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Integrating Mapping Methods for Atrial Fibrillation

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Introduction

How to use electrical and structural indices to guide ablation for atrial fibrillation (AF) is hotly debated. A plethora of electrical indices have been proposed including complex fractionated atrial electrograms (CFAE),¹ electrogram dispersion,² dominant frequency (DF),³ voltage mapping, and various approaches to map drivers including focal impulse and rotor mapping,⁴ Cartofinder,^{5,6} Acutus Medical,⁷ Ablacon⁸, and body surface mapping^{9,10} (of which many identify similar sites).^{8,11,12} Anatomically, targets are primarily the PVs, but also left atrial appendage (LAA),¹³ posterior wall and other sites. What is missing - and urgently needed - is a functional theme to rationalize indices, by directly comparing methods or by defining populations in whom some indices are particularly relevant.

Comparing AF Indices

In this issue of the Journal, Ammar-Busch *et al* report a welcome study comparing electrical signatures of CFAE and rotational drivers in persistent AF.¹⁴ They co-registered high-density maps of CFAE (annotated automatically with manual verification) and maps of phase singularities indicating rotational sites by body potential surface mapping (CardioInsight, Medtronic, MN). In a blinded, retrospective analysis, 78% of AF driver sites colocalized with CFAE for greater than 75% of each driver area. The importance of the right atrium (RA) for maintaining AF was supported since 15/16 patients displayed RA drivers and 4/11 (36%) of AF terminations occurred in the RA. When considering sites of AF termination, 9 of 11 sites showed CFAE prior to ablation. The authors conclude that ablating only AF drivers colocalized with regions of CFAE may be sufficient to terminate persistent AF.

The authors should be congratulated on their goal of identifying the most relevant or ‘dominant’ AF sites from secondary or potentially false-positive sites. This question is central to ongoing efforts to improve targeted AF ablation. Recent meta-analyses show that AF driver ablation increases AF termination rates and potentially long-term success over PVI alone, yet with significant heterogeneity between studies.^{15–17} One clear goal is to refine mapping. Prioritizing targets is important when AF maps reveal multiple potential drivers, as leaving critical AF regions suboptimally ablated may contribute to varying outcomes. Choosing another marker to ‘triangulate’ important features is thus a natural step,

and CFAE is attractive as it may signify slow conduction.¹⁸ Other candidate features include sites of rate-related conduction slowing,¹⁹ low voltage, electrogram dispersion,² or combinations of multiple panoramic AF mapping methods¹¹ which often agree.^{11,20}

Limitations of Study

Limitations of this study reflect the selected electrical indices, mapping approach, and clinical endpoints. First, the role of CFAE has been questioned¹ which could reflect their heterogeneous nature;²¹ this may be resolved in metrics such as electrogram dispersion.² Second, while ECGI has yielded promising clinical outcomes,²² its spatial resolution has been reported as about one square centimeter²³ which may complicate correlation to CFAE areas. Notably, AF drivers mapped by endocardial methods are less related to CFAE,^{24,25} which may reflect a higher threshold for defining CFAE or other factors. Of course, no perfect mapping system yet exists and endocardial basket mapping, while sufficient for AF driver mapping²⁶ may also produce false positives. Third, although termination reflects acute disruption of persistent AF, it remains a controversial endpoint for predicting long-term outcome, yet metrics of AF cycle length prolongation or even abolition of PV activity^{27,28} are not optimal predictors. Finally, the current study does not prove that critical AF drivers exist only at sites of CFAE. This conclusion could be challenged by the retrospective nature of the study, how the N=16 patients were chosen from the larger AFACART registry, that this criterion would ‘miss’ 18% (2/11) of AF terminating drivers, and that this discounts the potential impact of earlier site ablation on ultimate AF termination.

Conclusions

The authors should be congratulated on this interesting study that refines our understanding of electrical indices for AF ablation by comparing AF drivers with CFAE sites. Studies should extend this work to additional mapping modalities, and ultimately aim to identify mechanistic fingerprints for different patient phenotypes to improve long-term outcome.

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