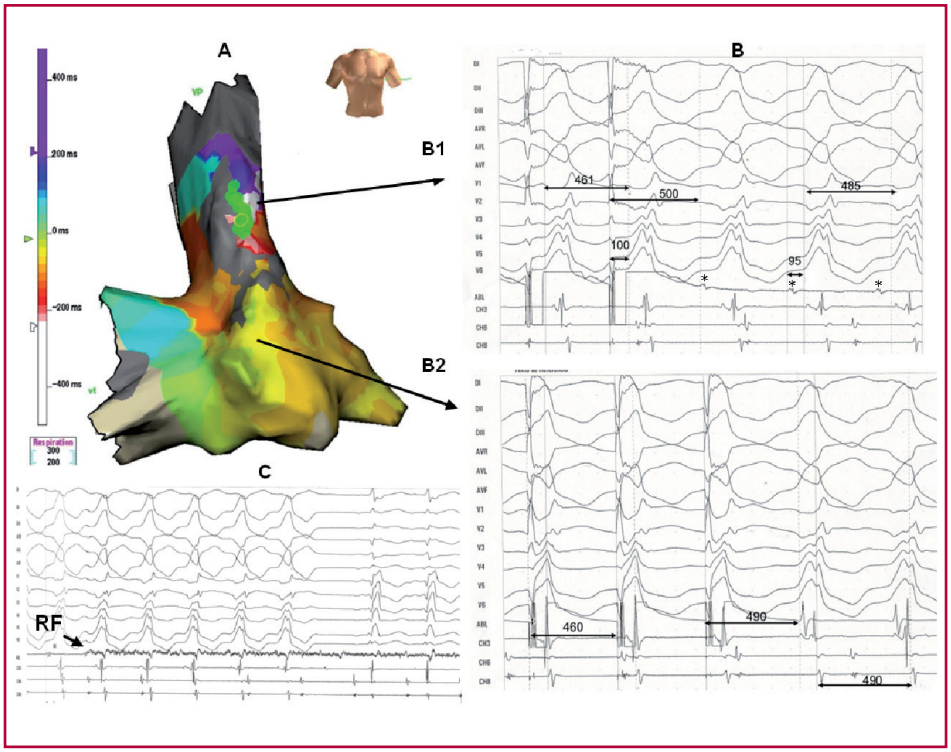

Fig. 3. A. Activation map of the right ventricle obtained during SMVT in anteroposterior incidence. Sequence may be observed macro-reentrant circuit with clockwise rotation around the scar of the anterior face of RV infundibulum. The white area is the earliest and lilac is the latest. **B.** Intracavitary recordings at the end of guidance trains by stimulation from the ablation catheter (arrows indicate the site of stimulation). They may be observed: 1) *Panel B1:* Critical Isthmus, characterized by concealed fusion, posestimulación return cycle similar to the cycle length of tachycardia (500 msec vs. 485 msec), presence of presystolic fractionated low voltage (*) potentials and spike-QRS interval (100 msec) similar to the local Eg-QRS interval (95 msec) and 2) *Panel B2:* Outer loop characterized by visible fusion with post-pacing interval equal to the length of the tachycardia cycle (490 msec vs. 490 msec). C. Termination of the arrhythmia within few seconds of starting the application of radiofrequency (RF) (línea de puntos de color verde).

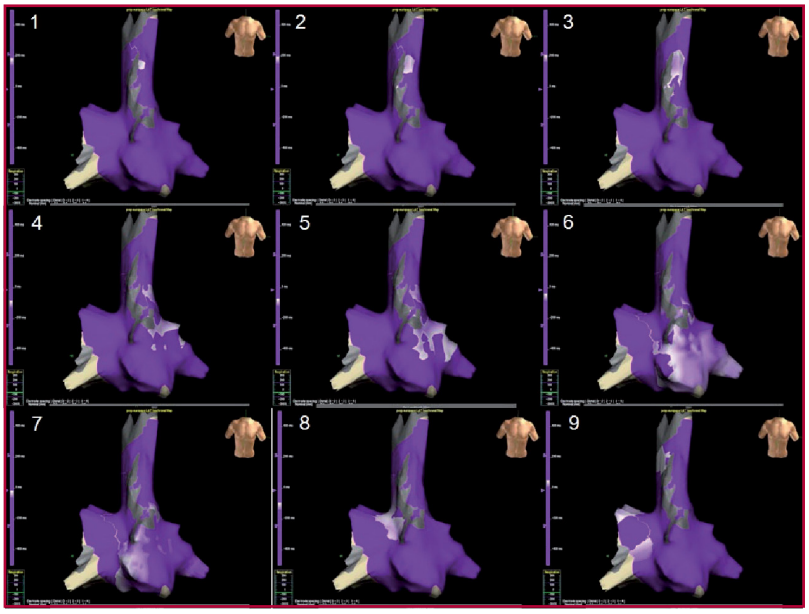

Fig. 4. Propagation map: sequence of images in which, in white, it may be observed the spread of the reentrant stimulus, which leaves from the anterior and superior edge of the scar and spreads around it on clockwise, sequentially activating the anterior face of infunfibulum, then the tip and the free wall to finally ascend by the posterior face of RV

the usefulness of three-dimensional electroanatomic mapping techniques, which complement conventional electrophysiology, favour the correct characterization of arrhythmogenic circuits, allowing the abolition of the arrhythmia by radiofrequency.

RESUMEN

Ablación por radiofrecuencia de una taquicardia ventricular tras la cirugía reparadora de la tetralogía de Fallot

La taquicardia ventricular monomórfica sostenida (TVMS) es una complicación tardía de la cirugía reparadora de la tetralogía de Fallot y si bien puede ser tratada por técnicas convencionales de ablación por radiofrecuencia, las características de los pacientes hacen que la tasa de éxito de su utilización no supere el 50%. El advenimiento de métodos de cartografía electroanatómica tridimensional favorece una ablación exitosa.

En esta presentación se describe el caso de un paciente de 53 años con cirugía previa reparadora de tetralogía de Fallot, a quien le fue colocado un cardiodesfibrilador automático implantable por una TVMS sintomática por síncope. Se decidió indicar una ablación por radiofrecuencia por la presentación de recurrencias a pesar del tratamiento con amiodarona. Asimismo, se describen las técnicas de cartografía electroanatómica tridimensional que, complementando a la electrofisiología convencional, permiten la caracterización correcta de los circuitos arritmogénicos, posibilitando así la abolición de la arritmia mediante radiofrecuencia.

A nuestro entender, este es el primer caso publicado en la Argentina de ablación de TVMS en pacientes con cirugía reparadora de tetralogía de Fallot.

Palabras clave > Tetralogía de Fallot - Taquicardia ventricular - Ablación por catéter

BIBLIOGRAPHY

1. Norgaard MA, Lauridsen P, Helvind M, Pettersson G. Twenty-to thirty-seven-year follow up after repair for Tetralogy of Fallot. Eur J Cardiol-thorac Surg 1999;16:125-30.

2. Gatzoulis MA, Balaji S, Webber SA, Siu SC, Hokanson JS, Poile C, et al. Risk factors for arrhythmia and sudden cardiac death late after repair of tetralogy of Fallot: a multicentre study. Lancet 2000; 356:975-81.

3. Arenal A, del Castillo S, Gonzalez-Torrecilla E, Atienza F, Ortiz M, Jimenez J, et al. Tachycardia-related channel in the scar tissue in patients with sustained monomorphic ventricular tachycardias: influence of the voltage scar definition. Circulation 2004; 110:2568-74.

4. Nakahara S, Tung R, Ramirez RJ, Michowitz Y, Vaseghi M, Buch E, et al. Characterization of the arrhythmogenic substrate in ischemic and nonischemic cardiomyopathy implications for catheter ablation of hemodynamically unstable ventricular tachycardia. J Am Coll Cardiol 2010;55:2355-65.

5. Stevenson WG, Friedman PL, Sager PT, Saxon LA, Kocovic D, Harada T, et al. Exploring postinfarction reentrant ventricular tachycardia with entrainment mapping. J Am Coll Cardiol 1997;29:1180-9.

6. de Chillou C, Lacroix D, Klug D, Magnin-Poull I, Marquié C, Messier M, et al. Isthmus characteristics of reentrant ventricular tachycardia after myocardial infarction. Circulation 2002;105:726-31.

7. Zeppenfeld K, Schalij MJ, Bartelings MM, Tedrow UB, Koplan BA, Soejima K, et al. Catheter ablation of ventricular tachycardia after repair of congenital heart disease: electroanatomic identification of the critical right ventricular isthmus. Circulation 2007;116:2241-52.

8. Chinushi M, Komura S, Furushima H, Aizawa Y. Segmental conduction block in a low-voltage area suppressed macro-reentrant ventricular tachycardia after surgical repair of tetralogy of Fallot. Intern Med 2009;48:1021-3.

9. Bogun F, Morady F. Ablation of ventricular tachycardia in patients with nonischemic cardiomyopathy. J Cardiovasc Electrophysiol 2008;19:1227-30.

10. Furushima H, Chinushi M, Sugiura H, Komura S, Tanabe Y, Watanabe H, et al. Ventricular tachycardia late after repair of congenital heart disease: efficacy of combination therapy with radiofrequency catheter ablation and class III antiarrhythmic agents and long-term outcome. J Electrocardiol 2006; 39:219-24.