A Decade of CFAE Mapping: Still Seeking More Specific Tools to Identify Sources and Substrate of Persistent Atrial Fibrillation

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A decade after its first description as ‘the electrophysiological substrate’ of atrial fibrillation,¹ mapping complex fractionated atrial electrogram (CFAE) as an ablation target for atrial fibrillation (AF) remains highly controversial. Early high-density mapping studies of induced AF in humans revealed distinct mechanisms that underlie electrogram fractionation: collision areas of distinct wavefronts, sites of wavelet pivoting, anisotropic/slow conduction and conduction block.² Further mapping studies revealed the functional nature of electrogram fractionation that implies important variations in distribution of fractionated activity within the same atria during different rhythms (AF versus sinus rhythm or paced rhythm).³

The recent multicentre randomised trial STAR-AF II failed to reveal any added benefit of CFAE ablation when performed in addition to pulmonary vein isolation in patients with persistent AF.⁴ Importantly, in that study only CFAE sites were targeted by ablation that were detected by the NavX ‘CFEmean’ algorithm (St Jude Medical). Previous studies have shown that the CFEmean algorithm detects fractionated activity at high voltage (>0.5 mV) – i.e. underdetecting CFAE within low voltage sites.³ Similarly, another randomised clinical study failed to show an added value of CFAE ablation when using the CFEmean algorithm.⁵

Multiple distinct types of CFAE may be observed during AF or regular rhythms. Although some CFAE patterns as continuous activity or presence of activation gradients between neighbouring bipoles⁶ have been described to have a greater impact with regard to AF termination or cycle length prolongation, their identification depends on the subjective judgment of the operator, because automatic CFAE algorithms fail to specifically differentiate these active CFAE types from passive ones. CFAE may be intermittent versus continuous versus high voltage (>0.5 mV) versus low voltage (<0.5 mV).⁷ Identification of the active CFAE sites that correspond to active AF driver sites remains a major challenge of future mapping techniques and developments.

In this issue of the journal Sohal and colleagues⁸ give a comprehensive overview of the distinct CFAE types and difficulties in their distinction that depends on the electrode size, the mode of electrogram filtering/recording (unipolar vs bipolar) and the CFAE detection algorithm used. They provide a future perspective on a novel, promising non-invasive mapping tool enabling detection of sources and drivers of AF: the ECVUE Mapping System (CardioInsight Technologies).^{8,9} Recent clinical data have identified AF drivers to CFAE sites within low voltage areas that display prolonged electrical activity when using simultaneous regional mapping with multi-electrode catheters with smaller electrodes and higher local mapping resolution than a 4 mm tip ablation catheter.^{7,10}

Future studies on persistent AF need to assess clinical efficacy of the novel AF mapping tools to identify the active CFAE sites from the passive ones, as well as impact of novel voltage-based substrate mapping/ablation strategies on rate of arrhythmia freedom.^{7,10,11} ■

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