The Esophagus Going Steady

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Ablation is a cornerstone of treatment for atrial fibrillation (AF), with increasing data on its safety and efficacy. A rare but dreaded complication related to AF ablation is esophageal injury, potentially leading to esophageal ulceration, upper gastrointestinal bleeding, and atrioesophageal fistula formation due to esophageal proximity to areas of the left atrium (LA) that are targeted with ablation[1–3].

To mitigate the risk of esophageal injury, preoperative, intraoperative, and post-operative measures have been utilized **(Figure).**Preoperative imaging to establish esophageal location and its three-dimensional relationship to the LA may allow for a tailored ablation approach; however, since the esophagus is a mobile structure, it is unclear if such preoperative imaging and planning can accurately assess esophageal location at the time of the ablation procedure[4,5]. Intraoperative measures to limit esophageal thermal injury include using high power, short duration radiofrequency ablation to avoid thermal injury to the deeper structures[6]. Use of contact force sensing catheters, and limiting the contact force to $<$ 20 grams, may also lead to less thermal injury to the esophagus[7]. Other postulated intraoperative strategies include imaging with intracardiac ultrasound for real-time assessment of esophageal location[8], mechanical displacement or active cooling of the esophagus[7], avoidance of general anesthesia[9], and monitoring intraluminal temperatures with esophageal temperature monitoring probes, although results are mixed[7]. Postoperative strategies to reduce esophageal thermal injury are limited and include the use of proton pump inhibitors[7].

In this issue of the *Journal of Cardiovascular Electrophysiology,*Nakatani et al. retrospectively studied 97 patients with AF who underwent ECG-gated, contrast-enhanced chest computed tomography (CT) with adequate quality 405±258 days apart and 1-3 days prior to consecutive AF ablation procedures. The authors determined esophageal position and assessed for *changes* in esophagus location between these two timepoints, assuming that the esophagus is a mobile structure[10]. They also evaluated if preoperative planning of ablation lesion sets to avoid LA sites in close proximity to the esophagus was feasible and reliable, taking into consideration the change in position of the esophagus over time.

Left atrial segmentations from CTs were done automatically and esophageal segmentation was added in a semiautomated method, with eventual calculation of the distance between LA surface to the esophagus. A distance of [?] 3 mm between the LA and esophagus was considered to be relevant and termed *area at risk* (AAR). The average distance of the esophagus to the LA reported by the authors, as well as their finding that the most common AAR was near the left pulmonary veins, is in line with prior studies[11,12]. The authors measured the difference in AAR, as well as the absolute difference in esophageal position, between two consecutive CT scans.

The authors demonstrated that, on the baseline CT, a mean LA surface area of 9.4+-3.6 cm^2 was in close proximity to the esophagus (AAR). This area was larger in women, people with lower body mass index (BMI), and left atria with greater dimensions. Positional change of the esophagus between the two CT scans was found to be moderate, with a median of 3.6mm [2.7 to 5.5mm]. Patients with a higher BMI had a larger positional change of the esophagus, and therefore had a larger AAR mismatch of the LA surface between two CT scans; however, patients with higher BMI generally had smaller AAR and thus the greater AAR mismatch may not be as clinically significant. The authors also showed that empiric wide area circumferential ablation (WACA) and WACA with linear ablation (WACA+L) lesions would significantly overlap at areas in close proximity to the esophagus (i.e. AAR), which can be mitigated by using personalized lesion sets that consider the esophageal location on the first CT. The authors concluded that this personalized approach might reduce the ablation lesions corresponding to AAR on the second CT by 75% and 53% for WACA and WACA+L respectively.

The authors confirmed several important points. First, the esophagus, although considered a mobile structure, remains in a relatively confined position when assessed in repeat imaging studies. Second, this finding can allow for preoperative planning of lesion sets that do not incorporate left atrial sites in close proximity to the esophagus. Importantly, the study also showed that women, patients with lower BMI, and patients with larger LA volumes have greater LA surface areas in close proximity to the esophagus, and thus these patients may hypothetically benefit to a greater extent from this personalized approach.

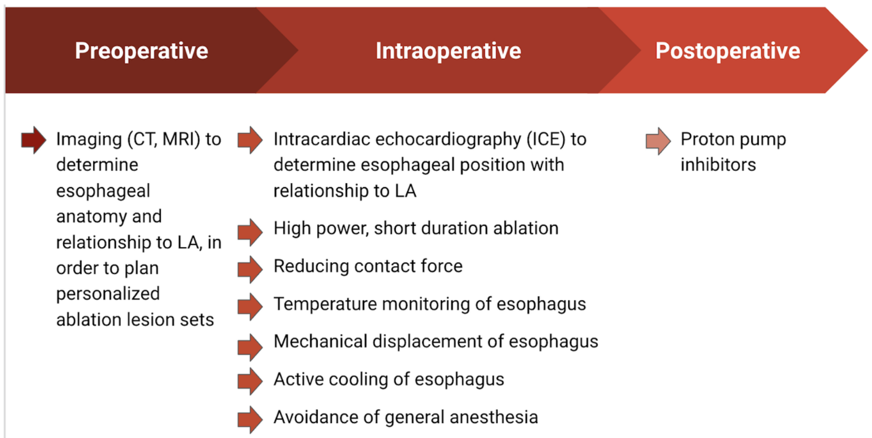
Limitations of this study are mainly due to the retrospective, single-center, and virtual nature of the methodology, which are well acknowledged by the authors. A clinical validation study would be the next important step to demonstrate that a predefined, personalized approach, based on preoperative imaging to avoid ablation at AAR, can indeed reduce esophageal injury. Furthermore, whether preoperative imaging is more accurate or more effective than intraoperative imaging and registration of the esophagus with intracardiac echocardiography and 3D electroanatomic mapping still needs to be determined.

To this point, another limitation is that the study provides no data with regards to intra-procedural imaging to localize the esophagus, or monitoring of esophageal temperatures, as AF ablations in this study were performed under conscious sedation without the use of esophageal temperature probes. We are therefore unable to correlate the findings that AAR defined by the authors are indeed areas in the LA that lead to esophageal temperature rise during ablation. A counter argument is that esophageal temperature monitoring may be suboptimal, does not cover the entire width and length of the esophagus, and can only detect intraluminal temperatures rather than intramural temperatures. In addition, routine preoperative TEEs to exclude left atrial appendage thrombus were not utilized in this study, which may affect esophageal position on the day of the procedure.

The authors further acknowledge that the relative stability of the esophageal course, despite a prolonged delay between two CT acquisitions, may not have adequate temporal resolution to firmly conclude that the esophageal position could be predicted during the procedure from preoperative imaging studies, and thus may result in erroneous ablation planning. In addition, mechanical esophageal displacement, active cooling strategies, or increasing use of pulsed field ablation with minimal collateral damage to nearby structures, may render the findings of this study to design personalized lesion sets to avoid esophageal damage less relevant[7]. Finally, although esophageal injuries are relatively common, esophageal injuries leading to significant morbidity and mortality are rare, and it is unclear whether any strategy to mitigate esophageal heating can have an impact on serious complication rates.

In summary, the authors should be commended on providing some of the first evidence on long term temporal stability of esophageal position, and in demonstrating feasibility of a personalized ablation strategy to avoid ablation at left atrial sites that are in close proximity to the esophagus. Further studies, however, are necessary to validate this approach, and whether this approach will have meaningful clinical implications is still to be determined.

Figure: Strategies for esophageal protection. CT: computed tomography, MRI: magnetic resonance imaging, LA: left atrium.



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