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Electrograms in redo-ablations: Near-field or far-field or both?

Radiofrequency catheter ablation (RFCA) is a curative treatment option for outflow tract ventricular tachycardia (OTVT). In the EP laboratory we record both unipolar and bipolar electrograms to identify the site of origin of an arrhythmia. Activation mapping has advantages over pace mapping and is associated with a higher success rate. To identify a target site for ablation, both unipolar and bipolar electrograms are recorded.

Unipolar electrogram records the potential difference between two electrodes, one recording electrode (from mapping catheter) and a remote electrode, often being the Wilson's central terminal [1]. Bipolar electrogram (EGM) is recorded between two closely spaced electrodes which helps to filter out far field signals. It represents local activation time and becomes easier to interpret especially in a structurally normal heart. Unipolar ventricular signal is generally a large amplitude electrogram representing cumulative myocardial depolarization. The steepness of the slope indicates how close we are to the site of origin [2]. A QS configuration indicates the wave front is completely moving away from the recording electrode [3]. This principle works well in a normal myocardium, but may not be applicable when there is scarring (local/patchy) as in redo-ablations. When the focus of origin is a few millimetres away from the endocardial surface, the mapping catheter recording electrode may not record a sharp unipolar signal even when the recording electrode is directly at the site of origin. At the site of origin of a focal tachycardia, the earliest local bipolar electrogram coincides with the rapid down slope or dv/dt of the unipolar recording. This concept of a QS unipolar morphology predicting the site of origin evolved from the work of Spach et al. who initially studied this in a thin sheet of myocytes and Purkinje fibres [1].

In this issue of IPEJ, Jena et al. have reported the utility of unipolar recording in patients undergoing redo-ablation of RVOT PVCs. The mean local activation time (bipolar) during repeat ablation was 36.6 msec compared to 31.8 msec during the first ablation. This indicates that the mapping catheter was closer to the site of origin compared to the first procedure. The shallow QS in some cases may be a reflection of local scarring due to prior ablation. The auto-annotation used by the mapping systems use the maximum dv/dt and corresponding timing of the bipolar EGM. This may be incorrect as we miss the true beginning of electrical activity (baseline crossing). Distinct muscle bundles with preferential conduction may inscribe a small pre-potential which may not be reflected in the unipolar signal. Unipolar electrogram has the advantage of reflecting the direction of local myocardial excitation more accurately compared to bipolar [2]. It also helps to assess tissue contact of the catheter [3].

The paper by de Bakker is an excellent read to understand the genesis and interpretation of Uni/Bi electrograms [4]. It reiterates that they are complementary to each other for accurate mapping and ablation. The unique properties of unipolar electrograms for VT/PVC ablation are summarized below:

(i) As ventricular outflow tracts represent the highest part of both ventricles, QS configuration on a unipolar EGM can be recorded over a large area outside the focal source of PVC [5,6], which limits the specificity of the QS-morphology of uni-EGM in predicting the origin of outflow PVCs [1,7,8]. In spite of its limitations, it can be integrated with bipolar electrograms for guiding activation and low output pace-mapping.

(ii) A negative concordance pattern (NCP) during the initial 20 ms of both uni-EGM and bi-EGM can help to localize the origin of focal ventricular arrhythmias [3].

(iii) Notched uni-EGM (defined as the uni-EGM presenting a QS morphology with $\geq$1 steep notches on the downstroke deflection) was a highly specific and moderately sensitive predictor of successful radiofrequency ablation in patients with VOT-PVCs [9].

(iv) Finally, unipolar recording can indicate a VT originating from epicardium or mid myocardium when all the early sites of activation record a small r wave [4].

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