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RIPPLE MAPPING: MAKING ELECTROANATOMIC MAPPING USER-FRIENDLY

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With the introduction of electroanatomic mapping systems, electrical voltage maps of the chamber of interest and activation maps of arrhythmias have emerged as invaluable tools for successful ablation of focal and reentrant arrhythmias.(1) In reentrant rhythms that cause hemodynamic instability, substrate modification has been demonstrated to achieve meaningful results.(2,3) In arrhythmias where a scar serves as the substrate for reentry, activation maps and voltage maps must be acquired and displayed separately. During isochronal activation mapping, a fiducial activation point is chosen and all mapped points are represented in relation to this reference. The inherent limitation in such mapping is in the assignment bias, where the subjective selection of an individual local potential within a multi-component electrogram can drastically alter a propagation map. Depending on whether the first component or last component of a split or multi-component potential is chosen, “early” activation can be made “late” and vice versa.

The Present Study

In this issue of the Journal, Linton and colleagues present a novel form of electroanatomic mapping called “ripple mapping”, whereby voltage, timing, and location are simultaneously displayed with continuous display of electrograms that were previously sampled and ‘post-processed’. (4)

The goals of this proof-of-concept study were to (i) simplify activation mapping by minimizing operator-dependence, (ii) eliminate interpolation of data between mapped points and (iii) to eliminate assignment bias by developing software to register continuous or fractionated electrograms, thereby removing a single, isolated local value as a representative of an entire coordinate. A large window was sampled, 500 ms before and after the QRS, and electrograms were time-gated and displayed as dynamic bars protruding from the surface changing in length and color depending on the local electrogram voltage-time relationship. With an analysis of sinus rhythm activation, three atrial tachycardias, and two ventricular tachycardias, the authors display ripple maps for arrhythmias due to reentrant mechanisms with successful ablation at sites of continuous activity in four of five patients.

The outlined objectives were met and the videos demonstrate a more user friendly display of activation. However, several limitations must be noted. Although demonstrated in common arrhythmias, the application of this software to clinical practice is likely to be necessary only

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in scar-mediated reentrant mechanisms, such as macroreentrant tachycardias in patients with prior surgery or structural heart disease. Large macroreentrant tachycardias in the absence of scar and fractionated signals, like cavo-tricuspid isthmus flutter, are unlikely to require this new technology. This mapping technology does have potential utility for left atrial flutter seen after atrial fibrillation ablation, which is known to be time consuming with multiple entrainment maneuvers necessary to regionalize the circuit.(5,6). However, far field potentials will pose a challenge for the application of this method especially when ventricular activation occurs at the time of atrial activation sampling (for example atrial sampling near the atrioventricular valve annulus).

Although potentially useful for ablation of ventricular tachycardia, the vast majority of ventricular arrhythmias are not suitable for activation mapping due to hemodynamic intolerance. (7,8) In these patients, substrate-based ablation based on sinus (or paced) rhythm maps remains the standard. Ripple mapping does have the potential to provide quick display of substrate map in sinus rhythm (especially identification of areas of slowed conduction, which typically have multi component electrograms). As with any mapping baseline, artifact from noise in cables, connections, and other energy sources is commonly seen when sorting out near-field from far-field potentials and the incorporation of all these signals without selectively excluding or filtering out bad data may confound these maps. Further, pacing for entrainment or resetting is often necessary to distinguish between captured near-field from far field electrograms for defining the reentrant circuit and isthmus in patients with mappable VTs.(9)

Finally, the accuracy of registering voltage during arrhythmia is unknown, compared to voltage mapping during sinus (or paced) rhythm. A reentrant propagation wavefront may alter the recording amplitude at a given site due to cancellation of wave fronts. Rate-dependent changes in electrogram amplitude may also affect accurate delineation of scar. Furthermore, a high density of sample points, although not subject to interpolation, is critical for defining the substrate for reentry. An assessment of unipolar signals, although potentially less accurate for voltage, may provide complementary information about activation.(10)

Conclusions

The current report is a proof-of-concept study that simplifies electroanatomic mapping and could minimize operator-dependence (at the mapping computer). The extent to which this technology will be incorporated into “real-time” application will require prospective evaluation. The maps in this study were generated offline and post-processing can take time. As the field of catheter ablation evolves, improvements in energy delivery and mapping technology will lead to improved therapeutics. Once prospectively validated and integrated, novel mapping methods, such as ripple mapping, are likely to be promising additions to the armamentarium for ablation in complex substrates. We could anticipate that advances like these may someday allow the experienced operator to continue manipulating the catheters without needing an expert assistant for editing and ‘assigning’ points at the console. The authors should be congratulated for developing this novel (and elegant) display of electroanatomic data.

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