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Mirror mirror on the wall: Which is the best ablation index of all?

Arrhythmia free survival after radiofrequency (RF) ablation for atrial fibrillation (AF) continues to be underwhelming, with arrhythmia recurrence in large contemporary AF ablation trials like CABANA and CIRCA-DOSE in 36%–46% of trial participants [1,2] at 1 year. A major reason for this modest success rate has been lack of uniform and durable transmural lesion formation during pulmonary vein isolation (PVI) [3], and this issue has persisted despite multiple advances in technology and techniques.

Several factors influence development, and durability, of transmural lesions that maintain bidirectional block. An important factor is reliable and good tissue contact, which can be monitored with contact force (CF) enabled ablation catheters. While initial data were promising, several subsequent randomized studies showed that CF alone could not be relied upon to predict adequate transmural lesions [4]. Catheter stability, duration and generator power are also important considerations as they influence the magnitude of electrical current delivery to the tissue. There has been an effort to combine these variables into indices that would predict reliable consistent and reproducible formation of lesions. Earlier simpler indices like Force time integral (FTI) were an improvement over measurement of CF or impedance drop alone, but were limited by the absence of important variable of power, and also did not reflect the non-linear nature of lesion formation. Ablation index (AI) is a proprietary algorithm from Biosense Webster derived from a complex equation combining RF power, contact force and RF duration combined into a single numerical value. Studies have shown that targeting specific AI values for different areas of the antrum, usually 350–450 for the posterior wall, roof and floor and 500–600 for the thicker anterior wall leads to durable PVI [5]. AI is used in conjunction with the VISITAG module allowing auto-lesion annotation, and the distance tracking tool, which allows lesion contiguity by keeping the interlesion distance <6 mm. This approach, known as the CLOSE protocol, has now been tested and validated in several studies with excellent clinical outcomes, for both paroxysmal as well as persistent AF [6,7]. In a recent meta-analysis [6], this approach was associated with approximately 90% 12 month arrhythmia free survival rates. Importantly, the approach was as safe as conventional ablation (with numerically lower rates for pericardial effusion) and significantly less procedure time. In parallel, delivery of higher power for shorter duration has been advocated for quicker and safer ablation practice. Use of Ablation index has also allowed high power short duration (HPSD) ablation with excellent results [8].

Catheter ablation results in release of cardiac enzymes, and there are some data to suggest that post-ablation serum levels of these biomarkers may correlate with clinical outcomes [9]. In this issue of the IPEJ, De Bortoli et al. [10] present their data on the release of myocardium specific biomarkers following AI enabled RFA for AF. In 46 patients undergoing first time ablation for paroxysmal or persistent AF by PVI utilizing the CLOSE protocol, they measured release of CK Mb and TnT and correlated these with ablation parameters including AI, FTI, impedance drop and RF duration. The authors found that while all the studied parameters correlated with biomarker release, Ablation Index showed the highest correlation. Few patients also underwent cavotricuspid isthmus ablation and elective cardioversion, procedures that may have confounded the biomarker release. Previous studies investigating relation of biomarker release with quantum of ablation have had had mixed results and the authors believe this could be due to factors other than ablation. By strictly controlling type of patients selected and rigorous sampling methodology, the authors believe they were able to eliminate interference on results by factors other than radiofrequency ablation. Although this was a small study, few other points are notable. While previous studies have indicated that higher biomarker release may also imply healthier left atrium and better clinical outcomes [11], the current study found no indication of this and there was no correlation between biomarker release and baseline left atrial volume. Thus the biomarker release is due to myocyte necrosis and higher release implies higher degree of transmural irreversible lesions and fewer lesion with reversible tissue injury. The authors also found that after adjusting for ablation duration, the biomarker release varied between different operators, and that this could be explained by the mean CF achieved. This raises an interesting possibility if we believe that higher biomarker release translates into better lesion formation and long term clinical outcomes. It would imply that within the framework of Ablation Index (AI), various combinations exist and these do not necessarily have the same impact. While contact force (CF) has some correlation with effective lesions, as also found in this study, this is not necessarily linear and studies investigating this have found differing results. Similarly, does using low power for longer duration (conventional approach) differ from using high power for short duration (HPSD technique)? This question assumes significance because HPSD approach is increasingly being used for PVI, but its overall impact on efficacy is still not clear. There is evidence that tissue heating characteristics change depending on how exactly the AI index value is reached. HPSD leads to more resistive tissue heating while conventional RF causes more tissue loss by conductive heating. This, in in vitro models, causes wider and shallow lesions with high power as compared to conventional power delivery [12] (ref). It has been implied that these tissue thermal dynamics are adverse for lower power applications and that high power short duration may be safe for preventing collateral damage [13]. There is also the question of catheter orientation where there

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is evidence that AI correlates with lesion characteristic only within a small range of catheter tissue angles(ref). Finally, there is the substrate itself. There is significant left atrial wall thickness heterogeneity with important regional and even intra-regional and inter personal variations [15]. This has a potential impact on outcomes of AI guided ablation [16]. An attempt has been made to tailor AI to the left atrial wall being targeted with the help of intracardiac echocardiography (ICE) but this increases procedure costs and complexity [17]. Also important is the underlying tissue health and presence of scarring. The lesion size correlation with CF and AI starts to weaken with underlying scarring and low voltage myocardium [18] (ref).

So where do we stand today for ensuring reliable and durable lesion formation during PVI? There is no doubt that as of today Ablation Index appears to be our best available surrogate for RF lesion size. But we surely need more clinical data of the impact of AI guided ablation on myocardium, given that there are differing left atrial substrates and ablation practices and the biophysical evidence itself continues to evolve. The article by De Bortoli et al. [10] correlating higher biomarker release with Ablation Index is a commendable attempt to providing another piece of this jigsaw puzzle. Given the increasing interest in balloon based and electroporation ablation strategies and the skill required for meticulous AI based ablation, it is not easy to predict the long term future of RF AF ablation. However given the fact that AI-guided electroanatomic mapping based ablation is available in most parts of the globe, it is reasonable to assume it will remain popular amongst electrophysiologists for some time to come.

Declaration of competing interest

All the authors declare that they have no conflict of interest pertaining to this manuscript.

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