Substrate Mapping for Ventricular Tachycardia: Assumptions and Misconceptions

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Summary

Substrate mapping was developed to treat poorly tolerated, infarct-related ventricular tachycardias (VT). The concept of substrate mapping was based on 30-year-old data derived from surgical and percutaneous mapping during sinus rhythm and VT, which demonstrated specific electrograms (EGMs) that characterized the “arrhythmogenic substrate” of VT. Characteristics of these EGMs included low-voltage, fractionation, long duration, split signals, and isolated late potentials as well as adjacent early and late activation.

Introduction of electroanatomical mapping (EAM) systems during the mid-1990s has allowed investigators to record EGMs in three dimensions and to identify sites assumed to represent the central common pathway (isthmus) during reentrant VTs. However, currently used substrate mapping techniques are based on assumptions that have not been validated, which limits our ability to accurately define the true arrhythmogenic substrate.

These assumptions include:

- Reentrant circuits are produced by fixed barriers of immutable, “inexcitable” scar tissue; hence, barriers forming the isthmus during VT are present during sinus rhythm
- Low-voltage amplitude (≤ 0.5 mV) implies dense “inexcitable” scar, and the bipolar amplitude is a reflection of the underlying tissue
- Isthmus used in patients with tolerated VTs using entrainment mapping are both valid and provide an accurate depiction of isthmuses in less hemodynamically tolerated VTs
- Current mapping tools and methods can delineate specific electrophysiologic features that will determine the barriers forming channels during reentrant VTs

Despite acute success of ablation strategies based on the assumptions above, the VT recurrence rate at one year remains unacceptably high, ranging 50–60%. In addition, recent experimental and human data using high-resolution mapping with very small electrodes cast doubt on the validity of those assumptions.

These data call for re-evaluation of substrate-mapping techniques to characterize the arrhythmogenic substrate of post-infarction VT. Many of the limitations of current recording techniques can be overcome with the use of new catheters with small electrodes and closer interelectrode spacing, which markedly improves resolution. Standardization of recording techniques including electrode size, interelectrode spacing, tissue contact, catheter orientation and wavefront activation must be taken into consideration.

No limitations were identified by the author in this publication.

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CONTRAINDICATIONS There are no known contraindications.

WARNINGS AND PRECAUTIONS The use of the Rhythmia Mapping System in conjunction with radio frequency ablation and other medical devices, as a part of the diagnosis and treatment of cardiac arrhythmias, may pose a risk of adverse events, such as cardiac perforation and arrhythmias (new and/or exacerbation of existing arrhythmias) that may require additional intervention. Do not operate the Rhythmia Mapping System near flammable anesthetics. System operation near flammable anesthetics may cause an explosion that could cause injury or death to the patient or user. All devices that are connected to the Rhythmia Mapping System must meet IEC 60601-1 requirements and any other relevant safety standards. When connected to other devices, the combined systems configuration must meet the IEC 60601-1 safety standards. The use of the Rhythmia Mapping System with accessories and devices that do not comply with relevant standards may reduce the safety of the system, cause equipment damage or system malfunction, or harm to the patient or user. Only stimulators that are certified for IEC 60601 should be used with the Rhythmia Mapping System. Do not connect life-sustaining stimulation through the Rhythmia Mapping System. The Signal Station is not intended to provide life-sustaining therapy and should not be used as such. In case of need for emergency pacing, or any failure of stimulator output, use other visualization tools, such as fluoroscopy or echocardiography to verify catheter location. Use the Rhythmia Mapping System and accessories intended to provide life-sustaining therapy and should not be used as such. In case of need for emergency pacing, or any failure of stimulator output, use other visualization tools, such as fluoroscopy or echocardiography to verify catheter location. 

The Rhythmia™ Mapping System and accessories are indicated for catheter-based atrial and ventricular mapping. The mapping system allows real-time visualization of intracardiac catheters as well as display of cardiac maps in a number of different formats. The acquired patient signals, including body surface ECG and intracardiac electrograms, may also be recorded and displayed on the system’s display screen. The Rhythmia Mapping System and accessories are intended for catheter-based atrial and ventricular mapping. The mapping system allows real-time visualization of intracardiac catheters as well as display of cardiac maps in a number of different formats. The acquired patient signals, including body surface ECG and intracardiac electrograms, may also be recorded and displayed on the system’s display screen.

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