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EDITORIAL COMMENT

Ablation Target Out of Range

A Journey Deep Into the Interventricular Septum*

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"Simplicity is the final achievement. After one has played a vast quantity of notes and more notes, it is simplicity that emerges as the crowning reward of art.

—Frédéric Chopin (1)

Recently, we celebrated the 40th anniversary of the very first catheter ablation, which was used back then for disassembling a rapidly conducting atrioventricular node (2). An important step in further progress was the change in the mode of energy delivery from a single, ultrashort, high-energy impulse to a heat-generating radiofrequency (RF) current. Such low-amplitude high-frequency flow of electricity through the targeted tissue warranted better control of the technique (3). In the next decades, catheter ablation gradually evolved as an effective option for treatment of much broader and challenging spectrum of arrhythmias, including atrial fibrillation and scar-related ventricular tachycardia (VT). Supported by multiple clinical trials, the ablation catheter emerged as 1 of the most powerful tools in the history of cardiovascular medicine.

The design of the catheter and RF delivery in a unipolar mode allowed us to deploy lesions as deep as 5 to 7 mm (4). However, this lesion depth became difficult to achieve in cases of underlying heterogeneous tissue or scar, which have much higher tissue resistivity and protect the critical site against effective RF delivery (5). Hence, a classic ablation procedure for particular locations, such as interventricular septum (IVS) or the left ventricular (LV) summit, appeared to be associated with impaired outcomes (6).

With these limits of RF range, another difficulty emerged: our inability to map the intramural VT source directly (7). Mapping catheters demonstrate signals recorded near the endocardium or epicardium only, close to the distal electrode tip, and the value of such mapping remains limited when an arrhythmic source lies somewhere in between. In cases of intramural targets for RF, an ability to see the signals from the inside of the myocardium would possibly convince operators to optimize their ablation strategy more rapidly (8).

In their report of refractory septal VT published in this issue of *JACC: Case Reports,* Waight et al (9) demonstrate the presence of such an intramural target by using a novel 2-F octapolar catheter. This microcatheter was advanced deep into the septal perforators of the coronary venous circulation, thereby allowing visualization of otherwise undetectable electrical potentials within the deep IVS, clear diastolic activity during VT. This simple mapping maneuver prompted Waight et al (9) to proceed directly with an emerging and, most importantly, more effective alternative for intramural substrates: bipolar ablation.

A few studies showed the usefulness of bipolar RF catheter ablation (Bi-RFCA) in complex redo cases. Advantages of Bi-RFCA were initially demonstrated for refractory septal accessory pathways (10). The efficiency of the bipolar approach was validated in the previous decade for the treatment of refractory septal (11) and LV summit (12) VTs. Nowadays, Bi-RFCA appears to be a relatively advanced and sometimes sophisticated technique. Is that really true?

Actually, Bi-RFCA was the initial concept for intracardiac RF delivery (3). However, the absence of open-irrigated catheters and scarce information

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about bipolar ablation biophysics in clinical use led to abandonment of this technique in the early 1990s. It took 3 decades for bipolar ablation to experience a renaissance. Bi-RFCA is no longer considered an uncontrollable method, and safety efforts combined with careful energy up-titration can result in secure and effective performance, even in relatively close proximity to vital structures, such as the bundle of His (13) or the coronary arteries (14).

The optimal duration of bipolar application continues to be debated. In vivo studies show that Bi-RFCA can be particularly beneficial at a duration above 60 seconds; however, some deep scar-related targets may require even much longer RF time (11). Obviously, bipolar applications cannot be extended to infinity. Waight et al (9) took the best from their microcatheter and stopped bipolar RF delivery on the loss of capture from the inside of the IVS, thus correctly concluding that the lesion set was complete. Importantly, such loss of intramural excitability occurred after more than 5 minutes of application. This finding indicates that Bi-RFCA may sometimes require patience for its maximal effectiveness. The durability of the bipolar lesion set was later confirmed by noninducibility of VT. Waight et al (9) showed that the use of this microcatheter for pacing from the inside of the targeted tissue can help to navigate Bi-RFCA, which in this case required prolonged applications.

The microcatheter itself is also important for energy transfer into the targeted tissue. Enhancement of current density inside the IVS can be caused by the antenna effect. Additionally, unlike in relatively thin mapping wires, the diameter of microcatheter is wide enough to impair the blood circulation within the septal branches of the cardiac veins. Such blockage of blood flow promotes the conductive heating effect inside the IVS and makes the desired transmurality more likely.

Finally, in the presence of pure intramural VT substrate, additionally protected by a midmyocardial scar, the effectiveness of a classic unipolar approach drops significantly. The information provided by this simple microcatheter was convincing enough for Waight et al (9) to conclude that the target is out of range of unipolar ablation. In such evident intramural VT cases, should we perhaps skip a likely exhausting and possibly ineffective unipolar attempt entirely and instead proceed with Bi-RFCA earlier? Should we lower the bar for advanced approaches dedicated to deeply located substrates when there is such a convincing evidence that our classic approach may fail? Future data from prospective studies, together with development of dedicated tools and implementation of appropriate safety measures, should inform these decisions.

In the absence of intramural recording, several commonly available features can be helpful to indicate a presence of deep VT substrate indirectly. First, activation mapping and pace mapping around the true source of arrhythmia are not usually perfect. Second, these mapping features obtained at the sites surrounding interventricular or LV summit area usually give similar and imperfect results. Finally, with the use of the “learning by burning” approach, experiencing VT suppression without its complete elimination provides us with other important information: we are close, but not yet close enough.

Someday in the future we will treat our patients noninvasively, and our ablation catheters will become obsolete. However, it will still take years until we abandon catheter ablation completely. So before this happens, let us push our beloved tool to its limits. Bipolar ablation may frequently allow us to do so.

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Dr Futyma has reported patent applications related to bipolar and high-voltage ablation; and has equity in CorSystem. Dr Chen has reported that he has no relationships relevant to the contents of this paper to disclose.

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