A Novel Approach to Substrate Mapping: Results of a Prospective Study of Mapping during Sinus Rhythm to Identify the VT Isthmus

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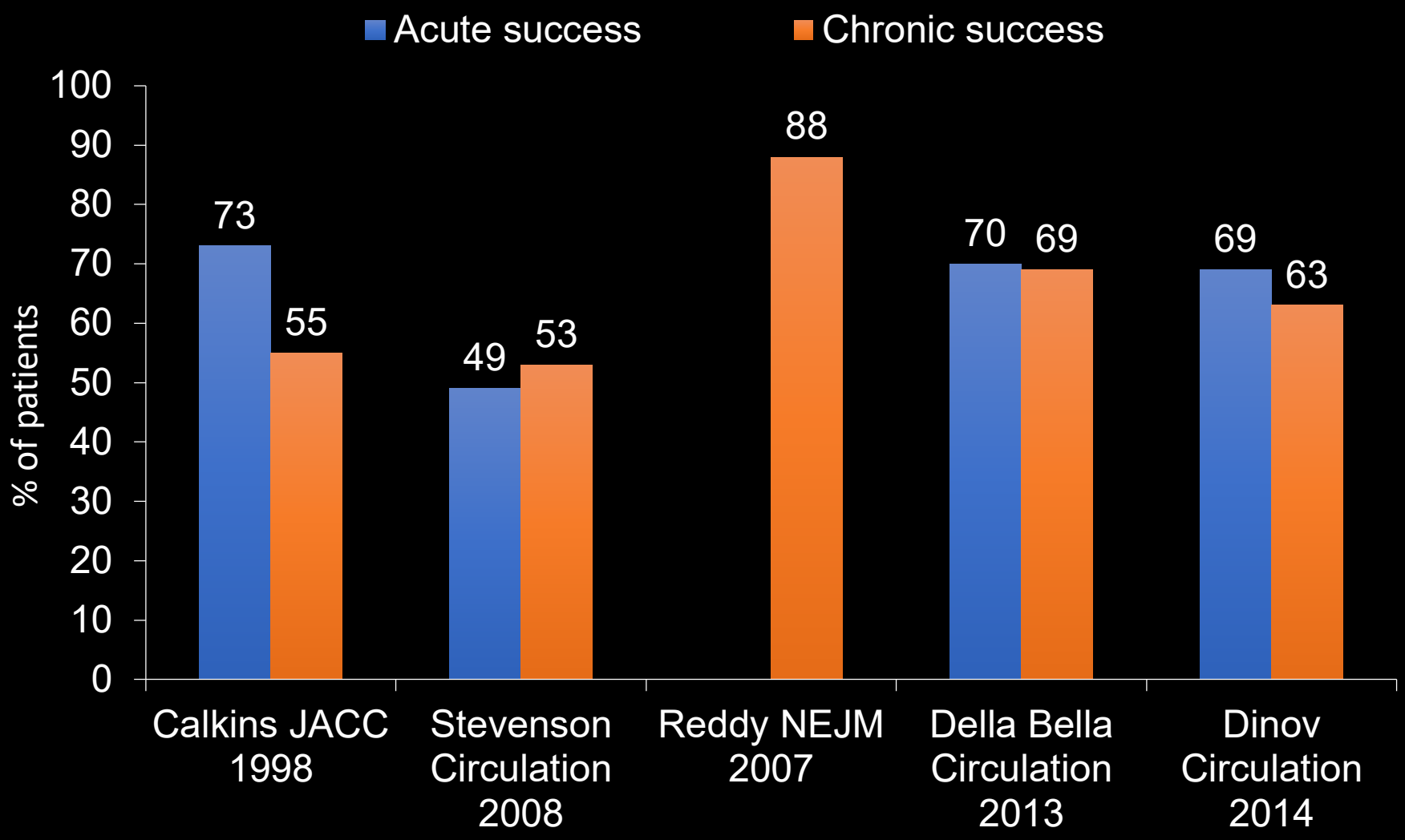
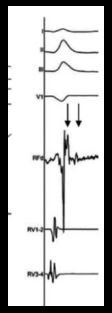
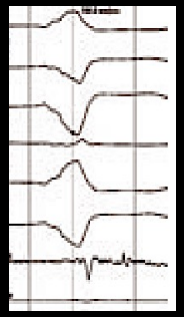
Why strive for improvement?



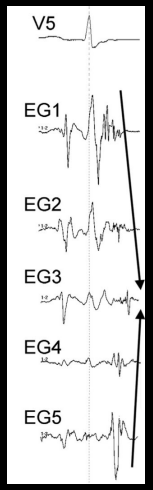
VT ablation strategies



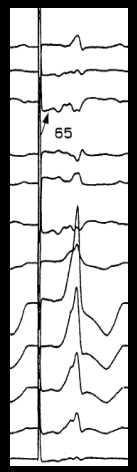
LAVA



LPs

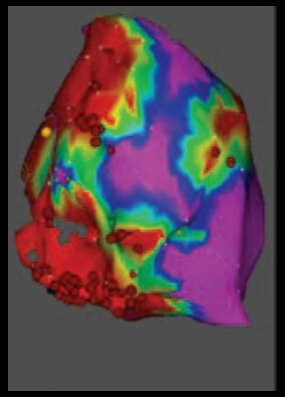


Channels



Pace mapping

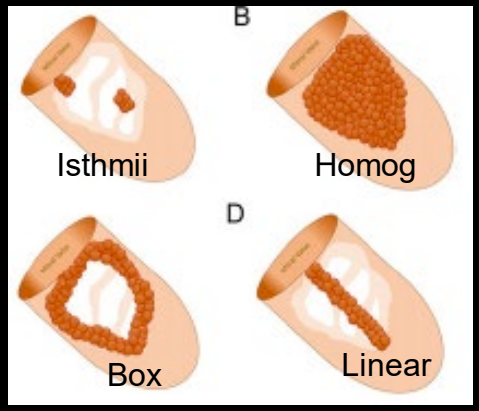
Voltage mapping



Optimal Procedural Success rate

Substrate identification

Lesion transmurality

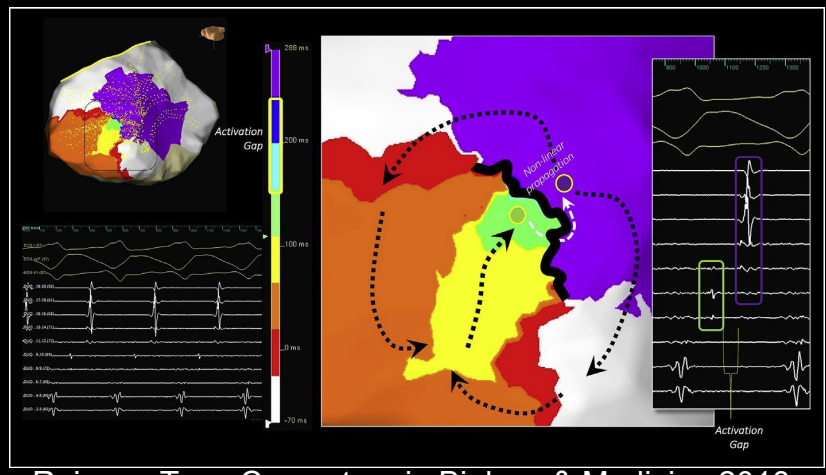


<u>MAPPING</u>
Identify underlying mechanism/substrate

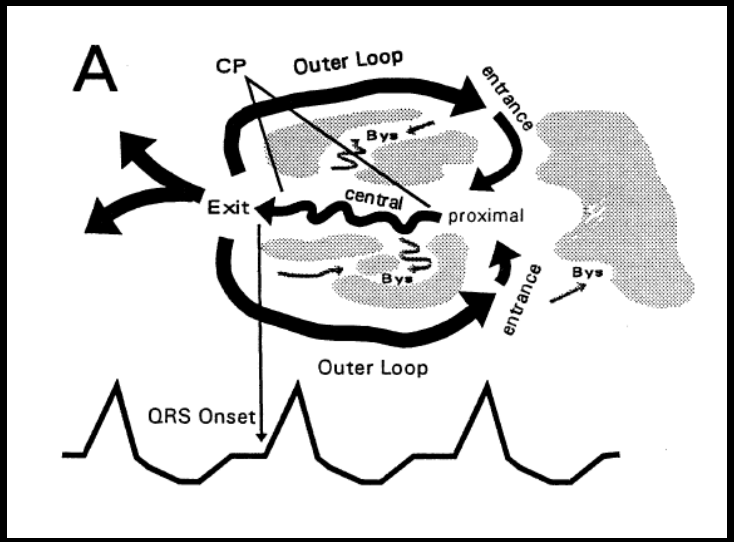
<u>ABLATION</u>
Create conduction block
(isthmii, channels, LAVA)

Mapping strategies

- Activation
  - -Long mapping times; unreliably inducibility; non-sustainability; switch from one VT to another; hemodynamic intolerance
- Entrainment
  - -unreliably inducibility; non-sustainability; switch from one VT to another; hemodynamic intolerance
- Substrate mapping emerged as predominant mapping strategy
  - -Smaller MIs, more rapid VTs
  - -NICM

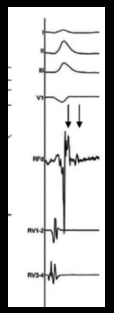


Raiman, Tung Computers in Biology & Medicine 2018



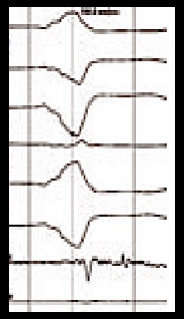
Stevenson JACC 1998

Substrate Mapping Strategies



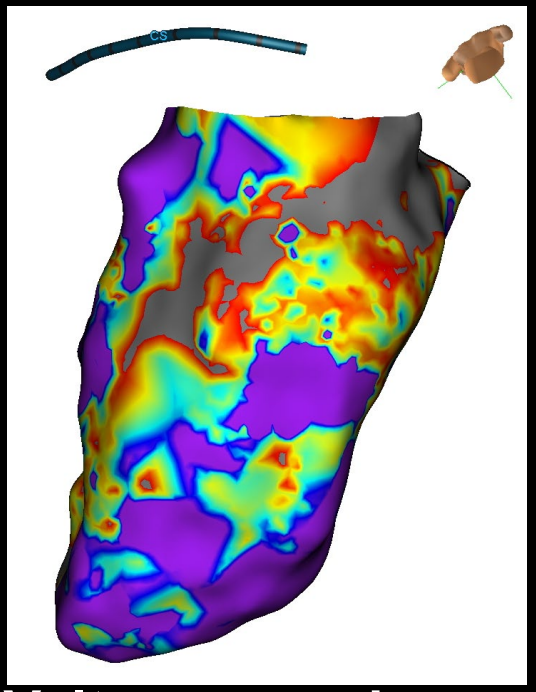
LAVA

Jais et al



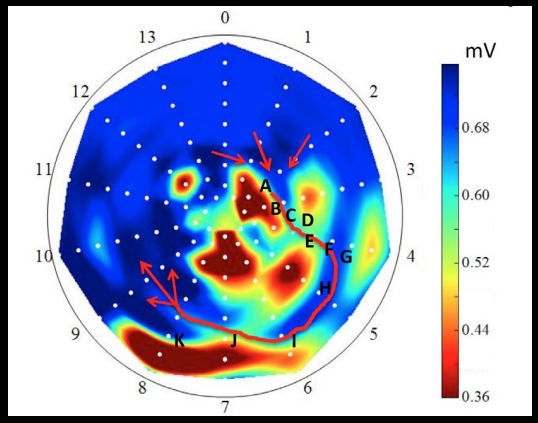
LPs

Della Bella et al

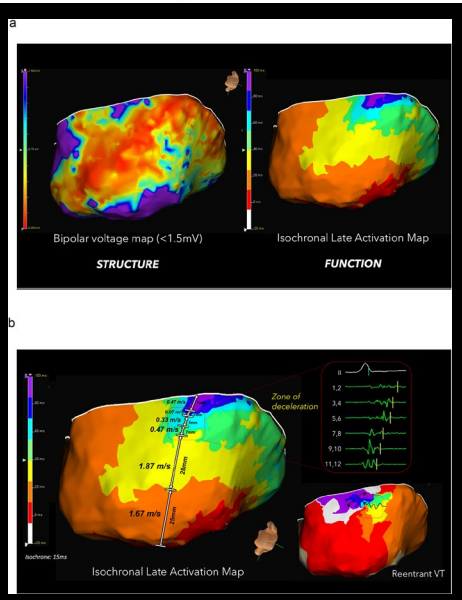


Voltage mapping

Nathakumar et al

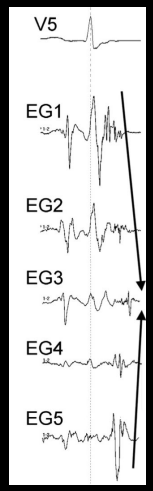


DEEP



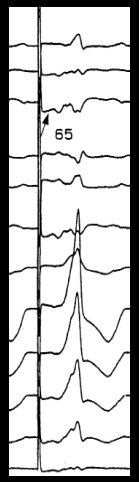
ISCHOCRONAL LATE ACTIVATION MAPPING

Tung et al



Channels

Berruezzo et al



Pace mapping

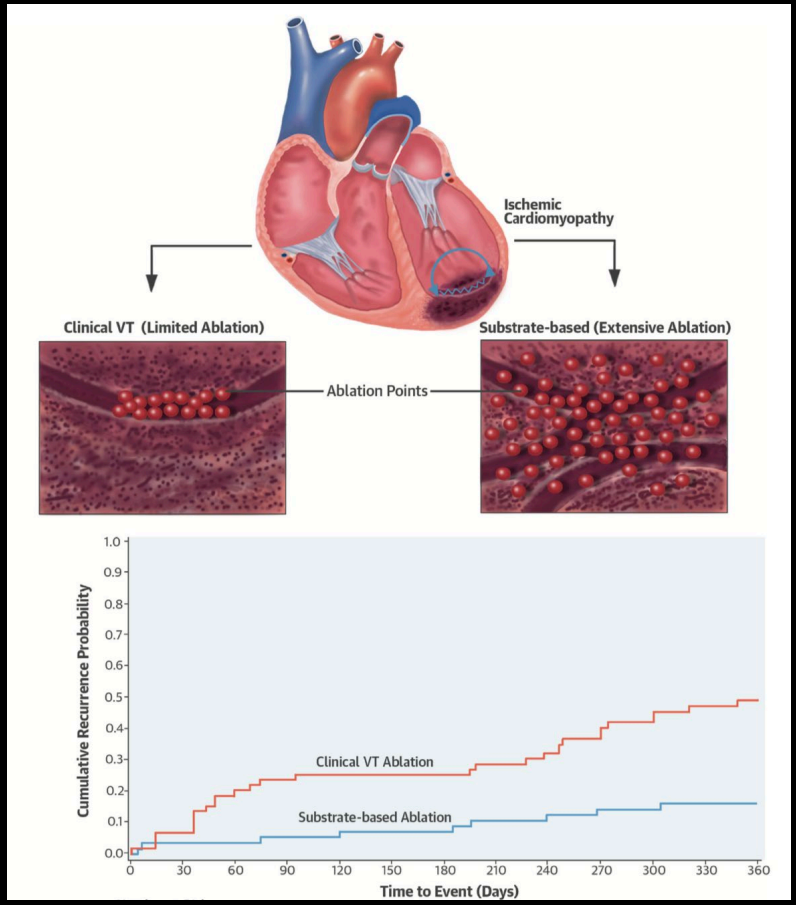
De Chillou et al

Targeted Ablation of VT Guided by Wavefront Discontinuities During SR: A New Functional Substrate Mapping Strategy

Aziz, Tung Circulation 2019

Substrate Modification

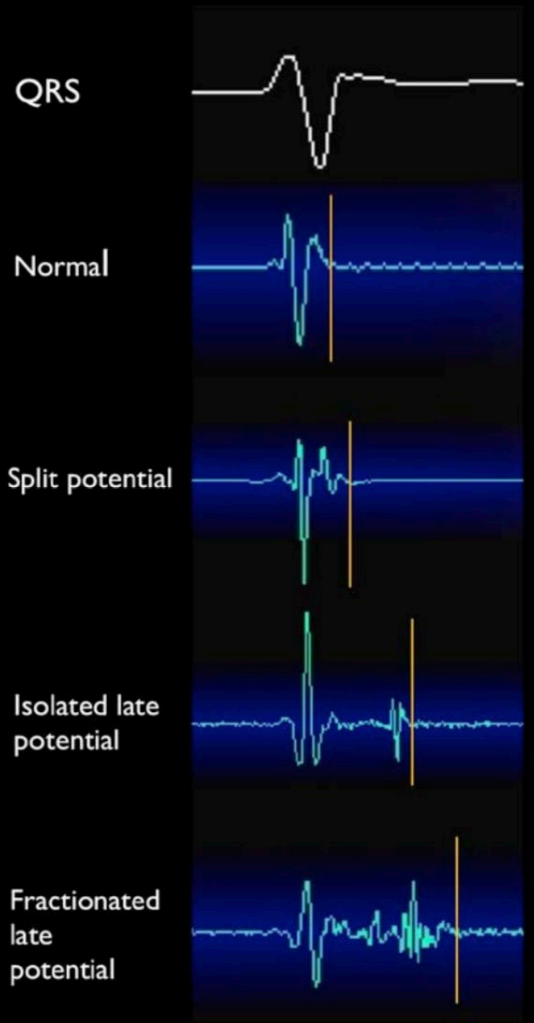
- Extensive ablation / homogenization preferred over limited ablation
- Can we limit ablation to critical VT isthmus sites?
- Can those sites be identified in SR with activation mapping?



Di Biase JACC 2015

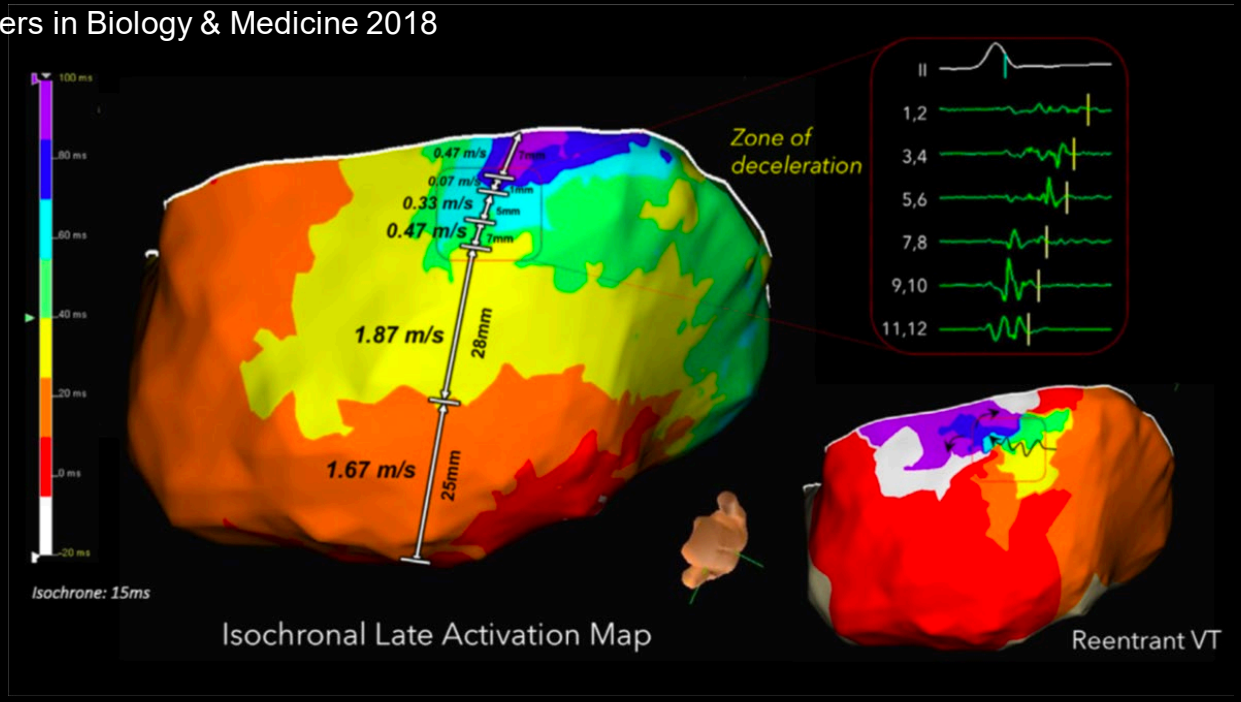
Isochronal late activation mapping (ILAM) and deceleration zones (DZ)

- Each electrogram timed at the offset of the local bipolar electrogram deflection, signifying the completion of local activation.
- ILAM constructed by manual or automated annotation of all points collected.

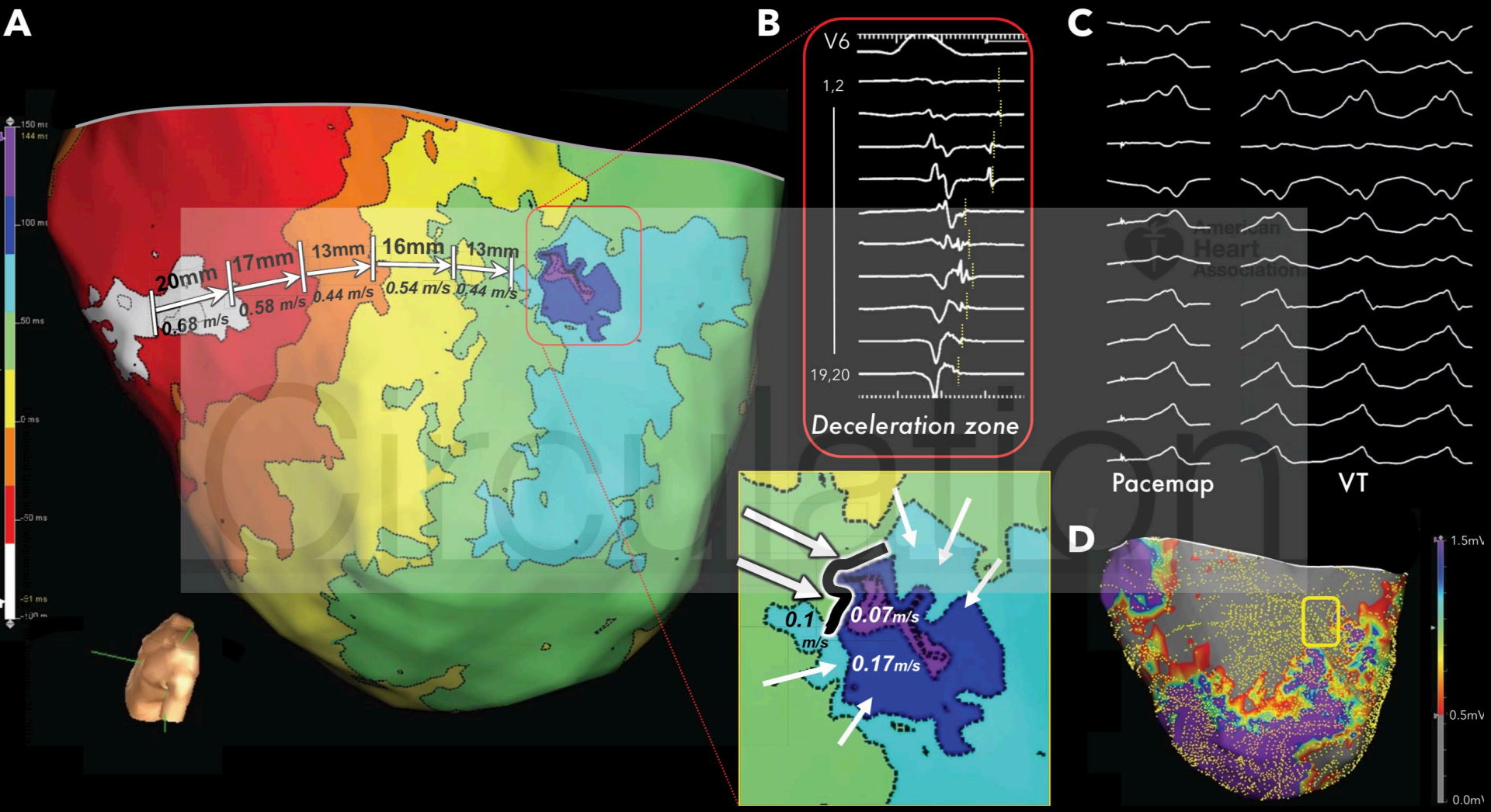


Irie CircEP 2015

Raiman, Tung Computers in Biology & Medicine 2018



- ILAM displayed with 8 equally distributed isochrones of activation (12.5% of ventricular activation comprised each isochrone).
- Deceleration zone (DZ) = regions with >3 isochrones within a 1 cm radius.
- DZ correlate with localized regions of conduction velocity slowing (<0.6*cm/s)*



localized line of conduction block - defined as a split potential with an isoelectric segment (>20ms) signifying an activation gap with reversal of isochronal activation distal to the region of slowest conduction.

Aziz, Tung Circulation 2019

Original Article

Relationship Between Sinus Rhythm Late Activation Zones and Critical Sites for Scar-Related Ventricular Tachycardia

Systematic Analysis of Isochronal Late Activation Mapping

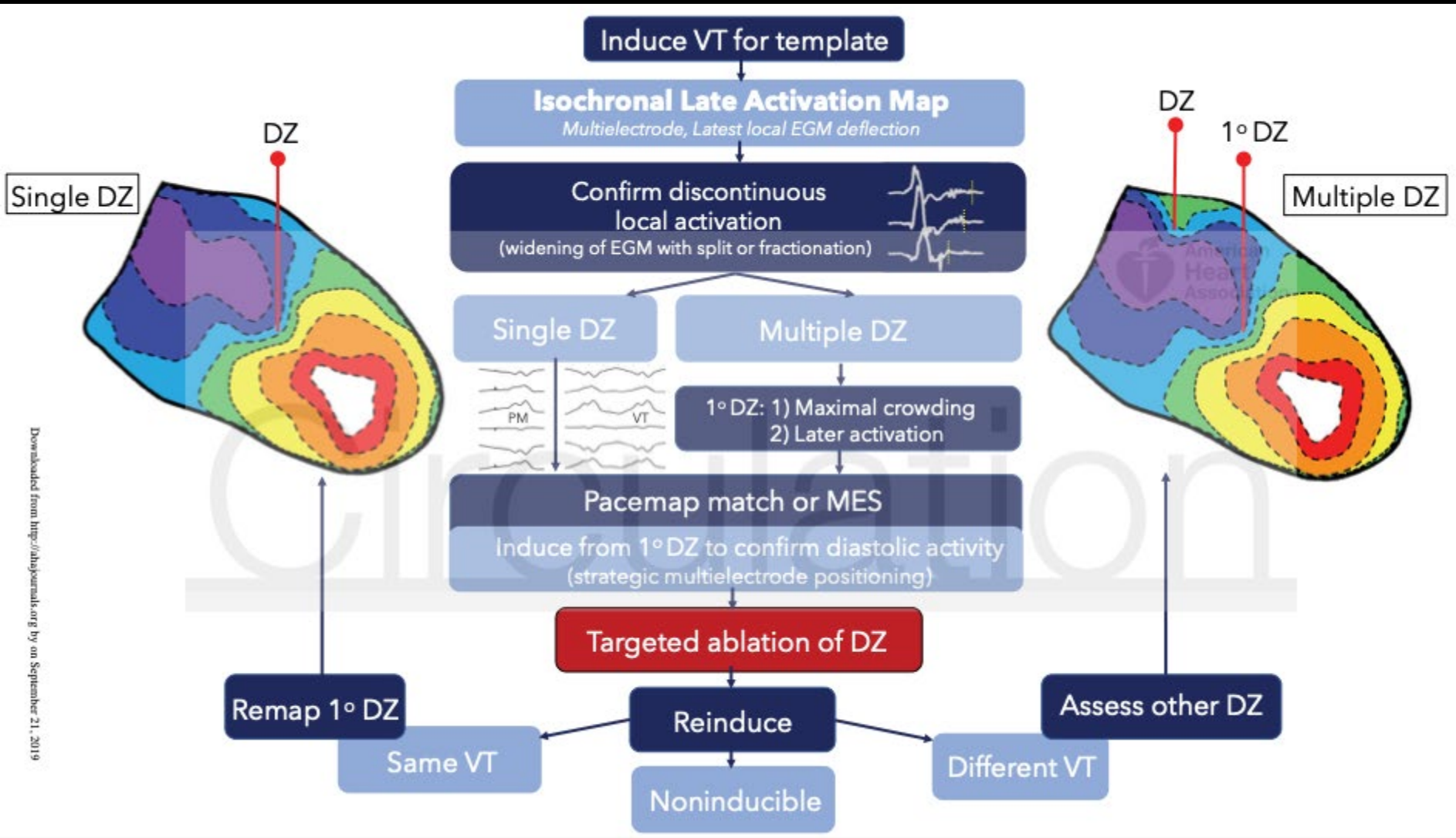
Tadanobu Irie, MD; Ricky Yu, MD; Jason S. Bradfield, MD; Marmar Vaseghi, MD, MS; Eric F. Buch, MD; Olujimi Ajijola, MD, PhD; Carlos Macias, MD; Osamu Fujimura, MD; Ravi Mandapati, MD; Noel G. Boyle, MD, PhD; Kalyanam Shivkumar, MD, PhD; Roderick Tung, MD

CircEP 2015

A strong correlation found between regions of isochronal crowding, or deceleration zones (DZ), during sinus rhythm and critical isthmus sites during VT

Study aims

- Report prospective outcomes of a novel ablation strategy guided by a voltage- independent mapping display to target DZ for the treatment of scar-related VT.
- Correlate DZ with termination sites during VT ablation to assess the strength of DZ as a mechanistic surrogate for high arrhythmogenicity.
- Demonstrate whether functional changes in wavefront propagation can be verified by remapping after targeted ablation of DZ to provide objective evidence of scar modification.



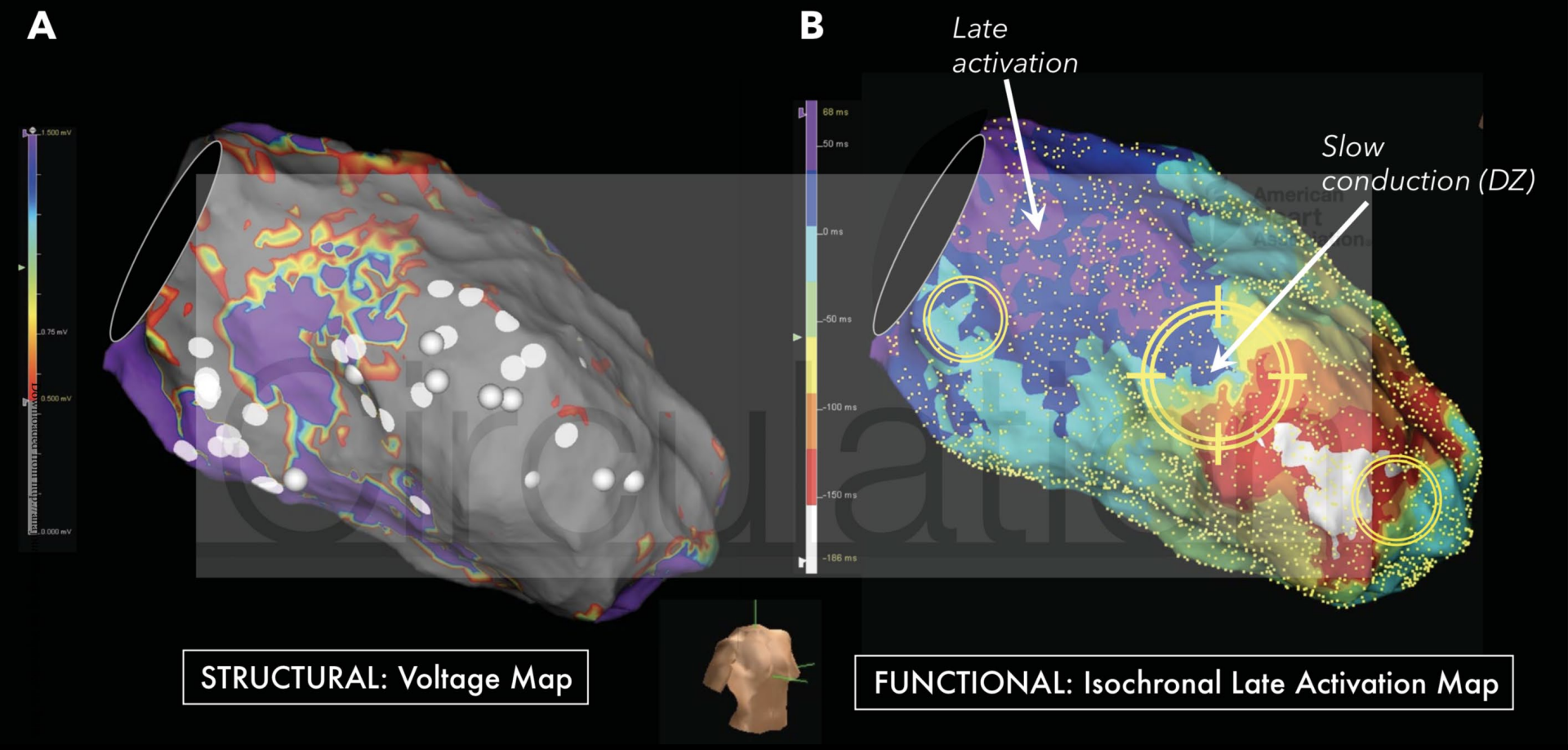
Targeted ablation, not extensive substrate modification

Baseline Characteristics

- March 2016-November 2018
- 120 pts, 144 procedures
- Median age 65 y; 15% F; median EF 31%; 46% storm, 91% BB, 49% amio; ICM 50%
- Epi access 59%
- 22% single VT; 45% ≥3 VTs inducible
- 77% NI, 9% non clinical VT inducible, 12% not tested, failure 2%
- Procedure duration 5.4±2 h

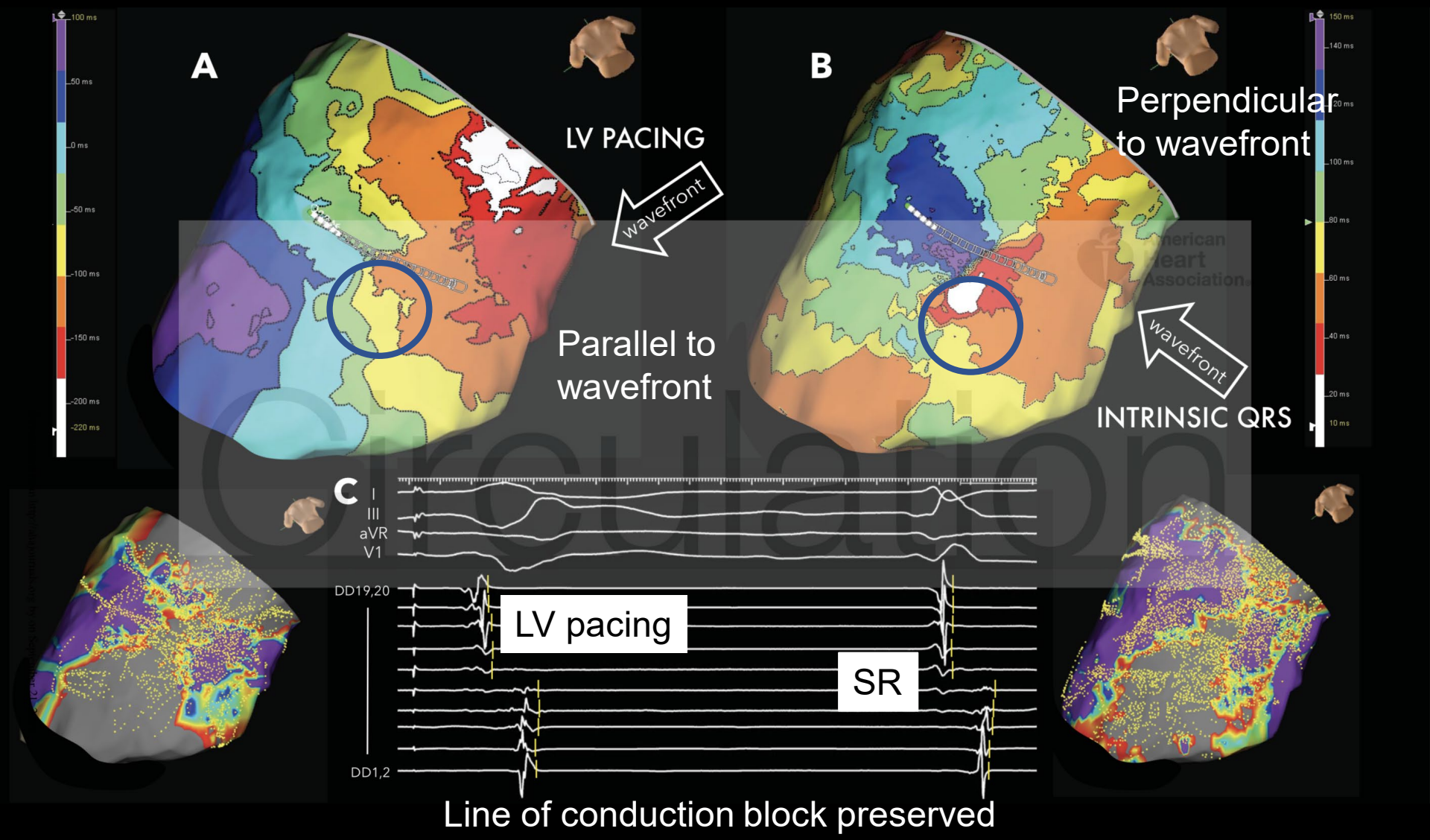
ILAM and DZ

- Median number of DZ identified was 2±1 (18% had a single DZ, 35% with 2 DZ, and 45% with >3).
- DZ were located in mixed scar (<1.5mV) tissue in 35% and in dense scar (<0.5mV) in 63%, with 2% of DZ in normal voltage (>1.5mV).



- 3 DZ identified
- Central area: slowest DZ where limited ablation performed
- Basal and apical deceleration zones targeted subsequently
- VT free 14 months' follow up

Deceleration zone conserved despite changing wavefront of propagation



DZ were conserved in the same regions in 86% during different activation wavefronts

Ablation

- Median targeted area for endocardial ablation 31.5% of the scar area (14.6% in epi)
- Ablation targets

  -Primary DZ 37% of cases

  -Additional zones 63%

  - 1 additional DZ 41%
  - 2 additional DZ 19%
  - 3 additional DZ 3%

Correlation of DZ to critical VT sites

- DZ correlated with

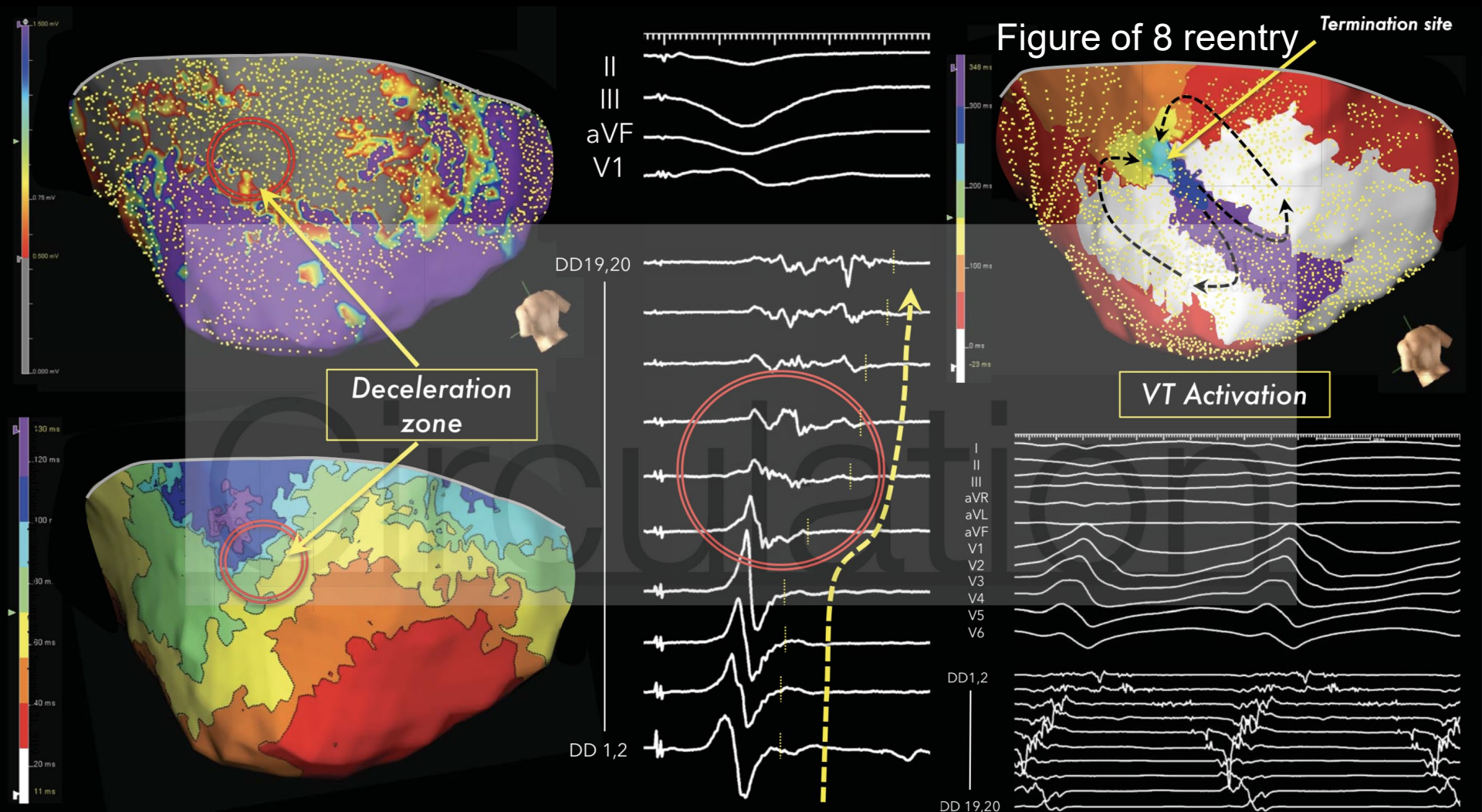
  Optimal PM sites (>10/12) 92%

  Co-localised to VT termination sites 95%

  Entrainment with concealed fusion 63%

  Median time to VT termination 11.5s

DZ co-localized to VT isthmus

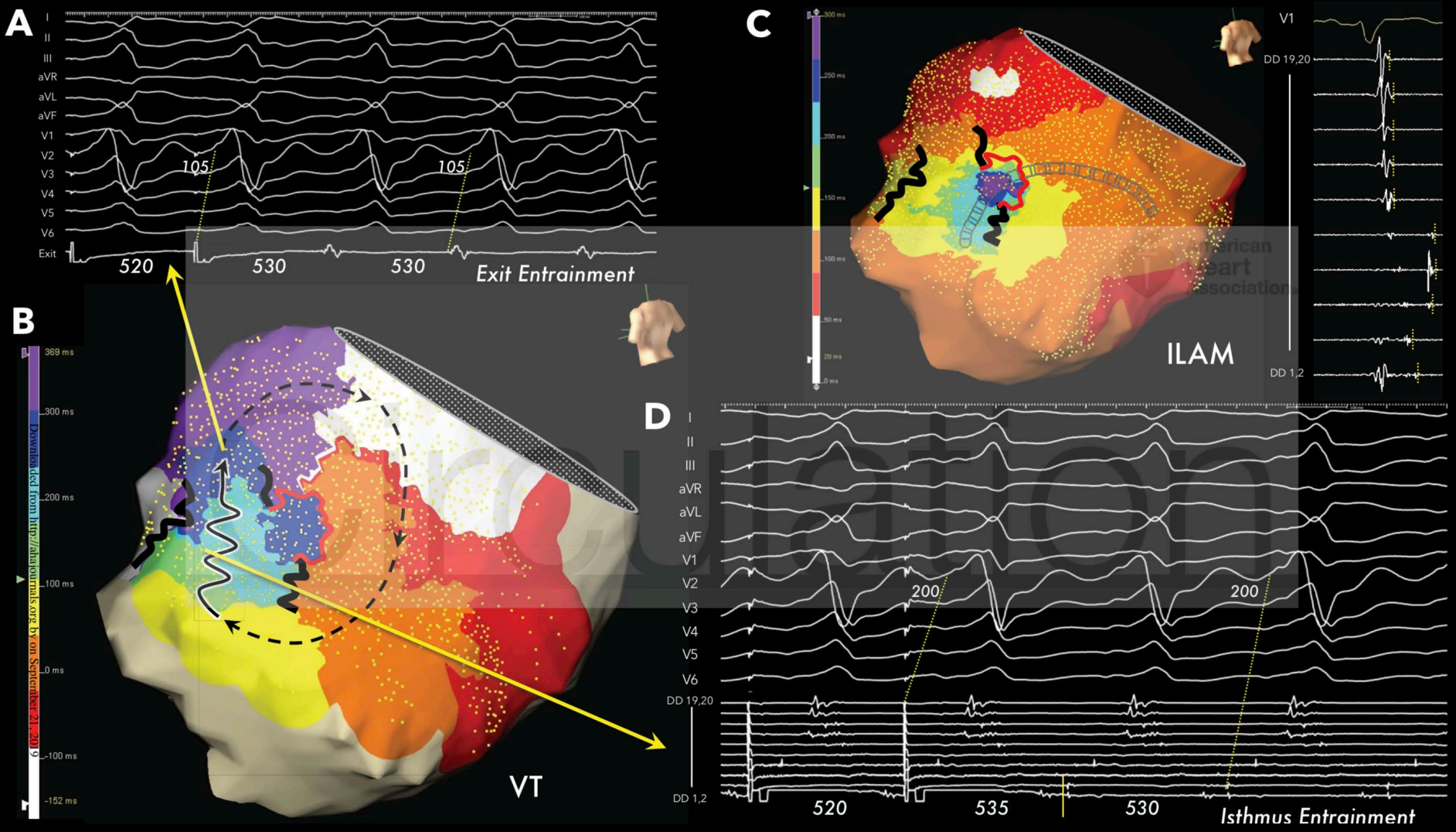


5 isochronal colors crowded

Abrupt conduction slowing

Entire diastolic pathway during VT

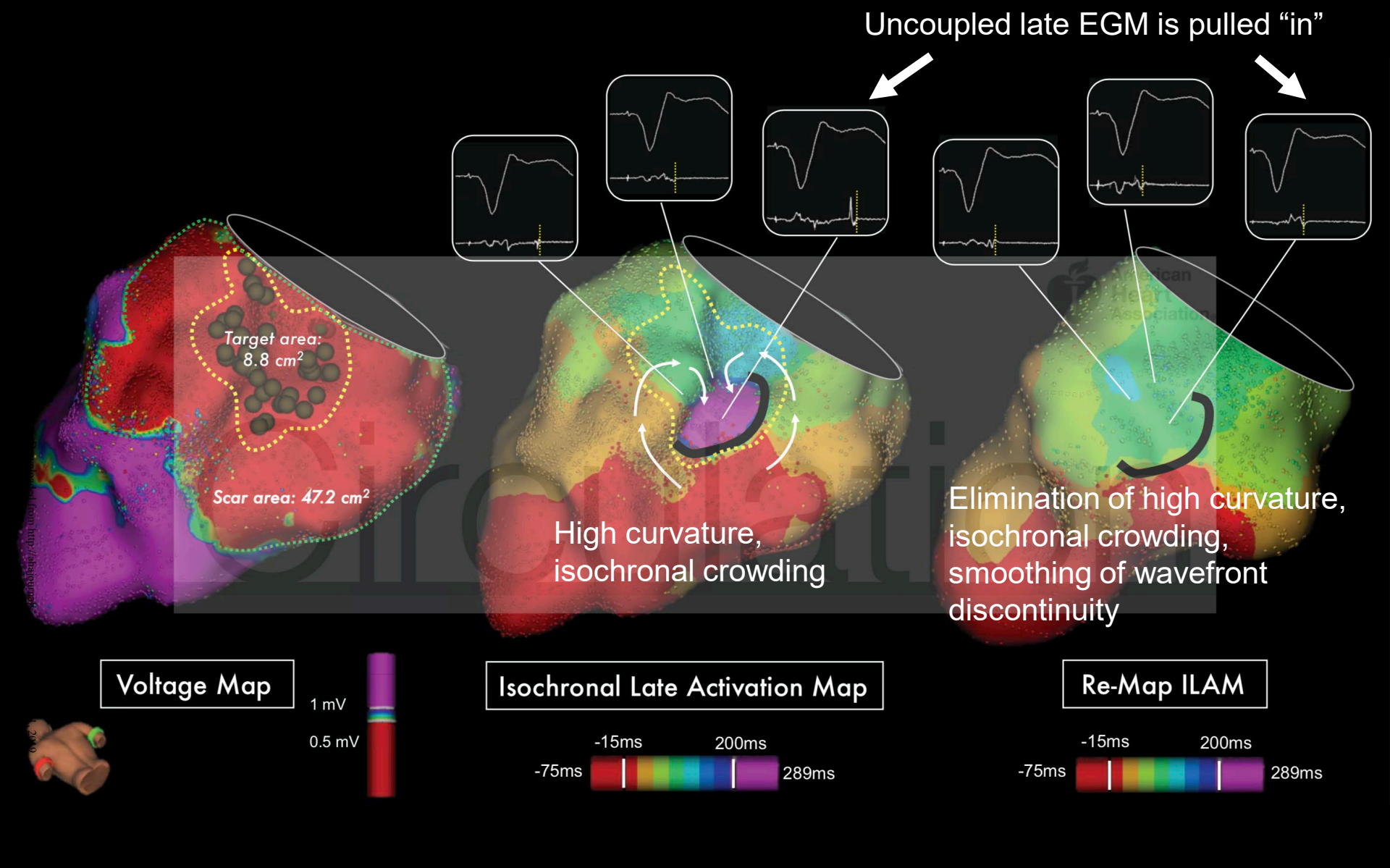
DZ

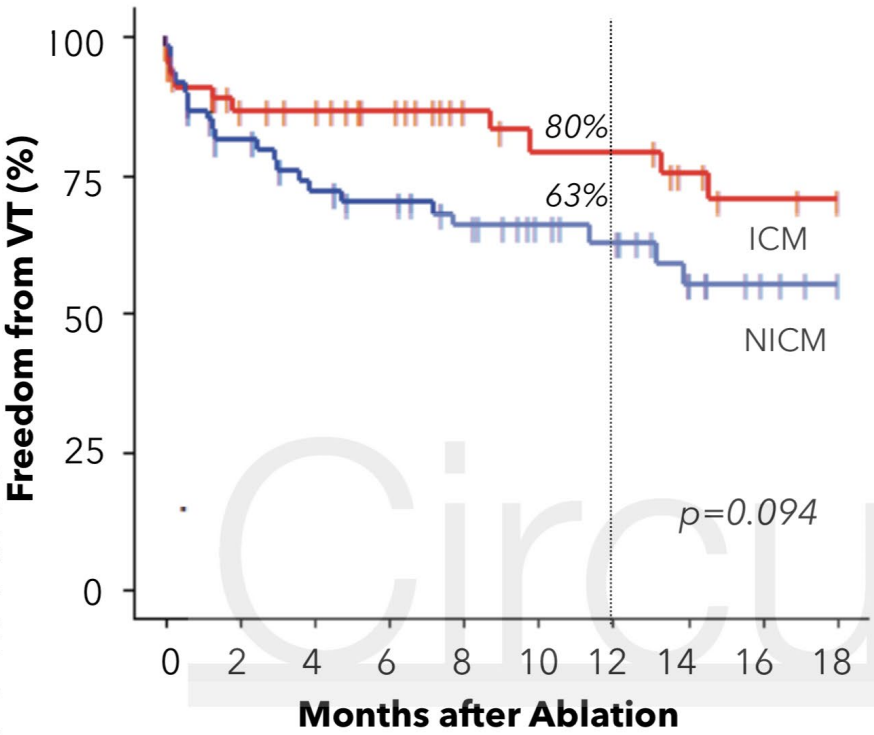


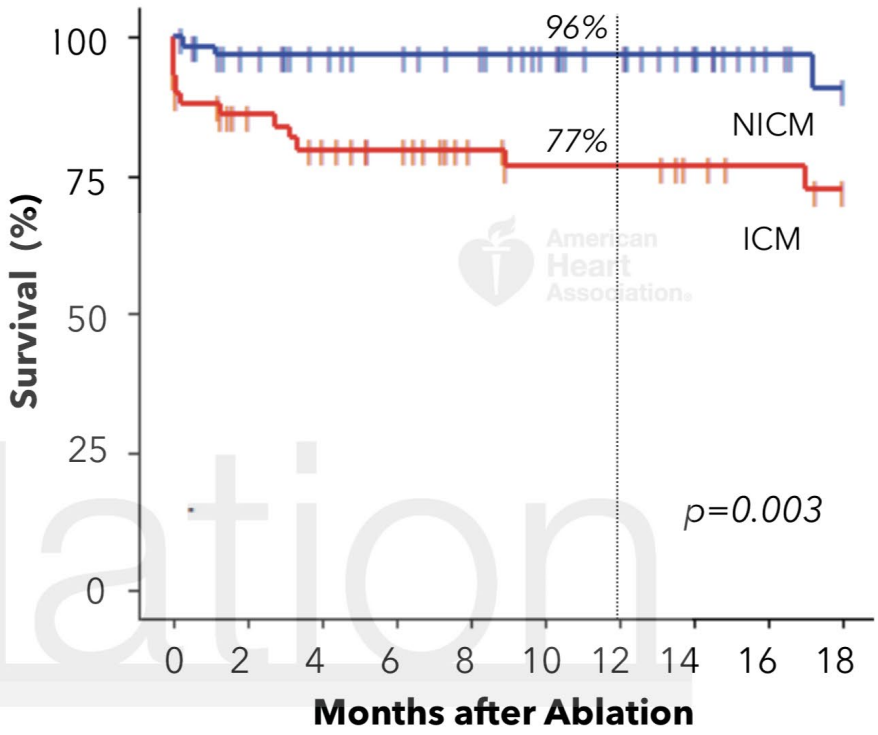
Epicardial Activation map

Entire diastolic pathway evident

Remapping post ILAM ablation: objective physiological evidence of scar modification







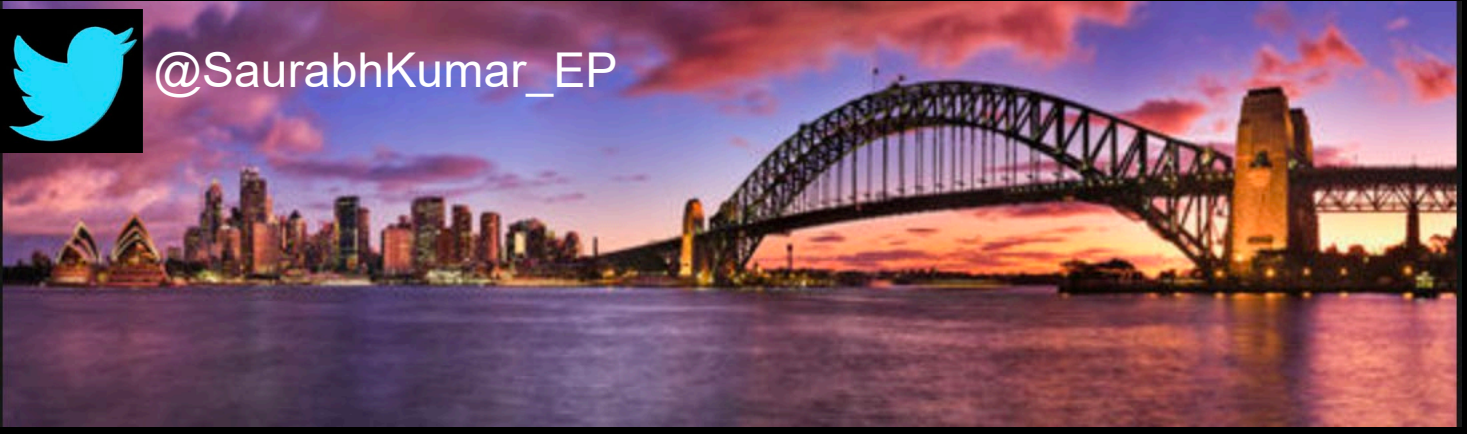
VT free survival at 12 months 70% ICM vs NICM (80% vs 63%; p=0.094)

Overall mortality 12%; ICM vs NICM (77% vs 96%; p=0.003)

Complications 8%; mortality 1.2%

Conclusions

- Voltage-independent functional mapping during is:
  - -Feasible, effective in identifying critical VT sites in scar
  - -Allows targeted ablation, eliminates need for extensive ablation
- DZ strongly predictive of critical sites for re-entry
- Remapping of DZ showing a functional change in propagation provides objective physiologic evidence of scar modification.
- Ablation times comparable to ‘control arms’ of homogenisation strategy but VT free survival comparable to homogenisation arm



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Dr Robert Anderson (Uni of Melb)
Dr Jonathan Ariyaratnam
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Josh Hawson (Un of iMelb)
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