High density mapping accuracy and efficiency in atrial fibrillation: real-world outcomes from the SECURE registry

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Background/Introduction: A high-density (HD) mapping catheter is valuable for validating pulmonary vein isolation (PVI) and analysing arrhythmic substrates of the left atrium (LA) during atrial fibrillation (AF) ablation. Multiple HD mapping catheters are available for use in clinical practice. A novel octa-spline mapping catheter with a close internal unipolar reference electrode is now available and may improve mapping efficiencies and image resolutions (Figure).

Purpose: This study aims to report real-world experiences with different commercially available HD mapping catheters in AF ablation and compare mapping performance.

Methods: SECURE is an ongoing observational, prospective, post-marketing study collecting real-world data on ablation procedures performed per standard-of-care. At the time of data extraction (Nov. 2023), 16 sites across 8 countries had enrolled 2,366 patients (pts), with 12-month follow-up data available for 828 pts. The current analysis, which included consecutive pts undergoing AF ablation, evaluated mapping efficiency and procedural outcomes with 3 HD mapping catheters: circular catheter (CC), penta-spline catheter (PSC), and octa-spline catheter (OSC). Mapping data were analysed with a cloud-based data management and artificial intelligence-powered algorithm.

Results: Overall, 859 pts with AF (paroxysmal AF [PAF], n=465; persistent AF [PsAF], n=240; long-standing PsAF [LS PsAF], n=154) were included in this analysis. The CC, PSC, and OSC were used in 428, 210, and 221 pts, respectively. Procedures using the OSC had a significantly higher mean mapping area (31,989.9 mm2) than those performed with the CC (23,152.2 mm2; $P<0.0001$) and PSC (29,804.6 mm2; $P=0.0027$), as well as a >3-fold higher mean mapping rate (138.4 vs 20.8 and 43.4 points/min, respectively; both $P<0.0001$). The higher number of mapping points translated to a higher mean mapping density (OSC, 0.34 vs CC, 0.05 and PSC, 0.07 points/mm2; both $P<0.0001$), with more uniform point distribution and less interpolation. With the CC, PSC, and OSC, respectively, total mean procedure times (incl PVI + other targets) were 118.0, 118.7, and 165.1 min, ($P<0.0001$ for OSC vs. both CC and PSC) and mean pre-ablation mapping times were 25.2, 25.0, and 21.5 min ($P<0.0004$ for OSC vs. both CC and PSC). The improved mapping quality and efficiency with the OSC allowed to include specific ablation targets beyond PVI. Fewer PVI-only procedures were performed with the OSC (29.4%) versus the CC (62.1%) and PSC (54.8%), while ablation of the PVI+ other targets was more common with the OSC versus the CC and PSC, including the cavotricuspid isthmus (37.1% vs 17.3% and 16.7%), LA roof (42.5% vs 13.1% and 21.4%), and LA posterior wall (21.7% vs 10.5% and 16.2%). Results were overall consistent per AF type (Table).

Conclusions: By providing more accurate mapping, the OSC allows for improved analysis of the arrhythmic substrate, which may improve ablation outcomes for pts with PAF and PsAF.

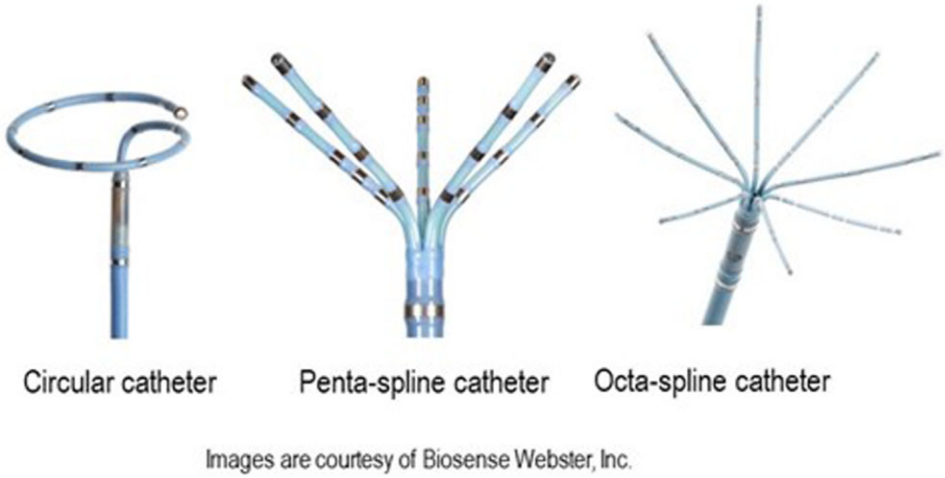

Figure 1

Table. Mapping and Procedural Outcomes for Patients With PAF, PsAF, and LS PsAF

Mapping or procedural outcome	PAF			PsAF			LS PsAF		
	Circular	Penta-spline	Octa-spline	Circular	Penta-spline	Octa-spline	Circular	Penta-spline	Octa-spline
Mapping outcomes	***(n=247)***	***(n=110)***	***(n=83)***	***(n=87)***	***(n=51)***	***(n=84)***	***(n=56)***	***(n=46)***	***(n=51)***
Mapping area, mm^2	22,250.0 (6473.2)	27,798.6 (7314.3)	29,755.1 (7225.2)*	24,299.2 (6862.3)	30,793.2 (8290.5)	33,369.5 (6940.3)*	25,349.5 (8757.1)	33,505.4 (12,200.8)	33,354.9 (7323.8)*
Mapping rate, points/min	20.6 (39.7)	42.9 (45.2)	140.7 (110.5)*,†	19.7 (28.2)	45.5 (42.6)	151.2 (120.3)*,†	23.4 (33.8)	42.0 (34.2)	113.7 (97.3)*,†
Mapping density, points/mm^2	0.04 (0.07)	0.07 (0.08)	0.32 (0.26)*,†	0.05 (0.07)	0.07 (0.06)	0.39 (0.32)*,†	0.05 (0.08)	0.08 (0.05)	0.31 (0.28)*,†
Procedural outcomes	***(n=270)***	***(n=110)***	***(n=85)***	***(n=101)***	***(n=54)***	***(n=85)***	***(n=57)***	***(n=46)***	***(n=51)***
Total procedure time, min[a]	115.0 (53.3)	108.5 (40.1)	142.1 (56.6)*,‡	119.2 (60.3)	118.7 (48.9)	178.7 (60.9)	130.4 (67.7)	142.7 (49.8)	180.9 (55.4)
Pre-ablation mapping time, min[b]	25.9 (13.7)	24.0 (14.1)	16.5 (10.6)*,‡	23.5 (11.3)	22.0 (12.3)	24.5 (21.7)*,‡	25.4 (10.6)	31.0 (14.1)	25.8 (20.4)*,‡
PV abstraction strategy, n (%)									
PVI only	188 (69.6)	74 (67.3)	38 (44.7)	53 (52.5)	23 (42.6)	13 (15.3)	25 (43.9)	18 (39.1)	14 (27.5)
PVI+	82 (30.4)	36 (32.7)	47 (55.3)	48 (47.5)	31 (57.4)	72 (84.7)	32 (56.1)	28 (60.9)	37 (72.5)
CTI	46 (17.0)	19 (17.3)	24 (28.2)	19 (18.8)	10 (18.5)	41 (48.2)	9 (15.8)	6 (13.0)	17 (33.3)
LA roof	23 (8.5)	11 (10.0)	19 (22.4)	16 (15.8)	16 (29.6)	49 (57.6)	17 (29.8)	18 (39.1)	26 (51.0)
LA posterior wall	9 (3.3)	8 (7.3)	14 (16.5)	23 (22.8)	12 (22.2)	25 (29.4)	13 (22.8)	14 (30.4)	9 (17.6)

CTI, cavotricuspid isthmus; LA, left atrial; LS PsAF, long-standing PsAF; PAF, paroxysmal atrial fibrillation; PsAF, persistent atrial fibrillation; PVI, pulmonary vein isolation; SD, standard deviation. Values were mean (SD) unless otherwise specified. [a]PAF: circular, n=269; penta-spline, n=109; octa-spline, n=85; PsAF: circular, n=100; penta-spline, n=54; octa-spline, n=84; LS PsAF: circular, n=56; penta-spline, n=46; octa-spline, n=51. [b]PAF: circular, n=151; penta-spline, n=62; octa-spline, n=67; PsAF: circular, n=55; penta-spline, n=22; octa-spline, n=66; LS PsAF: circular, n=21; penta-spline, n=21; octa-spline, n=33. *P<0.0001 for octa-spline versus circular catheter. †P<0.0001 for octa-spline versus penta-spline catheter. ‡P<0.0003 for octa-spline versus circular catheter. §P<0.003 for octa-spline versus penta-spline catheter.