Cross-System Comparison of Left Atrial Low-Voltage Area by Electroanatomical Mapping in Atrial Fibrillation

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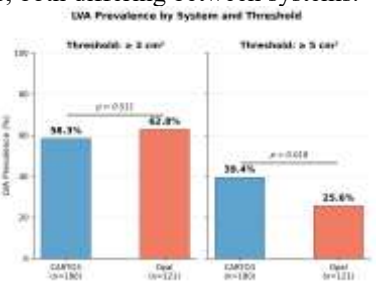
Background: Left atrial (LA) low-voltage area (LVA) is an emerging substrate marker for atrial fibrillation (AF). Different electroanatomical mapping systems are used to quantify LVA, yet methods rely on manual planimetry within proprietary software, limiting reproducibility, and cross-system LVA comparisons are lacking. We aimed to compare LVA quantification between CARTO3 and Opal using an automated, system-independent approach.

Methods: We studied 301 AF patients undergoing pulsed-field ablation (CARTO3 with Varipulse, n=180; Opal with Farapulse, n=121) at a single centre. A high-density 3D LA mesh was reconstructed per patient. We developed an automated catheter-to-triangle method: bipolar measurements ≤0.5 mV were assigned to the nearest triangle by centroid distance. LVA was the total area of triangles reached by low-voltage points. Catheter points were filtered by impedance-based contact quality. LA volume was computed via signed tetrahedra. LVA prevalence at thresholds ≥3 and ≥5 cm² was compared by chi-square test and logistic regression, after adjusting for AF type (persistent vs. paroxysmal) and LA volume, both differing between systems.

Results: CARTO3 and Opal cohorts were similar in age (65±10 vs 63±11 years, p=0.17) and female sex (30% vs 28%, p=0.82), while CARTO3 cohort included more persistent AF (49% vs 25%, p<0.001). CARTO3 had higher catheter density (median 1,193 vs 785 points/patient, p<0.001); CARTO3 and Opal LA surface areas were similar (183 vs 183 cm², p=0.78), while Opal LA volumes were larger (median 127 vs 117 mL, p=0.003). At ≥3 cm² no difference emerged (58.3% vs 62.8%, p=0.51), whereas LVA prevalence at ≥5 cm² was higher in CARTO3 (39.4% vs 25.6%; unadjusted OR 1.89 [1.14–3.14], p=0.018; adjusted OR 2.58 [1.38–4.84], p=0.003).



Conclusion: LA surface area and LVA prevalence at ≥3 cm² were similar in CARTO3 and Opal, while LVA prevalence at ≥5 cm² was higher in CARTO3. Whether this threshold-dependent discrepancy reflects true substrate heterogeneity warrants investigation.