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Original Article

Clinical utility of multielectrode contact mapping for scar-related ventricular tachycardia ablation: A prospective single-center experience

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ABSTRACT

Background: As with the use of circular catheters for pulmonary vein antral ablation, it may be favorable to use multipolar catheters for substrate mapping of the left ventricle (LV). The purpose of this study was to investigate the clinical feasibility of using multielectrode mapping combined with an impedance-based electroanatomic mapping system for scar-mediated ventricular tachycardia (VT).
Methods: By using the multielectrode catheter in conjunction with the Velocity system, we obtained both geometric and electrogram data simultaneously, through transseptal and transsubxiphoid approaches. Higher-density mapping was performed in areas of dense scar (< 0.5 mV) and border zones (0.5–1.5 mV). All late potentials (LPs) observed on the multipoles were tagged, and pace mapping was performed at those sites for comparison with the targeted VT morphology. Ablation was performed at target sites on the multipolar catheter that were identified by pace mapping, as well as at sites identified to have LPs and to be the origin of the premature ventricular complexes (PVCs) that triggered the VT.
Results: Sixteen patients (8/8: ischemic/nonischemic cardiomyopathy) underwent endocardial ($n=16$) and epicardial ($n=8$) mapping. The mean number of endocardial and epicardial mapping points was 504 ± 136 and 670 ± 211, respectively, with an average mapping time of 21 ± 6 min. LPs were seen in 13 patients (81%), and good (56%) and perfect (31%) pace maps were seen in 14 patients (88%). In two patients, sites with the earliest activation of PVCs that triggered VT were successfully identified with multipolar catheter mapping. A distinct geometric distortion of the endocardial LV was confirmed in two patients, and those were modified by dividing the LV into two chambers. After 10.0 ± 3.7 months, 71% of the patients have remained free of VT episodes.
Conclusion: Multipolar catheter mapping combined with the Velocity system results in a high-density delineation of the LV substrates in a relatively short time, suggesting that this is a feasible alternative mapping strategy for scar-related VT.

1. Introduction

Catheter ablation has been demonstrated to be an effective therapy for scar-mediated reentrant ventricular tachycardia (VT) and is being used prophylactically in the management of patients at risk for recurrent VT [1,2]. Substrate-based approaches with electroanatomic mapping (EAM) systems are critically dependent on an accurate delineation of the infarct architecture, which is a function of the mapping density. However, substrate-based ablation procedures often require long procedural times because of extensive point-by-point mapping. A method to improve the mapping density for the identification of late potentials (LPs) over a larger myocardial area holds promise for facilitating and expediting VT ablation.

Contact mapping of an infarction by using NavX has been systematically validated in the left ventricle (LV) [3]. One advantage of the system is that it allows for simultaneous data collection from all electrodes of any or all catheters, if desired. Therefore, it is possible to allow for a quicker acquisition of a larger number of points for scar delineation. Furthermore, a new feature of the

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new EnSite Velocity system called "OneMap" might expedite the baseline mapping since it allows for simultaneous recording of the electrophysiologic data while building the chamber geometry. Thus, it may be advantageous to use a multipolar catheter combined with the Velocity system in the ventricle for rapid mapping and to guide ablation. The purpose of this study was to investigate the clinical feasibility of using the multipolar EAM combined with a new software system for the ablation of scar-mediated VT.

2. Methods

2.1. Study patients

Detailed electroanatomic data were obtained from 16 consecutive patients referred for mapping and catheter ablation of scar-related VT at our institution. Patients with cardiomyopathy of ischemic and nonischemic etiologies were included. All patients underwent multipolar endocardial mapping, and epicardial mapping was performed at the discretion of the operator on the basis of the patient's ablation history and electrocardiographic (ECG) criteria suggestive of an epicardial site of origin [4,5]. Written informed consent was obtained from all patients before the ablation.

2.2. Multipolar electroanatomic mapping

A single LV access was obtained by using an 8F Mullins transseptal sheath ($n=10$) or a bidirectional deflectable sheath (Destino; OSCOR, Palm Harbor, FL, USA) ($n=6$). A transseptal puncture was performed by using a Brockenbrough needle (BRK-1), with adjunctive radiofrequency (RF) energy (30 W; Valley Lab, Lehighton, PA, USA) applied in patients with an aneurysmal or thick interatrial septal anatomy. Systemic heparinization to achieve an activated clotting time with a goal of 250 s was maintained throughout the procedure. In patients in whom epicardial mapping was performed, a transthoracic access to the pericardial space was obtained as described by Sosa et al. [6]. Access to the pericardial space for epicardial mapping was obtained before heparinization through a subxiphoid puncture [7].

Endocardial mapping was performed through the transseptal sheath by using either a decapolar (Livewire, 2–5–2 mm spacing; St. Jude Medical, Minnetonka, MN, USA) or duodecapolar steerable catheter (Livewire, 2–2–2 mm spacing; St. Jude Medical). Electroanatomic voltage mapping was performed during the intrinsic rhythm or paced rhythms by using the NavX system (Ensite, St. Jude Medical). A coronary sinus catheter was placed by using a 7F locking sheath through the internal jugular, and the position was shadowed on the EAM to serve as the internal reference. The geometry of the ventricle was created by using both an irrigated ablation catheter (Safire Blu, St. Jude Medical) and a multipolar catheter after optimization of the EAM system. Briefly, the ablation catheter was advanced into the apex of the LV and to the mitral annulus to create anatomical landmarks. Subsequently, a fully curved multipolar catheter was advanced into the apex with the greater curvature in contact with the apex. The catheter was then rotated at the same depth in the ventricle to create the geometry, and the curve was relaxed as the catheter was withdrawn toward the basal portion of the ventricle. During the construction of the geometry, bipolar voltage sampling for three-dimensional scar delineation was simultaneously performed. All points on the interior projection >8 mm from the geometry (exterior projection for epicardial mapping) were considered to represent insufficient contact and were excluded from the voltage map. Finally, a scaling algorithm (field scaling) was applied to the completed detailed geometry in all cases. All cases were performed with the Velocity software, allowing for the simultaneous acquisition of the geometry and voltage data. Higher-density mapping was performed within the scar and at border zones (BZs). The bipolar signals were filtered at 5–500 Hz and displayed at 100 mm/s.

Three-dimensional bipolar electroanatomic maps were displayed with a dense scar (DS) defined as having an electrogram amplitude of ≤ 0.5 mV, scar BZ from 0.51 to 1.50 mV, and total low-voltage area (TLV) <1.5 mV. Upon completion of the high-density EAM, the duodecapolar catheter was positioned in areas of DS and BZ. All LPs observed on the 10- or 20-pole catheters were tagged, and pace mapping was performed at those sites for comparison with the clinical or induced VT 12-lead template. A perfect pace-map match was defined as a 12/12 lead match and a good pace-map match was defined as a 10/12 match. VT was induced with pacing from the right ventricular apex before or after the creation of the EAM. Drive cycle lengths of 400 ms, with decrements of 10 ms until refractoriness or 200 ms, were used with up to three extrastimuli. Induced VTs were stored as a template for the pace mapping, and targeted VTs were defined as those being (i) similar to the12-lead ECG of the presenting VT, if available; (ii) similar in cycle length observed on implantable cardioverter defibrillator (ICD) interrogation; or (iii) reproducibly inducible. All VTs seen during the procedure, either spontaneously with catheter manipulation, or ablation induced, were counted. Ventricular flutter or sine wave tachycardia that degenerated into ventricular fibrillation was not counted as a VT morphology.

2.3. Electrogram analysis

Electrograms were classified as follows: LP was defined as any low-voltage electrogram (≤ 1.5 mV) with a distinct onset after the QRS, showing double or multiple components separated by a >20 ms isoelectric interval [8]. LPs were then classified into two groups: (i) very late potentials (vLPs), which were electrograms with an onset of >100 ms after the QRS [9] and (ii) moderate late potentials (mLPs), which were electrograms with an onset of <100 ms after the QRS [10]. The same definition was applied across patients with intrinsic and paced complexes. Electrogram duration was measured from the onset to the offset of the local electrogram.

2.4. Catheter ablation

Ablation was performed by using the transseptal sheath with an open-irrigated catheter (Safire Blu, St. Jude Medical) at a power of 30–50 W, a temperature limit of 45 °C, and a flow rate of 15–30 mL. The ablation lesions were tagged on the EAM, and the lesions were considered adequate if there was a diminution or abolishment of the local electrogram, failure to capture with pacing at 10 mA and a pulse width of 2 ms, or an impedance drop of >10–$15\ \Omega$.

If VT was hemodynamically tolerated, entrainment mapping was attempted at sites demonstrating diastolic activity from either the multipolar catheter or the ablation catheter. Pacing for entrainment was performed at 20–40 ms shorter than the tachycardia cycle length (TCL), and a site with a postpacing interval within 30 ms of the TCL with concealed fusion and an equivalent stimulus QRS interval to the electrogram QRS (30–70% TCL) interval was considered an isthmus. When hemodynamically untolerated VTs were noted, a putative isthmus was defined as a site at which the pace-mapping site exhibited perfect (QRS complexes identical in all 12 leads) and good (QRS complexes identical in >10 leads) matches to the targeted VT with a stimulus to QRS interval of ≥ 40 ms [4,11]. RF energy was delivered at those sites, and additional RF applications were then delivered at the tagged sites with LPs. Those lesions were connected within the DS, and the lesions were extended to the BZs.

At the end of the ablation procedure, an electrophysiologic study was performed with ventricular extrastimulus testing at drive cycle lengths of 400 ms, with decrements of 10 ms until refractoriness of

200 ms, with up to three extrastimuli. The acute procedural results were categorized into three groups: (i) complete success—all VTs noninducible after ablation; (ii) partial success—nontargeted VTs inducible; and (iii) failure—targeted/clinical VTs inducible [12]. VT recurrence after hospital discharge was assessed by means of interrogation of the ICD and with the clinical history from the patient interview.

3. Results

3.1. Patient characteristics

Sixteen patients underwent EAM and ablation with a transseptal access. All patients had an arrhythmogenic substrate. The patient characteristics are summarized in Table 1. The mean age was 67 ± 9 years, and all except two were men. The mean ejection fraction was 36 ± 7%, and 13 patients (81%) had an ICD. All patients were treated with antiarrhythmic drugs, with 88% of the patients with amiodarone use. Eight patients (50%) underwent epicardial mapping, and among those, all had nonischemic substrates.

3.2. Electroanatomic mapping

The results of the mapping and ablation are shown in Table 2. The mean number of endocardial and epicardial mapping points was 504 ± 136 and 670 ± 211, respectively, with an average mapping time of 22 ± 7 min. The mean TLV (≤ 1.5 mV) in the endocardium was significantly larger in the ischemic cardiomyopathy (ICM) group than in the nonischemic cardiomyopathy (NICM) group (79 ± 25 vs. 31 ± 17 cm^2, respectively; $p=0.0046$). A similar difference was observed with DS areas (39 ± 19 vs. 12 ± 10 cm^2,

Table 3
Distribution of LPs in low-voltage area.

	Endocardium ($n=16$)	Epicardium ($n=8$)	*p* Value
TLV [< 1.5 mV] area (cm^2)	61 ± 33	70 ± 30	0.5729
DS [< 0.5 mV] area (cm^2)	29 ± 21	18 ± 16	0.2451
No. of vLPs	4.0 (0, 6.8)	0 (0, 1.0)	0.1135
No. of mLPs	1.0 (0, 1.0)	1.0 (0, 5.0)	0.4781
No. of total LPs	5.0 (0, 8.0)	1.0 (0, 6.0)	0.3913

Values are expressed as mean ± SD or median (quartiles).

Table 1
Patient characteristics.

Patient	Age	Sex	Etiology	EF (%)	CABG	ICD	Antiarrhythmic drugs	No. of prior procedures	Epicardial access
1	63	F	NICM	29	No	Yes	Amio	0	Yes
2	73	M	ICM	36	No	Yes	Lido	0	No
3	70	M	NICM	29	No	Yes	Amio	0	Yes
4	51	M	NICM	38	No	Yes	Amio	0	Yes
5	76	M	NICM	36	No	Yes	Amio	1	Yes
6	77	M	NICM	32	No	Yes	Amio	0	Yes
7	73	F	NICM	45	No	Yes	Amio	0	Yes
8	45	M	NICM	48	No	Yes	Amio	0	Yes
9	72	M	ICM	40	No	Yes	Amio	0	No
10	56	M	NICM	30	No	Yes	Amio+Sota	1	Yes
11	72	M	ICM	23	No	Yes	Amio	0	No
12	73	M	ICM	40	No	No	Amio	0	No
13	64	M	ICM	38	No	Yes	Amio+Sota	0	No
14	70	M	ICM	44	Yes	Yes	Amio	0	No
15	65	M	ICM	45	No	No	Amio	0	No
16	76	M	ICM	28	No	No	Sota	0	No

Amio=amiodarone; Lido=lidocaine; Sota=sotarol; NICM=nonischemic cardiomyopathy; ICM=ischemic cardiomyopathy.

Table 2
Results of mapping and ablation.

Patient	EAM scar location	Mapping points		Pace map		Entrainment		PVC triggering VT		LPs seen		VTs induced	Mapping times (min)	Procedure times(min)	Acute success
		Endo	Epi	Endo	Epi	Endo	Epi	Endo	Epi	Endo	Epi				
1	Basal-lateral/septal	502	633	No	No	No	No	No	No	No	No	3	30	268	Failure
2	Inferior/anteroseptal	507	–	Perfect	–	No	–	No	–	Yes	–	2	15	226	Complete
3	Infero-lateral	734	980	No	No	No	No	No	No	No	No	3	23	212	Failure
4	Basal-lateral	556	538	No	Good	No	No	No	Yes	No	Yes	1	24	192	Complete
5	Basal-Inferolateral	320	706	Perfect	Good	No	No	No	No	Yes	No	5	28	292	Partial
6	Basal-inferior/septal	405	727	Good	No	No	No	No	No	Yes	No	2	30	193	Partial
7	Inferolateral	298	450	Good	No	No	No	No	No	No	No	1	15	176	Partial
8	Basal-lateral	247	467	No	Good	No	No	No	No	No	Yes	1	32	230	Complete
9	Anteroseptal	540	––	Perfect	–	Concealed	–	No	–	Yes	–	2	17	196	Partial
10	Anteriror	312	996	No	Perfect	No	No	No	No	No	Yes	1	25	182	Complete
11	Anteroseptal	513	–	Good	–	Concealed	–	No	–	Yes	–	2	13	184	Complete
12	Inferolateral	408	–	Good	–	No	–	No	–	Yes	–	1	14	176	Complete
13	Anteroseptal	704	–	Good	–	No	–	Yes	–	Yes	–	1	22	168	Complete
14	Inferolateral	526	–	Good	–	No	–	Yes	–	Yes	–	2	12	204	Complete
15	Inferolateral	515	–	Perfect	–	No	–	Yes	–	Yes	–	1	17	173	Complete
16	Inferolateral	493	–	Good	–	No	–	No	–	Yes	–	2	22	212	Complete
Mean ± SD		504 ± 136	670 ± 211									1.9 ± 1.0	22 ± 7	205 ± 35	

respectively; $p=0.0161$). Half of the patients had an inferolateral scar. The apical regions proved to be easier to map with rotation with a tighter curve on the multipolar catheter. Multipolar mapping of the basal portions of the LV often required extreme caution. To confirm contact, both the decapolar and duodecapolar catheters were also used as single-point catheters, by using the most distal electrode. If a perivalvular scar was suspected, adequate contact was further confirmed with the ablation catheter.

3.3. LP distribution within the scar

Detailed offline analysis of abnormal ventricular electrograms was performed after the procedure. Table 3 shows the distribution of LP in the low-voltage area in all patients. Concerning the total number of LPs, patients with NICM had significantly fewer endocardial LPs than patients with ICM (median 0 vs. 7.5; $p=0.0265$). This difference was driven by a lesser proportion of vLPs seen in patients with NICM (median 0 vs. 5.5, $p=0.0133$). In ICM patients, a large proportion of vLPs (83%) were recorded on the endocardial surface, whereas mLPs (62%) were frequently observed on both endocardial and epicardial surface in NICM patients (Fig. 1A). In all patients, a larger proportion of vLPs were recorded at DS, whereas mLPs were frequently recorded at BZ (Fig. 1B).

3.4. Catheter ablation

The mean number of VTs induced was 1.9 ± 1.0, with an average cycle length of 348 ± 81 ms. Concealed entrainment was performed and demonstrated in three VTs endocardially in two patients (12.5%). LPs were seen in 12 patients during endocardial

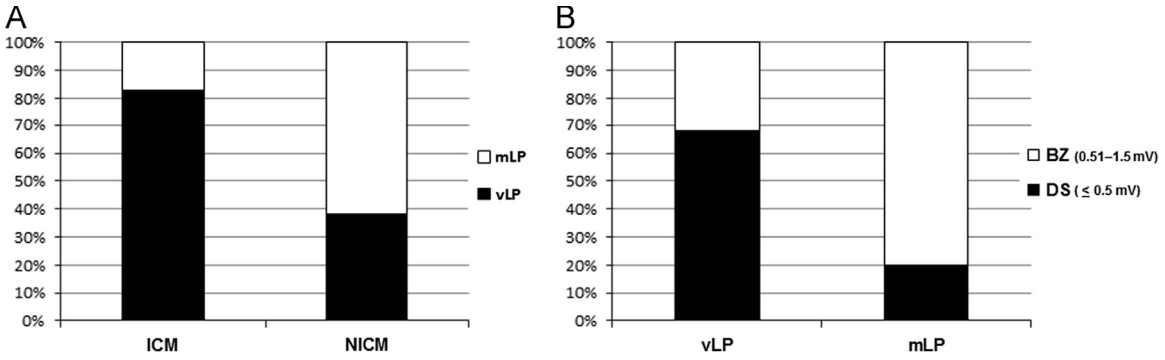

Fig. 1. (A) In ICM patients, a large proportion of vLPs (83%) were recorded on the endocardial surface, whereas mLPs (62%) were frequently observed on both the endocardial and the epicardial surface in NICM patients. (B) In ICM and NICM patients, a larger proportion of vLPs were recorded at DS, whereas mLPs were frequently recorded at BZ in all patients. (ICM=ischemic cardiomyopathy, NICM=nonischemic cardiomyopathy, mLP=moderate late potential; vLP=very late potential; BZ=border zone: DS=dense scar.)

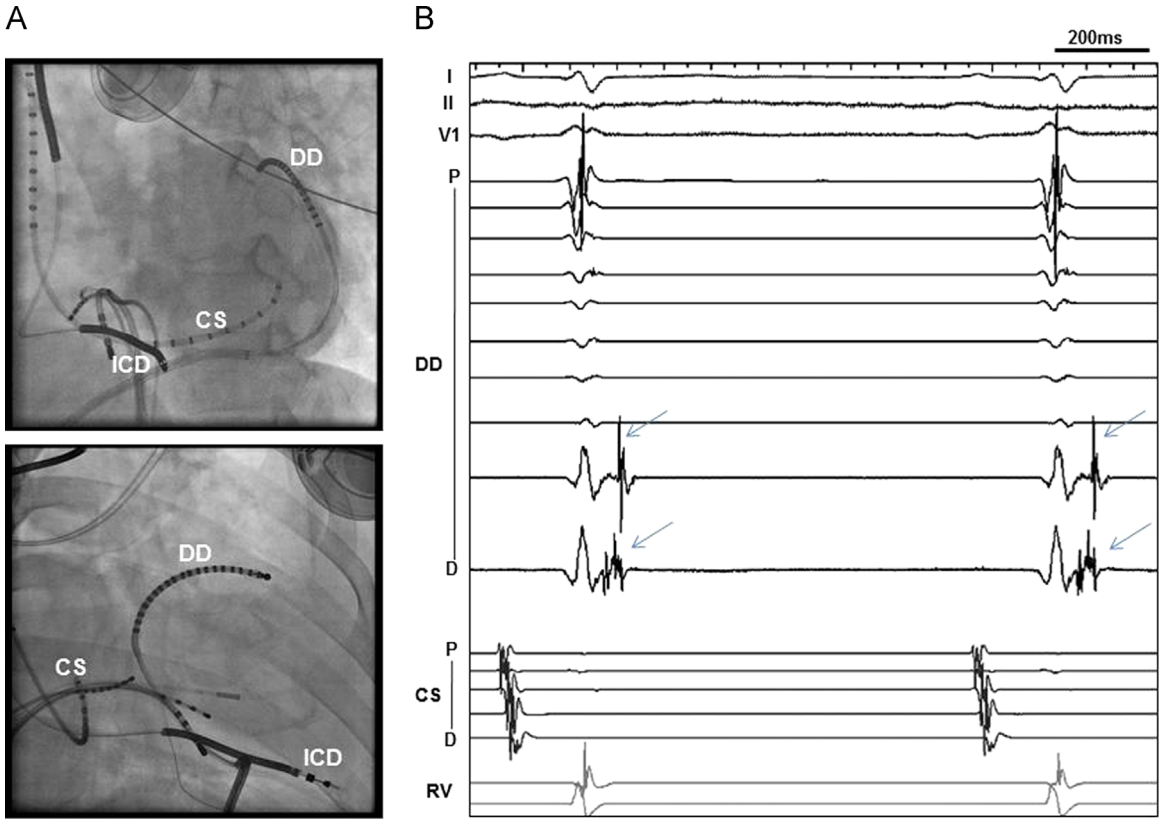

Fig. 2. (A) Left anterior oblique and right anterior oblique fluoroscopic views with a duodecapolar (DD) catheter positioned within the pericardium where late potentials were recorded. (B) Late potentials (LPs) during sinus rhythm seen on the distal electrodes of the DD catheter (arrows). (DD=duodecapolar catheter; ICD=implantable cardioverter defibrillator lead; CS=coronary sinus catheter.)

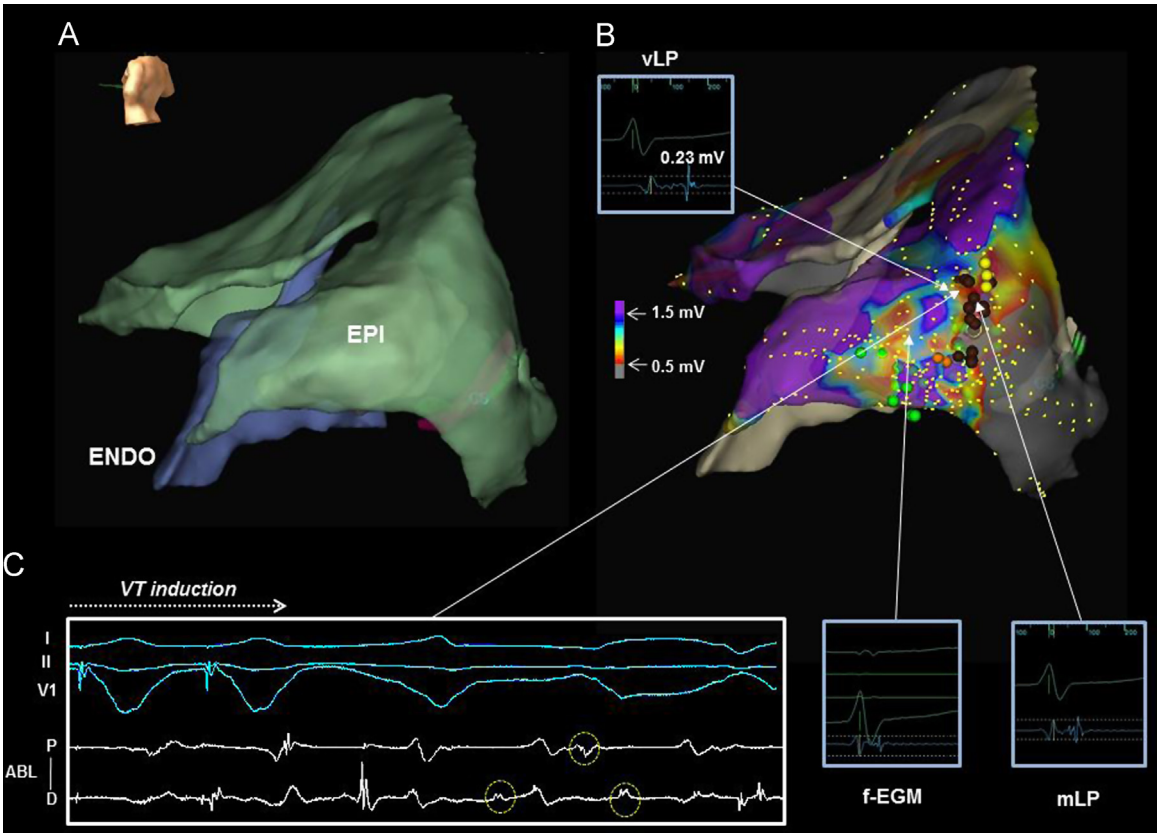

Fig. 3. Electroanatomical maps of the endocardial and epicardial left ventricle in the same patient from Fig. 1. (A) Right lateral Ensite NavX views with both the endocardial and epicardial geometries, created by using the DD catheter. (B) High-density mapping of the epicardial left ventricle showing a dense basal scar. Abnormal electrograms (EGM) including late potentials and a fractionated EGM are shown. (C) Induction of hemodynamic unstable ventricular tachycardia (VT) is demonstrated. The ablation catheter is located at the scar-border zone where LPs were identified by using the DD catheter. Note that the mid-diastolic potentials seen during the VT travel back and forth between the proximal and distal electrodes of the ablation catheter (f-EGM = fragmented electrograms).

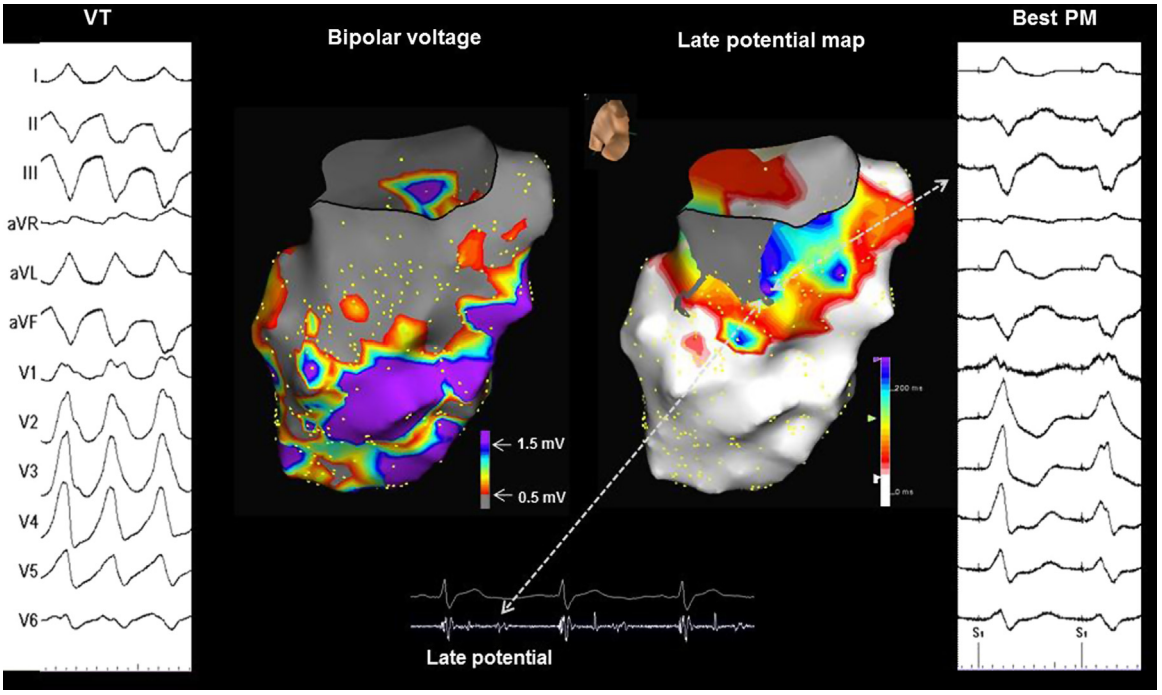

Fig. 4. Ultra-high-density mapping of the left ventricle showing a dense inferior scar. Activation maps showing late activation in endocardial areas are also shown. Pace mapping of the targeted ventricular tachycardia (VT) is shown. Pacing from a border zone site with a late potential (LP) demonstrates the best pace-map match at an exit site. The voltage setting is < 0.5 for dense scar and < 1.5 mV for border zones.

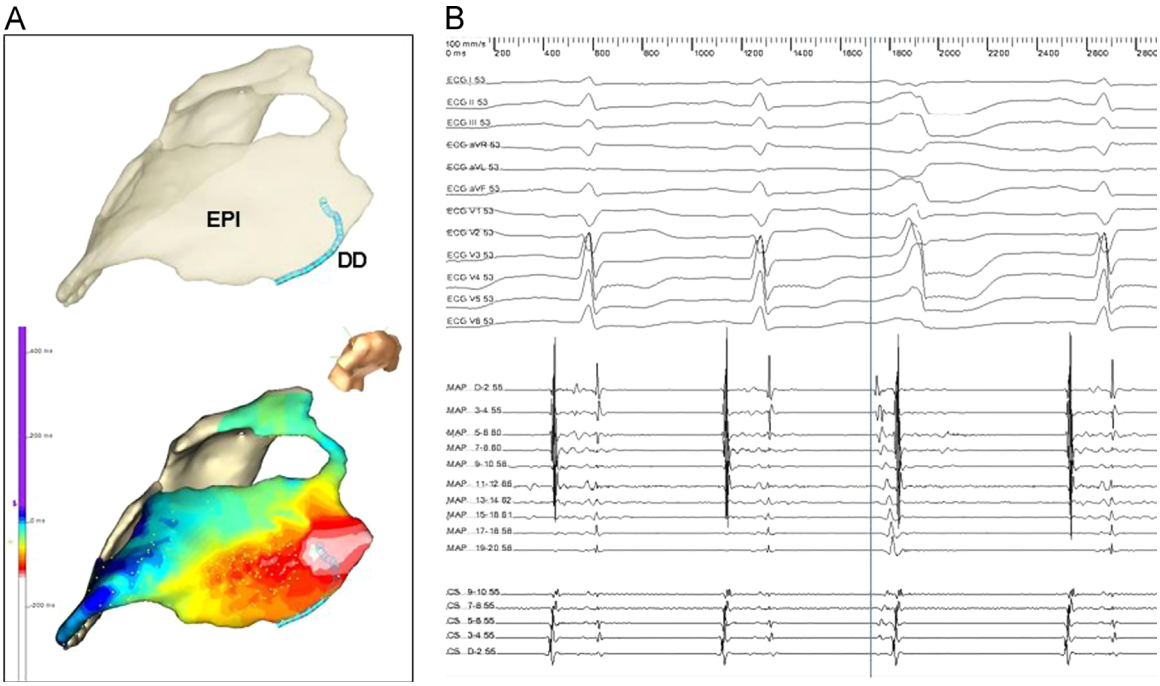

Fig. 5. (A) Activation mapping of a premature ventricular complex (PVC) that triggered the ventricular tachycardia (VT), by using the duodecapolar (DD) catheter within the epicardium. The earliest site was confirmed at the basal-lateral wall of the epicardial left ventricle. (B) The local electrogram recorded from the distal-portion (DD 1,2) of the DD catheter preceded the PVC onset by 26 ms. Catheter ablation at that site rendered both the PVC and VT noninducible.

mapping, and 4 patients in whom LPs were not seen had NICM. Good (56%) or perfect (31%) pace maps were demonstrated in 14 patients. Fig. 2 shows a representative case with dilated cardiomyopathy in which epicardial mapping with a multipolar catheter was performed. A duodecapolar catheter spanning from the normal myocardium to DS demonstrated sites with LPs (Fig. 2B). Fig. 3 demonstrates a representative high-density epicardial mapping. LPs at the BZ of a lateral scar, and mid-diastolic potentials were also recorded during the VT. Epicardial mapping with a multipolar catheter was performed in eight patients, and among those patients, LPs were identified in three patients. Thus, epicardial ablation targeting the sites with LPs combined with pace mapping was demonstrated in three patients. Endocardial mapping with a multipolar catheter was performed in all patients. Fig. 4 demonstrates the identification of endocardial LPs by using a multipolar catheter in patients with ICM. In 10 patients (ischemic/nonischemic: 8/2) LPs were documented by using this method, and in all patients, endocardial ablation targeting the sites with LPs combined with pace mapping was performed.

In two patients, the earliest activation of premature ventricular complexes (PVCs) that triggered sustained VT was documented. Those origins were successfully identified by using multipolar catheter mapping in the epicardial basal-lateral region (a nonischemic VT case) and endocardial septum (an ischemic VT case). A typical example of PVC activation mapping with a multipolar catheter is shown in Fig. 5. In this case, the earliest site of the PVC also demonstrated a good pace map of the targeted VT.

During the LV mapping with the use of a multipolar catheter, a distinct geometric distortion of the endocardial LV that was mediated with NavX field scaling was confirmed (Fig. 6A) in two patients (12.5%). However, those distortions were considerably modified by dividing the LV into two portions, such as between the basal and apical regions (Fig. 6B).

3.5. *Clinical outcome: acute and intermediate success*

The total radiofrequency energy delivery time was 33.5 ± 15.7 min, and the mean procedural time was 205 ± 35 min. The procedure times were longer in patients with ≥3 VTs than in those with <3 VTs (252 ± 57 min vs. 194 ± 20 min). Acute success was achieved in 88% of the patients, with complete success in 63% and partial success in 25%. Two patients died of progressive heart failure within 3 months after the procedure. An intermediate clinical follow-up was available in 14 of 16 patients. The intermediate success rate (free of VT recurrence) was 71%, with an average follow-up of 10.0 ± 3.7 months.

4. Discussion

This is the first prospective study to evaluate the clinical feasibility of using a multipolar catheter combined with a new impedance-based electroanatomical mapping system in patients with scar-related VT. The major findings were as follows: (i) deca- or duodecapolar catheters combined with the "OneMap" function of the Velocity system successfully delineated both the endocardial and epicardial electroanatomic substrates within a relatively short time in this series of patients; (ii) multiple potential targets, such as abnormal electrograms or PVCs that triggered VT, can be identified in an efficient way; and (iii) endocardial geometrical distortion derived from the heterogeneity of the endocardial impedance field occurred at a uniform rate, and those distortions were considerably modified by dividing the LV chamber to lessen that impact.

Multipolar catheter mapping combined with the Velocity system can be applicable regardless of the strategy used for scar-related VT ablation. Arrhythmogenic scar homogenization [13], or the elimination of areas of slow conduction guided by LPs, has been proposed as an endpoint for VT ablation [10]. In this study, LPs were identified during substrate mapping with the use of a multipolar catheter in 83% (13 of 16) of the patients. Combined epicardial and endocardial mapping with the use of a multipolar catheter may hold promise in assessing the presence of abnormal electrograms. Appropriate catheter contact is also indispensable for a successful ablation. We found that positioning the multipolar catheter with a large curve in the ventricle usually resulted in both endocardial and epicardial excellent contact. However, it was helpful to confirm the presence of an adequate contact between the multipolar catheter and

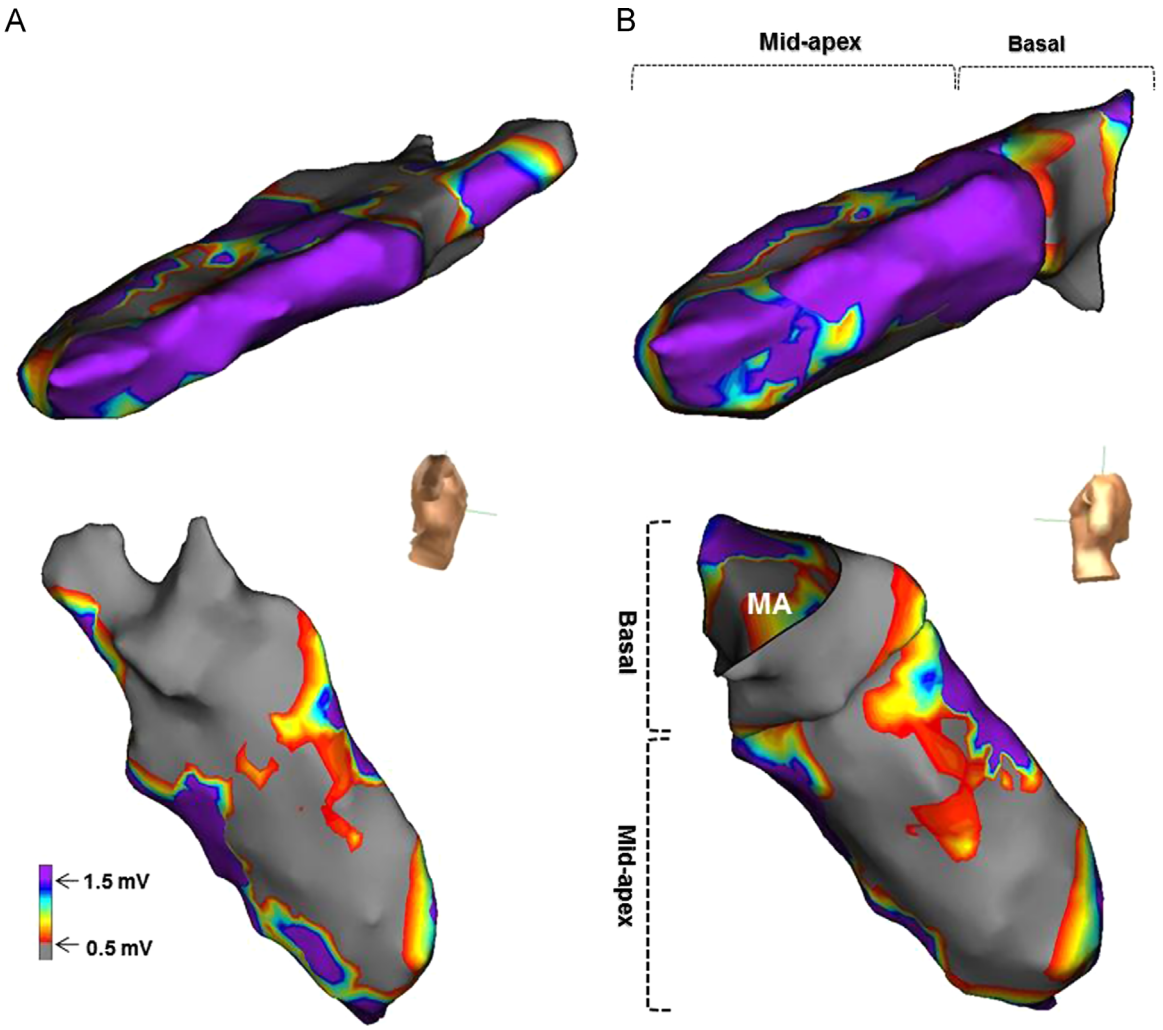

Fig. 6. (A) Typical example of a geometric distortion of the endocardial left ventricle (LV) after using the function of the NavX field scaling. (B) After dividing the LV into two portions (basal and mid to apex regions), a successful modification of the geometric distortion was achieved.

the ventricular surface with fluoroscopy, the EAM geometry, and the quality of the local electrograms. By using this mapping method, the mapping density was increased in areas of suspected scarring, and the findings of LPs were specific for differentiating a scar from a low-voltage area due to poor contact. Additionally, the routine use of the Velocity software further decreased the procedure times for substrate mapping. This software allows for simultaneous geometry and electrogram data acquisition, forestalling the need for two-step redundant mapping methods with the older software.

In this study, the distribution of LPs was also analyzed. Similar to previously published data, there was a tendency that vLPs were more frequently observed in patients with ICM than in patients with NICM. However, the total number of those abnormal ventricular electrograms was less documented than previously published data [10]. Furthermore, the surface areas of low-voltage regions including DS and BZ, especially in patients with ICM, were also smaller than in previous data [9,10]. These discrepancies may be due to the differences in the electrophysiological substrate of the ventricular scar or to the differences in the studied populations. Precise prospective studies are required to elucidate these findings.

A recent study showed that in post-myocardial infarction (MI) patients with frequent PVCs, the PVCs originated from sites with a low voltage corresponding to the infarct location in approximately 85% of patients, similar to patients with post-MI VT [14]. In this cohort, both endocardial and epicardial origins of the PVCs that matched the targeted VT morphology were successfully identified during mapping with the multipolar catheter in two patients. Furthermore, ablation of frequent PVCs rendered the targeted VT noninducible in those patients. This finding suggests that in patients with frequent PVCs and scar-related VT, those arrhythmias share an anatomically preformed reentrant circuit or at least a common exit site. Thus, mapping the PVCs with multipolar catheters can be a helpful additional technique for identifying critical areas, especially exit sites, in scar-related VT; however, a prospective study is necessary to confirm this hypothesis.

The NavX system registers the electrode impedance in relation to skin patches that apply a low-level electrical current [15]. The nonlinearity of the LV geometry that occurs as a result of local changes in the impedance fields may also affect that error; however, the field-scaling algorithm adjusts the geometry for this adverse effect, on the basis of the measured interelectrode spacing for all locations. In this study, a distinct geometric distortion of the endocardial LV occurred in two cases (12.5%), even after using the field-scaling algorithm. One plausible explanation for this distortion was due to the inhomogeneous dispersion of the impedance field within the endocardial LV. Another possible explanation was that an unexpected retraction of the proximal electrodes of the multipolar catheter into the sheath during the mapping may have occurred, which caused a partial impedance dispersion. Fortunately, that distortion was considerably modified by dividing the LV geometry into two portions. This inventive method may minimize that adverse impact and may facilitate the accuracy of

the NavX fusion technique for ventricular chambers [16]; however, further studies are warranted.

5. Conclusions

Multipolar catheter mapping–guided ablation combined with the Velocity system resulted in a high-density delineation of the ventricular substrates in a relatively short time, and yielded a sufficient success rate in our patient series. Multipolar catheter mapping has the potential of facilitating the identification of LPs and mapping the PVCs triggering VT, suggesting that this is a feasible alternative mapping strategy for scar-related VT.

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None.

Conflict of interest

None.

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