Cardiac intramural electrical mapping reveals focal delays but no conduction velocity slowing in the peri-infarct region

Supplemental Data: Conduction Velocity Calculation and Pace Specific Data

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Introduction

This Data Supplement describes the conduction velocity calculations and presents conduction velocity fields for multiple stimuli across the plunge needle array for hearts 1 and 2. These are shown in detail in Figures 1, 3 and 4.

Methods

The scattered electrode activation times (figures S1a A and S2a A) are interpolated onto a regular 3D grid (resolution $0.2\times0.2\times0.2$ mm^2) using C1 continuous natural neighbour interpolation(2). The MATLAB® implementation of this interpolant was used. Points outside the convex hull of the scattered data were assigned no interpolated value. A $5\times5\times5$ first derivative template was defined using a Moore-Penrose inverse of a Taylor series expansion(3) and this was efficiently applied to calculate the 3D gradients of activation time using circular shift offsets and 1D fast Fourier transforms(1). The L2 norm of activation time gradients that were fully supported with numeric values across the $5\times5\times5$ derivative template were inverted to give the conduction velocities.

Results

Only points in the convex hull of the scattered electrodes are interpolated using the natural neighbour interpolation, and only grid points supported across the 5×5×5 derivative template are used to determine a local conduction velocity. Consequently, conduction velocities are only calculated at points in sub-volumes of the space addressed by the electrode array (figures S1a B and S2a B). In some regions where plunge needles have merged, for example toward the endocardium in Heart 1 (Figure S1a A, left hand), there is insufficient support to interpolate AT fields and/or compute fully supported AT gradients.

The support and CV distributions varied with pacing site in both hearts. This is shown for pacing sites in Heart 1 by the data in figures S1a 1-9, S1b 10-24 and S1c 25-36; and for pacing sites in Heart 2 by the data in figures S2a 1-9, S2b 10-24, S2c 25-39, S2d 40-54 and S2e 55-61. The CV in all figures is saturated at 1 m/s as values greater than this typically arises only when activation fronts collide.

These CV data, when binned according to the distance from the scar, contribute to the emergent CV distribution shown in Figure 6.

References

1. **Rutherford SL, Trew ML, Sands GB, LeGrice IJ, and Smaill BH**. High-resolution 3-dimensional reconstruction of the infarct border zone: Impact of structural remodeling on electrical activation. *Circ Res* 111: 301-311, 2012.

2. **Sibson R**. A brief description of natural neighbourhood interpolation. In: *Interpreting Multivariate Data*, edited by Barnett V. Chinchester: Wiley, 1981, p. 21-53.

3. **Trew ML, Smaill BH, Bullivant DP, Hunter PJ, and Pullan AJ**. A generalized finite difference method for modeling cardiac electrical activation on arbitrary, irregular computational meshes. *Mathematical biosciences* 198: 169-189, 2005.

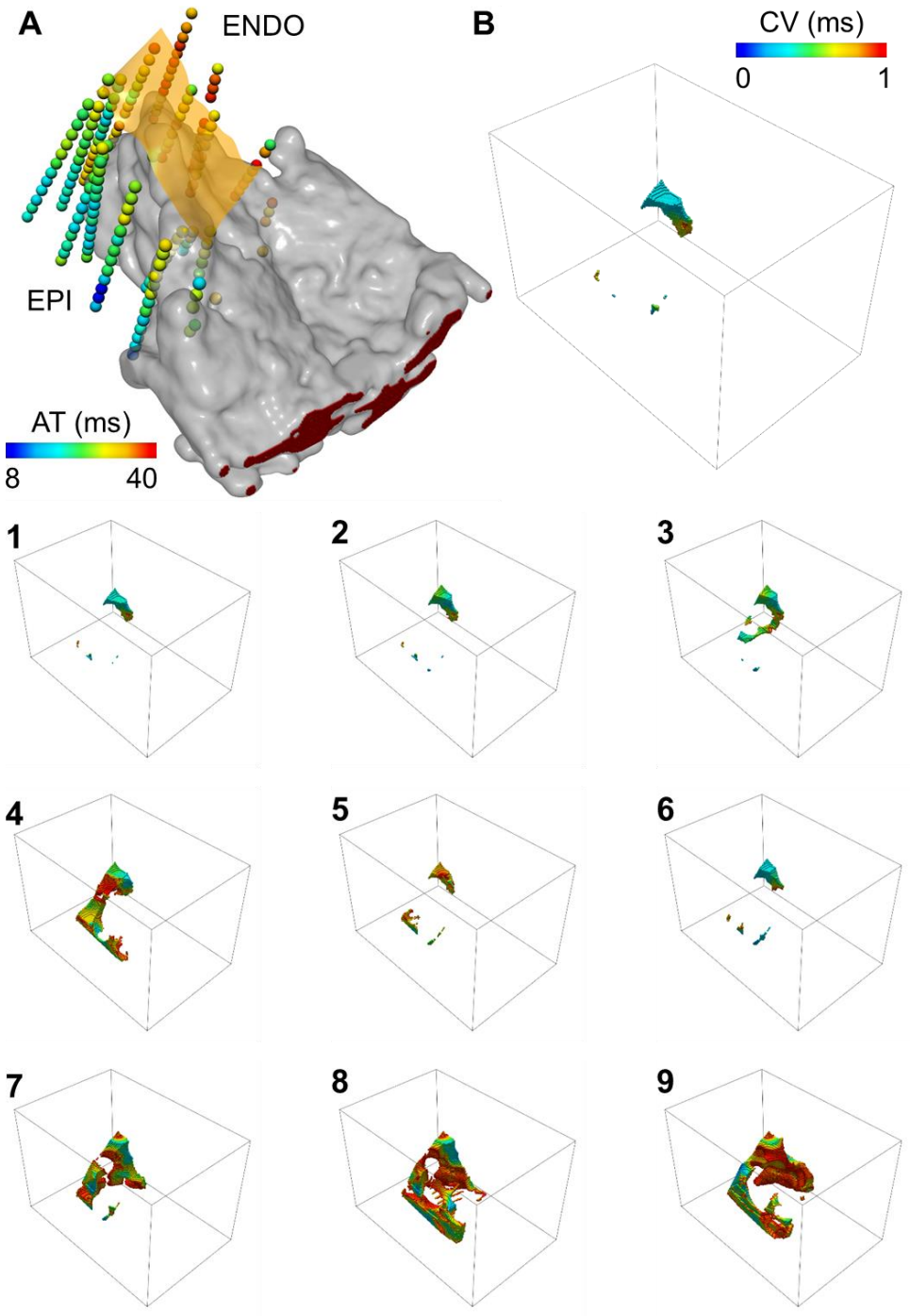

Figure S1a. Computed conduction velocity (CV) fields for Heart 1 (Figure 3). **A.** Infarct and electrode activation times (reproduced from Figure 3) for context. **B.** Computed CV field for the pacing site shown in Figure 3 and A. **1-9.** Computed CV fields for various array pacing sites.

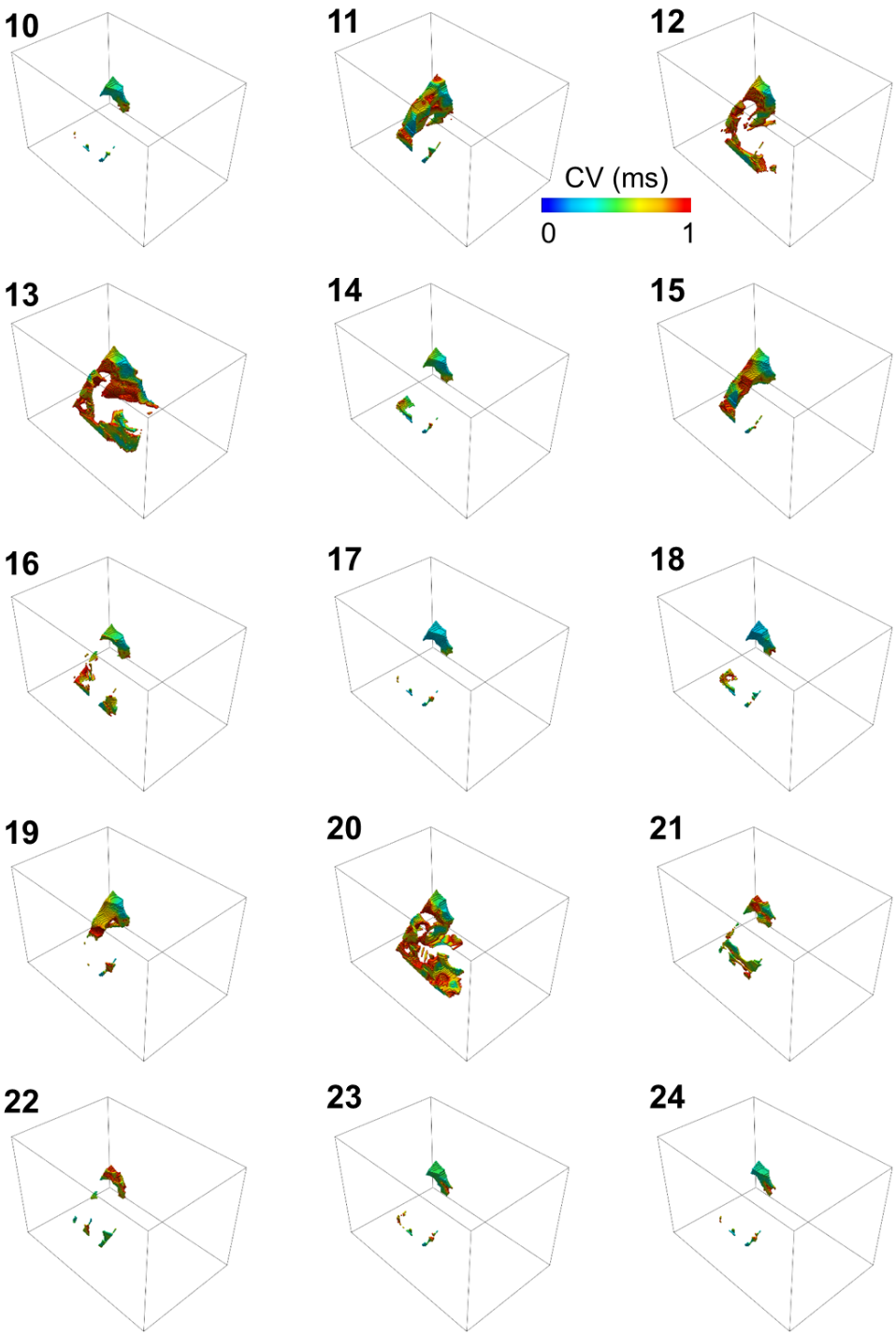

Figure S1b. Computed conduction velocity (CV) fields for Heart 1 (Figure 3) - continued. **10-24.** Computed CV fields for various array pacing sites.

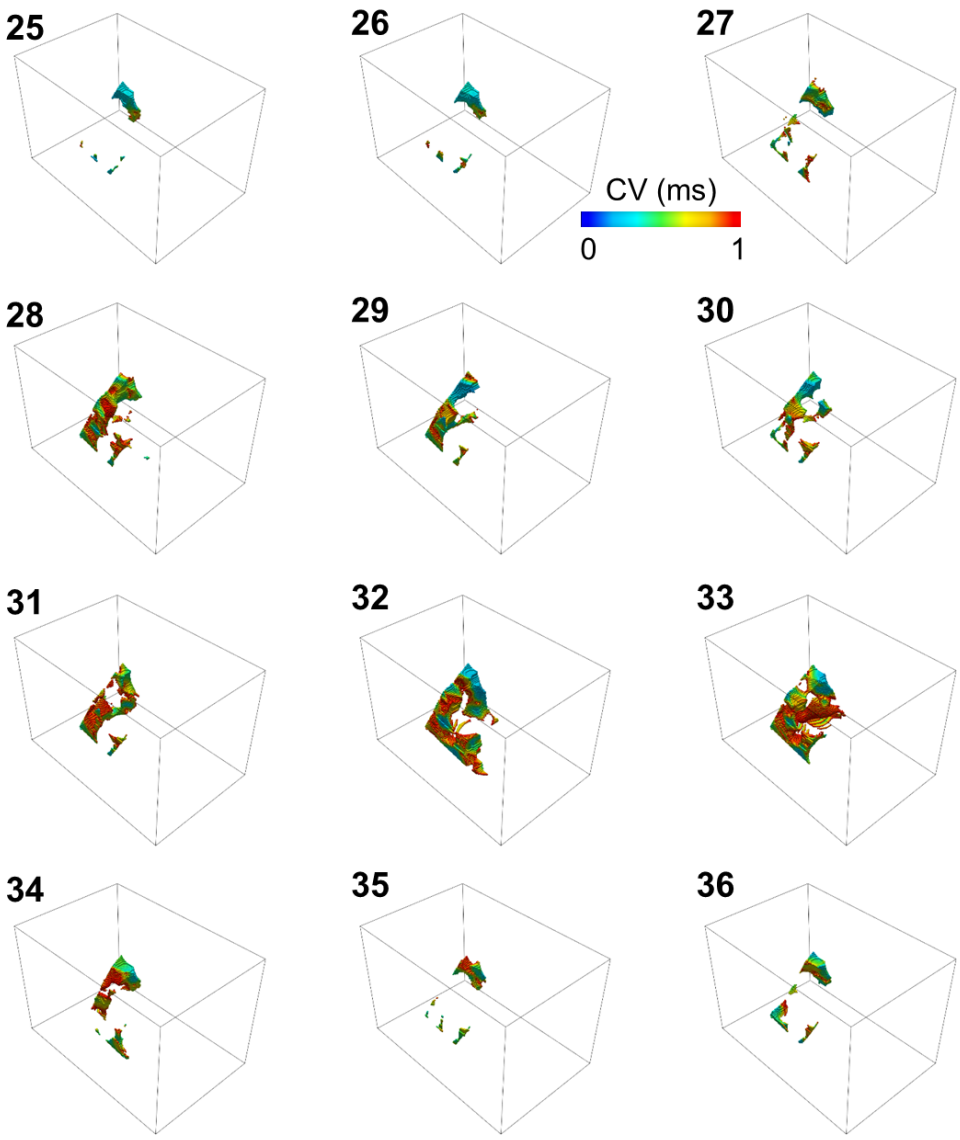

Figure S1c. Computed conduction velocity (CV) fields for Heart 1 (Figure 3) - continued. **25-36.** Computed CV fields for various array pacing sites.

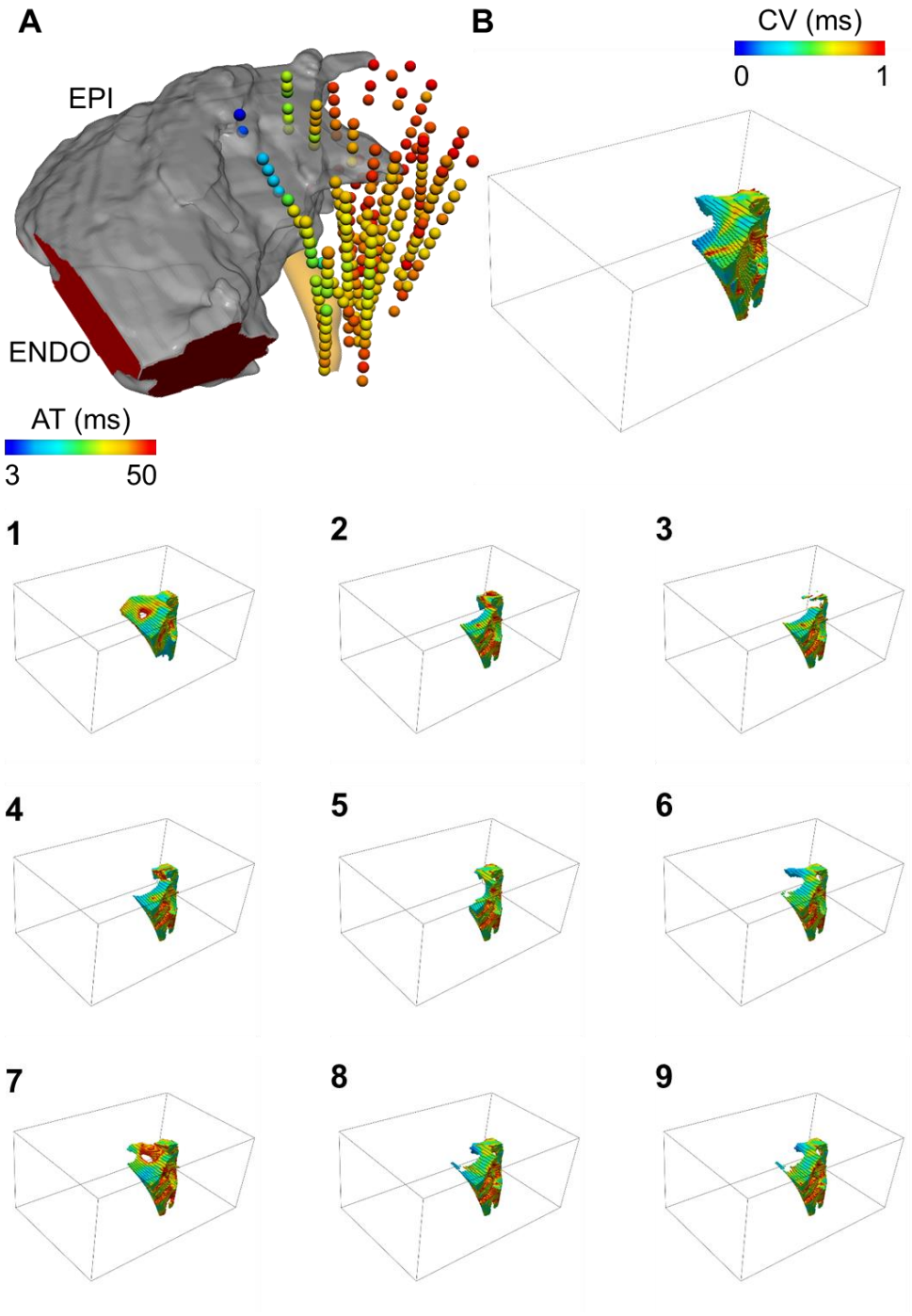

Figure S2a. Computed conduction velocity (CV) fields for Heart 2 (Figure 4). **A.** Infarct and electrode activation times (reproduced from Figure 4) for context. **B.** Computed CV field for the pacing site shown in Figure 4 and A. **1-9.** Computed CV fields for various array pacing sites.

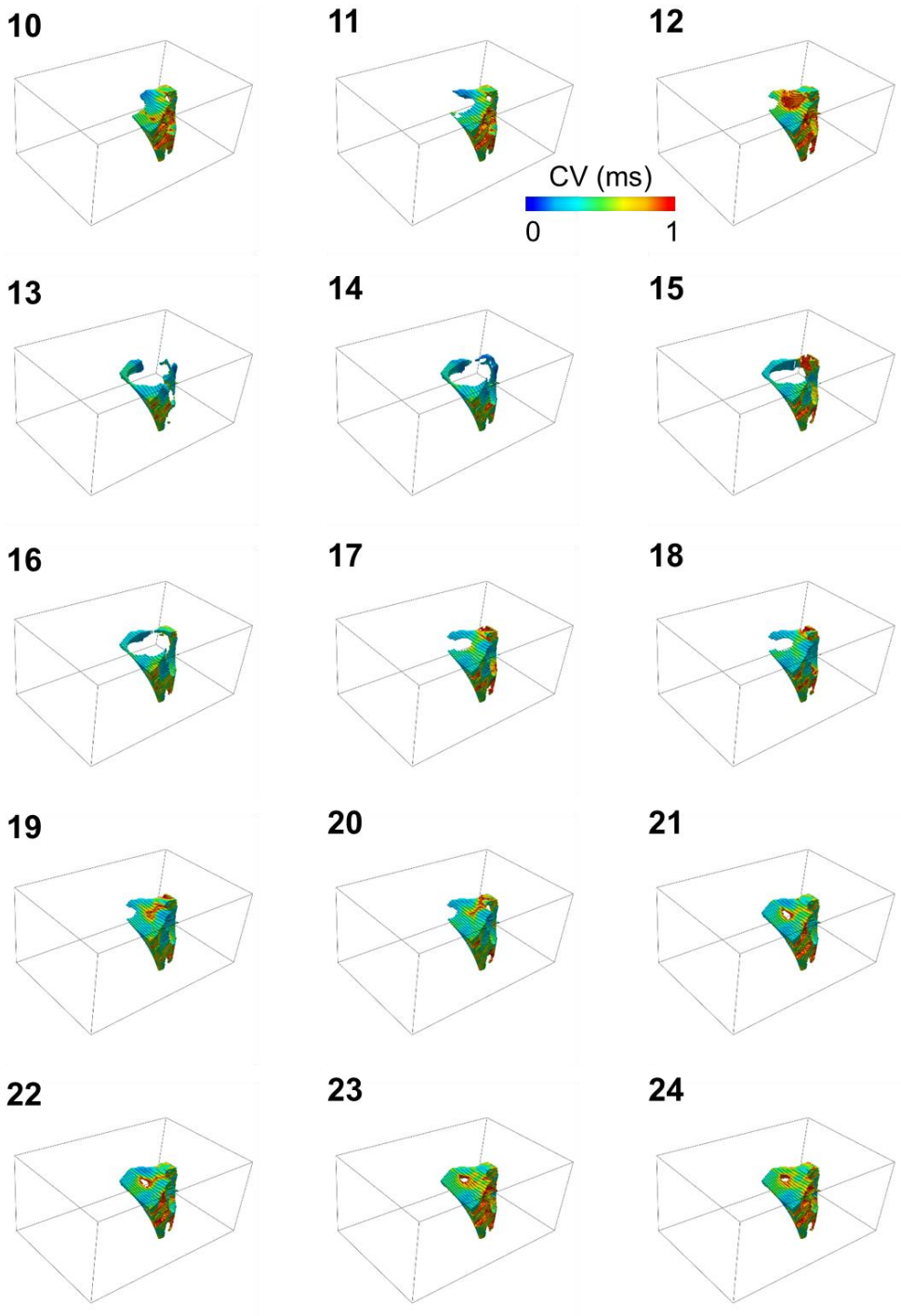

Figure S2b. Computed conduction velocity (CV) fields for Heart 2 (Figure 4) - continued. **10-24.** Computed CV fields for various array pacing sites.

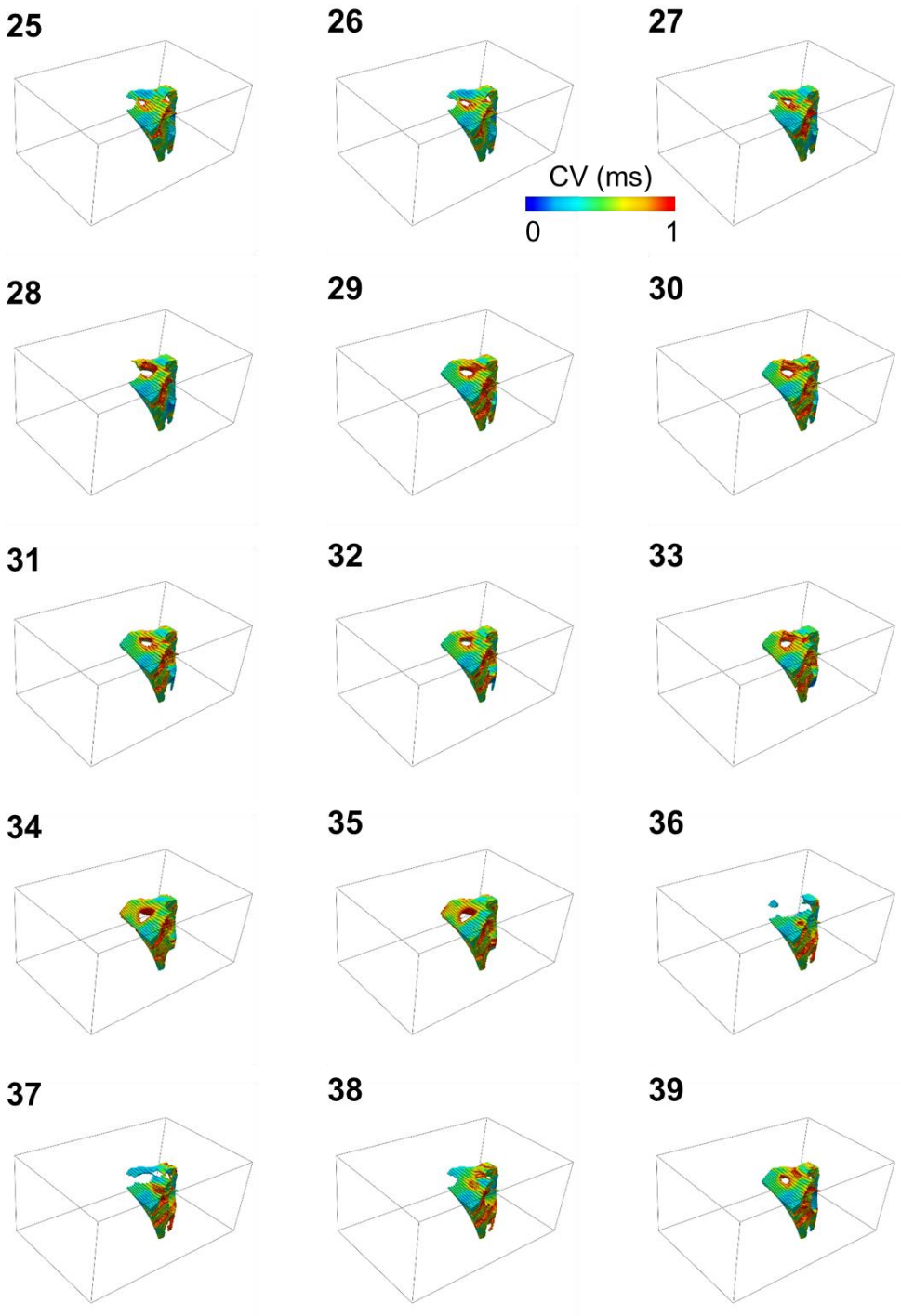

Figure S2c. Computed conduction velocity (CV) fields for Heart 2 (Figure 4) - continued. **25-39.** Computed CV fields for various array pacing sites.

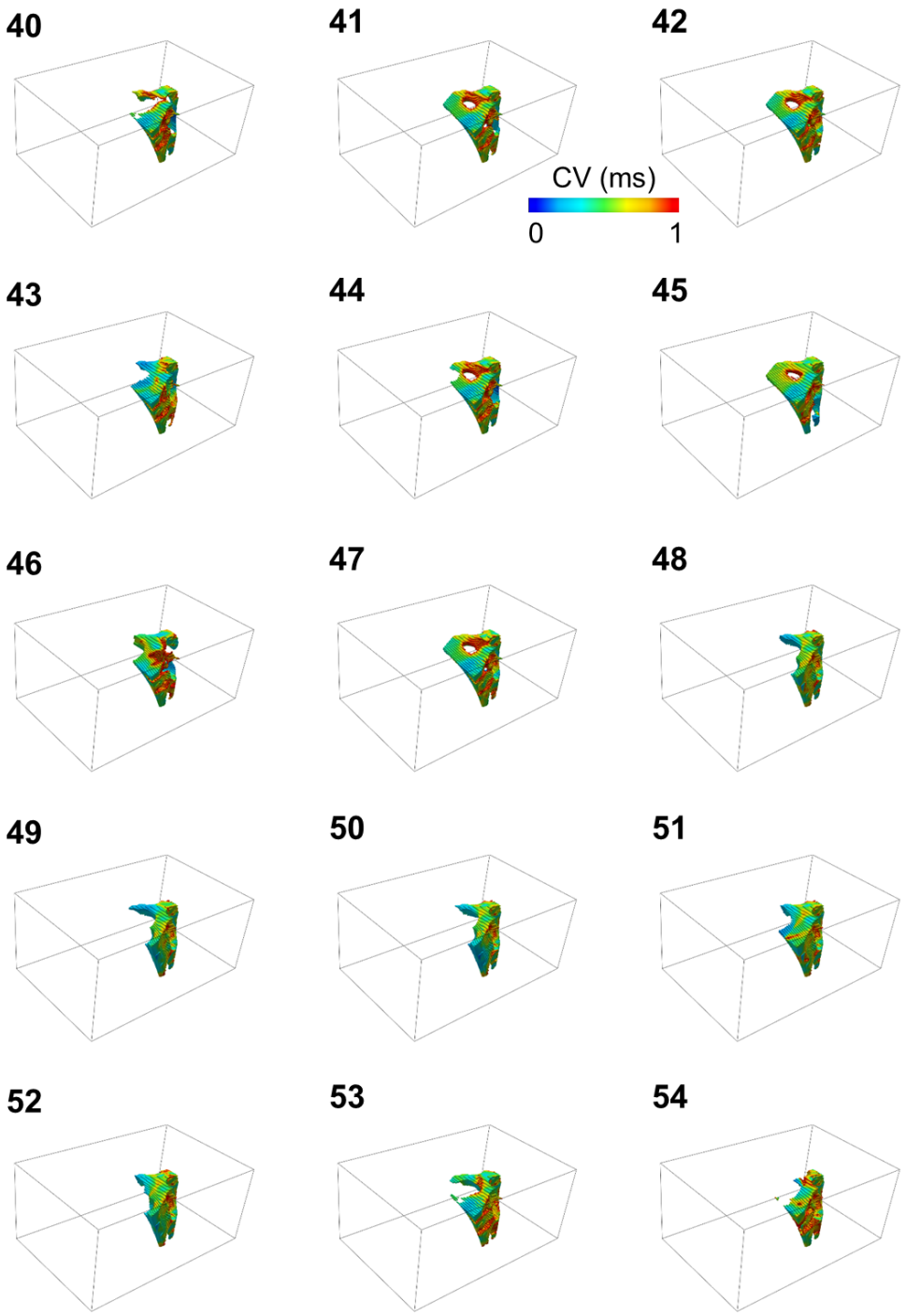

Figure S2d. Computed conduction velocity (CV) fields for Heart 2 (Figure 4) - continued. **40-54.** Computed CV fields for various array pacing sites.

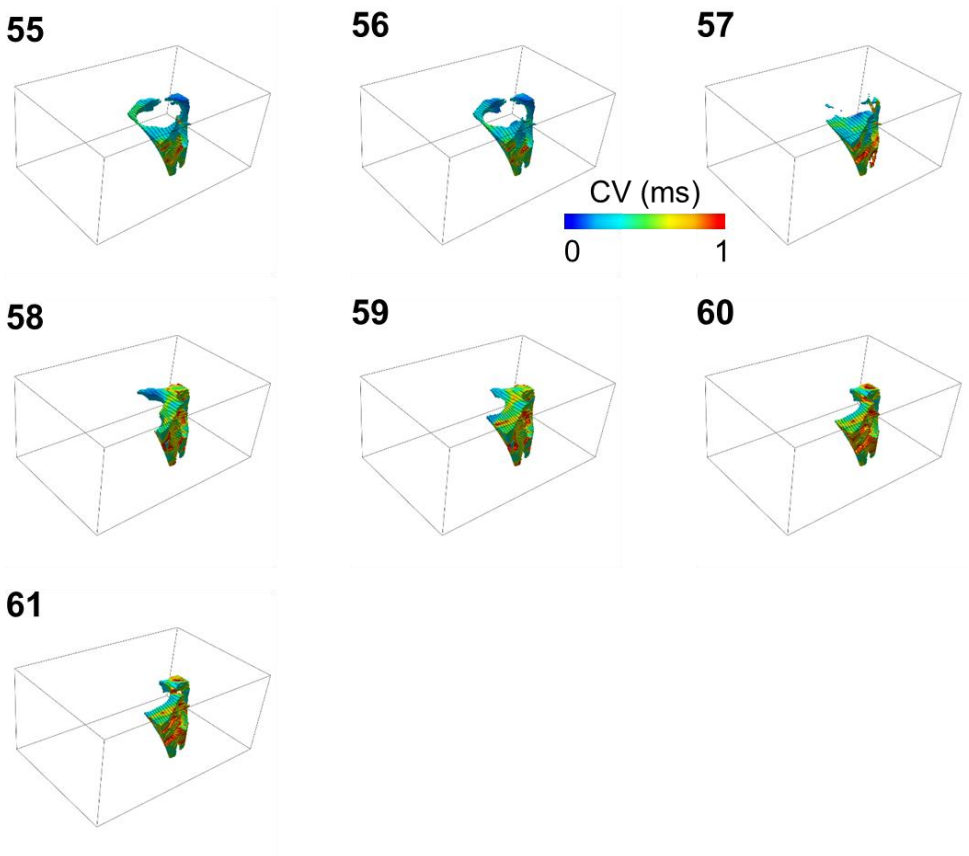

Figure S2e. Computed conduction velocity (CV) fields for Heart 2 (Figure 4) - continued. **55-61.** Computed CV fields for various array pacing sites.