Dielectric concept: "A Magnification Lens in EP Lab?"

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Abstract

Myocardial wall thickness is one of the crucial parameters affecting the lesion formation produced by radiofrequency current (RF) delivering. Knowing the tissue characterization is critical for improving the durability of the RF lesion. A novel dielectric based method (KODEX-EPD) has been developed for measuring the tissue thickness at the catheter-tissue interface. The authors of this study report for the first time the tissue characterization (i.e. atrial wall thickness) of the cavo-tricuspid isthmus in a series of patients undergoing common atrial flutter ablation, showing a higher thickness close to the tricuspid valve as compared to the inferior vena cava. This can affect the outcome of ablation

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It is well recognized that radiofrequency (RF) energy effect, is dependent upon several variables that impact lesion size and transmurality including catheter stability, contact force, power output, temperature, duration of RF output, and tissue characteristics and thickness. The notion that tissue thickness can impair the effectiveness of RF ablation is well known from experimental studies (1) and this again might have a role in the durability of lesions. Many advances in catheter technology have recently shown the potential to transform the approach to arrhythmia ablation and to improve its completeness in terms of transmurality and durability of the sets of lesions created. However, the chance to tailor RF delivery according to myocardial thickness is still lacking. A new dielectric-based method (KODEX-EPD mapping system, EPD Solutions, a

Philips company) for measuring tissue thickness at the catheter- tissue interface has recently been developed. This should provide significant information on tissue thickness in different cardiac areas and, theoretically provide clue for titrating power aiming at the most effective lesion formation. In this issue of the Journal, Schillaci et al. (2) reported preliminary data on real-time catheter-based measuring myocardial wall thickness in vivo, during typical atrial flutter (AFL) RF ablation in a small group of patients. Importantly, they used a KODEX version (1.5.0.30.) not commercially available yet but only for case replay and research purpose. Therefore, this study represents a preliminary attempt to describe in real time how the myocardial wall tissue can affect the RF energy delivering.

Why "Dielectric"?

Dielectric concept is based on gradients in the electrical field promoted by the different cardiac structures, such as the endocardial surface, cardiac veins and heart valves. The KODEX-EPD imaging system (3) properly creates high-resolution images of cardiac anatomy by exploiting the distinct dielectric properties of biological tissue. The system receives and analyzes the electrical field transmission and reflection from all catheter used in the procedure. (4). This "gradients of the electrical field" is sensed by the system and used to calculate the geometric characteristics of the three-dimensional (3D) image. With this technique, it is possible to collect anatomic information without immediate physical surface contact a few millimeters ahead of the catheter electrodes, resulting in a certain degree of "far-field imaging". Moreover, tissue thickness was measured by means of the Wall Viewer (WV) function, assessing a series of dielectric signals derived directly from real-time local interrogation of the catheter-tissue interface. The electric-field characteristics (e.g., the field shape) and dielectric tissue signature are acquired when the ablation catheter is stable and engaged with the endocardial wall momentarily (<1.5 sec). The Wall Viewer is displayed in millimeters and as a color code scale. The characteristic electrical field distribution can differentiate correctly between 7, 4 and 1.35 mm currently corresponds with the regional average wall thickness, although it can be calibrated to match the ECG gated diastolic phase as utilized in computed tomography-based atrial wall thickness measurement (5,6)

Can "tissue tickness" guide our ablation strategy?

Schillaci et al. have tested the KODEX-EPD system in patients with cavo-tricuspid isthmus-dependent atrial flutter, showing that the tickest atrial wall was pretty close to tricuspid valve (3.6±0.5 mm vs 2.4±0.3 mm, p<0.001) and a trend towards a progressive decrease of atrial wall thickness was observed moving the mapping catheter from the tricuspid valve to the inferior vena cava. This should suggest that more RF power needs to be transferred deeply in the atrial portion close to the valve as compared to the area towards the inferior vena cava. They claim to have used power between 30 and 40 Watts all along the line with a "point-by-point" RF delivering approach, reaching an acute bidirectional block in each patient. It would have been conceivable that RF delivering would be at higher power close to the tricuspid valve as to achieve a deeper lesion (and hopefully a durable one). Unfortunately, they do not describe any significant change in RF delivering while they are ablating. In fact, it is well known that missing the atrial portion close to the tricuspid valve is one of the reasons of resumption of conduction through the cavo-tricuspid isthmus. Moreover, the possibility to measure the substrate thickness before RF delivery could change the way to perform RF ablation, allowing a tailored energy delivering thus increasing the efficiency of the ablation procedures and potentially reducing the risk of complications.

*The dream of "an eye through"*By measuring the myocardial tissue thickness in any part of each cardiac chamber, we might envision to titrate the transfer of energy in relation to specific tissue characterization. This could be particularly crucial in the atria, where the wall thickness is reduced compared to the ventricles or close to the valves. Tailoring the power can increase the safety profile and reduce the likelihood of complications. None of the currently available 3D non-fluoroscopic mapping systems provides detailed information about the tissue thickness; the incorporation of a function (i.e. Wall Viewer) capable to yield thickness measurement could greatly improve our ability to effectively produce "durable" lesions and, thus improve the long-term clinical outcome of ablation procedures. Furthermore, one of potential advantages of the application of "tissue thickness measurement" over the cardiac MRI, is the real time information provided that can guide the strategy of ablation based on the " ablating by measuring" concept *Future applications* Theoretically, the analysis of tissue characterization in terms of wall thickness can be of value in the ventricles as well; just imaging to investigate not only the scar extension in ischemic or non-ischemic ventricular arrhythmias but also viewing "in depth" the pathological area could guide the ablation strategy, accordingly. Needless to say that the lesion created through different energy sources (RF, Cryo, Laser, PFA, etc) and the ablative techniques employed (impedance-driven, irrigated-tip electrode, high power-short duration) can have different and variable impact on effectiveness and durability of the lesion itself also in relation to the tissue thickness. Schillaci et al. have had the privilege to test the novel KODEX-EPD function showing the potential capability of the system to analyze the myocardial wall thickness and provide crucial information during RF energy delivering. They need to be congratulated for having paved a new avenue in the field and now we hope other EP "runners" could join the "ultramarathon" of ablation and produce brilliant results. References

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