



## Newsletter No. 118

The pulse of a clinical revolution: A summary of the 2026 HRS/EHRA scientific statement on pulsed field ablation

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The field of cardiac electrophysiology is undergoing a “clinical revolution”. After decades dominated by thermal energy sources such as radiofrequency and cryoablation, Pulsed Field Ablation (PFA) – an ablation method based on electroporation - has shifted the paradigm of catheter-based therapy. The 2026 HRS/EHRA Scientific Statement ([https://www.heartrhythmjournal.com/article/S1547-5271\(26\)00124-4/fulltext](https://www.heartrhythmjournal.com/article/S1547-5271(26)00124-4/fulltext)) provides a comprehensive framework for this technology. In the document, Basic PFA concepts, Procedural workflow, General ablation complications, PFA for non-AF arrhythmias, Future directions are discussed and Recommendations are given.

PFA delivers high-voltage, short-duration electrical pulses that induce irreversible electroporation. When electric field strength and duration exceed a critical threshold, cellular homeostasis is irreversibly disrupted, leading to cell death. Unlike thermal ablation, which causes protein denaturation, PFA is designed to be non-thermal, potentially sparing the extracellular matrix and allowing for more favorable healing.

Optimization requires balancing lesion depth and transmuralty against unwanted effects such as musculoskeletal stimulation, heating, and collateral tissue exposure. Current systems produce lesion depths of approximately 4–7 mm, comparable to thermal ablation.

### STANDARDIZATION AND TECHNICAL TRANSPARENCY

A critical mandate of this statement is the call for minimal technical disclosure from manufacturers to move away from “black box” proprietary waveforms and allow for scientific comparison between systems. Published PFA research report should disclose five critical parameters: pulse amplitude (current or voltage); vectoring configuration (bipolar vs monopolar configurations); total “on time” of a single train, the number of trains and pauses between them; total energy per application; and duty cycle.

Providing these metrics is essential for calculating thermal footprints and understanding the biophysical differences in lesion formation across various platforms.

### THERMAL EFFECTS AND MICROBUBBLE FORMATION

Although designed as non-thermal, PFA inherently produces ohmic heating proportional to the square of current density. Typical temperature increases range from 3 to 10°C, below thresholds for coagulative necrosis. Current density is highest at electrode edges. Poor electrode geometry or overlapping energy-delivery segments can produce excessive localized heating.

Microbubbles observed on intracardiac echocardiography may result from hydrolysis, blood degassing or local heating. While generally transient, excessive bubble formation may indicate increased thromboembolic risk and emphasizes on the importance of waveform optimization.



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*...continued from previous page***EFFECTS ON EXTRACARDIAC STRUCTURES**

PFA effects depend on electric field exposure thus off-target effect to esophagus, phrenic nerve and autonomic ganglia are expected to be minor. Esophagus: acute lesions extending into muscular layers have been observed. However, because PFA preserves extracellular matrix and vascular supply, tissue healing may occur within weeks. Phrenic nerve: transient stunning may occur, typically resolving within minutes to hours. Autonomic ganglia: unlike thermal ablation, PFA does not consistently produce durable autonomic denervation. Ganglia themselves are sensitive to electroporation, but epicardial fat insulation or insufficient lesion depth may limit their exposure to high electric fields.

**PROCEDURAL WORKFLOW**

Electric pulses induce neuromuscular stimulation, coughing, phrenic capture, and vagal responses. Deep sedation or general anesthesia is commonly required, although newer catheter designs and waveform modifications may allow lighter protocols. Adjunctive medications such as opioids, lidocaine and atropine may mitigate cough and vagal responses. Lesions durability depends more on adequate catheter-tissue contact than on high contact force, as lesion size plateaus beyond approximately 10g of force. Ensuring stable contact also reduces hemolysis by minimizing blood exposure to high electric fields.

Targeting PV myocardial sleeves before antral delivery improves durability. Increasing application number may enhance acute isolation increases hemolysis risk. Reversible PFA pulses have emerged as a mapping innovation, transiently blocking conduction to identify critical isthmuses without creating permanent lesions.

**SAFETY CONSIDERATIONS**

While PFA avoids many traditional thermal complications, such as PV stenosis and atrioesophageal fistula, it introduces distinct risks like hemolysis and acute kidney injury (AKI), coronary vasospasm and vagal reaction. High-voltage pulses can electroporate red blood cells, releasing free hemoglobin. Severe AKI requiring dialysis is rare (0.03%). Exposure of coronary smooth muscle to electric pulses can provoke intense vasospasm. Proximity-related spasm is a known risk when ablating near the mitral or cavotricuspid isthmuses. Prophylactic nitroglycerin is recommended in these cases. Rare delayed coronary events and malignant arrhythmias occurring minutes to days after the procedure have been reported, potentially related to nitric oxide depletion or microvascular dysfunction. PFA may trigger more pronounced vagal responses than thermal energy due to a wide, sub-lethal electric field that stimulates atrial ganglionated plexi.

PFA is currently approved primarily for AF ablation, supported by prospective and randomized trials demonstrating non-inferior efficacy compared with thermal energy and improved procedural efficiency. Emerging applications include ventricular and supraventricular tachycardia.

In conclusion, the 2026 HRS/EHRA Scientific Statement positions PFA as a transformative energy source for cardiac ablation. Its future depends on waveform transparency, rigorous reporting standards, optimized lesion assessment, and continued mechanistic investigation into electric field-tissue interactions. For the research community, the roadmap is clear: precision engineering, systematic surveillance, and deeper understanding of electroporation biology will determine the next phase of this clinical revolution.

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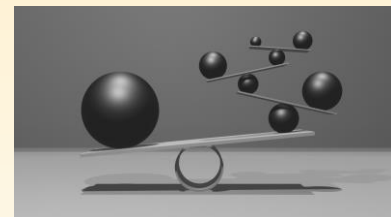
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*Cardiac Pulsed Field Ablation is  
a Balancing Act*

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