"Searching for the team-dream: to whom the palms of victory?"

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July 26, 2023

Abstract

In the last few years novel ablative technologies featuring several devices incorporating different energy sources and catheter design for ensuring an effective PVI have been proposed. In particular, two prominent technologies, such as the non-thermal ablation modality based on pulsed field ablation (also defined as "electroporation") and radio frequency balloon-based catheter has been introduced in the clinical practice. The adoption of such technologies aims at simplifying PVI procedures, improving efficacy, and increasing safety. Furthermore, the evaluation of the extension of area of lesion promoted by the two technologies might affect the clinical outcome

In this issue of the Journal, My and co-workers, in a single center experience, report the comparison between two ablation modalities for atrial fibrillation (AF), namely pulse field ablation (PFA) and radiofrequency balloon ablation (RFB) in terms of acute extensive area of lesion (1). Moreover, they also provide information about the release of biomolecules as expression of the entity of cardiac tissue injury. The study finds that PFA promotes larger acute lesion areas and higher troponin release upon successful PVI than multi-electrode radiofrequency balloon-based PVI

We acknowledge the advent of novel technologies in the last few years featuring several devices which incorporate different energy sources and catheter design for ensuring an effective PVI. The authors have elected two prominent technologies for their investigation, such as the non-thermal ablation modality based on pulsed field ablation (also defined as "electroporation") and radiofrequency balloon-based catheter. The adoption of such technologies aims at simplifying PVI procedures, improving efficacy, reducing procedure time, and increasing safety.

The concept of area of lesion

Assessment of the extension of area of lesion following PVI has been the target of several previous studies both after RF current applications, cryoballoon ablation and laser therapy (2-4). The general notion is that the use of balloon-based ablation treatments usually provides larger area of lesion as compared to conventional point-by-point catheter ablation. On the other hand, this could be challenged by others who argue that also with the completion of WACA modality of ablation is feasible the creation of a large antral lesion. In this regard, it appears easier to promote uniform antral lesion through the balloon-based ablation than that created by conventional point-by-point RF applications, due to the potential occurrence of lesion gaps along the line.

One could raise the question whether a large area of lesion is really required for achieving an effective PVI. Looking at previous studies the wide antral approach is more effective than ostial PVI in achieving freedom from atrial tachyarrhythmia recurrence at long-term follow-up (3). The other side of the coin of the creation of an extended antral lesion is the chance to favor macro-reentrant atrial tachycardia with a critical isthmus in the posterior wall of left atrium (5). Anyhow, the searching of novel catheter design associated to specific energy sources and their different modalities of delivering (unipolar vs bipolar,..etc) should yield higher acute success rate and better clinical outcome. In this study, My et al. have selected two different energy sources

coupled with two novel catheter designs and compared their effects on the extension of lesion and they found that PFA creates larger acute lesion areas (20.7 ± 7.7 cm2) than RF balloon-based ablation (7.1 ± 2.09 cm2; $p < 0.001$). Is this finding so crucial to support the hypothesis that larger antral lesion facilitates a better clinical outcome? Of course, there is no definite answer, due to the limited number of patients included and the lack of data over the follow up. We might anticipate that having a larger area of lesion could be more beneficial for persistent AF than paroxysmal, due to the critical role played by the posterior left atrial wall in the maintenance of AF.

Catheter ablation design

Catheter design is so critical when PVI is the main target of AF ablation. In my view, the adoption of the complaint RF balloon implies a more ostial lesion and, thus a more limited area of lesion is produced at the PV antrum. As opposite, the pentaspline PFA catheter provides two configurations (31 mm – basket - and 35 mm flower) which can favor, in eight setting of applications, ostial and antral lesions as well. Therefore, it should not be a surprise to achieve a broad area of lesion with PFA catheter than with RF balloon-based catheter, based on the specific catheter design.

Biochemical changes

The two energy sources also differ in terms of the level of inflammation produced, being the concentration of high sensitive Troponin 1 (hs TnI) significantly higher after PFA applications than RF ablation (625 ± 138 pg/ml vs 148 ± 36 pg/ml). Unfortunately, the authors did not provide any information about the Troponin concentration over time after the ablation (time-related), which could have given additional and critical data on the degree of inflammatory response. This is a reflection of the entity of tissue disruption and parallels the demonstration of an extended area of lesion. These data come from a minority of patients, but they likely express the true scenario in relation to the specific energy source applied. In this regard, similar results are achieved when cryoenergy is applied to myocardial tissue, suggesting a more extensive inflammatory process than that produced by point-by-point RF applications (6), suggesting that energy sources with different biochemical process than RF current produce a greater inflammatory response. Again, is there any robust clinical data that an extensive inflammatory process is followed by a better clinical outcome? Or the hypothetical better clinical outcome could be achieved with an extensive antral lesion regardless the modality of ablation employed? Hypothetically, if the area of lesion provided by RF balloon is comparable to that produced by PFA, will the clinical outcome be not significantly different?

Thus, do we care of energy source?

Therefore, assuming the extension of area of lesion is comparable between PFA and RF, could we foresee the same clinical behavior? Electroporation is characterized by a nonthermal energy source in which electrical fields are used to induce cardiomyocyte-specific cell death, thus avoiding adjacent anatomical structures (7). Initial clinical observations in controlled trials reported data on high degree of safety and acute efficacy and follow-up data of PFA-based PVI not significantly different from more conventional ablative therapy (8,9). On the other hand, the RFB is a compliant balloon catheter compatible with a 3D electroanatomical mapping system (CARTO 3, Biosense Webster, CA, USA) and provides an established energy source. One of the main advantages of this technology is the selective titration of RF energy delivery from each surface electrode to reduce collateral damage and to apply energy in a segmental area if needed (10). Multicenter trials (RADIANCE (10,11) and SHINE (12)) demonstrated the feasibility, safety, and 12-month outcome of this technology.

The wealth of clinical data collected from trials seems to indicate a comparable outcome between the two modalities of ablation but higher safety profile of electroporation over different energy sources (especially RF current). How much crucial is the extension of area of ablation towards the posterior wall in affecting the durability of lesions produced is still unknown.

At the end of the day, we all dream to devise the most successful ablative approach as to ensure a stable regular sinus rhythm to our AF patients, but undoubtedly there still a need to gather additional insights

into these two novel strategies of treatment before declaring the final winner.

References

1. My I, Lemoine MD, Butt M, et al. Acute lesion extension following pulmonary vein isolation with two novel single shot devices: pulse field ablation vs. multielectrode radiofrequency balloon. Journal of Cardiovasc Electrophysiol 2023. . .

2. Kawamura I, Neuzil P, Shivamurthy P, Kuroki K, Lam J, Musikantow D, Chu E, Turagam MK, Minami K, Funasako M, Petru J, Choudry S, Miller MA, Langan MN, Whang W, Dukkipati SR, Koruth JS, Reddy VY. How does the level of pulmonary venous isolation compare between pulsed field ablation and thermal energy ablation (radiofrequency, cryo, or laser)? Europace. 2021 Nov 8;23(11):1757-1766. doi: 10.1093/europace/euab150. PMID: 34151947; PMCID: PMC8576283.

3. Proietti R, Santangeli P, Di Biase L, Joza J, Bernier ML, Wang Y, Sagone A, Viecca M, Essebag V, Natale A. Comparative effectiveness of wide antral versus ostial pulmonary vein isolation: a systematic review and meta-analysis. Circ Arrhythm Electrophysiol. 2014 Feb;7(1):39-45. doi: 10.1161/CIRCEP.113.000922. Epub 2014 Jan 2. PMID: 24385448.

4. Sciacca V, Fink T, Korperich H, Bergau L, Guckel D, Nischik F, Eckstein J, Braun M, Hamriti ME, Imnadze G, Piran M, Sommer P, Sohns C. Magnetic resonance of left atrial scar a novel very for atrial fibrillation ablation. Europace. 2023 Apr 15;25(4):1392-1399. doi:

5. Tohoku S, Chun KRJ, Bordignon S, Chen S, Schaack D, Urbanek L, Ebrahimi R, Hirokami J, pulmonary vein isolation with pulsed field ablation. Europace. 2022 Nov 25:euac211. doi: 10.1093/europace/euac211. Epub ahead of print. PMID: 36427201.

6. Casella M, Dello Russo A, Russo E, Al-Mohani Ghaliah, Santangeli P, Riva S, Fassini G, Moltrasio M, Innocenti E, Colombo D, Bologna F, Izzo G, Gallinghouse JG, Di Biase L, Natale A, Tondo C. Biomarkers of myocardial injury with different energy sources for atrial fibrilaltion catheter ablation. Cardiol J.2014;21(5):516-23. Doi: 10.5603/CJ.a2013.0153

7. Koruth JS, Kuroki K, Kawamura I, et al. Pulsed Field Ablation Versus Radiofrequency Ablation: Esophageal Injury in a Novel Porcine Model. Circ Arrhythm Electrophysiol. 2020;13(3):e008303. doi:10.1161/CIRCEP.119.008303

8. Reddy VY, Dukkipati SR, Neuzil P, et al. Pulsed Field Ablation of Paroxysmal Atrial Fibrillation: 1-Year Outcomes of IMPULSE, PEFCAT, and PEFCAT II. JACC Clin Electrophysiol. 2021;7(5):614-627. doi:10.1016/j.jacep.2021.02.014

9. Lemoine MD, Fink T, Mencke C, et al. Pulsed-field ablation-based pulmonary vein isolation: acute safety, efficacy and short-term follow-up in a multi-center real world scenario [published online ahead of print, 2022 Sep 22]. Clin Res Cardiol. 2022;10.1007/s00392-022-02091-2. doi:10.1007/s00392-022-02091-2

10. Reddy VY, Schilling R, Grimaldi M, et al. Pulmonary Vein Isolation With a Novel Multi-electrode Radiofrequency Balloon Catheter That Allows Directionally Tailored Energy Delivery: Short-Term Outcomes From a Multicenter First-in-Human Study (RADIANCE). Circ Arrhythm Electrophysiol. 2019;12(12):e007541. doi:10.1161/CIRCEP.119.007541

11. Dhillon GS, Honarbakhsh S, Di Monaco A, et al. Use of a multi-electrode radiofrequency balloon catheter to achieve pulmonary vein isolation in patients with paroxysmal atrial fibrillation: 12-Month outcomes of the RADIANCE study. J Cardiovasc Electrophysiol. 2020;31(6):1259-1269. doi:10.1111/jce.14476

12. Schilling R, Dhillon GS, Tondo C, et al. Safety, effectiveness, and quality of life following pulmonary vein isolation with a multi-electrode radiofrequency balloon catheter in paroxysmal atrial fibrillation: 1-year outcomes from SHINE. Europace. 2021;23(6):851- 860. doi:10.1093/europace/euaa382