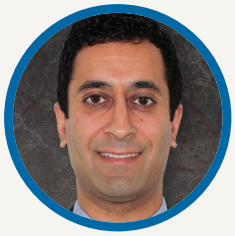
THE ROLE OF TEMPERATURE AND IMPEDANCE CONTROL IN RHINAER® TECHNOLOGY



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> **Temperature and impedance play very different but complementary roles; temperature is predictive and controlling, while impedance is reactive and confirmatory.**

Radiofrequency (RF) energy has long been recognized as a versatile tool for both ablative and non-ablative tissue applications. However, as RF use expands beyond tissue destruction into targeted neuromodulation, particularly in nasal procedures for chronic rhinitis, it becomes essential to understand which device parameters ensure safe, reproducible, and durable outcomes. Among these parameters, temperature and impedance play very different but complementary roles; temperature is predictive and controlling, while impedance is reactive and confirmatory.

Temperature is the Primary Driver of Tissue Response[1-3]

A substantial body of evidence shows that the biological effects of radiofrequency (RF) energy are primarily governed by temperature, which directs protein denaturation, cellular modulation, and controlled structural remodeling. RhinAer® technology is engineered to maintain tissue within a precise, controlled thermal environment that enables effective posterior nasal nerve (PNN) modulation while preserving mucosal integrity.

- **Temperature and Time:** The RhinAer system is designed to maintain tissue at approximately 60°C during treatment for a fixed treatment duration of 12 seconds. At this temperature, the thermal effects are predictable and controlled, producing the intended degree of PNN modulation and also creating extracellular matrix contraction and fibroblast cell activation that enables soft tissue treatment.This temperature and time allows the tissue to reach the desired therapeutic effect while preserving healthy mucosa and avoiding deeper tissue injury.

- **At Elevated Temperatures:** As thermal intensity increases with higher temperatures, the likelihood of broader or deeper tissue effects rises. These effects can include dehydration of the tissue surface, disruption of cellular structure, and a greater potential for compromising mucosal integrity. These outcomes are undesirable in a procedure designed to preserve the surface mucosa and maintain normal nasal physiology, which is why precise control of temperature and application time is essential.

RhinAer maintains a controlled thermal environment, enabling predictable nerve modulation.

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The Role of Impedance[4,5]

Impedance reflects the electrical resistance of tissue and changes dynamically as tissue composition and hydration shift during energy delivery. During RF treatment, impedance can initially fall as tissue warms and conductivity increases and then rises sharply once tissue begins to dehydrate and desiccate.

While impedance is a useful, reactive safety parameter, especially for confirming tissue contact, it does not provide predictive or target-specific information about neural structures.

- In traditional impedance-controlled RF systems, the generator reduces or cuts power when impedance rises sharply at the end of an ablation cycle, a mechanism originally designed to prevent charring once tissue has already reached desiccation, the intended endpoint of ablation. This late-rise-driven power reduction is helpful in destructive procedures, but it is not designed to maintain a consistent treatment temperature.

- In RhinAer, impedance readings primarily confirm adequate tissue apposition, i.e., that the electrode is in firm contact and current can flow into the tissue.

Impedance alone cannot indicate whether tissue has reached a specific temperature. Neither impedance nor temperature can confirm whether energy is being delivered specifically to the intended neural target versus adjacent structures.

Benefits of Temperature- and Impedance-Controlled RF[6-7]

RhinAer utilizes a closed-loop temperature- and impedance-controlled RF system, in which both parameters work together to ensure precision, safety, and reproducibility. Temperature serves as the primary control variable, directing the tissue response, while impedance provides real-time feedback to confirm tissue contact and signal secondary changes as energy is delivered.

This dual-feedback mechanism allows RhinAer to continuously monitor and adjust power output, maintaining a steady target temperature (~60°C) and preventing excessive heating. Together, temperature and impedance provide a balanced system that optimizes treatment accuracy and tissue preservation. This approach enables:

- **Predictable tissue response:** Maintaining ~60°C optimizes tissue remodeling without over-treatment.

- **Mucosal preservation:** Continuous temperature feedback ensures energy is confined to the intended target zone, reducing the likelihood of excessive thermal spread and supporting mucosal preservation.

- **Durable outcomes:** Prospective, multicenter, and RCT studies for chronic rhinitis have demonstrated sustained symptom improvement and quality-of-life gains through three years of follow-up.

> **Temperature governs the desired biological effects and tissue response, whereas impedance reflects tissue apposition once energy has been delivered.**

Conclusion

In RhinAer, a temperature- and impedance-controlled RF therapy, temperature leads while impedance follows. Temperature governs the desired biological effects and tissue response, whereas impedance reflects tissue apposition once energy has been delivered. For procedures such as chronic rhinitis treatment, where the goal is physiological modulation, temperature-and impedance- controlled RF provides precision, safety, and predictability.

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