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DEVELOPMENT OF A NOVEL MAPPING SYSTEM TO VISUALISE ACTIVATION IN VENTRICULAR SCAR


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Introduction: Ventricular scar is characterised by fractionated electrograms (egm) and not well displayed by current 3D mapping systems. We hypothesised that displaying intracardiac egms on 3D geometry as dynamic bars changing height according to the voltage-time relationship relative to a fiduciary egm, would enable visualisation slow conduction channels (SCC) in the infarct scar.

Methods: The Ripple Mapping(RM) program was developed using CartoXP(CXP) data on Matlab & validated in atrial tachycardias(AT). Maps were exported and selected egms assessed for ripple bar(RB) height concordance with varying egm voltage & activation sequence. RM guided diagnosis of AT mechanism was compared with entrainment manoeuvres and annotated CXP maps. RM and CXP maps were presented in random order to experienced CARTO users to compare the techniques.

Analysis of ischaemic left ventricular(LV) scar was performed on CARTO3 datasets. Sinus rhythm LV maps created during VT ablation were analysed for evidence of RM conduction channels(RMCC) with sequential RB movement whilst concurrently adjusting surface voltage to delineate the border of the channels. Conduction velocity(CV) within RMCCs was compared with healthy myocardium. Co-localisation of RMCC with entrainment sites and ablation lesions was used to assess functional relevance.

Results: 10 CXP AT maps were examined and RM activation sequences concurred with entrainment based diagnosis and LAT maps in all cases with confirmation by successful ablation in 9. Blinded assessors (n = 11) made the correct diagnosis in 35/44 (80%) using RM vs 22/44 (50%) using CXP (p = 0.029). RM was improved to display RBs on a surface bipolar voltage map. 16 AT studies were reviewed (7Carto3, 9MEM). Map density varied (MEM = 1136 ± 783 vs Carto3 = 318 ± 74pts, p < 0.02) with MEM maps created more rapidly (3vs17min/100pts, p = 0.01). Considerable annotation was required for a diagnosis (total mapping to ablation MEM = 49 ± 32 vs Carto3 = 64 ± 33min, p = 0.4). Analysis of the unannotated maps on RM yielded the correct diagnosis confirmed by entrainment and termination by ablation. Having proved that RM was an accurate mapping system, we were able to assess LV scar during sinus rhythm for evidence of activation channels.

In 21 LV maps, 77 RMCCs were seen; 33 = 0.5–1.5mV, 15 = 0.30–0.5mV & 29/C20 0.3mV. Mean RMCC CV was 64 ± 31 vs 260 ± 230cm/s in healthy myocardium(p < 0.001). 7 sites met conventional criteria for diastolic pathways. All coincided with a RMCC. All 7 patients with ablation lesions co-locating to all RMCCs remained free of VT (F/U = 662 ± 317d). 5/14 patients who had at least 1 RMCC with no ablation had recurrence (F/U = 479 ± 315d). RMCCs were sensitive(100%) for VT recurrence with specificity(43%) limited by likely ‘blind alley’ channels.

Conclusion: RM identifies SCCs within LV scar. The main limitation has been the off-line system. RM can now be used in live cases on CARTOv4 enabling prospective randomised validation of RMCCs to guide substrate based VT ablation.