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EDITORIAL COMMENT

Ablation of idiopathic premature ventricular contractions – exploring the electrophysiologist's toolbox in complex procedures

Ablação de extrassístoles ventriculares idiopáticas – explorando a caixa de ferramentas do eletrofisiologista em procedimentos complexos

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Idiopathic premature ventricular contractions (PVCs) and ventricular tachycardia occurring in structurally normal hearts correspond to 10% of all patients referred for assessment of ventricular arrhythmias.[1] The clinical course is usually benign and the prognosis is favorable. However, patients with a PVC burden >10% in 24 h Holter monitoring may progress with a potentially reversible form of left ventricular systolic dysfunction. In general, and given a predominately monomorphic target, catheter ablation is more effective than antiarrhythmic drugs to treat PVCs, with success rates exceeding 80%.[2] Most idiopathic PVCs emerge from the outflow tract region of either ventricle, more commonly from the right ventricle outflow tract (RVOT). Other variants of PVC, with similar underlying mechanisms, originate from the aortic root and aortic cusps, the superior basal septum, the aortomitral continuity, mitral or tricuspid inflow tracts, papillary muscles, pulmonary artery and epicardium.[1]

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Compared to those emerging from the RVOT, ablation of idiopathic PVCs originating from the left side of the heart is more complex and can involve higher risks of complications, including stroke or coronary artery injury.[1] In-depth knowledge of cardiac anatomy, in particular of the complex anatomical relationships of the outflow tracts, is extremely important for safe catheter maneuvering during mapping and ablation. This procedure requires advanced skills in cardiac electrophysiology and should be performed in experienced centers. In the absence of structural heart disease, catheter ablation is currently recommended in patients presenting with symptomatic PVCs when antiarrhythmic drugs fail, are not tolerated or based on patient's choice.[3]

The mapping of cardiac arrhythmias has improved in the advent of innovative three-dimensional (3D) electroanatomic mapping systems.[4] The cornerstone for focal arrhythmias, such as idiopathic PVCs, is activation mapping. The activation maps display the local activation time (LAT), color-coded (earliest red, latest purple) and superimposed on a reconstructed 3D geometry of the heart. The goal is to identify the site of earliest activation which is the target of ablation for focal arrhythmias.[5] It can be performed by point-by-point mapping with a standard mapping/ablation

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catheter, a high-density multielectrode mapping catheter or multielectrode arrays. The creation of activation maps has been facilitated by the development of automated annotation algorithms using morphology template matching. When a PVC meets a predefined threshold for a match with a pre-acquired template, the local electrogram (EGM) is annotated automatically. In high-density mapping, an automated algorithm simultaneously acquires and annotates multiple EGMs, based on a set of predefined beat acceptance criteria.[6] The number of points selected are just a fraction of the total number of points acquired. Within minutes, a color-coded activation map with thousands of EGMs is generated.

In this issue of the Journal, Sousa et al.[7] present an approach for complex PVC ablation, combining the use of a high-density multielectrode mapping catheter (PentaRay®, Biosense Webster) and a continuous mapping filter software (Pattern Matching, Biosense Webster) to selectively acquire beats with a predefined clinical morphology. This strategy was compared to a conventional point-by-point mapping strategy using the same ablation catheter (Thermocool SmartTouch®, Biosense Webster) for mapping and ablation, in a 12-month retrospective cohort. They compared the number of activation points acquired, the total radiofrequency (RF) and procedure times (primary endpoint), and the effectiveness and safety of the ablation (secondary endpoints). The results showed that this approach can improve the level of detail, accuracy and reliability of the activation map, while reducing the number of RF applications and procedural time. There were no complications during the procedure or the follow-up.

We might argue that the number of patients included in this study is low. In fact, this reflects the Portuguese standards, an issue that electrophysiologists have been debating in recent years. There is an urgent need to increase the referral of these patients, considering that antiarrhythmic drug therapy might not be the best option.

In this study, all the procedures were performed by a single primary operator in different periods, each differing in terms of potential changes in routine, equipment, and learning curve, which might have affected some of the primary endpoints, such as RF time or duration of procedure. On the other hand, since this was a feasibility study, it is possible that the team experienced a learning curve with the novel workflow, which could also reflect the total procedural time.

Particularly remarkable in Sousa's article are the images. For instance, Figure 3 beautifully illustrates one of the main advantages of using high-density multielectrode mapping versus conventional point-by-point mapping. During the same mapping time, a much smaller target for ablation (red area) was outlined in the first approach, given the higher spatiotemporal resolution,[8] which might explain the reduction in RF and even procedure time.

It should be noted that in the study group the EGM annotation was fully automatic and no LAT point was edited. Current QRS-matching software cannot distinguish, for instance, a spontaneous from a catheter-induced ectopy, which is more likely to occur with some multielectrode catheters. The question of whether it is better to have a lower number of high-quality data points than a large amount of questionable data is still subject of debate. According to Acosta et al.,[9] validation of an automated annotation algorithm against manually annotated maps during focal PVC ablation, using irrigated catheters of 3.5 mm size, showed overall good correlation. But these findings cannot be extended to multielectrode catheters such as PentaRay®. Also, the study was not randomized, a condition needed to confirm the benefits of automatic LAT annotation. Until such a study exists, experts would probably advise against replacing careful interrogation of the local EGM timing and configuration with fully automated mapping. Nonetheless, the results presented in this study are promising.

Finally, there was a case of ablation failure in PVCs arising from the right coronary cusp in the control group. No specific explanations were provided by the authors. Would the high-density mapping strategy have resulted in a different outcome? Or does this merely reflect the complexity of the procedure? Conceptually, RF ablation of PVCs is an attractive treatment modality, as long as PVCs are stable focal phenomena and that these foci are reachable. However, in the real-world there are several pitfalls.[1] Ablation can be challenging due to multiple factors, such as non-endocardial foci, inadequate catheter stability, difficulty in achieving and maintaining sufficient contact for RF delivery, errors in mapping such as annotation of catheter-induced PVCs, mechanical trauma caused by catheter manipulation during mapping that can transiently abolish the arrhythmia, position shifts in 3D mapping systems,[10] or even single ventricular ectopic foci with divergent breakouts,[11] reflecting the complexity of ventricular myocardial extensions, both at a structural and functional level.

In summary, the present study demonstrates the feasibility of a clinical workflow using both a high-density multielectrode mapping catheter and continuous mapping filter software. The combination might be a useful choice for the treatment of complex PVCs, even considering the costs of adding a high-density multipolar mapping catheter on top of an ablation catheter with 3D mapping. We must remember that these tools are meant to facilitate ablation procedures, but can also be counterproductive and should not distract the operator from the basic principles of electrophysiology. Ultimately, thorough knowledge and experience may result better than advanced technical tools to overcome complex ablation procedures.

Conflicts of interest

The author has no conflicts of interest to declare.

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