Validation and utility of a novel mapping system in ablation of complex arrhythmias in adult congenital heart disease

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Background: Multiple tachycardia circuits in patients with congenital heart disease (CHD) pose a challenge in identification of the critical isthmus. We sought to validate a novel wavefront mapping system using the High-density (HD) Grid catheter (Abbott Medical). The system was validated for (1) mapping complex wavefront patterns in atria tachycardia (AT) (2) defining critical isthmus in areas of scar.

Methods and Results: Patients with CHD undergoing catheter ablation for AT. A 16-pole-4 spline grid catheter was used to acquire bipolar signals using HD wave solutions for orthogonal bipoles across the 16 poles. These were used to generate wavefront propagation maps. ATs were mapped and critical isthmus was identified using HD wave solutions and conventional bipolar mapping (independently) and confirmed with entrainment and response to ablation. The mean voltage amplitude within the critical isthmus was calculated using best duplicate algorithm for the HD wave and manually for conventional bipolar maps. 2 independent observers analysed the propagation maps to define the site of the critical isthmus and points for voltage amplitude within the critical isthmus. Each observer was blinded to the clinical case and analysed HD wave and bipolar maps separately (i.e. not simultaneously). Only LAT maps were available for review to ensure point selection for voltage amplitude within the critical isthmus. 41 patients with CHD underwent mapping using the HD grid. Of these, 18 were excluded from the study (VT ablation, n=2; SVT, n=2; unable to induce or sustain AT, n=14). In the remaining 23, underlying CHD was repaired ASD/AVSD(n=8), AP Fontan(n= 3), AVR/Root replacement(n=2), TGA (n=3), ToF(n=1), repaired VSD(n=3) and pulmonary atresia/MAPCAs/PVR(n=3). HD wave accurately mapped 16 micro-rentrant ATs and 7 CTI-dependent flutters. 236,001 points were collected in an average time of 16 min with HD and 92,026 with conventional bipoles. Within the critical isthmus, the mean voltage amplitude and number of points using HD wave was higher than conventional bipoles (1.21mV, 76 versus 0.73mV, 58). Critical isthmus sites were missed in 4 micro-rentrant ATs using conventional bipoles alone. 2 independent observers verified these data. Ablation at the identified critical isthmus led to arrhythmia termination in all cases. There were no procedural complications. Arrhythmia free survival was 78% at a mean follow-up of 5 months.

Conclusions: This novel mapping approach accurately defined critical isthmus by mapping complex wavefronts using orthogonal bipoles and the "best voltage duplicate" algorithm in complex CHD patients. Moreover, this high density mapping system was able to identify critical channels in areas of scar, which were missed on conventional mapping due to limitations in bipolar density and single orientations meaning wavefront propagation is not fully defined. This is particularly relevant for multiple focal ATs in this group of patients.