Electrical and Thermal Effects of Esophageal Temperature Probes on Radiofrequency Catheter Ablation of Atrial Fibrillation: Results from a Computational Modeling Study

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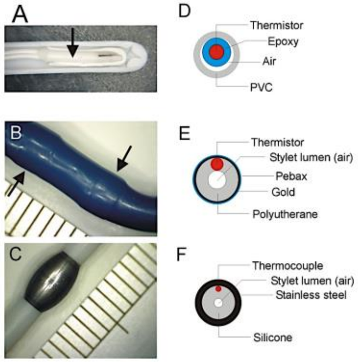
Introduction: Luminal esophageal temperature (LET) monitoring is commonly employed during catheter ablation of AF to detect high esophageal temperatures during RF delivery along the posterior wall of the LA. However, it has been recently suggested that the esophageal probe itself may serve as an RF 'antenna' and promote esophageal thermal injury.

The aim of this study was to assess the electrical and thermal interferences induced by different types of commercially-available esophageal temperature probes (ETPs) on RF ablation (Figure 1).

Methods and Results: A computational model was developed to assess the electrical and thermal effects of three different types of ETPs: a standard single-sensor and two multi-sensor probes (one with and one without metallic surfaces). LET monitoring invariably underestimated the maximum temperature reached in the esophageal wall.

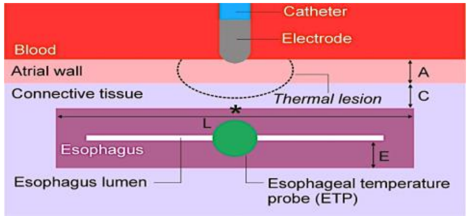
RF energy cessation guided by LET monitoring using an ETP yielded lower esophageal wall temperatures. Also, the phenomenon of thermal latency was observed, particularly in the setting of LET monitoring.

Most importantly, while only the ETP with a metallic surface produced minimal electrical alterations, the magnitude of this interference did not appear to be clinically-significant.

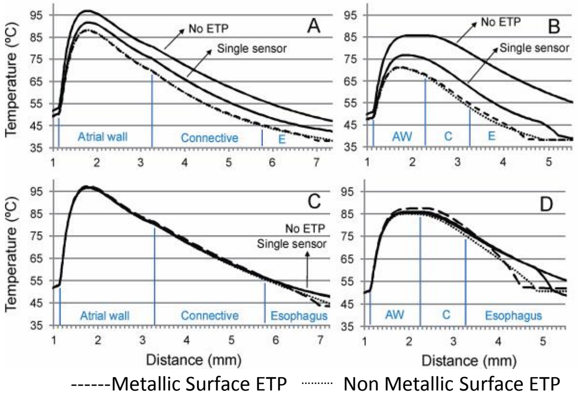


ETPs (A-C) commonly employed to monitor LET during RF ablation of AF. A: a 9-Fstandard single-thermistor ETP; B: a 10-F multi-sensor non-metallic surface (plastic) ETP, the arrows indicate the location of the sensors; C: an 11-F multi-sensor metallic ETP; D-F: Spherical models of each of the ETPs, representing simplified two-dimensional geometries but including the detailed inner constructions.

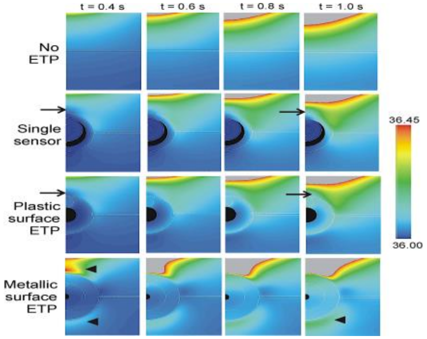
The proposed theoretical model (out of scale).



A: atrial wall thickness; C: connective tissue thickness between the atrial wall and the esophagus. *



Temperature profiles along the symmetry axis for each of the ETPs at the time when the temperature in the ETP reached 38ºC, i.e. where RF ceased for two distances between Eso and ablation electrode: 5 mm (A) and 2.5 mm (B). Temp profiles along the symmetry axis for each of the ETPs after 60 seconds of 35 W ablation for two distances between Eso and ablation electrode: 5 mm (C) and 2.5 mm (D).



Progressions of temperature distribution within the tissue (scale in ºC) without ETP and with different ETPs: single-sensor (SS), multi-sensor non-metallic (A) and multi-sensor metallic (B) ETPs. The plots correspond to a distance of 2.5 mm. Arrow heads indicate the location of hot points around the ETP with a metallic surface. Arrows indicate the location of cold points on the surface of ETP without a metallic surface (multi-sensor and single-sensor ETPs).

Conclusion: Temperature rises in both the esophageal wall and the ETP seem to be primarily produced by thermal conduction, and not caused by electrical and/or thermal interactions between the ablation catheter and the ETP, itself. As such, the proposed notion of the 'antenna effect' producing satellite esophageal lesions during AF ablation was not evident in this study.