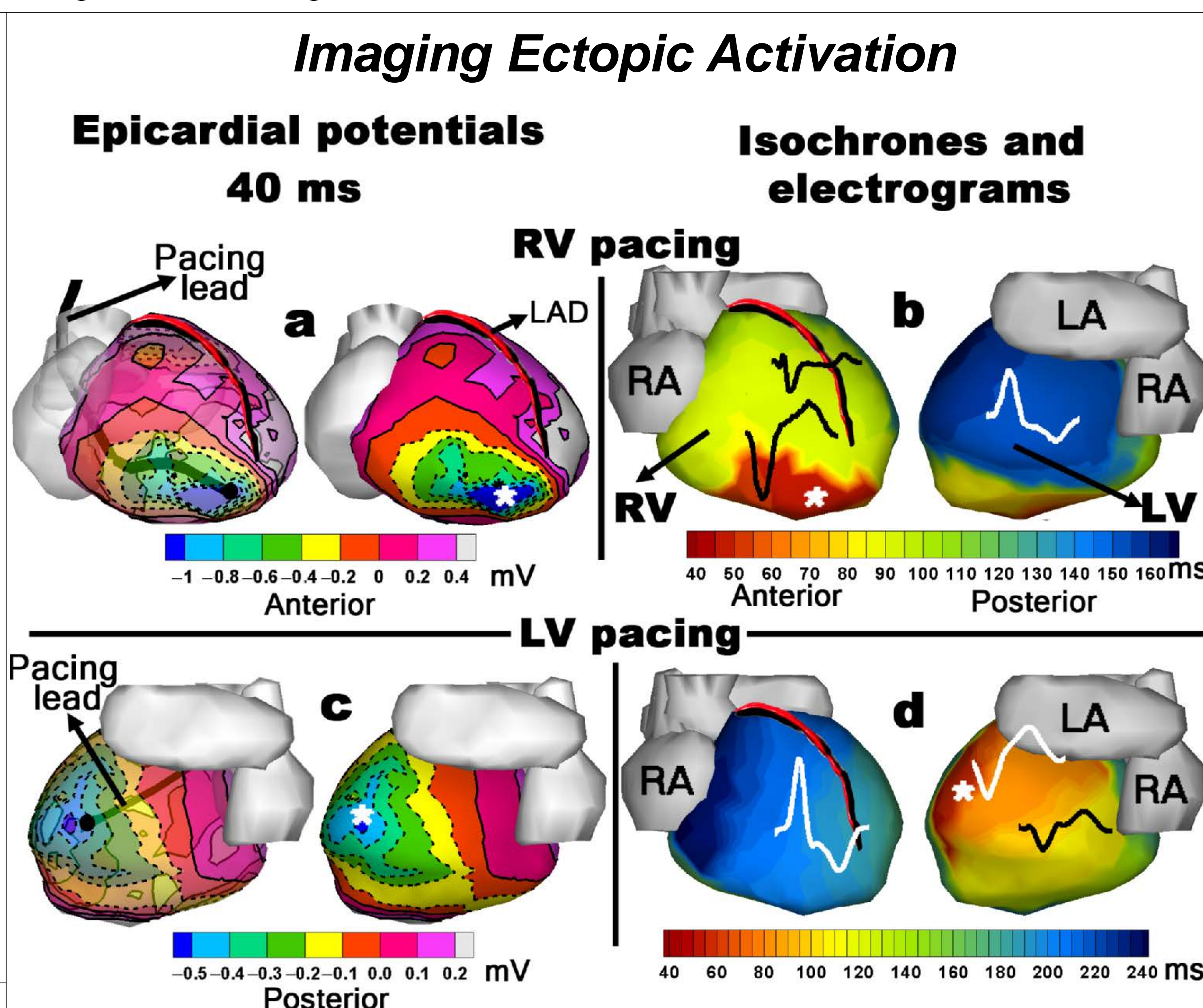
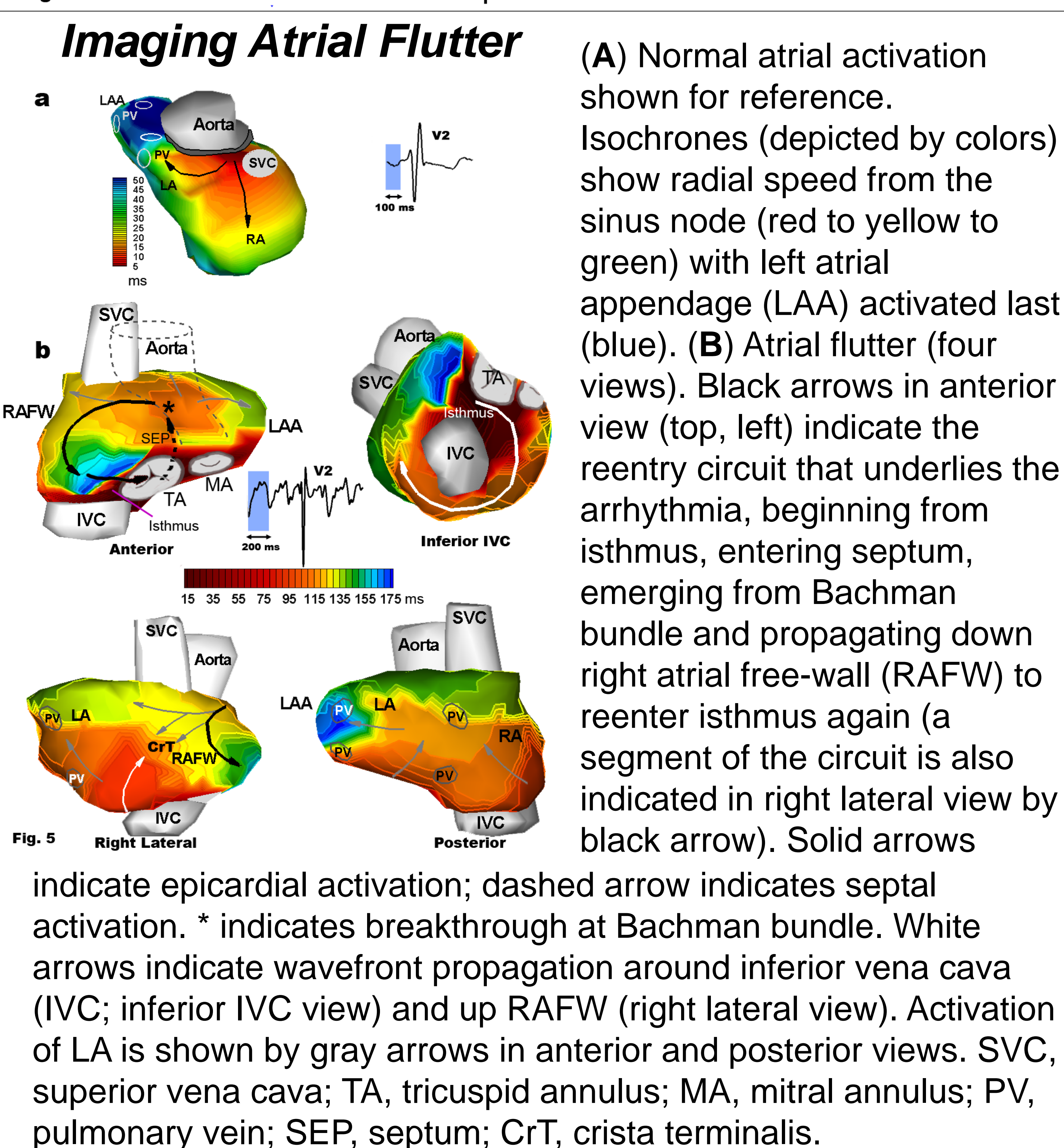
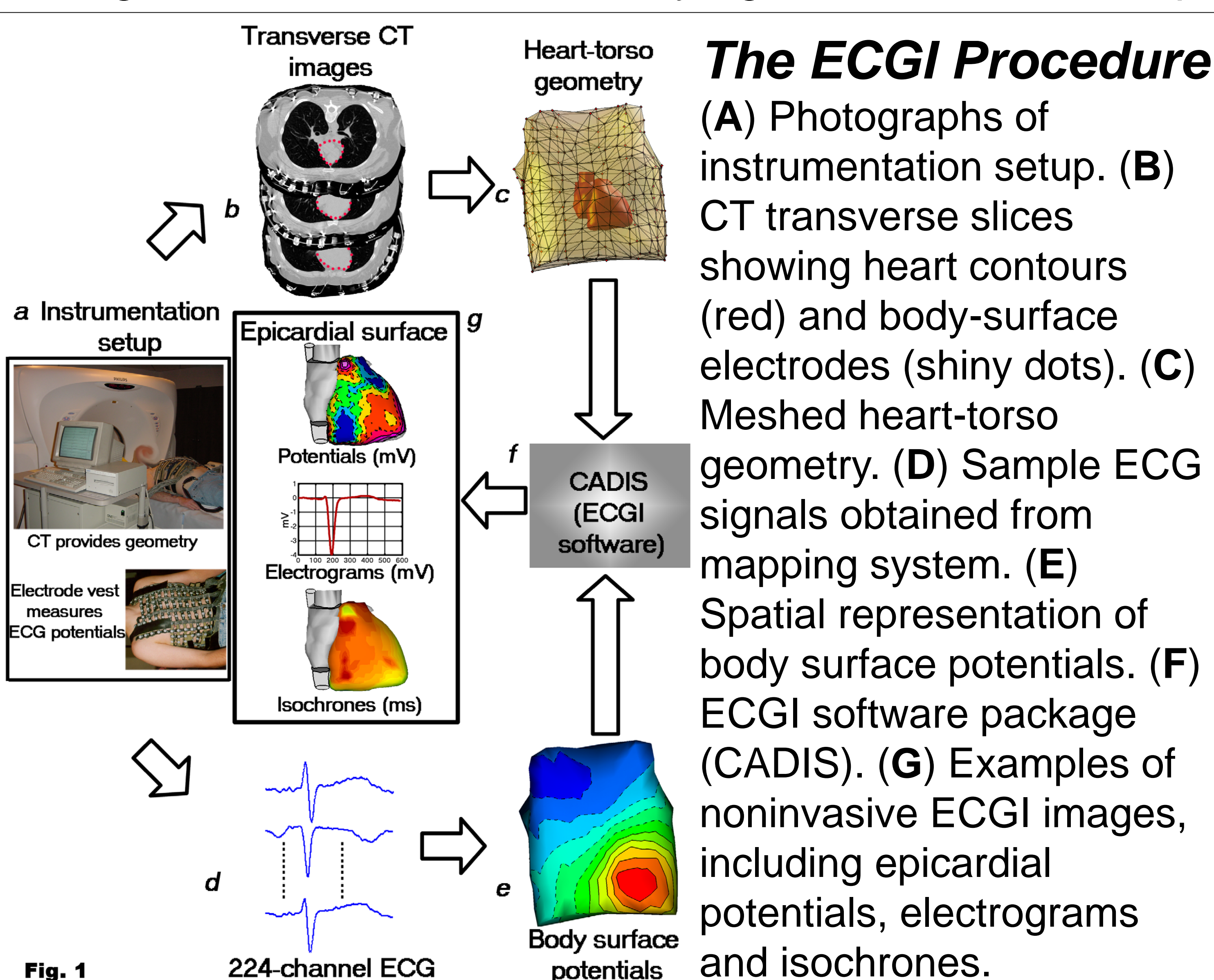


Noninvasive Electrocardiographic Imaging for Cardiac Electrophysiology and Arrhythmia

Charulatha Ramanathan, Raja N Ghanem, Ping Jia, Kyungmoo Ryu & Yoram Rudy
Nature Medicine **10**, 422 - 428 (2004)

Abstract: Over 7 million people worldwide die annually from erratic heart rhythms (cardiac arrhythmias), and many more are disabled. Yet there is no imaging modality to identify patients at risk, provide accurate diagnosis and guide therapy. Standard diagnostic techniques such as the electrocardiogram (ECG) provide only low-resolution projections of cardiac electrical activity on the body surface. Here we demonstrate the successful application in humans of a new imaging modality called electrocardiographic imaging (ECGI), which noninvasively images cardiac electrical activity in the heart. In ECGI, a multielectrode vest records 224 body-surface electrocardiograms; electrical potentials, electrograms and isochrones are then reconstructed on the heart's surface using geometrical information from computed tomography (CT) and a mathematical algorithm. Shown here are examples of ECGI application during focal activation initiated by right or left ventricular pacing and during atrial flutter.



(A) Anterior views of noninvasive epicardial potential map during right-ventricular (RV) pacing. Left, translucent view showing pacing lead determined using CT. Right, opaque view showing potential minimum at pacing site location (*). Anterior view is tilted 10° to show pacing site location on inferior RV apex. (B) Anterior and posterior views of noninvasive epicardial isochrone map for RV pacing; activation starts from the pacing site (red;*). Electrograms from three locations are shown at their respective spatial locations. (C) Posterior views of epicardial potential map during left-ventricular (LV) pacing (same format as in A). (D) Epicardial isochrone map with electrograms for LV pacing (same format as in B). LAD, left anterior descending coronary artery; LA, left atrium; RA, right atrium.

Conclusions

- Results demonstrate the ability of ECGI to image human cardiac electrophysiology noninvasively.
- ECGI located pacing sites, simulating ectopic arrhythmogenic foci, to within 7 mm (RV) and 11 mm (LV).
- ECGI imaged the reentry circuit responsible for atrial flutter, showing that the circuit was located entirely in the RA, with the isthmus between IVC and tricuspid annulus being a critical component of the reentry circuit (consistent with it being a target for ablation therapy).