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Editorial commentary: Luminal esophageal temperature monitoring during catheter ablation of atrial fibrillation to prevent atrio-esophageal fistula: What we have learned so far to prevent this dreaded complication?



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Atrio-esophageal fistula (AEF) is the rare risk (0.1–0.25%) but is one of the most dreaded complications of radiofrequency catheter ablation as well as cryoablation of atrial fibrillation (AF), which is an elective procedure [1]. AEF makes patients prone to thromboembolism including stroke, mediastinitis, empyema and sepsis. It is associated with a significantly high mortality (up to 80%) due to the nature of disease and in many cases, delayed diagnosis. There are several methods being used to reduce thermal injury of the esophagus related to catheter ablation using radiofrequency (RF) energy and cryoablation so that the risk of AEF can be minimized. However, because of the rarity of AEF, evaluation and validation of strategies to reduce AEF remain challenging. In fact, electrophysiologist's awareness AEF and meticulous monitoring of luminal esophageal temperature (LET) during ablation may have kept the incidence very low. The degree of esophageal thermal injury and its sequelae after ablation of AF may be minimal to fatal. These include mucosal erythema/inflammation, esophageal perforation, esophagopericardial fistula and AEF. The mechanism of esophageal injury is thought to be due to direct thermal injury. However, additional factors such as vascular injury to the esophagus mucosa, acid reflux due to vagal nerve injury and esophageal dysmotility during general anesthesia may also play a substantial role in the development of AEF. The esophageal injury is mainly because of a very thin layer of insulation between the left atrial (LA) posterior wall and esophageal mucosa. The factors reported to be associated with a high risk include: female sex, low body weight, elderly, and high CHADS-VASc score [2].

Since this complication is rare but mostly fatal, can LET monitoring prevent the risk of AEF after ablation of AF [3]? How accurate are these probes in measuring esophageal temperature during the procedure? Can we justify the LET monitoring with expensive probes? Answers to these questions are not straightforward. One of the main reasons is that the anatomy is variable among patients. Ablation catheter in the posterior LA to mucosal distance depends upon the thickness of LA tissue (1–3 mm) epicardial fat and connective tissue (1–5 mm) and the esophageal adventitia (2–5 mm) [4]. Therefore, the anatomical factor may be more important because in the worst scenario the wall thickness be-

tween the mucosa and the ablation catheter or cryoballoon may be just 4–5 mm. Furthermore, the esophageal wall thickness may decrease during esophageal dilatation which may occur during general anesthesia. In addition, the barrier between the LA posterior wall and esophageal mucosa is thinnest in this area close to inferior pulmonary veins, making esophagus juxtaposition to lower posterior LA more vulnerable to thermal injury, especially the area close to the left inferior pulmonary vein.

The other mechanism suggested for mucosal injury is damage to mucosal vasculature from heat and mechanical force. Esophageal injury can occur by the application of high force in the posterior LA wall during ablation. To minimize the risk of esophageal injury, it is recommended to have LET monitoring during LA posterior wall ablation with low energy (20–25 W) even lower watts and even using non-irrigation technique with lower mechanical force (<30 g). The recent use of high energy (50–60 W) with short 5 s bursts in the LA posterior wall is shown to pose a lesser risk in *in vitro* experiments, since higher energy results in a wider but less deep tissue damage; however, the *in vivo* data of esophageal injury are not available with high energy ablation. Surprisingly, contrary to popular belief, the use of contact sense force catheter is associated with a higher risk of AEF than the noncontact force sense catheter, magnetic guided catheter and cryoballoon.

Regarding the LET monitoring methods, various probes are being used clinically and its efficacy and complications are mentioned by Kadado et al. in this issue of the Journal [3]. These are single sensor, and multipolar sensor LET probes that can have thermistors or thermocouple sensors. Thermistors generally contain a metal oxide sensor, the resistance of which decreases with increasing temperature. Thermocouples work from the principle that the junction of two different metals creates a measurable voltage, which increases with temperature. In both types of sensors, the mass of the sensor must be heated or cooled by intervening tissue on its surface before temperature change can be detected. The infrared thermography is another more sensitive probe, which provides instantaneous high-resolution temperature monitoring while scanning the esophageal surface without having to manually move the probe.

The limitations and risks of various LET monitoring use for ablation: Contrary to the belief that a multisensor LET (more sensitive for esophageal temperature changes at a larger area) and contact force catheter (minimizes pressure related esophageal damage during RF ablation) use are meant to minimize the esophageal injury, both seem to make the esophagus more vulnerable to thermal damage. The use of various LET monitoring with multipolar sensor is associated with a higher esophageal injury when compared to the use of single sensor LET monitoring. In fact, in RF ablation procedures in which no LET monitoring had less thermal injury to the esophageal mucosa as compared to the procedures in which no LET monitoring was used [3]. The heat sink from the metal sensors, or stretch of esophagus with the use of stiff curves, in one type of multisensor LET probe is implicated as a cause of injury. Furthermore, underestimation of esophageal mucosal temperature rise may be due to various factors such as: lack of optimum sensitivity of temperature sensors, sensor lying close to posterior esophageal mucosa (especially in dilated esophagus during general anesthesia), insulated probes and a lag of temperature rise detected during catheter ablation as well as during cryoablation.

Esophageal temperature of 39.5 °C to 40 °C using commonly available LET sensors is suggested to be the cut off during RF ablation and drop of more than 5 °C during cryoablation to minimize esophageal thermal injury during LET monitoring. Infrared thermography has commonly shown temperature rise up to 38 °C to 41 °C during posterior LA ablation but the thermal injury happens when temperature rises to 50°. However, more clinical data are needed with this type of sensor. Apart from direct local thermal injury to esophagus, other mechanisms such as thermal injury to the periesophageal vagus nerve (which can cause esophageal motility disorder and acid reflux), vascular injury to esophageal mucosa and LET probe related mechanical injury are all difficult to recognize during ablation. Therefore, the risk of esophageal injury cannot be eliminated totally even with LET monitoring during the procedure.

AEF formation is a rare complication of AF ablation with high mortality but may be underreported to some extent due to late presentation. The Heart Rhythm Society consensus statement

states that it is reasonable to use an esophageal LET monitoring during AF ablation procedures to help guide energy delivery (Class IIa) with the level of evidence CEO (expert opinion based on the clinical experience of the writing group) [5]. However, the data so far are not strong in the favor of LET monitoring, rather it may be associated a higher risk of AEF. Furthermore, a lack of temperature rise during LET monitoring during AF ablation may give the operator a false sense of security to increase power delivery or ablation duration, especially during extensive ablation of posterior LA in persistent AF ablation. In addition, vagus nerve injury or mechanical injury to the esophageal mucosa cannot be monitored during the procedure. More questions remain unanswered regarding the risk of AEF, which include: why LET monitoring, contact sense force use, circumferential rather than CFAE/linear ablation and do first rather than subsequent AF ablations make patient prone to AEF [6]? Therefore, further studies are needed to critically appraise the utility of LET monitoring and other modalities for real time monitoring of thermal and nonthermal injuries to the esophagus to prevent this high mortality complication of AF ablation.

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