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High-Accuracy Non-Invasive ECG Mapping for Ventricular Arrhythmia Localization: First Clinical Experience with the CorLector System

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Abstract

Background: Accurate preprocedural localization of ventricular arrhythmogenic substrates is crucial for successful ablation. However, localization can often be challenging: foci may be ambiguous, substrates complex to map or PVCs suppressed by sedation—factors prolonging procedures and compromising outcomes. Non-invasive cardiac mapping technologies have emerged as valuable tools for identifying arrhythmogenic regions. The CorLector system applies a 12-lead ECG-based inverse algorithm to reconstruct activation maps in real time without additional hardware.

This study aimed to evaluate the first clinical experience, spatial accuracy, and reliability of this ECG-based 3D mapping approach in patients with premature ventricular contractions (PVC), ventricular tachycardia (VT), and paced rhythms and compare it to invasive electroanatomical mapping (EAM).

Methods: A total of 16 ECG recordings were analyzed at the Munich Heart Center (September–October 2025). Twelve-lead ECGs recorded during arrhythmia episodes were processed using CorLector to reconstruct 3D activation maps. Results were compared in a blinded fashion to invasive EAM reference data (CARTO™ 3). Localization accuracy was scored on a 0–5 ordinal scale (0 = opposite ventricle, 5 = exact anatomical segment). Quantitative metrics included the 3D distance between earliest-activation points and map-agreement scores. Scores ≥ 3 were considered clinically acceptable, with a predefined acceptance target of $\geq 80\%$.

Results: All 16/16 cases (100%) met the predefined acceptance threshold, exceeding the 80% target. Exact-segment agreement (score 5) was achieved in 75% of cases, adjacent-segment localization (score 4) in 19%. The mean localization error was 9 ± 4 mm (median 8 mm, IQR 5–11 mm). No cross-ventricular or remote mislocalizations were observed. Accuracy remained consistent across both ventricles for PVCs, VT and pacing conditions. Expert visual comparison confirmed close replication of activation topography between invasive and non-invasive maps. Minor regional displacement (score 4) was observed in three cases, all corresponding to adjacent or overlapping basal–inferoseptal borders indicating physiologically and anatomically acceptable variance.

Conclusions: The CorLector non-invasive mapping system demonstrated high spatial fidelity and reproducibility, achieving segment-level precision comparable to invasive EAM and full compliance with predefined clinical acceptance thresholds. A median localization error of 8 mm confirms reliable identification of early-activation sites using standard 12-lead ECG without CT co-registration. These findings support the integration of non-invasive ECG mapping into pre-ablation assessment to optimize therapy and workflows. Future prospective multicenter studies with larger patient populations are warranted to validate these findings.

Keywords: Innovations in Cardiology, Non-Invasive Cardiac Mapping, Digital Health, Clinical Electrophysiology, Ventricular Arrhythmia