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Characterization of Density of High Dominant Frequency Sites in Persistent Atrial Fibrillation Patients

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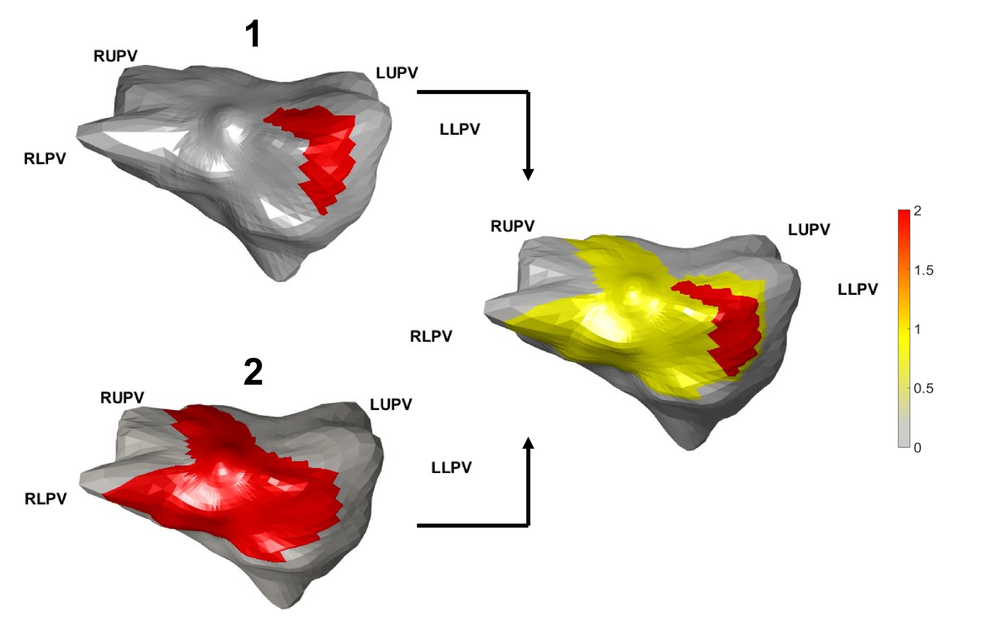
INTRODUCTION

- Dominant Frequency (DF) analysis of atrial electrograms (AEGs) has been used to characterise atrial fibrillation (AF). Sites of high DF (HDF) might help identifying drivers of persistent AF (persAF). Previous studies have shown that DF of AEGs lacked in spatiotemporal stability, hence targeting sites of HDF from a single time frame is unlikely to be a reliable ablation strategy.
- Characterization of HDF spatiotemporal distribution and stability are critical to their relevance as targets for catheter ablation. This study focused on accumulating HDF maps over time to produce HDF density maps, which allowed us to statistically distinguish the dense regions that could be targets for ablation.

METHODOLOGY

- Ten patients undergoing catheter ablation for persAF were studied. 2048 noncontact virtual unipolar AEGs were simultaneously recorded using a balloon array (Ensite Velocity, St. Jude Medical, resampled at 512 Hz).
- After QRST subtraction, fast Fourier transform was used to detect the DF on each AEG (range 4 Hz - 10 Hz; 4 s time window; 50 % overlap; HDF, DF - 0.25 Hz; up to 75 seconds/patient). HDF, organization index (OI) and regularity index (RI) were calculated at each site. The number of times HDF occurred at each node of the left atrium (LA) was counted in in order to find the HDF density for each patient (Figure 1).

Figure 1

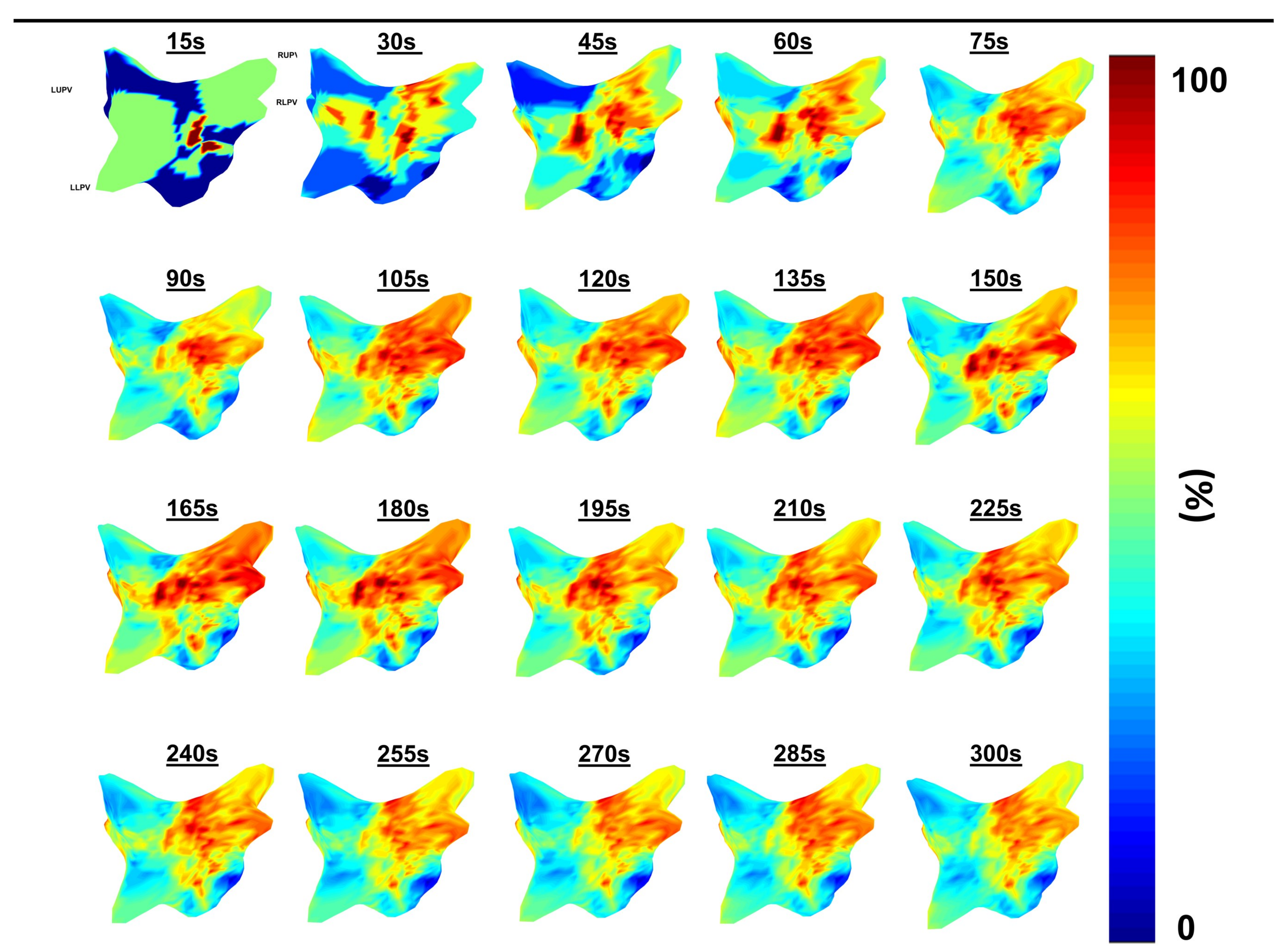


- The 2048 nodes in the LA were divided into two groups according to the HDF density (Group A > 80 % and Group B ≤ 80 %).

RESULTS AND DISCUSSION

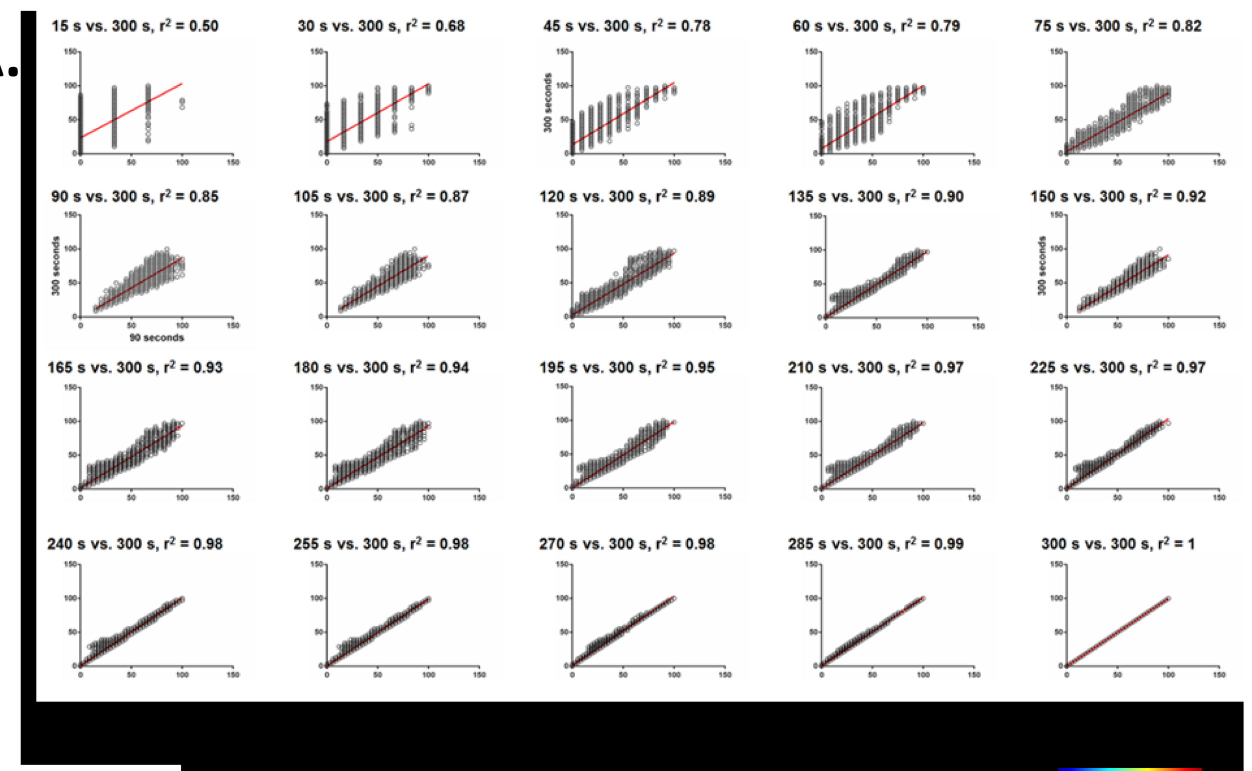
- The HDF regions, together with their neighbouring sites, (DF values within 0.25 Hz of the highest DF), produced an area consisting of a collection of points that reflect average order to find the HDF density for each regional activity.

Figure 2

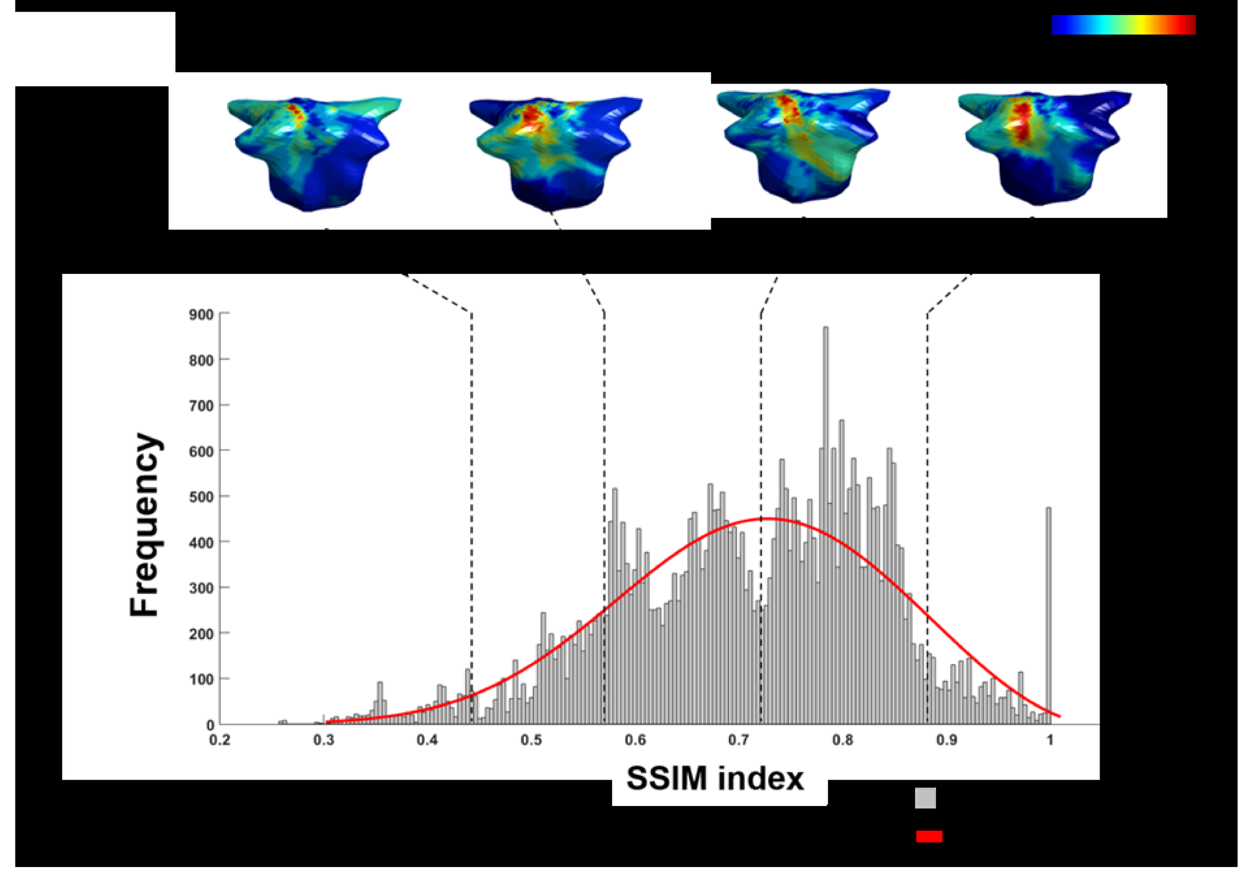


- The boundary of the area of the HDF-dense regions varied as the HDF maps are plotted over time (Figure 2). In this study spatial site, 'red' and 'blue' color areas are the sites that were visited the most and the least by the HDF 'clouds' respectively patient.

Figure 3A.



B.



- Plots of various scatter graphs (for 1 patient) (Figure 3A) showing different directions and strengths of correlation of HDF density maps (produced using several segment of VEGM recording) when compared to the HDF density map created using 300 s of VEGM recording.
- The histogram and distribution of the structural similarity (SSIM) index (for 1 patient) comparing the similarity of every HDF density map (produced using 75 seconds) with each other. The histogram at this site exhibited high kurtosis with a sharp peaked distribution and negative skewness. This site exhibited higher SSIM index with a mean of 0.71 (Figure 3B).
- Therefore, any random segment of VEGM recording of **75 seconds** could potentially indicate consistent locations of the dense regions.
- HDF, OI and RI values of Group A and B, **(Mean ± SD: 6.32 ± 0.49 vs 5.87 ± 0.95; 0.36 ± 0.13 vs 0.39 ± 0.14, 0.432 ± 0.13 vs 0.437 ± 0.14)** were significantly different from each other ($p < 0.0001$).
- Therefore, it could be understood that the cores of the HDF dense region have higher atrial activity and less organized frequency organization than their periphery. Such spatial distribution of HDF density also provides evidence of occurrences of recurrent activities and therefore suggests potential sources that may reflect mechanisms driving and maintaining

CONCLUSION

- AEGs with HDF are believed to represent atrial substrates with periodic activation responsible for the maintenance of persAF. HDFs do revisit the same atrial regions and sites where HDF are frequently seen in persAF could indicate drivers of AF and are potential targets for ablation therapy in persAF.

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