Keywords: pulsed-field ablation

Problem: For decades, thermal ablation has been the gold standard of treatment for atrial fibrillation (AF). However, change is on the horizon. Irreversible electroporation, or pulsed-field ablation, shows significant promise in treating AF.

Solution: This article overviews pulsed-field ablation, an innovation expected to change AF treatment.

Pulsed-Field Ablation: What's New in Cardiology?

A new approach to cardiac arrhythmia intervention is creating quite a buzz. The emergence of irreversible electroporation, or pulsed-field ablation (PFA), boasts good durability, quicker procedure times and less harm to adjacent tissue.

Atrial fibrillation (AF) results in high morbidity and mortality rates. For decades, thermal ablation has been the gold standard of treatment. However, change is on the horizon. PFA shows exceptional promise for managing arrhythmias. So, what is all the hype about? This article overviews pulsed-field ablation and why experts are talking about it.

Key Takeaways

- Thermal ablation is the gold standard of treatment for atrial fibrillation. However, pulsed-field ablation (PFA) shows significant promise.
- PFA is a technological innovation producing exciting results. PFA can kill disruptive cells while leaving surrounding tissue unharmed, which sets it apart from thermal ablation.
- PFA is a non-thermal ablation method that utilizes electroporation, an ultra-rapid electrical pulse that increases cell permeability.
- Electric ablation proved unsafe in the late 1900s. However, advancements in catheter design and energy distribution have improved PFA's safety and efficacy ratings.
- Further research is essential before cardiologists can utilize this precise, technological marvel.

What is pulsed-field ablation?

Pulsed-field ablation (PFA) is a procedure that delivers extremely rapid electrical pulses that increase the cell's permeability. Low-intensity applications produce a reversible effect. Reversible electroporation may help doctors insert genes or drugs directly into cells. The low voltage increases permeability without long-term cellular damage. After the procedure, cells return to normal function. Conversely, irreversible electroporation destroys mischievous cardiomyocytes, enabling the heart to regain its normal rhythm.

When drug therapy proves ineffective, physicians frequently turn to catheter ablation to treat paroxysmal AF. Thermal ablation is a highly effective treatment option. However, it causes indiscriminate harm, often damaging the esophagus, pulmonary vein and phrenic nerve.

PFA's precision is unmatched. **Cardiac cells are highly susceptible to electrical currents, but surrounding structures are not.** Unlike the effects of thermal ablation, electrical pulses have little to no impact on the esophagus, pulmonary veins and phrenic nerve. Doctors can kill cells implicated in the arrhythmias while leaving healthy cells undisturbed. This unique feature of PFA is an undeniable benefit. In fact, this characteristic is what sets PFA apart from other ablation methods.

Early attempts at non-thermal ablation

In the 1980s, experts attempted direct external current (DC) ablation. After a decade of studies and trials, the international registry on DC ablation of VT observed a mortality rate of 25%. For years, scientists abandoned this ablation method. Many believe the energy delivery options and catheter design inhibited the application's potential.

Radiofrequency ablation won the efficacy and safety competition. Therefore, cardiologists currently rely on thermal ablation. However, technological innovations may soon change this trend. **Advancements in catheter design and energy distribution yield better results.** Pulsed-field ablation may quickly become the go-to treatment for unresponsive AF.

Thermal ablation vs. pulsed-field ablation

Radiofrequency and cryoballoon are the leading ablation methods for atrial fibrillation. These thermal methods produce satisfactory results and safe outcomes. However, thermal ablation is time-consuming and technically challenging. Additionally, the results are highly operator-dependent and often influenced by nearby vessels or tissue.

Thermal ablation methods often cause collateral damage to surrounding tissue, vessels and organs. Conversely, PFA's ability to destroy deviant cardiac cells while leaving healthy tissue undisturbed may *improve efficiency*, *precision and outcomes*.

Pulmonary vein stenosis after ablation is a serious concern. Even mild cases can cause long-term complications. In a randomized comparison of PFA and thermal ablation, **PFA produced no pulmonary vein stenosis.**

The risks and benefits of PFA compared to thermal ablation are not fully known. More clinical trials related to pulsed-field ablation are needed. However, experts believe this advancement can change cardiology practices globally.

Trials and research

Ten clinical trials and a real-world survey show promising results for PFA. Experts at the 2023 American Heart Association Scientific Sessions shared these observations:

- Exceptional efficacy with pulmonary vein isolation for most patients
- Low rate of adverse events, like pericardial tamponade, stroke and coronary spasm
- Faster procedure time than thermal ablation
- Comparable success rates to thermal ablation

Acute and chronic success rates determine primary efficacy. Successful ablations result in one year with no atrial arrhythmias, no antiarrhythmic drug use, and no need for cardioversion or repeat ablation. In the first randomized controlled trial, **PFA and thermal ablation yielded 73.3% and 71.3% success rates, respectively.**

Further exploration needed

Though PFA is producing rave results, several issues need further exploration. More information and research are required for the following:

- Voltage
- Pulse duration
- Frequency
- Biphasic or monophasic
- Electrode configurations
- Device designs

Cardiologists need evidence-based guidelines before implementing this innovation into clinical practice.

Interesting Ideas

Research continues to improve effectiveness and safety while reducing past limitations. Some interesting ideas that may enhance the function of PFA are the following:

- **Miniaturization of catheters:** Smaller tools enable optimal precision, even on irregular structures.
- **Optimization of energy delivery parameters:** Efficient, uniform application reduces the need for repeat ablations.
- Utilization of artificial intelligence: Meticulously analyzed data improves target accuracy.

With continued research and improvements, many cardiologists anticipate that PFA will be the tool they have been waiting for.

Supporting cardiology innovations that are on the horizon

Pulsed-field ablation is an exciting technological advancement on the horizon. Early attempts at using non-thermal electrical pulses to treat arrhythmias were unsafe and ineffective. However, innovative design changes make PFA an up-and-coming cardiological marvel.

Our hospital is passionate about innovation, technology and quality care. That is why we invest in resources to improve your patients' lives. Looking for exceptional cardiology services? We are your partner in care. Click the "Refer" button to get started.

Resources

"The promise of pulsed field ablation and the challenges ahead." NIH: National Library of Medicine, 2023, The promise of pulsed field ablation and the challenges ahead - PMC.

"Pulsed field ablation is noninferior to thermal ablation in paroxysmal atrial fibrillation." European Society of Cardiology, 2023, Pulsed field ablation is noninferior to thermal ablation in paroxysmal atrial fibrillation.

"Pearls and Pitfalls of Pulsed Field Ablation." NIH: National Library of Medicine, 2023, Pearls and Pitfalls of Pulsed Field Ablation - PMC.

"Pulmonary vein narrowing after pulsed field versus thermal ablation." Oxford Academic: EP Europace, 2024, Pulmonary vein narrowing after pulsed field versus thermal ablation | EP Europace | Oxford Academic.

"Electroporation: The Past and Future of Catheter Ablation." NIH: National Library of Medicine, 2014, Electroporation: The Past and Future of Catheter Ablation - PMC.

"Pulsed-Field Ablation: A New, Highly Selective Catheter Ablation Method for Heart Arrhythmias." Cleveland Clinic, 2024, Pulsed-Field Ablation: A New, Highly Selective Catheter Ablation Method for Heart Arrhythmias.