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Correlation of left atrial low voltage and fractionation substrate between sinus rhythm and atrial fibrillation: high density mapping of the arrhythmogenic substrate in patients with persistent AF

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Background: Novel low-voltage based ablation therapy for persistent AF – in addition to pulmonary vein isolation (PVI) - has been recently introduced and can be performed either in sinus rhythm (SR) or during AF. However, the spatial correlation between the arrhythmogenic substrate displaying (a) low voltage area (LVA) and (b) prolonged fractionated potentials (FPs) in different rhythms (AF vs SR) remains unclear.

Purpose: To compare the relationship of atrial LVA and prolonged fractionated potentials (FPs) between SR and AF in patients with persistent AF.

Methods: Thirty-nine patients with persistent AF underwent high density mapping of left atrium (LA) (>1000 points/LA) in AF and SR prior to ablation. LVA was defined as <0.5mV during AF and <1.0 mV in SR. In SR, FPs were defined as atrial electrograms displaying ≥5 deflections and a duration ≥50ms on a single bipolar. In AF, prolonged fractionated activity was defined as EGM with a duration ≥70% of local AFCL. Both were considered as pathological substrate and were annotated on the LA geometry for correlation to LVA.

Results: 69% of patients showed low voltage substrate (LVS) during both rhythms. 3% had no LVS in any rhythm, 15% had LVS in AF only. The extent of LVS in AF vs SR was 29±22% vs 27±24% of total LA surface.

In AF, the locations of LVS were: posterior LA (87% patients), anterior LA (85%), antero-septal (74%), roof (64%), and lateral LA (38%). In SR, the locations of LVS were: anterior LA (62% of patients), antero-septal (49%), posterior LA (46%), roof (41%) and lateral LA (15%).

Discrepancies in LVA were present between AF and SR: 17% of analyzed LA areas displayed low voltage in AF, but not in SR. Moreover, 7% of regions displayed low voltage in SR, but not in AF. 52% of LA regions showed LVS in both AF and SR.

Quantification of overlapping LVA between AF and SR allowed a detailed comparison: The highest overlap between LVS in AF and SR was found at the anterior and antero-septal LA (78% and 67% of AF-LVS overlapped with SR-LVS). At the anterior and posterior LA, more than 80% of SR-LVS (in SR) overlapped with AF-LVS. Fig. 1 A&B illustrate the correlation of LVS-extent between AF and overlapping LVS in AF&SR.

Comparison of electrogram fractionation between AF&SR: 67% vs 73% of FPs were located in LVA during
AF vs SR. 67% sites with prolonged FPs in AF showed fractionation in SR. In contrast, 71% of FPs in SR also showed prolonged FPs in AF. Electrogram bipolar voltage of FPs during SR and AF were 0.76±0.42 mV vs 0.72±0.42 mV.

Importantly, 50% of potential AF sources within low voltage area and prolonged activity displayed FPs in SR (Fig. 1C).

Conclusions: Significant differences in electrogram voltage, fractionation and duration exist between SR and AF at same locations. However, 71% of fractionated potentials in SR display potential arrhythmogenic activity during AF (prolonged activity=70% AFCL).