How to best assess ablation lesion formation with late gadolinium enhancement MRI

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Abstract

Kurose et al. report on a lower number of gaps in RF-lesions compared to Cryo-lesions as determined by late gadolinium enhancement MRI (LGE-MRI). However, unlike claimed by the authors, there is ample evidence based on LGE-MRI in this context. Most importantly we have specifically compared RF and Cryo lesions in a recent case control study on AF Ablation. In contrast to the results of Kurose et al., our study, despite larger sample size, did not detect a difference in the number of gaps between the two energy sources. While numerous factors may account for the conflicting results, two points should be considered in particular. 1. The time point of LGE-MRI at a mean of 55 days post ablation has never been validated for chronic lesion formation, and is considerably earlier than the validated and well-established 3-months timepoint chosen by most groups. In fact, according to previous reports, gadolinium enhancement at earlier time points may, at least in part, reflect a transient inflammatory response rather than chronic scar formation. 2. The method of Kurose et al. is based on the definition of an area of healthy atrial tissue in each patient as an internal reference. However, it appears almost impossible to define a truly healthy area in the atrium of patients with atrial fibrillation. Thus the method is likely to underestimate ablation-induced fibrosis in patients with advanced disease and/or underlying pathologies and to overestimate it in younger, rather healthy patients.

How to best assess ablation lesion formation with late gadolinium enhancement MRI

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We read with interest the article by Kurose *et al* .[1] The authors report on a lower number of gaps in RF-lesions compared to Cryo-lesions as determined by late gadolinium enhancement MRI (LGE-MRI). We truly welcome this additional evidence on MRI-based assessment of RF and Cryo ablation lesions.

However, unlike claimed by the authors, there is ample evidence based on LGE-MRI in this context. In fact, we and others have previously reported on LGE-MRI assessment of RF-lesions created with contact force sensing catheters in large cohorts[2]. In another study, we have defined contact force-dependent effects on LGE-MRI-determined lesions[3]. Finally, we have specifically compared RF and Cryo lesions in a recent case control study on AF ablation[4], and it would have been intriguing to have seen the data of Kurose et al. presented in the context of our previous findings. We feel that this would have substantially enhanced the article. In contrast to the results of Kurose et al., our study, despite larger sample size, did not detect a difference in the number of gaps between the two energy sources. While numerous factors may account for the conflicting results, two points should be considered in particular.

1. Kurose et al. performed LGE-MRI at a mean of 55 days post ablation – a timepoint that is considerably earlier than the 3-months timepoint chosen by most groups. It has to be noted, that post-ablation scar formation is a dynamic process which implicates constant changes affecting cellular composition, extracellular space, water content and vascularisation, as well as small-vessel permeability and intravascular pressure. These changes in turn, are likely to alter tissue-inherent magnetic properties and wash-in/wash-out kinetics of gadolinium.[5,6] In fact, accumulating evidence suggests that the ability of LGE-MRI to predict chronic scar formation is highly dependent on the exact timepoint [7].

While LGE-MRI-based lesion assessment 3 months post ablation has been shown to reliably indicate chronic lesion formation and was rigorously validated with respect to functional gaps detected by electroanatomical mapping and clinical endpoints like AF recurrence[2,7-9], validation of earlier timepoints is lacking. In fact, according to previous reports, gadolinium enhancement at earlier time points may, at least in part, reflect a transient inflammatory response rather than chronic scar formation[7].

2. The method of Kurose et al. is based on the definition of an area of healthy atrial tissue in each patient as an internal reference for normalization. However, unlike postinfarction ventricular scar, which is typically well-demarcated and homogenous, atrial fibrosis describes a continuum of progressive tissue remodeling, characterized by rather diffuse, often subtle expansions of extracellular space where gadolinium is retained to different extents. Increases in extracellular space can be caused by underlying pathologies such as cardiovascular disease, atrial myopathy and atrial fibrillation itself, among others; however, they may also reflect physiological ageing in the absence of overt disease. Thus, while it may be possible to discriminate areas with more gadolinium enhancement from those with less or even without obvious enhancement, a definition of atrial tissue as a truly healthy reference must be viewed critically in aged individuals with atrial fibrillation.

Against this background, the approach of Kurose et al. is likely to underestimate ablation-induced scarring in patients with advanced disease, ageing or underlying pathology, while it may overestimate it in otherwise young and healthy patients. This should be considered, particularly in light of the significant difference in left ventricular ejection fraction between the two study groups. To overcome these drawbacks, we have established and validated a method, that normalises signal intensity of individual atrial voxels to mean blood pool intensity with thresholds for normality and dense scarring based on distinct cohorts of young healthy individuals and post-ablation patients, respectively[10].

We would sincerely invite the authors to contribute to a discussion of their article in the context of the current literature, and we are looking forward to their response.

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