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Ablation of ventricular tachycardia in 2021

Stefano Bianchi[1]* and Filippo Maria Cauti[2]

[1]*UOC Cardiologia, Ospedale Fatebenefratelli Isola Tiberina, Roma, Italy; and*
[2]*Unità di Aritmologia Cardiaca, Ospedale Fatebenefratelli Isola Tiberina, Roma, Italy*

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Nowadays, ablation of ventricular tachycardia (VT) in structural heart disease is an increasingly used procedure. In fact, it is the most effective strategy in controlling arrhythmic burden in VT patients. The ablative approaches are the result of the last 10 years of technological advances (Catheters, 3D mapping systems) and the constant study of the pathophysiological mechanisms underlying arrhythmic circuits. This presentation seeks to revisit the state of the art in the ablative treatment of VT.

Catheter ablation is currently considered the most effective non-pharmacological approach in reducing recurrence of ventricular tachycardia (VT).[1] Several randomized trials (SMASH VT, VTACH, VANISH) have evaluated and demonstrated the efficacy of the ablative technique in VT with ischaemic substrate.[2–4] To date, the guidelines recommend as Class I indication ablation in patients with sustained ventricular arrhythmia and ischaemic substrate after failure of drug therapy.[5] Optimal timing with which to act is also the subject of study. In fact, clinical outcomes appear to be better the earlier the treatment.[6] Just as the absolute urgency in the ablative treatment of patients with electrical storm is an established fact.[7]

The ablation strategy as well as the effectiveness of the ablation itself is closely related to the substrate under examination. The ablation of VT in patients with post-ischaemic dilated heart disease has a significantly better outcome than that of patients with non-ischaemic dilated cardiomyopathy.[8]

However, it is necessary to specify that this ‘crude’ subdivision (ischaemic VT/non-ischaemic VT) does not take into consideration the variety of non-ischaemic substrates: idiopathic dilated cardiomyopathy, arrhythmogenic cardiomyopathy, cardiac sarcoidosis, channelopathies, valvular heart disease, and congenital heart disease.

If we take this further subdivision into consideration, ablative efficacy shows a wide variability.

The ablative strategy involves the use of three-dimensional navigation systems that allow not only non-fluoroscopic navigation (which can be magnetic/electric/dielectric or hybrid) of the different leads inside the heart chambers and epicardium but also an electrical characterization of the substrate under consideration.[9]

In recent years, the use of high-density mapping catheters has revolutionized the way of mapping ventricular arrhythmias, making VT ablation no longer a prerogative of high-volume centres.

The procedure is now faster, safer, and more effective.

The countless space–time information acquired simultaneously by high-density mapping catheters has allowed a more accurate study of the pathophysiological mechanisms underlying the arrhythmic circuits both in animal models and in humans.

This assumption completely changed the procedural endpoints.

The first radiofrequency approaches in fact took their cue from the surgical approach in which the diseased area was ‘resected’.

The functional study of the substrate in fact allowed the transition from a coarse ablation aimed at the ‘abolition’ of the scar (substrate homogenization) to a more selective and elegant ablation.

In recent years, two pioneering mapping methods heavily dependent on the analysis of the functional substrate have been introduced and have shown very encouraging results.[10,11]

Tung *et al.* introduced the isochronal late activation map capable of defining zones of deceleration (DZ) during sinus rhythm acquisition. The deceleration zones have a strong

*Corresponding author. Email: stefbianchi@gmail.com

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correlation with the critical isthmus during tachycardia and it is for this reason that the targeted ablation of these DZs determines a drastic reduction in arrhythmic relapses in the follow-up.

Similarly, our group demonstrated additional ablative targets based on the ventricular electrogram duration map (VEDUM). The VEDUM map is in fact able to outline a discrete area of long-lasting potentials which during VT identifies the vulnerable punctual region of the critical isthmus and in sinus rhythm the area of possible arrhythmogenic circuits.

The mapping/ablation methods are therefore varied but cannot be separated from an accurate analysis of the substrate in sinus rhythm/pacing/atrial fibrillation (substrate mapping) and when possible during VT (activation mapping).

Whichever intra-procedural endpoint is used, numerous studies have shown that non-inducibility at the end of the procedure remains the gold standard.

Despite technological advances and numerous pathophysiological studies, the long-term ablative outcome is still frustrating.

This is due not only to poor knowledge of the substrate but also sometimes to the difficulty in reaching the area of interest.

Radiofrequency catheters have evolved over the years, also becoming safer and more effective in creating the lesion. The depth of the lesion is a function of the intratissue temperature reached, in turn correlated to various factors such as pressure, local impedance, temperature, and power.

The impossibility of reaching some intramural ablative targets has created the conditions for the development of new techniques such as the application of an ablation electro-catheter lead with a needle at the tip (needle catheter),[12] which allows to penetrate the thickness of the myocardial wall, the application of radiofrequency with a bipolar circuit,[13] the use of high impedance, and low ionic irrigation solutions (half normal saline).[14]

Cardiac imaging

Pre-procedural imaging (CT/CMR) integrated with navigation systems has been established since the early 2000s. Obtaining an imaging before the procedure is undoubtedly extremely useful to define a priori the localization and some details of the substrate in question.

Two software have been introduced on the market (ADAS VT and MUSIC) for the characterization of the intrinsic properties of the myocardium. Object of study is their use to guide ablative procedures.[15,16]

New frontiers

The neuro-autonomic target

The sympathetic nervous system plays a key role in the genesis of ventricular arrhythmias.[17] Sympathetic cardiac denervation performed with classic (T1–T4) or modified (T2–T4) methods demonstrated a significant reduction in arrhythmic events after ablative failure.[18,19] Renal denervation also demonstrated an additional role in controlling arrhythmic burden in cases of failure of standard methods.

New minimally invasive approaches

Cuculich *et al.*[20] introduced the use of stereotaxic radiotherapy to non-invasive treatment of the substrate responsible for the arrhythmic genesis in the VT panorama.

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