Te Whatu Ora
Health New Zealand
Te Toka Tumai Auckland

Evolution of AF Ablation

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Atrial Fibrillation

- In NZ 1:20 people >55 will be diagnosed with AF
- Māori/Pasifika develop AF 10 years younger and outcomes are worse
- AF results in:

  - palpitations, exertional intolerance, diaphoresis, shortness of breath, fatigue, anxiety/depression

  - atrial dilatation, myocardial fibrosis, functional mitral regurgitation, heart failure, stroke, increased mortality

1981 – Mel Scheinman

- AV node ablation with catheter-based DC ablation

”It was very quick, but the resultant heart rate was quite slow. He required a pacemaker”

- 7% life-threatening complication rate

1987 – COX MAZE

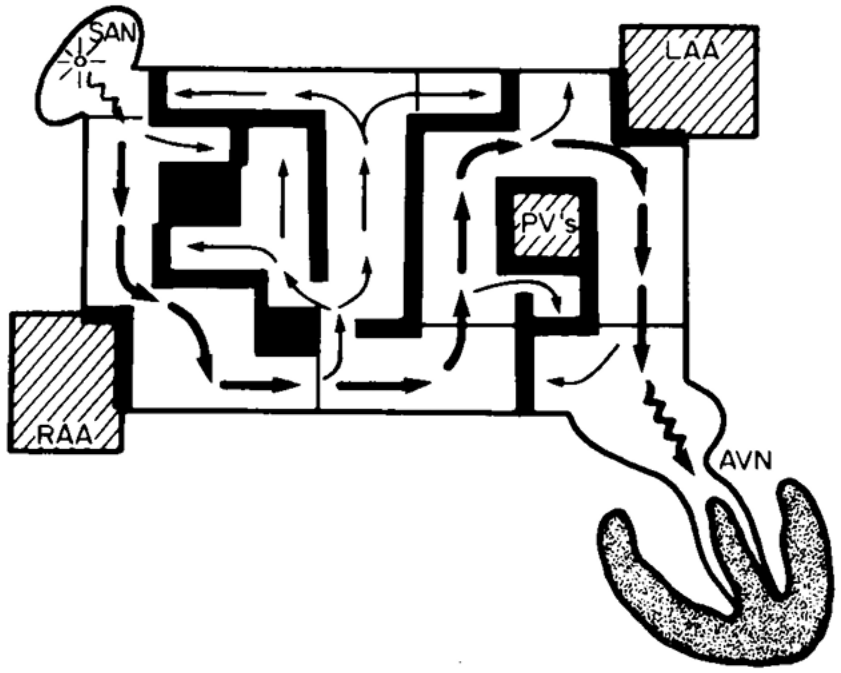


Fig. 9. Maze procedure for atrial fibrillation. Because atrial fibrillation is characterized by the presence of multiple macroreentrant circuits that are fleeting in nature and can occur anywhere in the atria, a surgical procedure based on the principle of a maze was developed. Both atrial appendages are excised and the pulmonary veins are isolated. Appropriately placed atrial incisions not only interrupt the conduction routes of the most common reentrant circuits, but they also direct the sinus impulse from the SA node to the AV node along a specified route. The entire atrial myocardium (except for the atrial appendages and pulmonary veins) is electrically activated by providing for multiple blind alleys off the main conduction route between the SA node and the AV node, thereby preserving atrial transport function postoperatively. For abbreviations see Fig. 2.

Michel Haissaguerre 1998

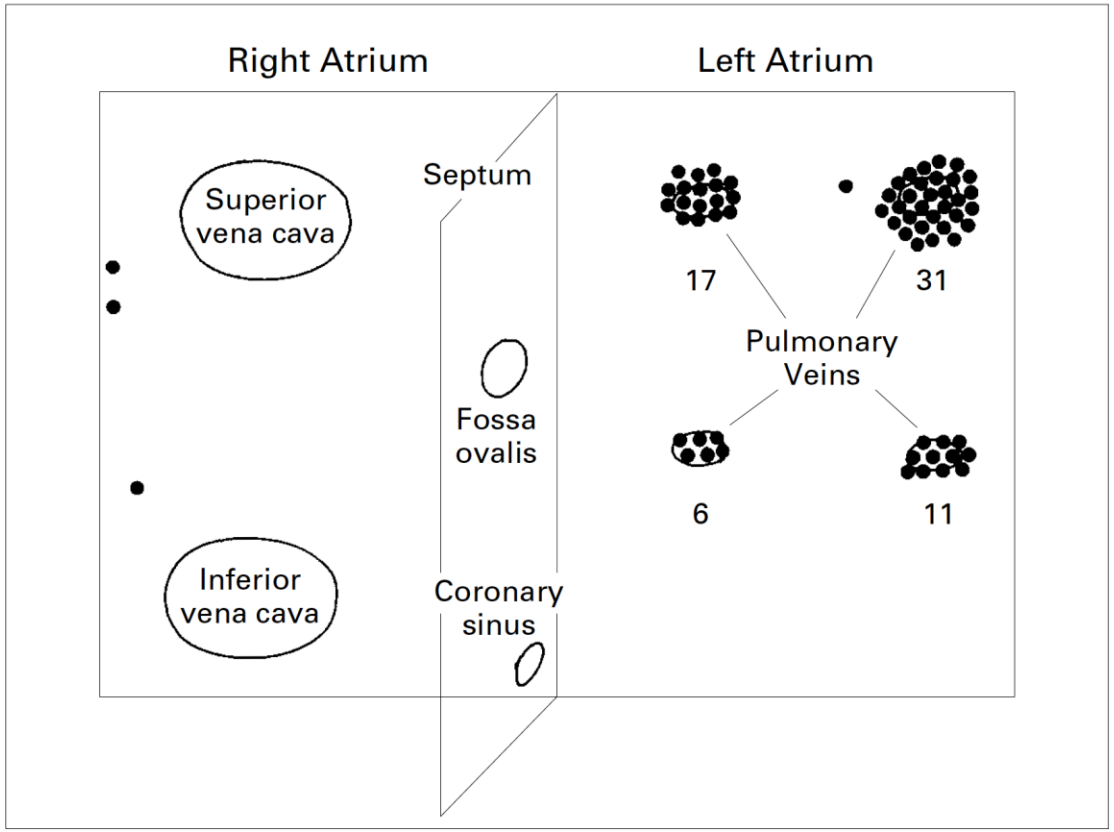


Figure 1. Diagram of the Sites of 69 Foci Triggering Atrial Fibrillation in 45 Patients.
Note the clustering in the pulmonary veins, particularly in both superior pulmonary veins. Numbers indicate the distribution of foci in the pulmonary veins.

Radiofrequency Catheter Ablation

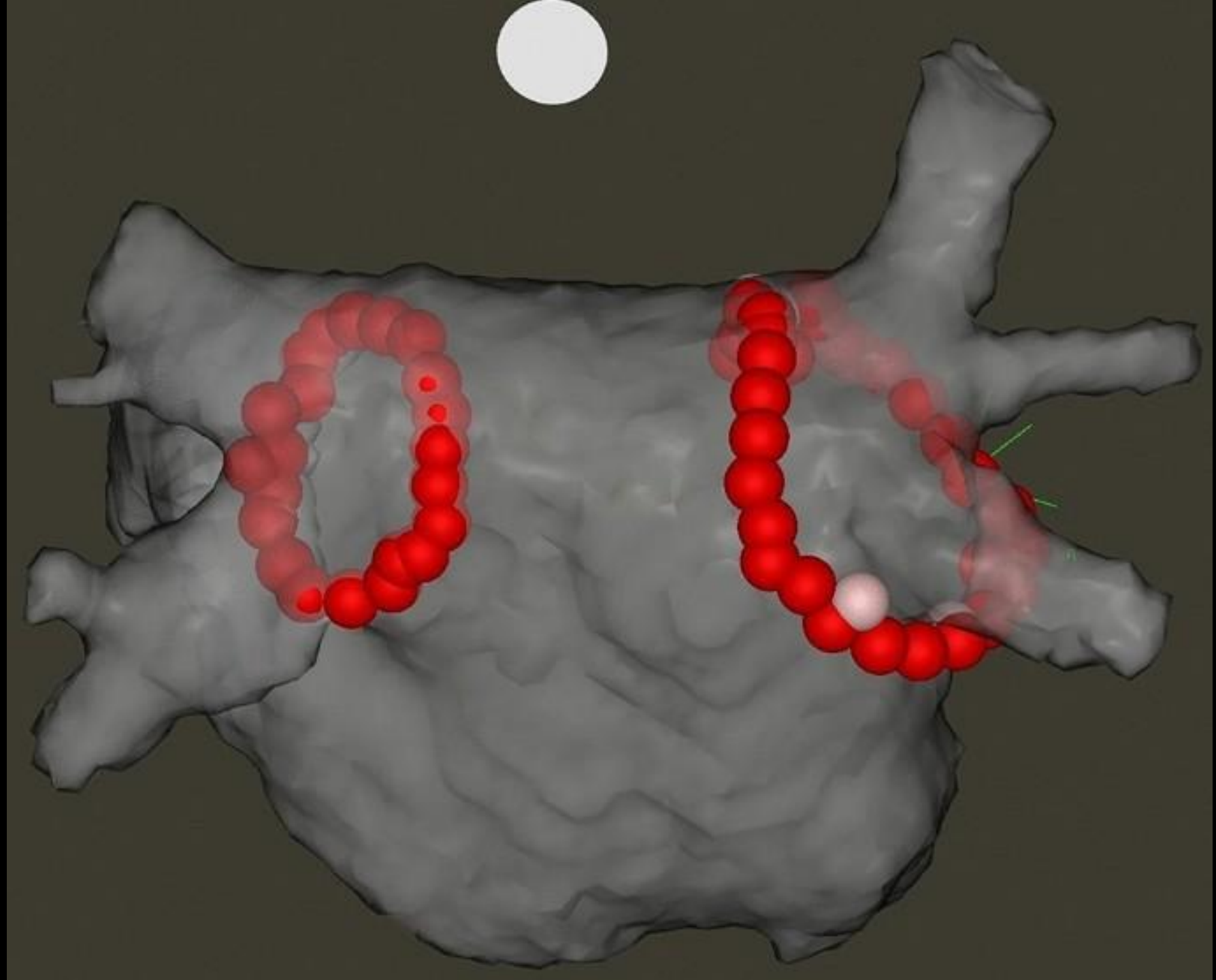
- Mechanism: High-frequency AC energy application generating thermal injury. Results in coagulative necrosis and scar formation.
- Best suited for complex substrate modification
- Time-intensive: Point by point approach requires prolonged procedure time, especially in persistent AF.

- Evolution:
  - Non-irrigated catheter, low power ablation
  - Irrigated catheters
  - Contact force sensing
  - Mapping technology

- Potential for complications: Oesophageal injury, phrenic nerve damage, steam pops, pulmonary vein stenosis.

AF Ablation Targets

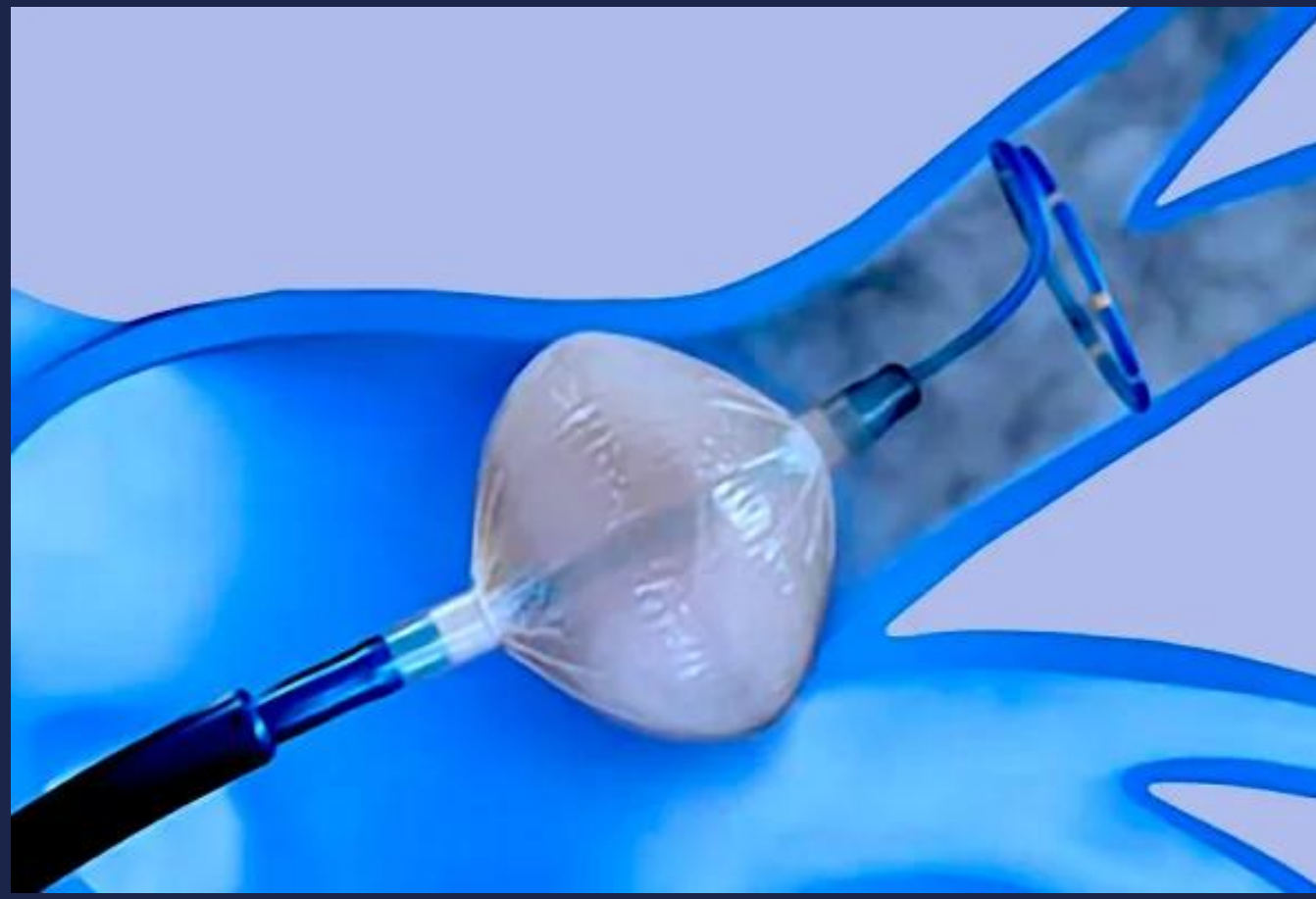
- Focal trigger ablation
- Ostial PV isolation
- Wide Antral Catheter Ablation – WACA
- Complex Fractionated Atrial Electrograms – CFAE
- Linear ablation
- Substrate homoginisation
- Vein of Marshall alcohol ablation
- Ganglionic plexi ablation



Cryo-balloon ablation - 2010

- Mechanism: Rapid cooling creates ice crystals, disrupting cell membranes and causing apoptosis.
- Advantages: Technically easier, GA not required. Reduced procedure time
- Common complications: Phrenic nerve palsy
  - 2-10%

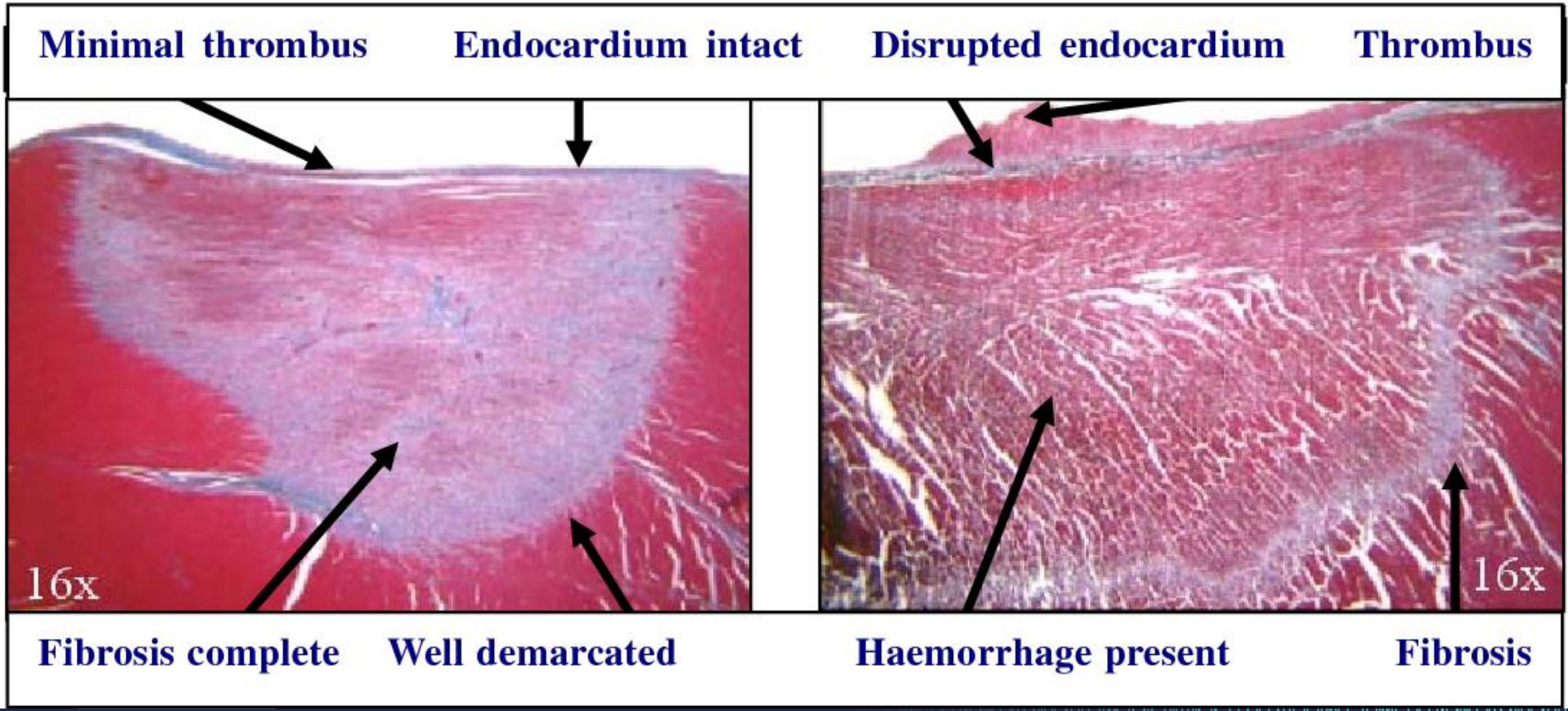
- Lower durability in cases of complex substrates or non PVI ablation



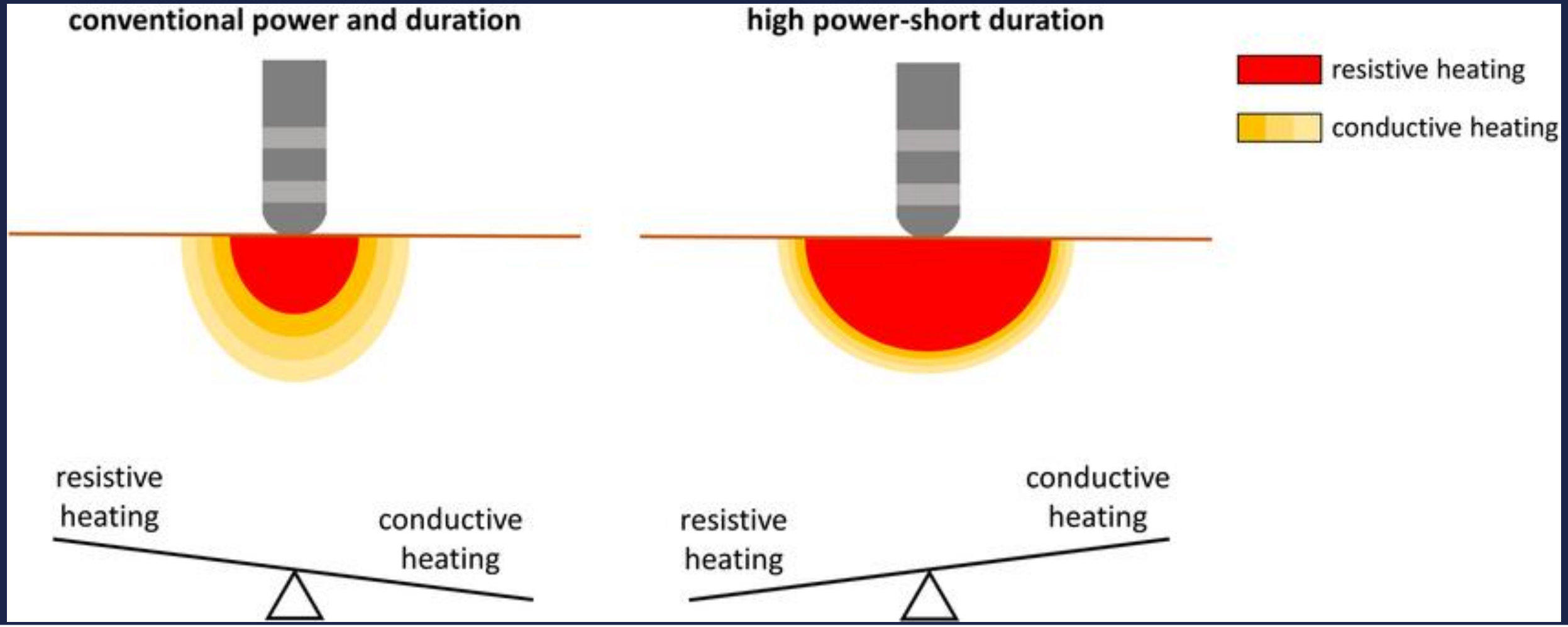
References:
•Gaita F et al., Circulation, 2000.
•Andrade JG et al., Europace, 2020.
•Chierchia GB et al., Europace, 2009.

Cryo

RF


Minimal thrombus
Endocardium intact
Disrupted endocardium
Thrombus
16x
16x
Fibrosis complete
Well demarcated
Haemorrhage present
Fibrosis

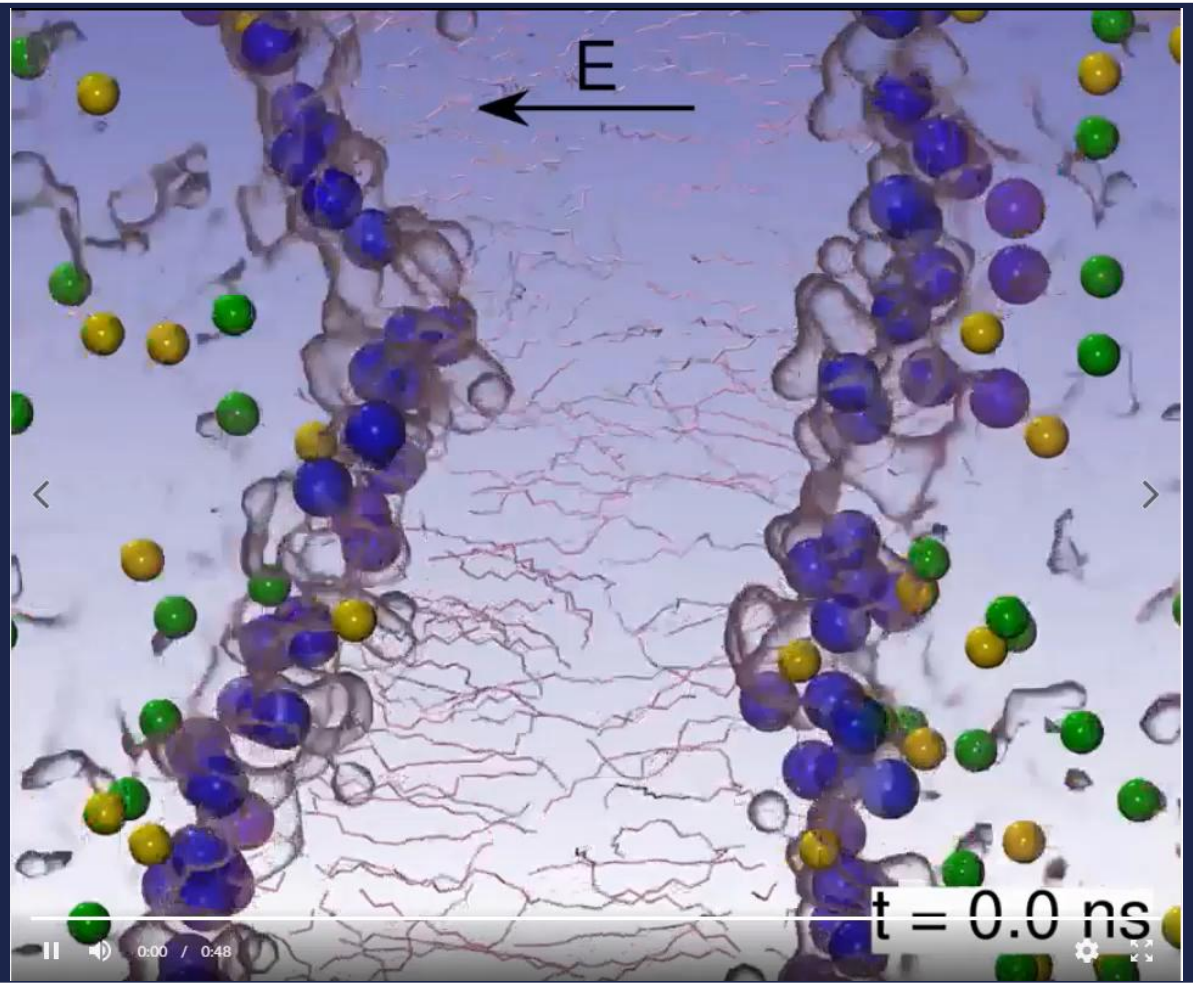
High Power Short Duration (HPSD)



Pulsed Field Ablation – 2021/2024

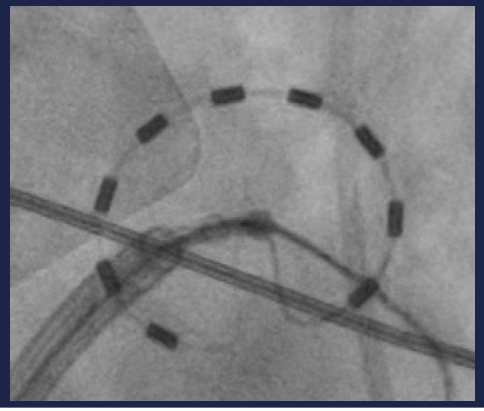
- PFA is a minimally thermal method of tissue ablation technology that utilizes high-amplitude pulsed electrical fields to create irreversible electroporation.
- Unlike thermal ablation technologies, PFA does not rely on heating to damage and destroy tissue.
- PFA creates nanopores in cell membranes due to transient, high-voltage (1,500-4,000V) exposure that disrupts cell wall integrity, which leads to cell death.

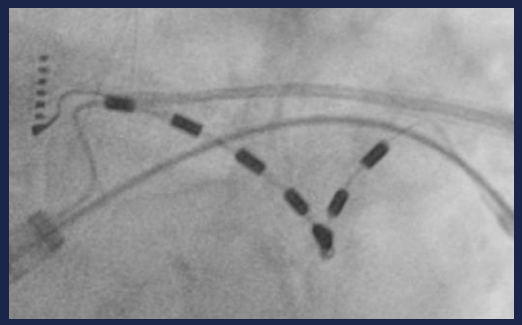
Pulsed Field Ablation Application



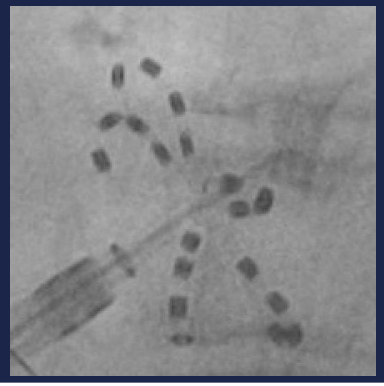
Systems

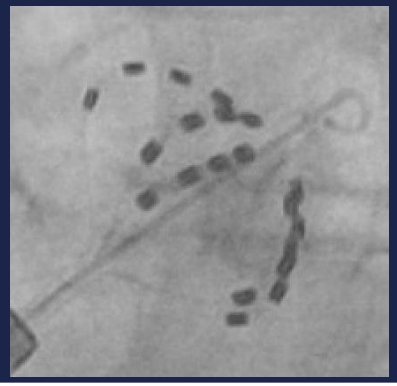
- PulseSelect (Medtronic)
  - 137 cases
  - Circular catheter
  - 2 catheter shapes: semi-circle and spiral

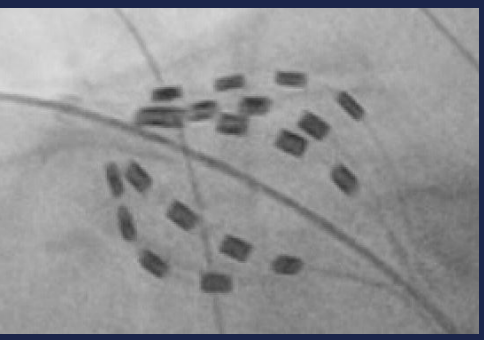




- FaraPulse (Boston Scientific)
  - 187 cases
  - Pentaspline catheter
  - 3 catheter shapes flower, basket and olive







Pulsed Field Ablation

Benefits

- Tissue selectivity
- Essentially no risk of:
  - Oesophageal injury
  - Phrenic nerve palsy
  - Pulmonary vein stenosis
- Faster procedures – 30 mins
- ‘Single catheter’ procedure

Drawbacks

- Intense vagal reaction
- Painful during energy delivery
- Coronary spasm
- Haemolysis (recommended to limit to 75 applications with Farapulse and 120 with Pulse select).

Boston Scientific – Farapulse

- Variable distal shapes (flower, basket & olive) - which helps with varying patient anatomies
- Two sizes – 31 mm & 35 mm
- Thumb activated slider
- 16.8 Fr sheath (clear shaft)
- 12 Fr catheter shaft

Pros / cons of Farapulse

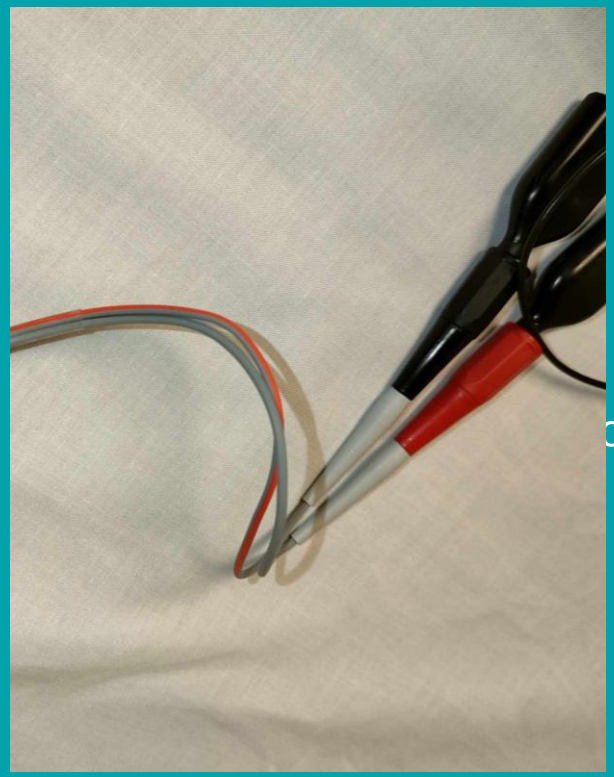
Advantages

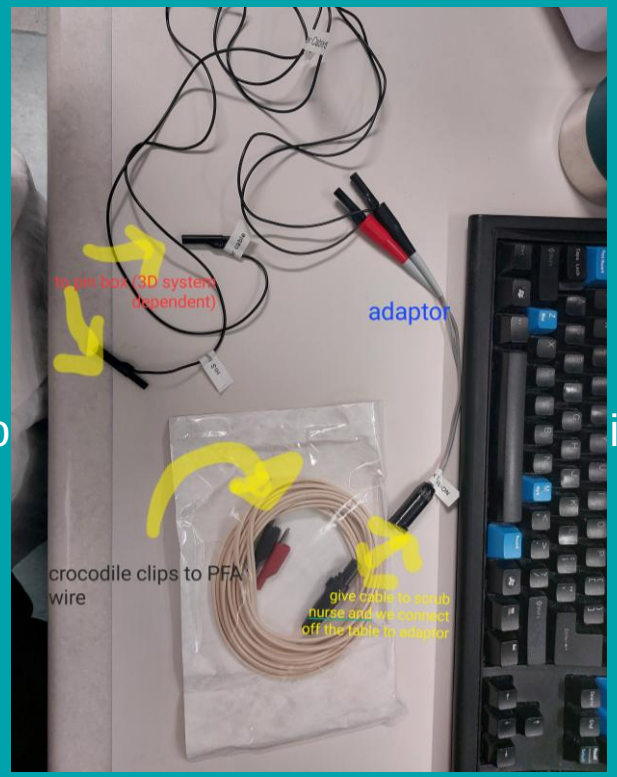
- Three configurations
- See-through sheath
- Counts applications

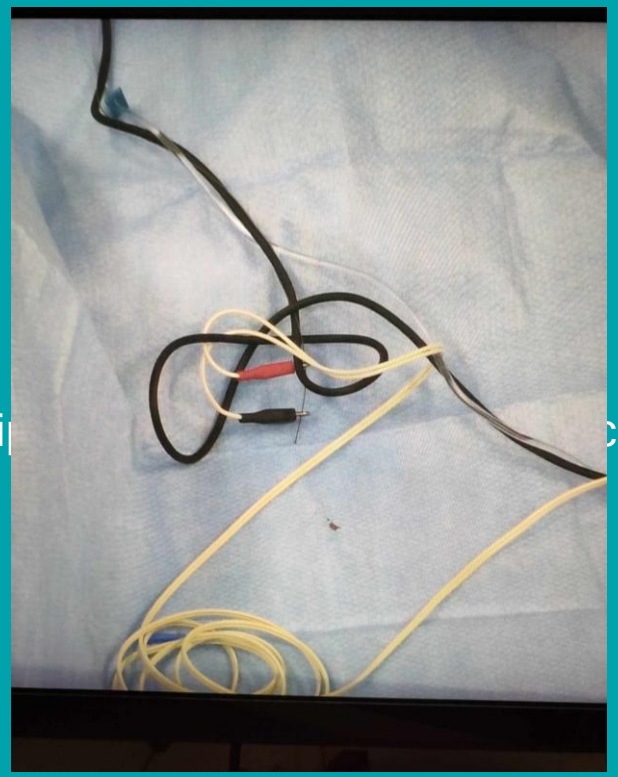
Disadvantages

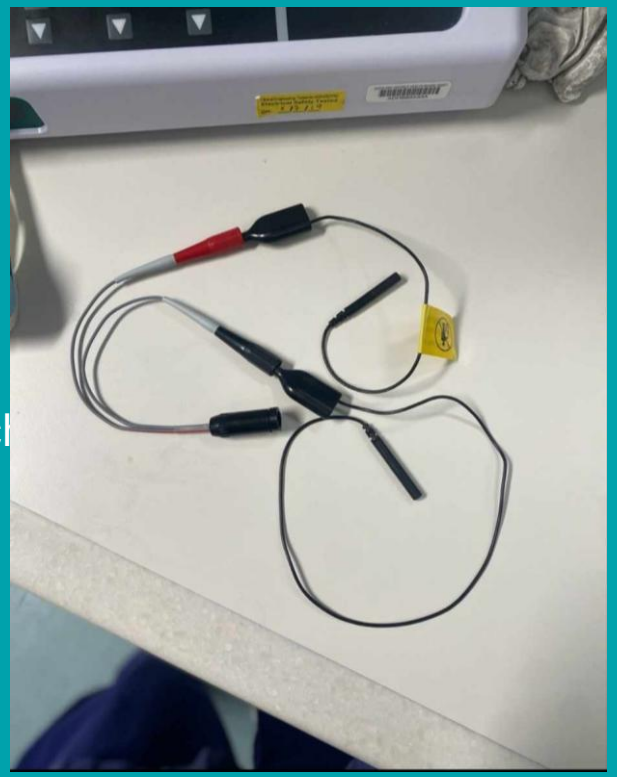
- Bulky system with Console + isolation unit
- Having to put all catheters via isolation unit
- ECG jumpers
- Specific wire (tissue biopsy issues and getting wedged in sheath with other wires)
- Unable to collate total applications per vein or get a total time (however collates total applications)
- Haemolysis – if applications exceed 75
- Swamps Claris system stopping the ability to pace. Unsure of its effect on other Pacing systems.

Wire Visualisation









Wire visualisation

Medtronic – Pulse Select

- 9 electrodes that sense, pace and ablate
- 25 mm loop – 2 shapes, semi-circle & spiral
- Fixed electrode spacing (consistent contiguous energy delivery)
- 20-degree forward tilt to ensure more consistent uniform tissue contact.
- R-wave gated
- 9Fr catheter shaft
- Two Sheath tip sizes available (13 mm & 20 mm tip) to help with variation in anatomy
- FlexCath Contour sheath 10 Fr

Pros / cons of Pulse Select

Advantages

- No isolation unit (no ECG jumpers or isolating of catheters).
- Remote / hand controls – we can relax (also helps those doctors with control issues)

Disadvantages

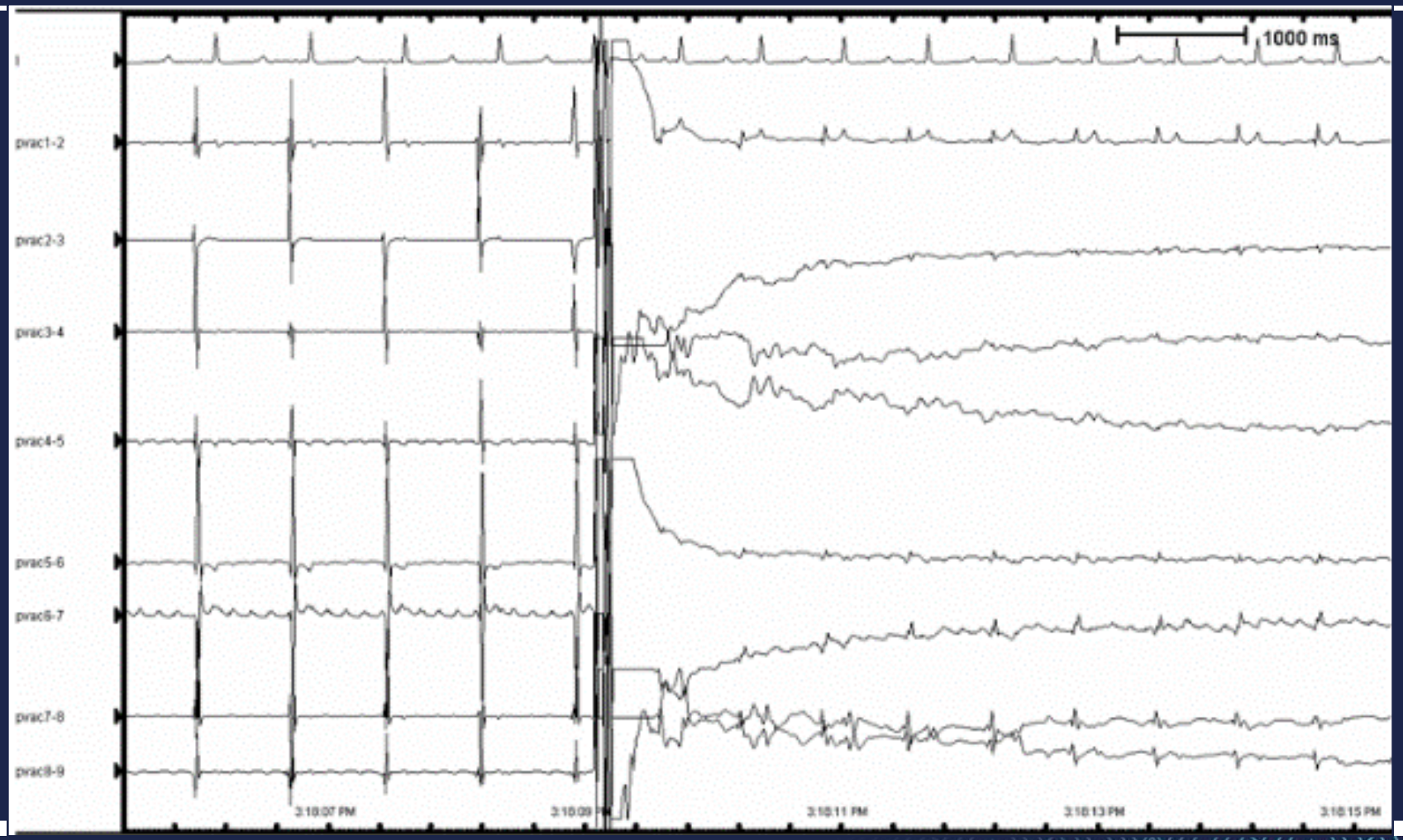
- Learning curve for some Physicians – difficult handling of catheter / knowledge of location.
- Care is needed in mitral valve area
- Doesn't count applications
- Ivy – R-wave gating - Does not work if R-wave small, ECG artifact or PM implant. Can be quite tedious if HR is slow.

(Can turn function off for fixed rate)

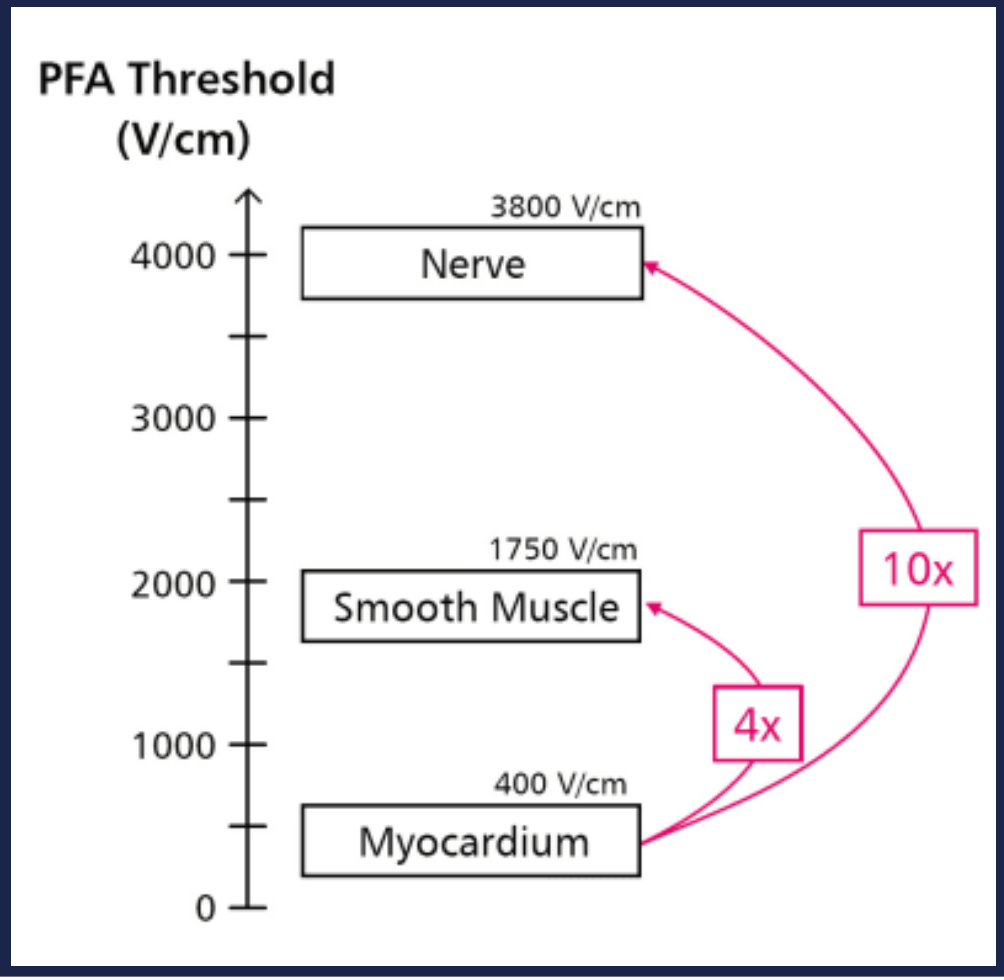
PFA Approach

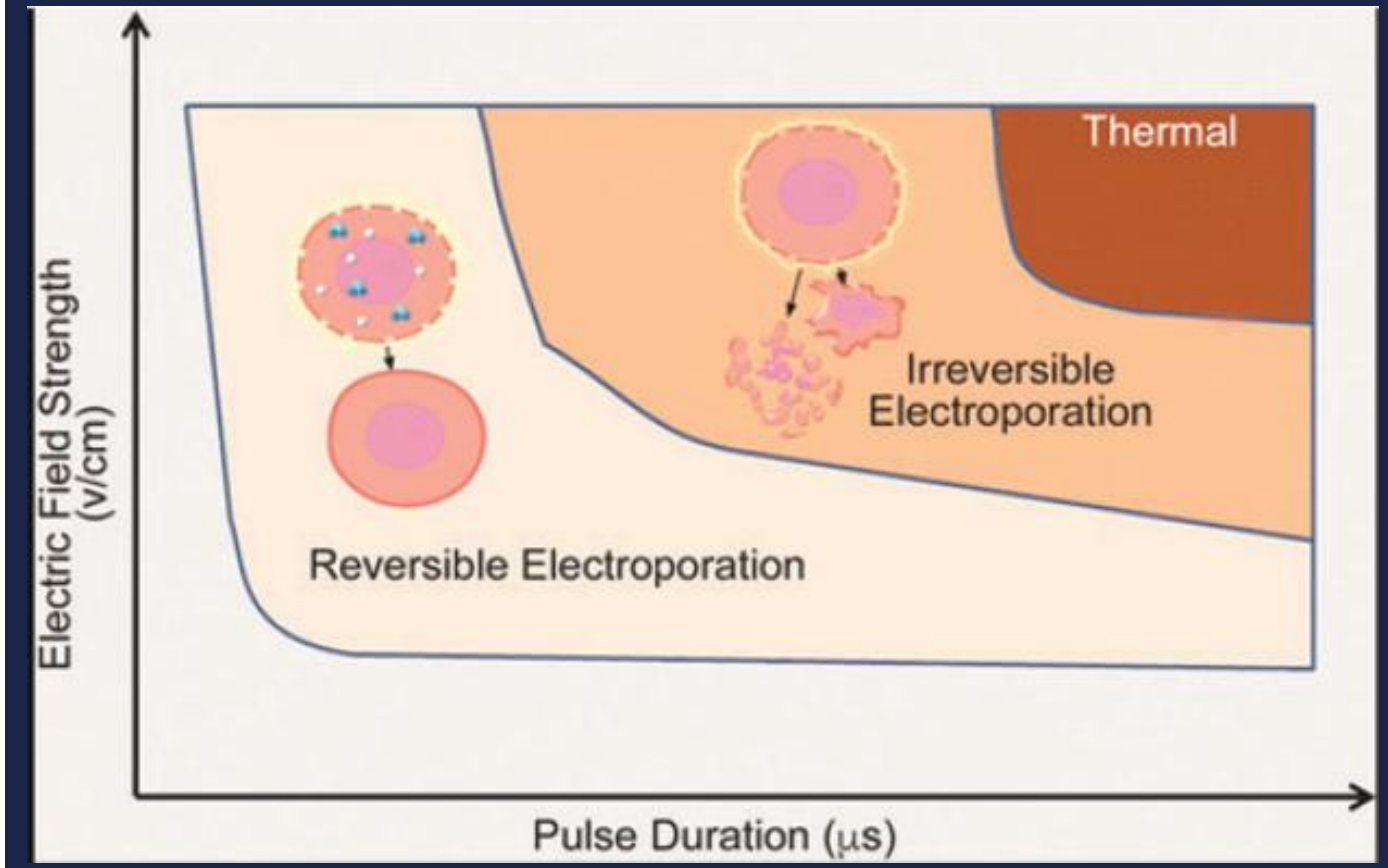
- Transseptal (puncture from RA to LA)
- Specific wire use – with visualisation of wire on 3D mapping system.
- Map with PFA catheter
- Heparin / Atropine
- Farapulse - Ideally a minimum of 8 applications per vein. 4 in Basket configuration, 4 in flower (Each packet is 2.5 sec in duration)
- PulseSelect – Recommendation of 12- 15 applications per vein (each packet is 0.64 sec)
- Can PFA LA back wall – applications per vein with slight adjustments per application.

Pulsed Field Ablation Application



Threshold for irreversible electroporation



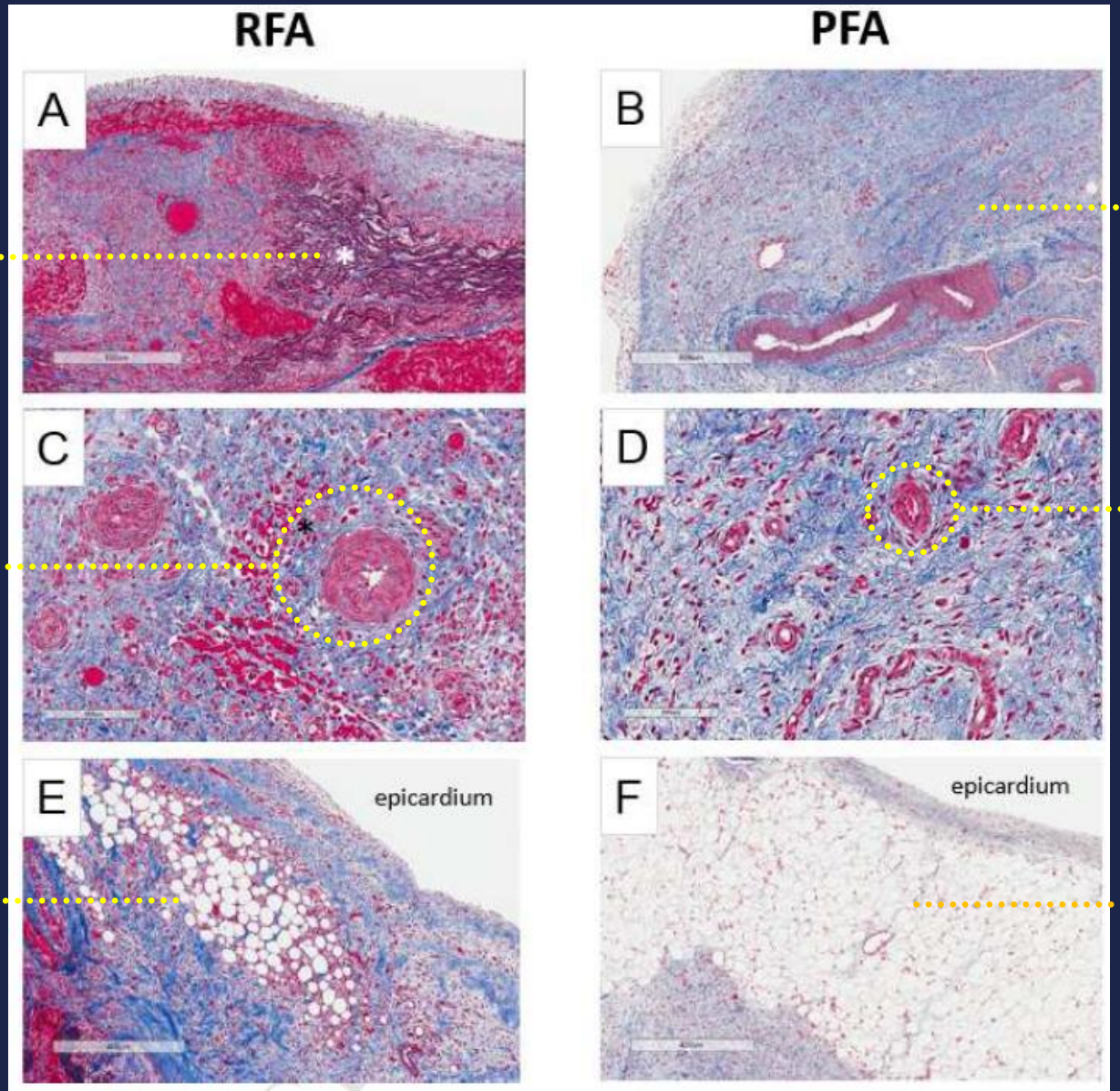


Cardiac-selectivity

RF ablation: myocardial sequesters, haemorrhage and thrombosis present in cardiac tissue.

RF: remodeled arterioles, interstitial haemorrhage

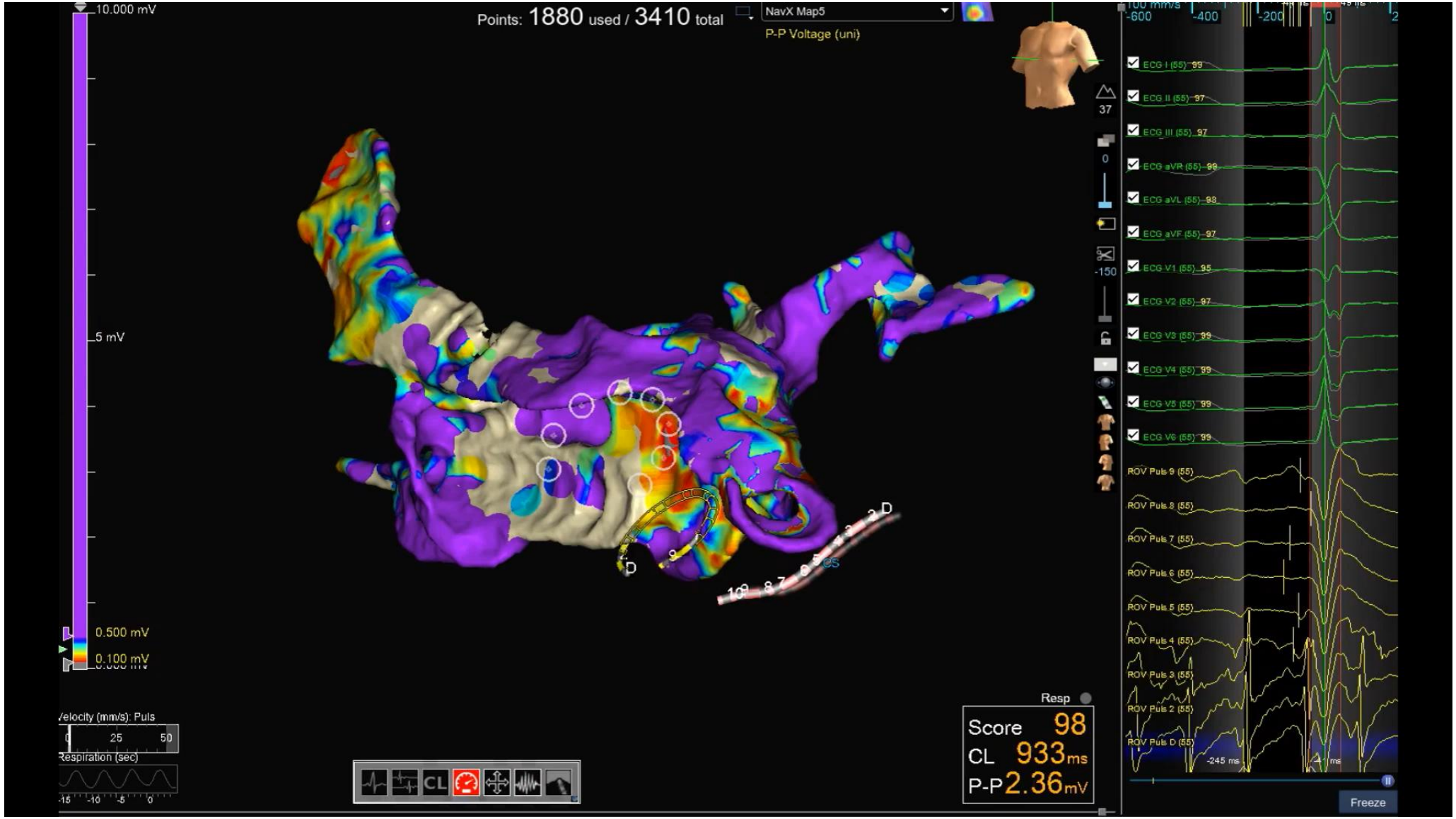
RF: Fibrosis and lipogranulomatous inflammation



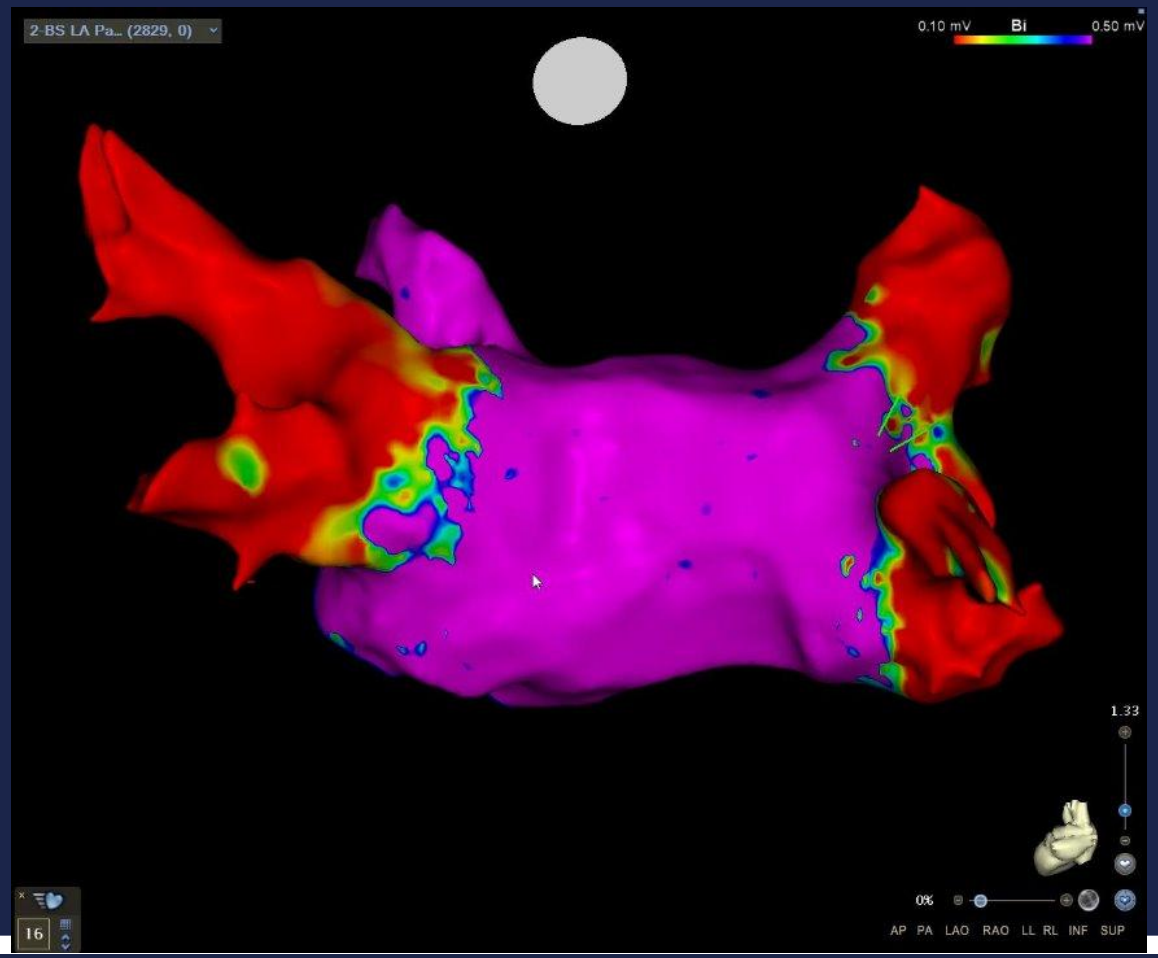
PFA: homogenous fibrosis normal patent vessels

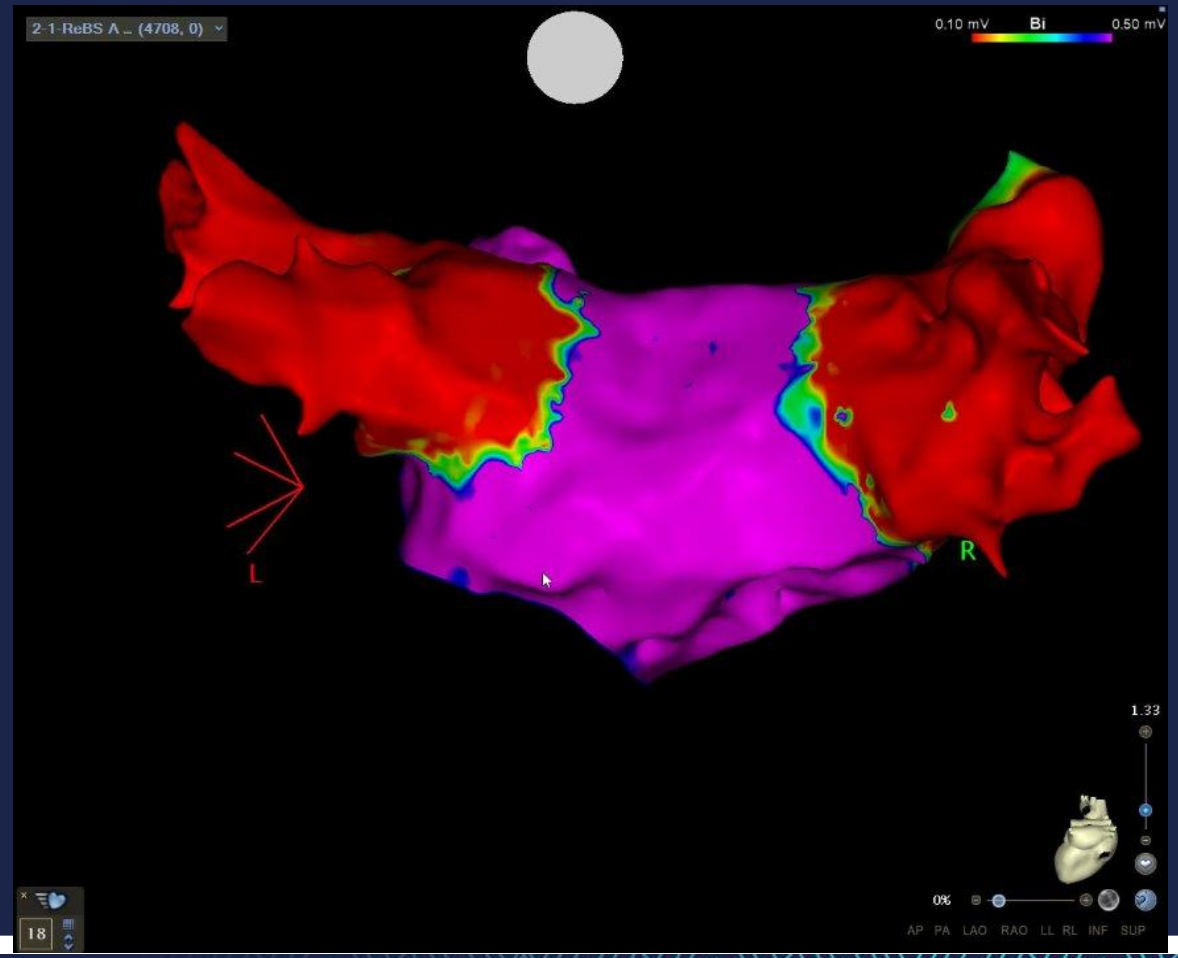
PFA: normal arterioles no haemorrhage

PFA: normal epicardial fat


10.000 mV
5 mV
0.500 mV
0.100 mV
Points: 1880 used / 3410 total
NavX Map5
P-P Voltage (uni)
Velocity (mm/s): Puls
Respiration (sec)
CL
Resp
Score 98
CL 933ms
P-P 2.36mV
ECG I (55) 99
ECG II (55) 97
ECG III (55) 97
ECG aVR (55) 99
ECG aVL (55) 98
ECG aVF (55) 97
ECG V1 (55) 95
ECG V2 (55) 97
ECG V3 (55) 99
ECG V4 (55) 99
ECG V5 (55) 99
ECG V6 (55) 99
ROV Puls 9 (55)
ROV Puls 8 (55)
ROV Puls 7 (55)
ROV Puls 6 (55)
ROV Puls 5 (55)
ROV Puls 4 (55)
ROV Puls 3 (55)
ROV Puls 2 (55)
ROV Puls D (55)
-245 ms
Freeze

Mapping pre and post PFA

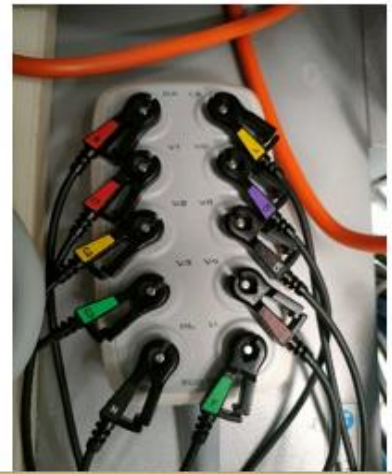




BSc PFA and Carto set up

Plug in 4 black cables and 1 grey/green cable into front of Isolation Unit

Plug in 2 grey cables into front of console

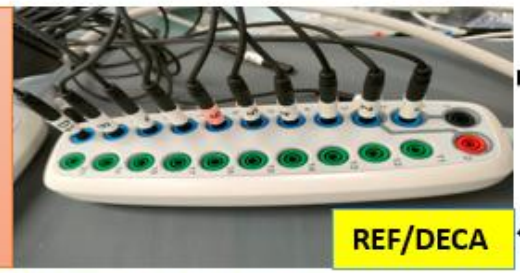


Claris ECG to Carto nipple box

Carto ECG to BSc nipple box

BSc ECG to patient

Black EGM cable pins 1-10 from Isolation Unit plugs into Carto pin box 1-10 for CS signals

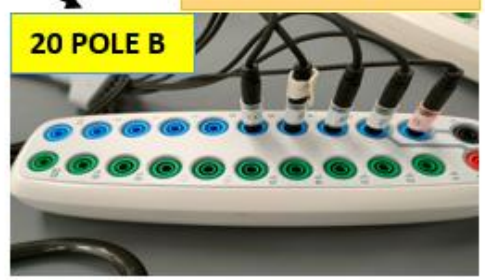


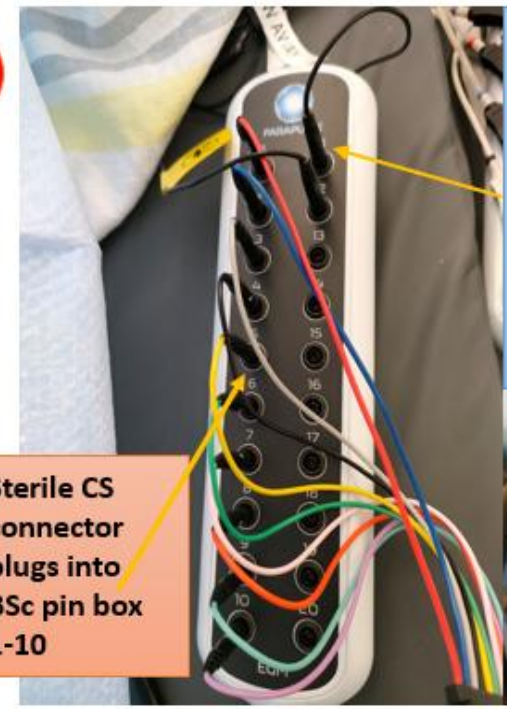
Remember to turn Magnet off during PFA applications

BSc grey/blue EGM cable pins 6-10 from console plugs into Carto pin box 1-5 for PV signals

After mapping with Octaray plug the pin boxes into following location and select wire for 20A and Farapulse for 20B

Black EGM cable pins 11&12 from Isolation Unit plugs into Carto pin box 1&2 for wire visualisation





Wire visualisation adaptor plugs into BSc pin box 11&12. Sterile gator clip cable will plug into adaptor

Sterile CS connector plugs into BSc pin box 1-10

*Remember to plug both gator clips on wire in order to visualise

Select CathMap: ACH Octaray+CS on Claris for corresponding signals and select page down for mapping and PFA templates

AF treatment in 2025

First-line rhythm control therapy		
Catheter ablation is recommended as a first-line option within a shared decision-making rhythm control strategy in patients with paroxysmal AF, to reduce symptoms, recurrence, and progression of AF.[16,591–594]	I	A

Lifestyle and co-morbidity management remain critical, but catheter ablation now safer and more effective than anti-arrhythmic medications and enters first line therapy.

Current state in NZ

- We have a growing AF epidemic
- Waitlists across the country are growing with inequitable access
- RF in all EP labs
- Cryo in all EP labs
- PFA rapid uptake where it is available (Auckland and Waikato)

Complications at Auckland Hospital

- 1 pericardial effusion from CS catheter perforation (managed conservatively)
- 1 femoral vein dissection (managed conservatively)
- Several Asystole despite atropine 600mcg
- No coronary spasm* (GTN used prophylactically in 2 cases)
- No CIED issues
- 1 PFA Generator failure

Procedures

- Total number of cases to date: 642 (across all 3 Auckland sites – public & private)

- 72% of cases we used EnsiteX mapping system
- 6% Precision
- 17% Carto
- 5% conventional electrodes

- Fluoroscopy time: Mean 19 min
  - Range 4 – 46 min

- Procedure duration: Mean 84 min
  - Range: 22 - 310 min

- 2 x Redos

Future developments

- Focal PFA catheters
- 3D mapping system integration with PFA (Opal).
- PFA waveform modifications:
  - Eliminate coronary artery spasm
  - Single application requirement
  - Reduce skeletal muscle stimulation (?remove the requirement for GA)

Thank you