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The Extent of Mechanical Esophageal Deviation to Avoid Esophageal Heating During Catheter Ablation of Atrial Fibrillation

Chandrasekar Palaniswamy, MD, Jacob S. Koruth, MD, Alexander J. Mittnacht, MD, Marc A. Miller, MD, Subbarao Choudry, MD, Rahul Bhardwaj, MD, Dinesh Sharma, MD, Jonathan M. Willner, MD, Sujata S. Balulad, MD, Elizabeth Verghese, MD, Georgios Syros, MD, Anurag Singh, MD, Srinivas R. Dukkipati, MD, FHRS, Vivek Y. Reddy, MD

ABSTRACT

OBJECTIVES This study sought to determine the extent of lateral esophageal displacement required during mechanical esophageal deviation (MED) and to eliminate luminal esophageal temperature elevation (LET_{Elev}) during pulmonary vein (PV) isolation.

BACKGROUND MED is a conceptually attractive strategy of minimizing esophageal injury while allowing uninterrupted energy delivery along the posterior left atrium during PV isolation.

METHODS MED was performed using a malleable metal stylet within a plastic tube placed within the esophagus. Barium was instilled to characterize the trailing esophageal edge. For each MED attempt, the $MED_{Effective}$, defined as the distance from the *trailing* esophageal edge-to-ablation line, was correlated to occurrences of LET_{Elev}.

RESULTS In 114 consecutive patients/221 PV pairs undergoing MED (age 62.1 ± 11 years, 75% men, 62%/38% paroxysmal/persistent AF), esophageal stretching invariably occurred such that the esophageal edge trailed behind the plastic tube. $MED_{Effective}$ distances of 0 mm to 10 mm, 10 mm to 15 mm, 15 mm to 20 mm or >20 mm were achieved in 60 (27.1%), 64 (29%), 48 (21.7%), and 49 (22.2%) attempts, respectively. Overall, LET elevation >38°C occurred in 81 of 221 (36.7%) PV pairs. The incidence of LET_{Elev} among the 4 groups was 73.3%, 35.9%, 25%, and 4.1%, respectively. $MED_{Effective}$ distances were 9.1 ± 6.5 mm and 18 ± 7.6 mm in patients with and without LET_{Elev}, respectively ($p < 0.0001$). Three patients (2.6%) experienced clinically significant MED-related trauma, albeit only with a stiffer stylet.

CONCLUSIONS Mechanical esophageal deviation >20 mm from the PV ablation line prevents significant esophageal heating during PV isolation, but this level of displacement was difficult to safely achieve with this off-the-shelf mechanical stylet approach. (J Am Coll Cardiol EP 2017;■:■–■) © 2017 Published by Elsevier on behalf of the American College of Cardiology Foundation.

Catheter ablation has emerged as an effective and widely adopted treatment strategy for patients with symptomatic atrial fibrillation (AF). The procedure consists of pulmonary vein (PV) isolation alone or in combination with other lesion sets, predominantly in the left atrium (LA). Although it is safe overall when performed by experienced operators, the procedure is nonetheless associated with a small but significant risk of injury to collateral structures. Foremost among these is the esophagus, which lies in close proximity to the posterior LA and, in particular, the PV antrum, making it susceptible to ablation-related injury. Thermal injury to the esophagus resulting in atrioesophageal fistula

From the Helmsley Electrophysiology Center, Icahn School of Medicine at Mount Sinai, New York, New York. Dr. Reddy has reported owning stock options in Circa Scientific, Inc, a manufacturer of esophageal temperature probes. All other authors have reported that they have relationships relevant to the contents of this paper to disclose.

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ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation

LA = left atrium

LET = luminal esophageal temperature

MED = mechanical esophageal deviation

PV = pulmonary vein

RF = radiofrequency

remains one of the most feared complications of AF ablation. Despite increased awareness in the electrophysiology and cardiology communities of the signs and symptoms associated with post-ablation atrioesophageal fistula, and despite prompt diagnosis and treatment of the condition, the mortality of atrioesophageal fistula remains 55% (1). Beyond the fatal, but relatively rare, complication of atrioesophageal fistula, thermal damage to the vagus nerve plexus on the outside surface of the esophagus is thought to also lead to esophageal and gastric dysmotility issues such as gastroparesis (2). Recent data have emerged that these dysmotility issues are more common that previously appreciated, affecting 17% of patients after AF ablation (3).

There is no universally accepted approach for minimizing thermal injury to the esophagus. Many physicians use a strategy of monitoring the luminal esophageal temperature (LET) to identify esophageal heating during energy delivery. Radiofrequency (RF) energy is typically interrupted for an LET of 38° to 39°; however, this approach negatively affects procedural workflow because cessation of energy delivery (upon esophageal heating) must be followed by a waiting period before the esophageal temperature returns to baseline to allow subsequent lesions. Other strategies to minimize esophageal injury include: delivery of lower energy (usually ≤25 W), lesions of shorter duration, and planning more medial or lateral ablation sets on the posterior wall to minimize esophageal heating. However, these approaches may also negatively affect the long-term PV isolation rates and clinical success of the ablation procedure. Furthermore, none of these techniques completely avoids esophageal heating leading to atrioesophageal fistula and dysmotility. Esophageal cooling using a cooled water-irrigated esophageal balloon has also been described as a strategy to minimize thermal injury. Real-time visualization of the esophagus with intracardiac echocardiography, especially with the probe deployed in the LA, may also be used as a monitoring strategy to reduce esophageal injury.

Alternatively, we had previously reported the feasibility of mechanical esophageal deviation (MED) using an off-the-shelf malleable metal stylet delivered within a plastic tube to deviate the esophagus during AF ablation as a means to completely avoid esophageal injury (4). MED is an attractive strategy because esophageal injury could potentially be completely avoided while nonetheless allowing uninterrupted energy delivery along the posterior LA. Significant esophageal stretching may occur during MED such that the trailing esophageal edge may yet be in proximity to the thermal wave front emanating from the point of RF energy delivery. We sought to determine the extent of *effective* lateral esophageal displacement during MED ($MED_{Effective}$, defined as the distance from the *trailing* esophageal edge-to-ablation line), and correlate this with elevations of the esophageal temperature.

METHODS

PATIENT POPULATION. Consecutive patients undergoing AF ablation procedures using an approved RF ablation catheter from November 2014 to October 2015 at our institution were studied. The study was approved by the Institutional Review Board of Mount Sinai Hospital. Patients were excluded if they had a prior history of severe esophagitis or ulcers, strictures, or esophageal surgery. Patients undergoing repeat ablation procedures where the PVs were persistently isolated from prior procedures were also excluded. All patients underwent ablation under general anesthesia with a strategy of uninterrupted oral anticoagulation with either warfarin or a non-warfarin oral anticoagulant. Double transseptal punctures were performed after intravenous unfractionated heparin was administered to maintain an activated clotting time of 350 to 400 seconds.

MECHANICAL ESOPHAGEAL DEVIATION TECHNIQUE. MED was performed after approval by the Mount Sinai Hospital "Novel Procedures Oversight Committee"; in addition to the standard consent for AF ablation, all patients were separately consented for MED. MED was performed after transseptal puncture and before creation of LA geometry with the electroanatomic mapping system. This was performed by anesthesiologists or electrophysiologists with prior experience in MED during our earlier study (4). As previously described, a standard orogastric tube was inserted. The tip was positioned at the distal end of the esophagus, and 20 to 30 ml of oral barium sulfate contrast (Liquid E-Z-Paque, E-Z-EM Canada Inc., Lake Success, New York) was injected to allow the contrast to fill the mid and distal esophagus. Instillation of barium helped accurately characterize the trailing edge of the esophagus. Next, a 32 Fr flexible polyvinyl chloride thoracic catheter (e.g., Atrium Medical Corporation, Hudson, New Hampshire) was inserted into the esophagus. The tip was positioned a few centimeters below the level of the lower PVs. A preshaped malleable metal stylet was inserted into the lumen of the thoracic catheter to create a curve in the distal half. In this series, there were 2 versions