

Mitigating Esophageal Injury after Atrial Fibrillation Ablation Guided by Ablation Index; CLOSEr to goal

Jason Chinitz¹ and Eli Harris²

¹South Shore University Hospital

²Nassau University Medical Center

February 22, 2024

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Jason S. Chinitz, MD¹ and Eli Q. Harris, MD²

1. South Shore University Hospital

Northwell Health

Bay Shore, NY

2. Nassau University Medical Center

East Meadow, NY

Financial support : none.

Disclosures : Dr. Chinitz serves on the scientific advisory board for Biosense Webster and has received consulting fees

Corresponding Author

Jason S. Chinitz, MD

Northwell Health Physician Partners, Cardiology at Brightwaters

402 Potter Boulevard

Brightwaters, NY 11718

jchinitz@northwell.edu

In the ongoing quest to optimize outcomes for atrial fibrillation ablation, efforts continue to balance the reliable creation of durable transmural ablation lesions, while minimizing risk to neighboring sensitive structures. Various effective strategies have been developed to guide titration of radiofrequency (RF) energy delivery, leveraging our understanding of ablation biophysics and titratable factors such as contact force, power and duration of ablation. The Ablation Index (AI, Biosense Webster) utilizes this information to guide more predictable lesion creation, and has led to improved procedural success and efficiency.¹ However, despite important advancements such as this, the ideal amount of ablation in a given location, with variable tissue characteristics and surrounding structures, remains unknown. Strategies designed to improve lesion efficacy must be weighed against the risks of complications from over-ablation, including esophageal injury during ablation on the posterior wall of the left atrium.

The CLOSE protocol combined AI targets and structured intertag distance limits to standardize and optimize ablation delivery during pulmonary vein isolation (PVI), and has shown impressive short-term results including 1 year freedom from atrial tachy-arrhythmia recurrence >90% and low rates of pulmonary vein reconnection at redo procedures.² The original CLOSE protocol involved standard power ablation at 25-35W, but derivations to the CLOSE protocol have adapted this strategy with high power ablation (45-50W), also producing impressive clinical outcomes.³ High-power-short-duration (HSPD) ablation has been shown to produce a more homogenous, broad based lesion, and may further improve efficacy of PVI as well as procedure efficiency; theoretically, HSPD may also improve safety of ablation in the left atrium adjacent to the esophagus by limiting lesion depth and conductive heating.⁴ However, as most esophageal lesions resulting from ablation are asymptomatic, smaller clinical studies evaluating novel ablation strategies may under-appreciate the risk of esophageal injury, and favor strategies that promote efficacy at the expense of safety.

This manuscript by Francke et. al.⁵ focuses on the safety of the combined high-power CLOSE-guided ablation approach, using endoscopy in 300 patients to identify esophageal lesions following AF ablation. In this study, PVI was performed with contiguous 50W RF applications, delivered on the posterior wall of the left atrium until an Ablation Index target of 400 was reached. Whereas traditional HPSD ablation limits ablation to around 5 seconds when adjacent to the esophagus, using pre-specified AI targets to guide ablation duration in this study protocol resulted in RF duration of 11-12 seconds on average per lesion on the posterior wall. The ablation strategy employed in this study did not use esophageal temperature monitoring or any other defined strategy to avoid collateral esophageal damage. Accordingly, the effects to the esophageal tissue from uninterrupted high power ablation guided by AI targets were more directly examined.

The findings reported 35/300 (11.7%) of patients with endoscopy detected esophageal lesions (EDEL), including 10/300 patients (3.3%) with type 2 esophageal lesions based on the Kansas City Classification (and four patients with type 2b lesions, indicating deep ulceration). Notably these findings are overall consistent or better than results of prior investigations with standard power ablation which have shown EDEL in up to 15% of cases.⁶ In one recent multi-center study evaluating high-power AI-guided ablation with target AI of 350 on the posterior wall, pooled analysis in 953 patients showed EDEL in 6%, half of which were type 2 lesions and one that resulted in esophageal perforation.⁷ Though the overall risk of clinically relevant esophageal injury remains very low, the residual incidence of esophageal injury demonstrable by endoscopy with the potential for catastrophic progression remains concerning, and warrant even better efforts for risk mitigation.

One clinically relevant finding in this study was that high contact force during posterior wall ablation was a primary risk factor for esophageal injury, independent of other baseline or ablation parameters. This finding is consistent with prior studies which have shown reduction in esophageal lesions by limiting contact force to <20 grams.⁸ As applied contact force is now controllable during ablation, avoiding high contact force on the posterior wall may be an important strategy to prevent direct esophageal injury, particularly when high power is used. However, with reduced contact force, longer duration of ablation is needed to reach AI targets. The target AI of 400 consistently takes >10 seconds of continuous ablation at 50W to reach, and the algorithm will not even begin to display the dynamic AI until after at least 6 seconds of ablation, thereby precluding the use of AI during traditional time-limited HPSD ablation. In the POWER-AF study, using 45W in the posterior wall required an average of 13 seconds (range 11-14 seconds) to achieve a target AI of 400.⁹ Similar ablation duration was required to reach AI of 400 using 50W in this study, with maximum RF duration on the posterior wall reported up to 19.9 +- 3.5 seconds.⁵ As acknowledged by the authors in the Discussion, there is a more narrow safety margin with high power ablation, and therefore prolonged high power applications may negate the safety benefits of HPSD biophysics.^{3,9} Steam pops have been shown to occur before target AI of >450 are reached when using high power ablation, particularly at higher starting impedances.¹⁰ In addition, the limits in time associated with HPSD ablation not only reduce the risk of over-ablation, but may allow for more consistent catheter-tissue contact during RF application. It is therefore questionable whether the same AI targets are appropriate when using high power, and whether lower AI targets, time-limited ablation, or use of other ablation strategies may achieve similar efficacy with less risk.

A uniform approach to ablation over the posterior left atrial wall may not be ideal in all patients. Given variations in atrial myocardial thickness, tissue characteristics, esophageal location and proximity to sites of ablation, the optimal duration and pattern of high-power ablation is variable in clinical practice. In addition, “heat stacking” has been demonstrated with multiple HPSD lesions delivered in close spatial and temporal proximity, arguing against consecutive and contiguous ablation applications as described in this study protocol.¹¹ Patient specific characteristics including baseline tissue impedance, and extent and slope of impedance decrease during ablation gives important feedback regarding tissue heating, and can further guide effective and safe lesion delivery.

Esophageal temperature monitoring was not utilized in this study, and it is unknown whether addition of this information would have changed the results. No incremental clinical benefit has been demonstrated in recent studies using luminal esophageal temperature monitoring with either standard or high-power ablation.¹² Skepticism regarding the benefit of esophageal temperature monitoring is rooted in the limited sensitivity of the luminal temperature probe, which is dependent on the location of the probe relative to the site of ablation, and can underestimate or completely miss heating changes at other regions of the esophagus-left atrial interface. Furthermore, the latency of temperature changes may permit esophageal damage even before temperature rise is detected, particularly with HPSD ablation.¹¹ Regardless, esophageal temperature monitoring when used appropriately can alert the operator when esophageal heating occurs, and should prompt a change in approach to avoid unnecessary additional ablation in at-risk regions until temperature decreases. Other strategies such as esophageal deviation and active esophageal cooling also have shown limited clinical benefits and carry additional costs and potential adverse effects that have limited their adaptation. Despite the limitations, until a better understanding of lesion titration and risk mitigation on the posterior wall exists, it seems prudent to encourage concomitant use of compatible strategies to avoid this potentially life-threatening complication.

With major progress in technology and understanding of ablation biophysics, the risk of esophageal injury may have been tempered. While the approach and findings described in this study provide a step in the right direction in our understanding of ablation to achieve effective and safe PVI, even better strategies to minimize the collateral risk are still needed. Using high-power and pre-specified AI targets may increase the likelihood of lesion transmural, but with risk of over-ablation at sensitive locations, where less aggressive ablation may be sufficient. Optimal AI targets with HPSD require further study, and further evaluation is needed to determine whether AI provides clinical benefit over time-limited HPSD alone. A combination of approaches is needed, including tailoring of ablation delivery to take into account tissue thickness and proximity of ablation to sensitive structures. As AF ablation now more frequently includes posterior wall isolation in many institutions, rates of clinically relevant esophageal injury will have to be driven even closer to zero. Otherwise, Pulsed Field Ablation is set to challenge RF as a primary approach to AF ablation in the near future.

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