

## Diverse activation patterns during persistent atrial fibrillation by noncontact charge-density mapping of human atrium

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### Introduction/Objective

This study aimed to use this novel charge-density mapping technology to identify diverse activation patterns and their distributions in the left atrium (LA) during persistent AF.

### Methods

- 25 consecutive patients with persistent atrial fibrillation undergoing de novo ablation.
  - Mean age  $65 \pm 12$  years; Median AF duration of 10 months; Mean LA diameter was  $44 \pm 6$  mm
- Temporal segments of AF were selected for off-line analysis from within at least five of the longest R-R intervals identified in each 30-second pre-ablation recording.
- The LA was systematically divided into 18 regions. Any activation pattern appearing more than twice, consecutively, during each segment was counted as "repetitive." A pattern which appeared equally on the border of two regions was attributed to both regions.
- Activation patterns were classified as Focal Centrifugal Activation (FCA), Localized Rotational Activation (LRA), or Localized Irregular Activation (LIA).
  - FCA: A discrete early activation within the mapping region with radial propagation to the periphery.
  - LRA: A spiraling wave of activation (rotation of  $\geq 270^\circ$ ) centered on a confined zone located inside the mapping region.
  - LIA: A localized activation with isthmus-like entry and exit across a confined zone, and pivoting or unsynchronized propagation in at least two directions in the adjacent region surrounding the zone.
- Four distinct features of LIA:
  1. Slow Conduction: deceleration of an activation wave within a confined zone.
  2. Collision: fusion of two or more waves of activation within a confined zone.
  3. Pivoting: partial rotation of an activation wave around a confined zone, with an angular sweep of  $<270^\circ$ .
  4. Accelerated Conduction: acceleration of an activation wave after breaking out of a gap in a confined zone.

### Results

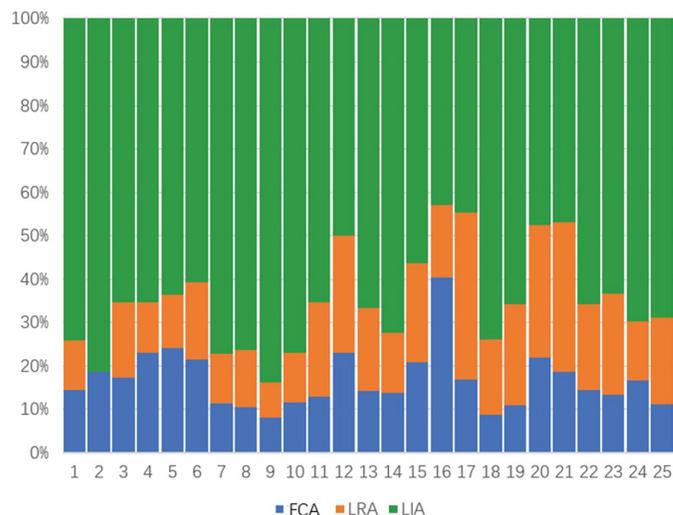
- Persistent AF is characterized by highly dynamic and heterogeneous patterns of atrial activation consisting predominantly of LIA (63%). LRA and FCA accounted for 20% and 17%, respectively.
- LIA occurred in all LA regions but was more common on the anterior and posterior walls.
- LIA consisted of a combination of slow conduction, pivoting, collision, and accelerated conduction.
- On average,  $4 \pm 2$  preferential conduction areas were observed per patient with highest frequency of repetitive LRA and LIA commonly observed in the mid-anterior (48%) and lower-posterior (40%) walls.
- The coalescence of LIA into a single broad wavefront can result in LRA and sustained LRA may break and degenerate into LIA.

### Study Limitations

- Epicardial activation was not evaluated simultaneously, thus we cannot distinguish focal activation from an epi- or endo-breakthrough site.
- We were not able to perform simultaneous bi-atrial mapping and therefore could not draw any conclusion on the relationship between the activation patterns between the two atria.
  - In a subgroup of 16 patients, 118 AF segments of RA activation were analyzed. Similar patterns of activations were observed. The most frequent pattern was LIA (75.6%), followed by FCA (21.1%) and LRA (3.1%) at posterior wall & septal junction.
- Longer durations of AF activation maps may provide further insights into the temporal distribution of these characteristic activation patterns.
- The role of 3D structure and complex geometry of the atrial myocardium on the different types of activation was not evaluated.

### Conclusion

- Persistent AF is characterized by highly dynamic and heterogeneous patterns of atrial activation consisting predominantly of LIA (63%). LRA and FCA accounted for 20% and 17%, respectively.
- Global mapping can help to identify the characteristics of AF activation and provide a better understanding of mechanisms responsible for AF perpetuation.



**Fig. 1:** Percentage of atrial fibrillation activation patterns for each patient. The x-axis denotes the patient number; the y-axis denotes the frequency of each activation pattern. FCA = focal centrifugal activation; LRA = localized rotational activation.

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#### U.S. Indication for Use:

The AcQMap System is intended for use in patients for whom electrophysiology procedures have been prescribed.

When used with the AcQMap Catheters, the AcQMap System is intended to be used to reconstruct the selected chamber from ultrasound data for purposes of visualizing the chamber anatomy and displaying electrical impulses as either charge density-based or voltage-based maps of complex arrhythmias that may be difficult to identify using conventional mapping systems alone.

AND – When used with the specified Patient Electrodes, the AcQMap System is intended to display the position of AcQMap Catheters and conventional electrophysiology (EP) catheters in the heart.

OR – When used with conventional electrophysiology catheters, the AcQMap System provides information about the electrical activity of the heart and about catheter location during the procedure.

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