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CASE REPORT

Catheter ablation of hemodynamically unstable ventricular tachycardia in ischemic cardiomyopathy using high-resolution mapping

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Key Clinical Message

Catheter ablation is a recommended therapy option for ventricular tachycardia (VT). The antegrade transseptal approach for targeting VT with left ventricular origin is feasible with the high-resolution basket catheter. High-resolution mapping offers the potential to quickly acquire detailed voltage and activation maps. This may help to identify the crucial VT-substrate even in patients with huge scar areas and hemodynamically unstable VT.

Keywords

Basket catheter, catheter ablation, high-density, high-resolution, ischemic cardiomyopathy, mapping, Orion, Rhythmia, ventricular tachycardia.

Introduction

Ventricular tachycardia (VT) is associated with severe symptoms that often lead to hospitalization and furthermore is a risk factor for sudden cardiac death especially in patients with chronic heart failure [1]. According to the present guidelines of the European and American societies of cardiology, catheter ablation (CA) is a highly recommended therapy option for these patients [2, 3]. Challenges encountered during CA of VT include hemodynamic instability and lack of inducibility. Both can limit therapeutic success in a relevant number of patients and led to the development of several different ablation strategies [4]. In this case report, we demonstrate successful ablation of a hemodynamically not tolerated VT by performing transseptal left ventricular high-resolution substrate and VT mapping.

Case Report

A 69-year-old male patient with ischemic cardiomyopathy (ICM) and a recurrent, sustained VT was admitted to our department for radiofrequency catheter ablation. The patient described a presyncope as initial event one and a half year ago. The emergency physician diagnosed a VT at that time, and an ICD had been implanted according to current guidelines [5]. During follow-up, the patient experienced a VT with the same cycle length (290 msec) that did not respond to antitachycardia pacing (ATP) and was terminated by the first ICD-shock. At that time, the patient already received full medical treatment with maximally tolerated dosing including ß-blocker, AT1 receptor-antagonist, diuretics, and an aldosterone antagonist; furthermore, he was taking aspirin, antidiabetics, and a statin. Meanwhile, the medication has not been

changed. At admission, he presented himself in a good condition (according to New York Heart Association class II [6]) but avoided intense physical activity fearing a new arrhythmia. The left ventricular (LV) systolic function was significantly reduced (ejection fraction 35%). The patient had two ischemic heart attacks that were treated by lysis about 20 years ago and subsequently received percutaneous coronary interventions during follow-up angiographies. Progression of his coronary artery disease was ruled out with coronary angiography. As the patient asked for an alternative treatment instead of long-standing antiarrhythmic drug therapy because of potential side effects, we offered a primarily interventional approach [7].

Catheter Ablation Procedure

CA was performed under sedation using propofol. LV mapping was performed in sinus rhythm and VT via antegrade transseptal approach utilizing a three-dimensional electro-anatomical mapping system (Rhythmia™, Boston Scientific, Marlborough, MA) with a high-resolution basket catheter (Orion™ 64-pole basket-catheter, Boston Scientific) (Fig. 1). The transseptal puncture was performed under fluoroscopic imaging using a curved needle (Brockenbrough™, Medtronic, Minneapolis, MN) and a nonsteerable introducer (Swartz™ SL0, St. Jude Medical, St. Paul, MN) with a subsequent change to a steerable sheath (Zurpaz™, Boston Scientific). In total, 1327 beats and 9959 electrocardiograms were acquired over 47:45 min during sinus rhythm. Low-amplitude electrograms indicating scarring (0.5–1.5 mV bipolar voltage), and already dense scar areas (<0.5 mV bipolar voltage) were detected in the whole region of the posterior wall and the basal part of the interventricular septum (Fig. 2). Local abnormal ventricular activities (LAVAs) including isolated late potentials were observed mainly at the posterior wall. A VT with a cycle length of 300 msec was induced by two extra stimuli. Due to unstable hemodynamic status during the VT, the activation mapping had to be discontinued after a total mapping time of 03:31 min and even after repeated VT reinduction and subsequent termination remained incomplete. At that point, 256 beats and 4283 electrocardiograms had been acquired and automatically annotated. The VT could successfully be terminated by overdrive stimulation. The subsequently performed entrainment mapping had to be discontinued due to the hemodynamic status as well. However, activation mapping indicated a reentrant circuit within the midventricular posterior region. And even though the activation map did not allow identifying precisely the critical isthmus of the VT circuit, it led to the most likely involved scar region. The voltage map acquired during sinus rhythm, respectively, showed dense areas of LAVAs in this zone as described above. In this specific target region pace mapping was not appropriately feasible due to missing local capture. Voltage mapping using the outlined cutoff values indicated a dense anterior scar although voltage criteria have not been systematically investigated using this mapping system and might be lower as supported by initial experimental evidence. In consequence, a substrate-based ablation was performed using an antegrade approach with a 7F, 3.5 mm irrigated-tip catheter (Thermocool SF®, Biosense Webster, Diamond Bar, CA) and up to 32 W [8]. In total, 19 RF applications (total duration of 2694 sec) were performed targeting LAVAs and late potentials in the crucial scar areas that were detected by the activation and voltage map [9]. The signals acquired with the ablation catheter showed high consistency compared to those acquired with the basket-catheter. Afterward no VT was inducible via electrical programmed stimulation and burst pacing. No periprocedural complications occurred. The patient was discharged 2 days later without any changes of the already established medication and freedom of any symptoms and no evidence of VT-recurrence were observed during the 9-month follow-up period.

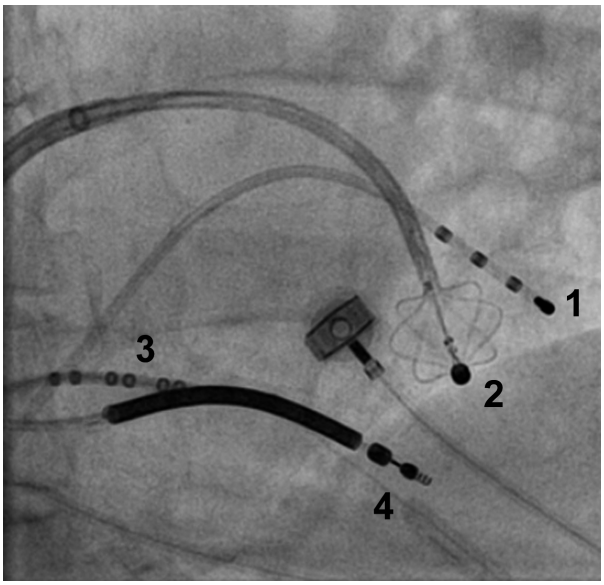

Figure 1. Fluoroscopy of the catheter setup. (1) Four-pole EP-catheter in the right ventricle. (2) Sixty-four-pole high-resolution basket catheter in the left ventricle via antegrade transseptal approach. (3) Ten-pole EP-catheter in the coronary sinus. (4) Right ventricular lead of the ICD.

Discussion

Catheter ablation of VT is an important therapy option that gathers more and more clinical relevance as recommended by the current guidelines [3]. Different ablation strategies have been shown to be effective in reducing the

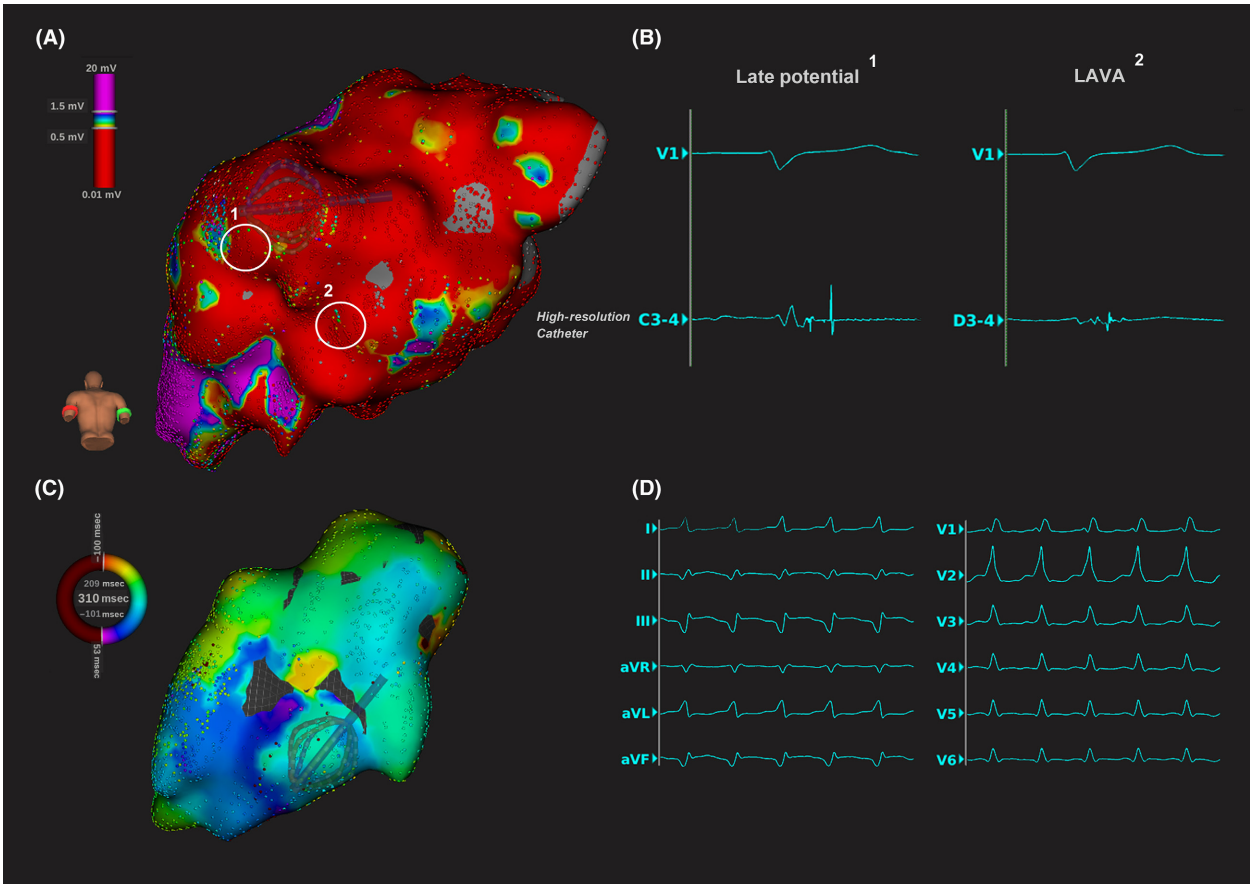

Figure 2. Left ventricular electroanatomical high-resolution mapping. (A) Voltage map of the left ventricle in posterior–anterior view showing a large dense scar area in red (defined as 0.01–0.5 mV). The high-resolution basket catheter is shown as a shadow in the mid-lateral region. The numbered ellipses represent crucial scar areas with high density of local abnormal ventricular activities (LAVAs) and late potentials. (B) Examples of late potentials and LAVAs measured with the high-resolution basket catheter. (C) Activation map during VT showing different sites of early activation (purple indicating earliest activation) in posterior–anterior view. The map is incomplete with a lack in the middle (gray zone). The arrow indicates the probable direction of the VT circuit as identified with the propagation function. The high-resolution basket catheter is shown as a shadow in the apico-septal region. (D) Twelve-lead ECG of the ventricular tachycardia that could be induced during the procedure.

recurrence rate of VT. However, further procedural improvements especially in difficult settings including hemodynamically unstable VT are desirable.

Novel technologies including high-resolution mapping offer the opportunity to rapidly reconstruct ventricular electroanatomy in detail and with high spacial resolution in order to characterize a VT and its underlying substrate. VT ablation in our patient with ICM supports that such approaches appear to be feasible although no final conclusions can be drawn from a single patient. However, our observation is in line with experimental findings indicating that an improved degree of automation including accurate time annotation of multicomponent electrograms plus high-resolution mapping might bring relevant benefits especially in mapping of hemodynamically not tolerated VTs [10].

Noteworthy, interpretation of acquired maps needs to be performed with caution as electrode size and spacing of novel multielectrode mapping catheters and its automated annotation of electrograms might impact substrate and activation mapping of a VT. Until now, there is a lack of prospective studies on how different catheters and related mapping systems that can be used for high-resolution mapping might influence procedural outcome. Both available approaches, a basket catheter and another multielectrode-mapping catheter (e.g. PentaRay®), might provide more accurate maps with high resolution in comparison with classical concepts, especially in low-voltage areas [11]. On the other hand, both can produce premature ventricular contractions especially in the left ventricle what can impact the mapping itself. In addition, sometimes it is not easy to make a good contact of the

basket catheter on the endocardial surface due to the ventricular anatomy. Repetitive opening and closing of the catheter can be useful to improve the contact of the catheter with the tissue especially in close relation to the papillary muscles.

Until now, there are some promising results regarding the effectiveness of high-resolution mapping using a basket catheter in the treatment of supraventricular tachycardias [12]. For the use in VT mapping and ablation only single experiences have been reported [13]. At this point, investigations comparing the use of high-resolution mapping versus standard mapping are limited.

In our case, only limited activation mapping of the left ventricle was possible due to hemodynamic instability. This is a well-known phenomenon in a relevant number of patients. Additional technical developments using advanced new map setups (which additionally fasten VT mapping) in combination with catheters adopted for ventricular mapping might partly overcome this challenge. Despite the short mapping time, the activation map acquired with the used basket catheter already delivered relevant VT characteristics. In combination with the high-resolution voltage map, it was possible to identify crucial parts that were most likely responsible for the initiation and maintenance of the targeted VT in this extensively scared ventricle. The resulting precise, although only limited map, appears to be a possible advantage especially in time critical procedures including nonsustained and hemodynamically not tolerated VTs.

Conclusion

High-resolution mapping of the left ventricle via antegrade transseptal approach is feasible even under hemodynamically unstable circumstances. More studies investigating the usefulness of high-resolution mapping to guide catheter ablation of hemodynamically not tolerated ventricular tachycardia are desirable.

Authorship

LK: involved in conception of the work, drafting the article, critical revision of the article, and final approval of the version to be published. RÖA: involved in data acquisition, critical revision of the article, and final approval of the version to be published. MJ: involved in data acquisition, critical revision of the article, and final approval of the version to be published. JN: involved in critical revision of the article and final approval of the version to be published. SW: involved in critical revision of the article and final approval of the version to be published. CM: involved in conception of the work, critical revision of the article, and final approval of the version to be published.

Conflict of Interest

Dr. Willems reports honoraria relevant to this topic. Dr. Meyer participated in a group discussion supported by Boston Scientific. Other authors: None declared.

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