

Post-Infarction Ventricular Tachycardia With a QRS Complex Narrower Than 140 ms: Characterization and Catheter Ablation

Mauricio S. Abello, José L. Merino, Rafael Peinado, Mariana Gnoatto, Mar González-Vasserot, José A. Sobrino, and José L. López-Sendón

Unidad de Arritmias y Electrofisiología, Servicio de Cardiología, Hospital Universitario La Paz, Madrid, Spain

Typically, sustained monomorphic ventricular tachycardia (SMVT) in patients with a previous myocardial infarction (MI) is characterized by a wide QRS complex. However, occasionally patients present with SMVT and a narrow QRS complex (N-SMVT). We studied retrospectively the incidence of N-SMVT (i.e., QRS interval <140 ms) in patients with a previous MI and inducible SMVT who underwent electrophysiological evaluation. Of the 135 consecutive patients with inducible SMVT, 8 (5.9%) presented with inducible N-SMVT. The mean QRS complex duration in patients with N-SMVT was 126 (8) ms. Radiofrequency ablation was successful in 5 out of 6 patients (83%). One of the remaining two received an implantable defibrillator, while the other was given amiodarone. Findings during radiofrequency ablation showed that the reentry circuit was located in the left septum in 4 out of the 5 patients (80%). N-SMVT is relatively uncommon, but the success rate of radiofrequency ablation is high. The reentry circuit is most often located in the septum.

Key words: Catheter ablation. Electrophysiology. Tachycardia. Myocardial infarction.

Taquicardia ventricular postinfarto de QRS inferior a 140 ms: caracterización y ablación con catéter

Las taquicardias ventriculares monomórficas sostenidas (TVMS) en pacientes con infarto de miocardio (IM) previo presentan, habitualmente, un complejo QRS ancho. Sin embargo, en ocasiones se han descrito TVMS de complejos QRS «estrechos» (TVMS-E). Se analizó retrospectivamente la incidencia de TVMS-E (QRS < 140 ms) en pacientes con IM previo y TVMS inducidas en el estudio electrofisiológico. De 135 pacientes consecutivos con TVMS inducibles, 8 (5,9%) presentaron al menos una TVMS-E. La duración media del QRS de las TVMS-E fue de 126 ± 8 ms. La ablación con radiofrecuencia (ARF) fue eficaz en 5/6 pacientes (83%). De los restantes, en uno se implantó un desfibrilador y en el otro se indicó amiodarona. El resultado de la ARF evidenció una localización septal izquierda del circuito en 4/5 pacientes (80%). Las TVMS-E son relativamente raras pero la eficacia de la ARF es elevada; el septo es la localización más frecuente del circuito.

Palabras clave: Ablación con catéter. Electrofisiología. Taquicardia. Infarto de miocardio.

INTRODUCTION

Sustained monomorphic ventricular tachycardia (SMVT) in patients with a previous myocardial infarction (MI) is usually characterized by a wide QRS complex. Patients have occasionally been reported to have SMVT and a QRS complex <0.14 s.^{1,2} This “pseudonarrowing” of the QRS complex has been attributed to both a septal location of the circuit and an early penetration of the His-Purkinje system, with a later rapid activation of the rest

of the ventricular myocardium.² However, the characteristics of this type of tachycardia have not yet been studied systematically and the results of radiofrequency ablation (RFA) have not been previously analyzed. The aim of this study was to determine the incidence of SMVT with a QRS <140 ms (narrow SMVT: N-SMVT) and analyze its clinical and electrophysiological characteristics, as well as the results of RFA.

METHODS

This retrospective study included 135 patients with a prior MI before admission to our center in whom at least one SMVT was induced during the electrophysiological study. We examined the incidence, clinical and electrophysiological characteristics and the results of RFA in the patients in whom at least one N-SMVT was induced.

Correspondence Dr. J.L. Merino.
Unidad de Arritmias y Electrofisiología.
Paseo de la Castellana, 261. 28046 Madrid. España.
E-mail: jlmerino@secardiologia.es

Received April 25, 2006.
Accepted for publication November 2, 2006.

TABLE 1. Main Clinical Characteristics of the Patients With Sustained Monomorphic Ventricular Tachycardia and a QRS Complex <140 ms*

Patient	Age, Years	Sex	LVEF, %	Infarction	Ventricular Aneurysm
1	57	M	16	Anterior and inferior	No
2	39	M	38	Inferoposterior	No
3	73	M	20	Anterior	Yes
4	78	F	48	Inferoposterior	No
5	53	M	38	Inferoposterior	Yes
6	64	M	51	Anterior	Yes
7	76	M	30	Inferolateral	Yes
8	84	M	45	Inferior	Yes

*LVEF indicates left ventricular ejection fraction; M, male; F, female.

The anti-arrhythmic medication was suspended five half-lives before the study. The duration of the QRS complex was measured in the electrocardiogram lead recording the greatest width for which the start and end of the QRS were clearly evident, determined by two independent observers, with a recording speed of 100 mm/s. In the event that the clinical SMVT was able to be induced again, this constituted the sole end point of the RFA. In patients in whom its induction was not possible, only the “non-clinical” SMVT that was induced most frequently, with a cycle length (CL) >240 ms and hemodynamically tolerated, was considered.

Identification of the slow conduction zone of the circuit was made by initial approximation to the suspected region with the search for fragmented potentials of low amplitude and appearance, coinciding with or later than the most delayed portions of the QRS complex in sinus rhythm. Once the SMVT was induced, the criteria used were: recording of the mid-diastolic potentials, entrainment with concealed fusion, postentrainment return cycle not more than 30 ms greater than the cycle length of the SMVT and electrogram-QRS interval during the SMVT the same as the spike-QRS interval during entrainment.^{3,4}

The radiofrequency applications were done by a catheter with a 4 mm distal electrode in those catheter positions in which at least two of the previously mentioned mapping criteria were fulfilled.

The impossibility of later reinduction of the SMVT when RFA had been done was considered to reflect an efficient RFA. An automatic defibrillator was implanted in the patients with an ejection fraction (EF) <35% whose RFA was done after publication of the MADIT study.⁵

Statistical Analysis

The data are expressed as the mean (standard deviation) or the median (interquartile range), depending on the

type of distribution. The interobserver variability was analyzed by the intraclass correlation coefficient.

RESULTS

Of the 135 patients included in the study, eight (5.9%) had SMVT with QRS <140 ms. The main clinical characteristics of these patients are shown in Table 1.

One single N-SMVT morphology was induced in all eight patients. The mean number of SMVT induced per patient was 3.8 (1.5). In four of these, the SMVT induced was similar to the clinical SMVT. No induced SMVT with a wide QRS complex (W-SMVT) had a similar morphology to its respective N-SMVT. However, in three patients, the W-SMVT induced showed a bundle branch block image concordant with the N-SMVT, as did five of the six morphologies induced in another two patients (Figure). All the N-SMVT and 92% of the W-SMVT were induced from the apex of the right ventricle. The interobserver variability of the duration of the QRS complexes of the N-SMVT had a correlation coefficient (R) of 0.77. The main electrophysiological characteristics of these patients are shown in Table 2.

The intrachamber mapping showed a SMVT origin in the left ventricle in all the patients. The entrainment of the N-SMVT from the apex of the right ventricle showed return cycles 70 ms greater than the cycle length. The characteristics of the mapping and the RFA are given in Table 3. After the efficient RFA, in three patients it was impossible to reinduce any of the SMVT, whereas in two patients just poorly tolerated SMVT were inducible, with a CL <240 ms.

One of the two patients in whom RFA was not done had a mechanical septal block of the N-SMVT during the mapping, which was impossible to reinduce later. No exhaustive mapping was performed in the other patients due to the state of the patient and the long procedure time. For this reason no areas were found that fulfilled

at least two criteria for RFA and treatment was started with amiodarone (Table 3).

DISCUSSION

The incidence of SMVT with a QRS complex <140 ms in patients with a prior MI was 5.9%. Although their presentation is uncommon, N-SMVT must nevertheless be considered in the differential diagnosis with supraventricular tachycardia with aberrant conduction.

Miller et al² reported an incidence of 12% N-SMVT (≤ 0.14 s) in a series of patients with SMVT. This greater incidence as compared with our study might be explained by the inclusion in their series of idiopathic SMVT, which, because they originate near the divisions of the left branch, usually present a narrow QRS complex, as well as having considered a cut-off point that was "lower than or equal to" rather than just "lower than" 0.14 ms, as was the case in our study. Additionally, Hayes et al⁶ described an incidence of N-SMVT (≤ 0.11 s) of 4.7%. Unlike these results, in our study no N-SMVT was induced with a QRS duration <0.11 s. Although the methodology used for measurement was not reported in their series, the differences with our study could be attributed to the greater precision of the digital measurements used nowadays.

As already mentioned, a short QRS complex duration is attributed to a circuit exit of the N-SMVT in the proximity of the interventricular septum. Although the spatial localization of the slow conduction zone was not confirmed by RFA in all the patients, the septum was the most common site of this zone of the circuit in the cases with an efficient RFA (80%), as well as probably in the cases with mechanical block during the procedure. Although the data support this hypothesis, the results should be confirmed in larger series of patients.

Bogun et al described the presence of a shared isthmus in some 40% of post-MI SMVT.⁷ The main feature of this shared tissue is that the same slow conduction zone may be a vital component in sustaining different SMVT,

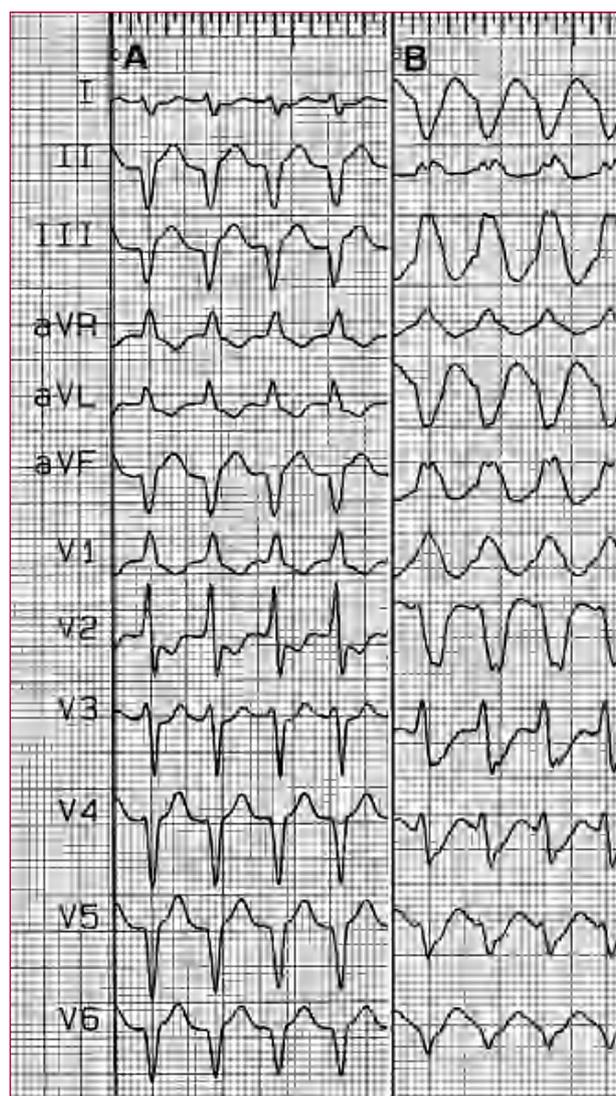


Figure. Twelve lead electrocardiographic tracings at 25 mm/s of 2 ventricular tachycardias (VT) induced in the same patient A: narrow QRS complex VT. B: wide QRS complex VT

TABLE 2. Main Electrophysiological Characteristics During Sinus Rhythm and Ventricular Tachycardia*

Patient	HV SR	No. VT†	M N-VT	DQ N-VT	CL N-VT	HV N-VT	Ind N-VT	DQ W-VT	CL W-VT
1	43	4	LBBB I	121	342	18	T+1 es	184 (15)	262 (13)
2	36	2	LBBB S	111	260	NA	T+3 es	172	260
3	48	4	LBBB I	134	292	4	T+2 es	180 8169	304 (47)
4	56	2	RBBB S	129	350	-24	T	214	340
5	39	3	LBBB I	132	314	36	T+4 es	150 (11)	325 (28)
6	34	6	RBBB S	121	298	NA	T+2 es	176 (17)	350 (30)
7	46	6	RBBB S	130	392	26	Spontaneous	166 (12)	344 (63)
8	44	4	RBBB S	134	368	14	T+1 es	198 (14)	354 (50)

*RBBB indicates right bundle branch block; LBBB, left bundle branch block; DQ, duration QRS complex; es, extrastimuli; I, inferior axis; ind, inducibility; CL, cycle length; M, morphology; NA, histogram not appreciable; SR, sinus rhythm; S, superior axis; T, train; VT, ventricular tachycardia (N-VT, narrow QRS VT; W-VT, wide QRS VT).

†Number of ventricular tachycardias induced with CL>240 ms. The numeric values are expressed in milliseconds.

TABLE 3. Main Characteristics of the Ablation Procedure and Therapeutic Behavior

Patient	CF	MP	RC-CL	E/S QRS	RFA	Success	RFA Circuit	Site Efficient RFA	Post-RFA Treatment*
1	Yes	Yes	-5	NE	Yes	Yes	N-VT/clinical	Anteroseptal	Amiodarone
2	Yes	Yes	20	NE	Yes	Yes	W-VT/not clinical	Posterolateral	β -blockers
3	NE	NE	NE	NE	No	-	-	-	β -blockers-AID
4	No	Yes	60	NE	No	-	-	-	Amiodarone
5	Yes	Yes	22	-32	Yes	Yes	W-VT/clinical	Basal inferoseptal	β -blockers
6	Yes	Yes	30	NE	Yes	No	W-VT/clinical	-	β -blockers-AID
7	Yes	Yes	-10	14	Yes	Yes	W-VT/not clinical	Inferoseptal	β -blockers
8	Yes	Yes	20	-2	Yes	Yes	N-VT/clinical	Basal inferoseptal	-

*RFA indicates radiofrequency ablation; RC-CL, difference between the return cycle and the cycle length of the tachycardia; AID, automatic implantable defibrillator; E/S QRS, difference between electrogram; CF, entrainment with concealed fusion; NE, not evaluated; MP, mid-diastolic potentials; QRS and QRS stimulus; W-VT, wide QRS ventricular tachycardia; N-VT, narrow QRS ventricular tachycardia.

which would permit the concurrence of different morphologies of induced SMVT. In our study, the inability to reinduce mappable SMVT (CL >240 ms) after an efficient RFA in all the patients indicates that, as an expression of different ventricular exits, the same patient may have not only SMVT with a different morphology but also SMVT with a different QRS complex duration or cycle length.

Finally, the success rate of the RFA in patients with N-SMVT was comparable with the results of other series on SMVT RFA and prior MI.^{8,9} Nevertheless, due to the limited number of patients with N-SMVT, these results should be confirmed in larger series of patients.

REFERENCES

- Wellens HJ, Bar FW, Lie KI. The value of the electrocardiogram in the differential diagnosis of a tachycardia with a widened QRS complex. *Am J Med.* 1978;64:27-33.
- Miller JM. The many manifestation of ventricular tachycardia. *J Cardiovasc Electrophysiol.* 1992;3:88-107.
- Stevenson WG, Khan H, Sager P, Saxon LA, Middlekauff HR, Natterson PD, et al. Identification of reentry circuit sites during catheter mapping and radiofrequency ablation of ventricular tachycardia late after myocardial infarction. *Circulation.* 1993;88:1647-70.
- Merino Llorens JL, Peinado PR, Pérez-Villacastin J, Arenal MA, Almendral GJ. Ablación con catéter mediante radiofrecuencia de taquicardias ventriculares en pacientes con cicatriz postinfarto. *Rev Esp Cardiol.* 1997;50:157-65.
- Moss AJ. MADIT-I and MADIT-II. *J Cardiovasc Electrophysiol.* 2003;14:S96-S8.
- Hayes JJ, Stewart RB, Green HL, Bardy GH. Narrow QRS ventricular tachycardia. *Ann Intern Med.* 1991;114:460-3.
- Bogun F, Li YG, Groenefeld G, Hohnloser SH, Schuger C, Oral H, et al. Prevalence of a shared isthmus in postinfarction patients with pleiomorphic, hemodynamically tolerated ventricular tachycardias. *J Cardiovasc Electrophysiol.* 2002;13:237-41.
- Stevenson WG, Friedman PL, Kocovic D, Sager PT, Saxon LA, Pavri B. Radiofrequency catheter ablation of ventricular tachycardia after myocardial infarction. *Circulation.* 1998;98:308-14.
- Álvarez M, Merino JL. Registro Nacional de ablación con catéter de la Sociedad Española de Cardiología del año 2001. *Rev Esp Cardiol.* 2002;55:1273-85.