

## INTRODUCTION

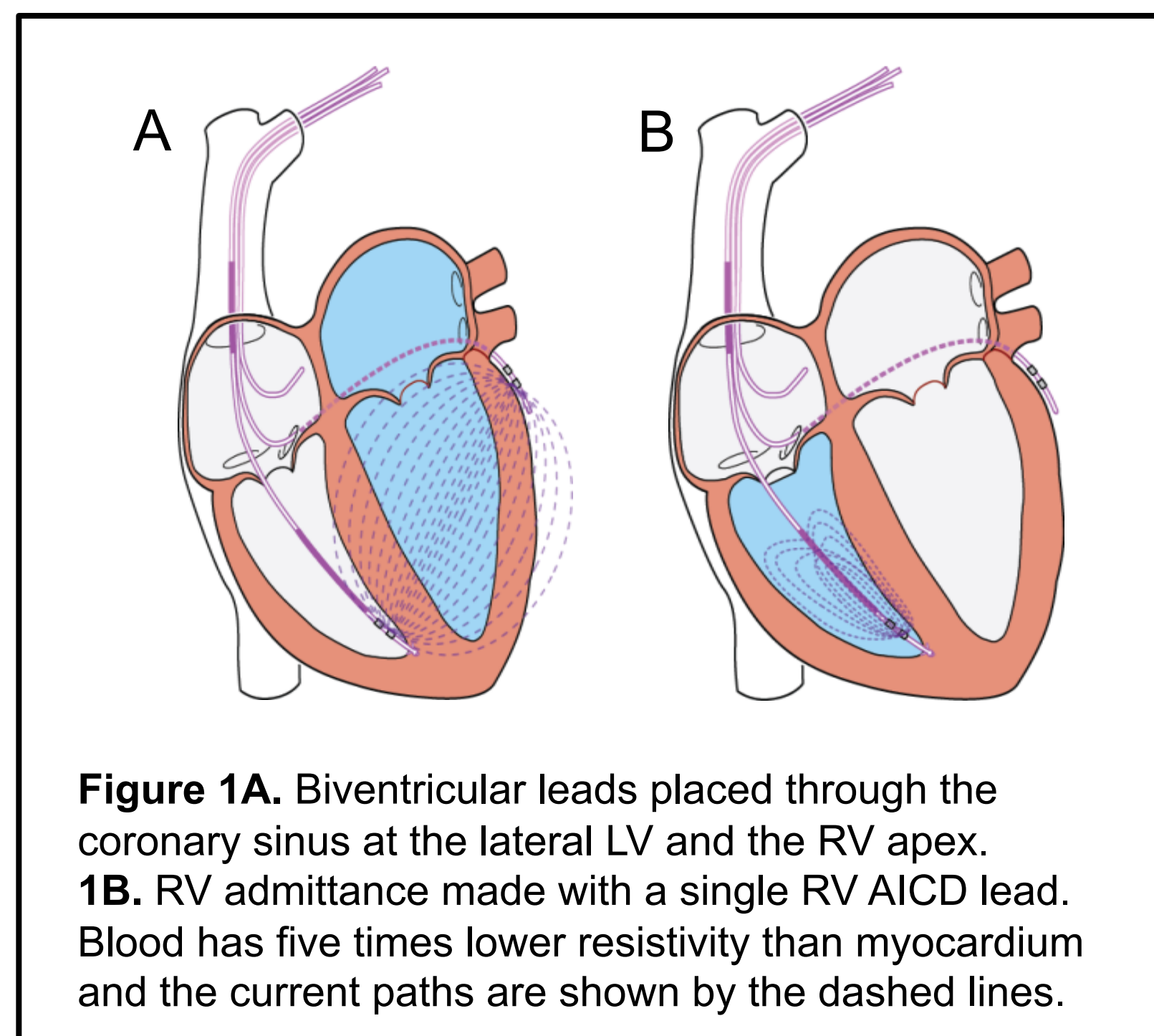
**Hypotheses:** Left ventricular (LV) admittance tracks LV stroke distance, and right ventricular (RV) admittance tracks cardiac volume.

**Significance:** HF is recognized as the leading cause of hospital readmission, costing nearly \$32 billion annually. Preventing HF readmissions is designated a priority among health care organizations. Clinical guidelines recommend implantation of bi-ventricular (bi-V) and automatic implantable cardiac defibrillators (AICD) in HF patient to improve cardiac function, ameliorate symptoms, and prevent sudden cardiac death. These cardiac implantable devices (CID) have been proven to be very effective in treating symptomatic HF and reducing SCD; thus the number of annual CID implants has increased by over 60% from 1997 to 2004. In addition, CID can be used to limit HF admission by determining lung wetness. Such measurements are performed by extending a DC electric field from the generator to the RV shocking lead or LV lead. Unfortunately, these impedance recordings measure only lung wetness, and not the more desirable chamber volume signal.

**Admittance:** Our technology, called admittance, measures complex electrical properties. The electric signals span through the blood volume pool rather than the lungs and chest wall, see Fig 1. The real and imaginary components of admittance are used to separate and discard the myocardial from the blood components of the signal, yielding a sensitive and selective measure of cardiac function.

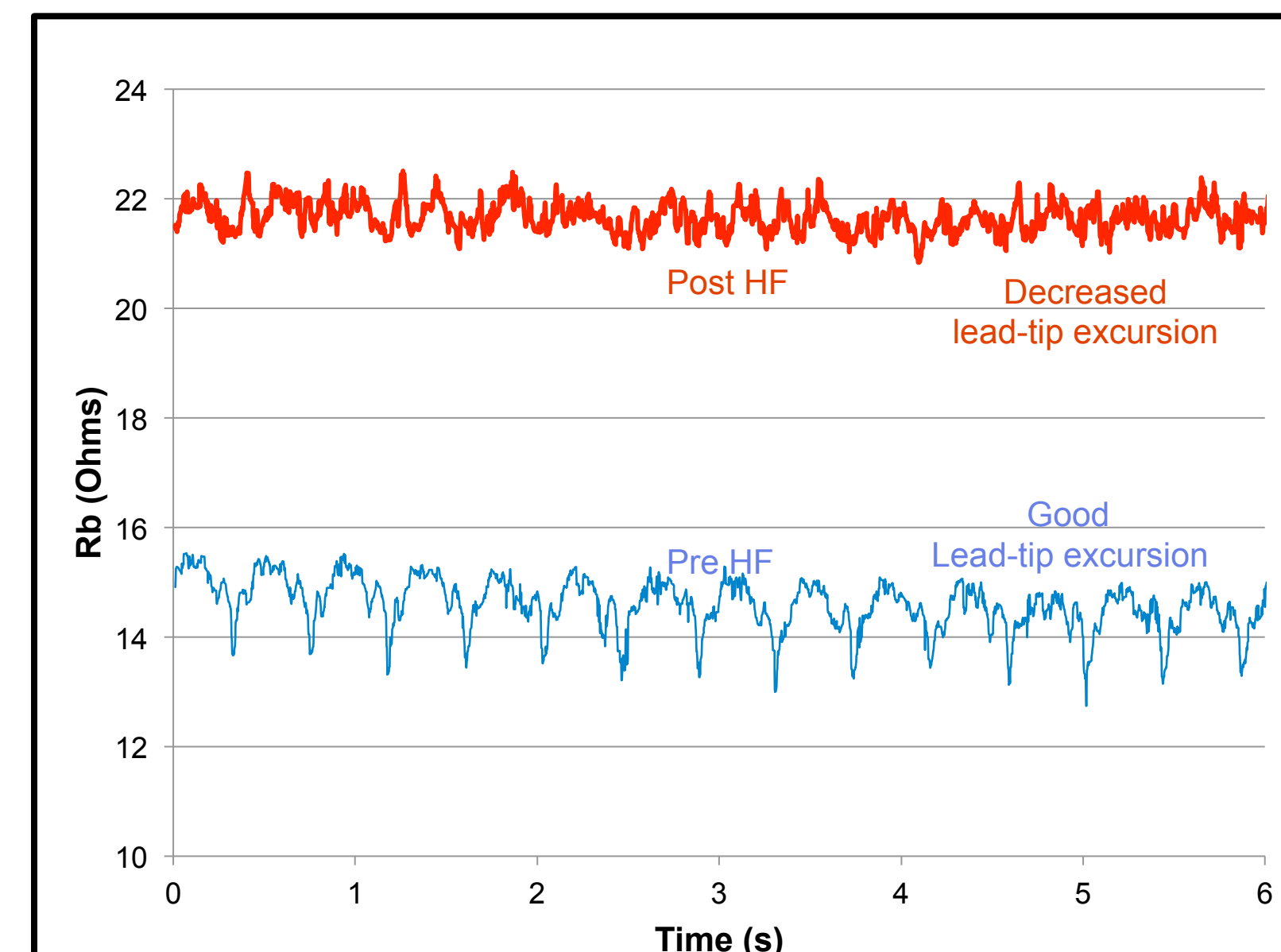
## METHODS

Bi-V leads were implanted in 8 canines at their usual locations, capped and buried in a skin pocket. The animals were recovered for 60 days to allow lead fibrosis. After lead maturation, baseline RV and LV admittance measurements and 2D trans-esophageal echocardiography (TEE) to obtain LV end diastolic (EDV) and end systolic volumes (ESV) were made. The capability of LV admittance to track lead tip excursion, which is a surrogate of cardiac contractility, was confirmed by the St Jude Ensite mapping system. LV admittance measurements were made between the RV and LV electrodes (Fig 1A). RV admittance measurements were made between the RV ring, tip, and coil (Fig 1B). Heart Failure (HF) was induced by rapid RV pacing (220-250 BPM) for an additional 30 days.

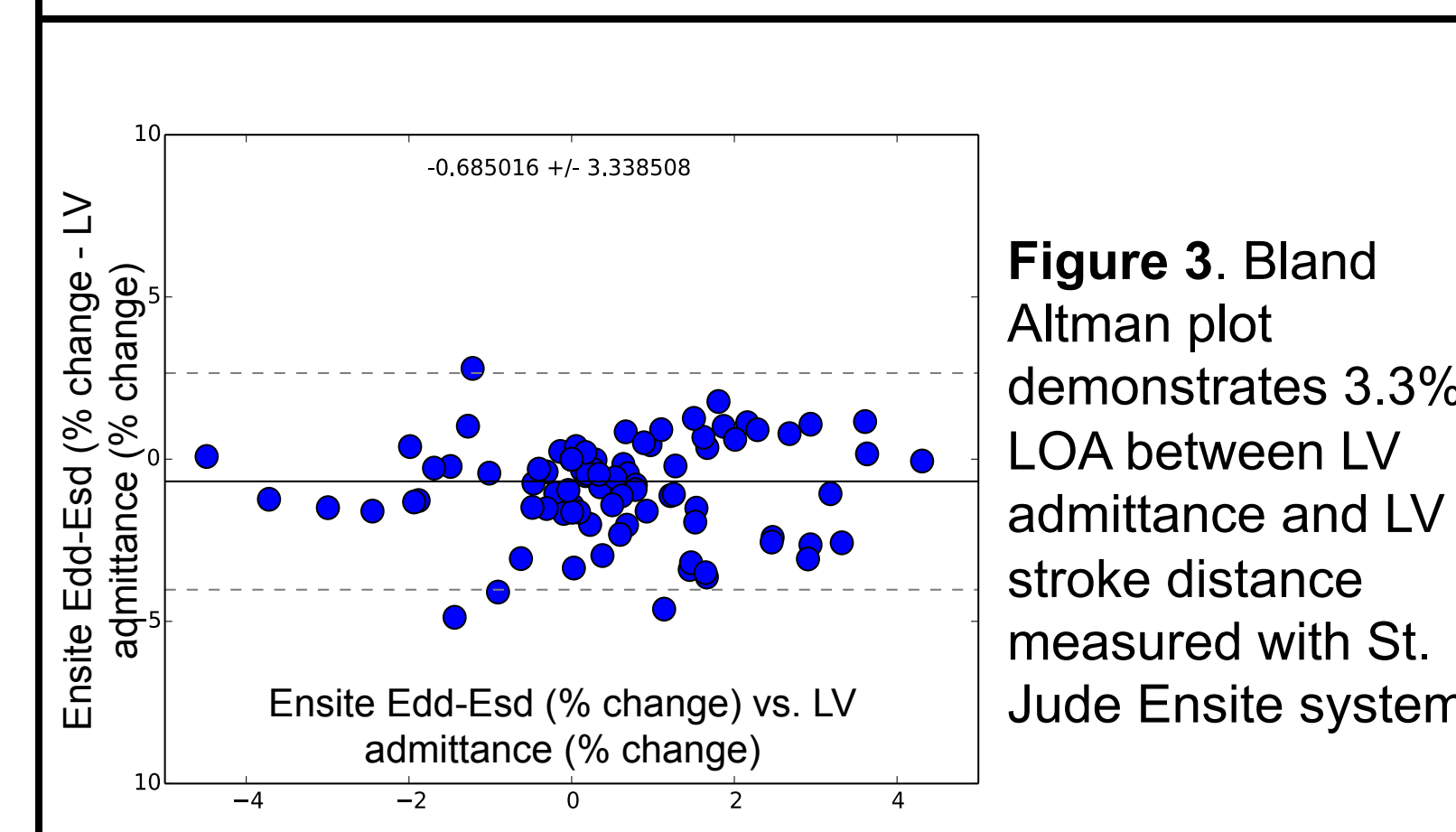


## RESULTS

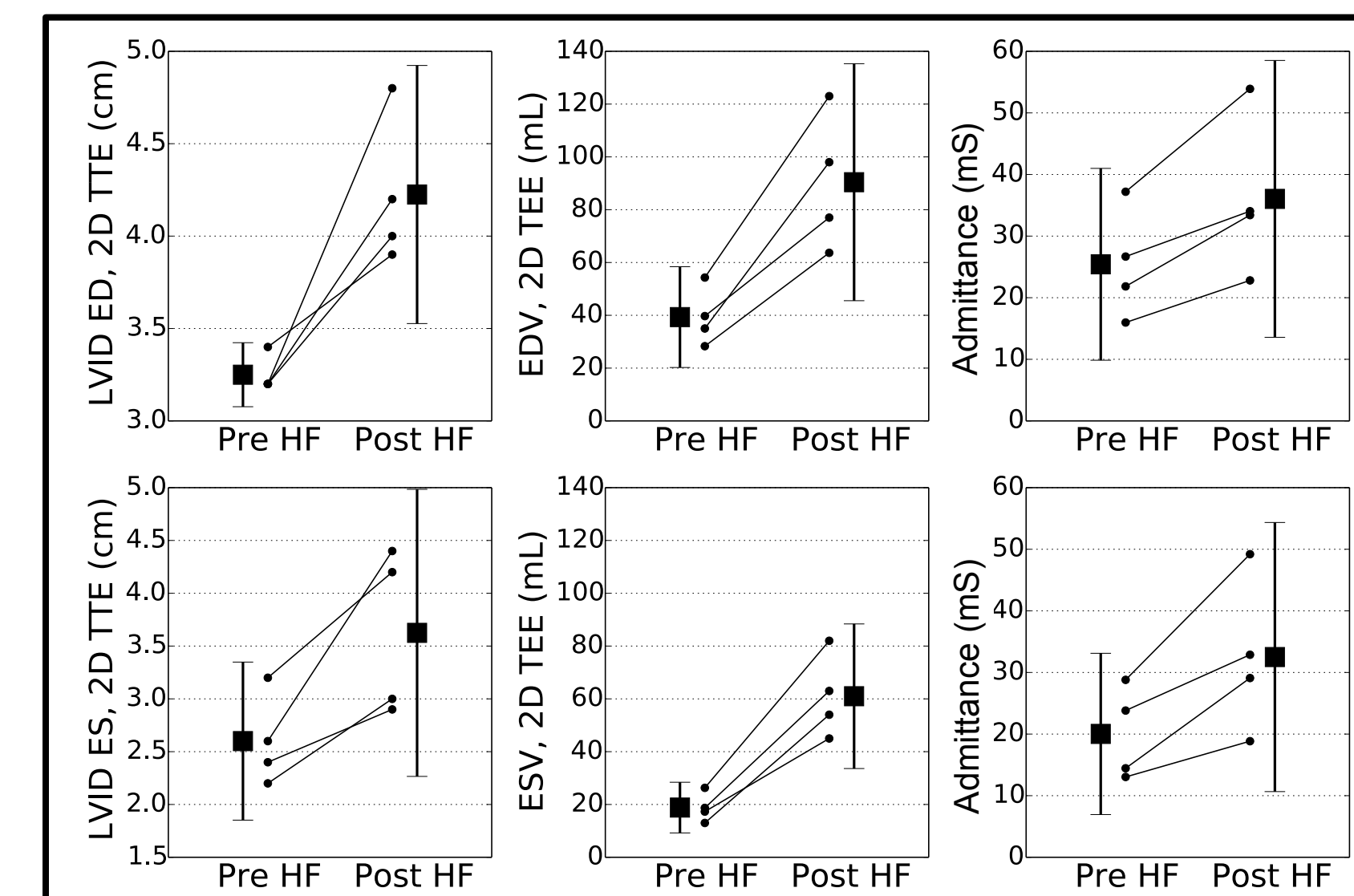
**Tracking cardiac function:** We consider movement of the lead-tip as a surrogate for cardiac function. With the development of cardiac dilation and HF the lead-tip excursion should decrease. To corroborate this theory movement of the lead was tracked by LV admittance and confirmed with St. Jude Medical Ensite mapping.



**Figure 2.** A representative sample demonstrates that with the development of HF due to rapid RV pacing, the lead tip excursion decreases (red vs. blue signal).



**Tracking heart volume:** Fig. 4 shows an increase in RV admittance as the heart dilated with development of acute HF. An increase in LVID (10mm), LVEDV (45mL), and RV admittance (16.7mS) was observed by TTE, TEE and RV admittance respectively when comparing measurements taken within 3 days of the pacemaker implant (Pre-HF) to measurements taken after pacing cessation (Post HF).



**Figure 4.** RV admittance results (n=4) Rapid RVA pacing induced increase in end systolic and diastolic was tracked by RV admittance and confirmed by 2D TTE and TEE. For all results Post HF mean is significantly different than Pre HF mean (squares, bars represent 2\*σ) by paired student's T-test, p < 0.03

## CONCLUSION

Admittance measured using chronically implanted RV and Bi-V AICD leads can monitor increases in cardiac size with the onset of acute decompensated HF. Admittance can not only detect heart dilation but can also track heart function as the heart dilates and systolic dysfunction develops. Thus admittance measurements with ICD leads could potentially serve as an effective tool for detecting the progression of HF.