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EDITORIAL

Prevention of oesophageal injury during catheter ablation of atrial fibrillation: is monitoring of oesophageal temperature the solution?

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This editorial refers to 'Oesophageal temperature monitoring and incidence of oesophageal lesions after pulmonary vein isolation using a remote robotic navigation system' by A. Rillig *et al.*, doi:10.1093/europace/euq061

Atrio-oesophageal fistula is among the most dangerous complications of interventional treatment of atrial fibrillation. The complication was first observed during intraoperative radiofrequency ablation of atrial fibrillation[1] but subsequently also reported after catheter based radiofrequency ablation of atrial fibrillation.[2] Atrio-oesophageal fistula is associated with high mortality[3] even if the correct diagnosis is made relatively early. However, the diagnosis of the complication often is delayed because of the significant time delay of its occurrence after the ablation procedure (which mostly is 1–4 weeks) and unspecific initial symptoms.[3,4] The mechanism most likely leading to atrio-oesophageal fistula after radiofrequency ablation of atrial fibrillation is the induction of thermal oesophageal injury during the ablation procedure; this pathophysiologic pathway could recently be observed in a patient who declined intervention after diagnosis of atrio-oesophageal fistula.[4] The incidence of oesophageal injury after radiofrequency ablation of atrial fibrillation has been described between 5% and almost 50%[5–7] depending on the radiofrequency power settings and ablation strategies. After the initial injury of the oesophagus, inflammation, and tissue necrosis promoted by the biological milieu in the oesophagus seem to pave the way for the occurrence of atrio-esophagel fistula. However, it is unclear which factors determine the progression of the frequently observed oesophageal lesion to the relatively rare but devastating complication of atrio-oesophageal fistula. Once the fistula has established, recurrent air embolization and septicaemia lead to the often fatal subsequent course. Thus, prevention of the initial oesophageal injury during the ablation procedure seems to be of utmost importance to avoid atrio-oesophageal fistula. How to prevent oesophageal injury?

The oesophagus has a very close anatomical relation with the left atrium. Within the mediastinum the oesophagus is usually located directly posterior to the left atrium. However, the anatomical relation between the oesophagus and the left atrium shows a high interindividual variability.[8,9] A detailed analysis of this anatomical relation using high-resolution computed tomography (CT) imaging revealed potential contact sites of the oesophagus to the left atrium from the posterior aspect of the left pulmonary veins all along the posterior wall of the left atrium to the posterior aspect of the right pulmonary veins.[9,10] Thus, visualization of the individual course of the oesophagus in relation to ablation sites was done using contrast media or guide wires placed in the oesophagus or by tagging the oesophagus using electro-anatomical mapping systems. The awareness of the proximity of the oesophagus to potential ablation sites led to special caution and a reduction of the radiofrequency power settings or shorter radiofrequency application times in order to avoid lesion penetration to the oesophagus. However, oesophageal damage occurred despite these preventive measures indicating that such precautions may lead to a risk reduction but not to complete avoidance of oesophageal perforation.[3] This is not surprising since additional factors, besides radiofrequency power output and application time, significantly affect the extent of radiofrequency induced lesions. The most important additional factor is the intensity of ablation electrode to tissue contact which is a crucial determinant of lesion depth. In order to obtain direct functional feedback from the oesophagus during left atrial ablation, special temperature probes with up to three thermocouples integrated have been developed to online monitor oesophageal temperature. In the largest study published so far on the value of oesophageal temperature monitoring it has been shown that maximal measured esophagal temperature was highly predictive of oesophageal injury.[7] In this study using manually driven catheter ablation supported by steerable sheath technology no oesophageal lesions were observed when the maximal intraluminal temperature was below 41°C.[7]

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In this issue of *the Journal*, Rillig *et al.*[11] report on the usefulness of oesophageal temperature monitoring during radiofrequency ablation of atrial fibrillation using a remote robotic navigation system. In their study a temperature rise in the oesophagus to more than 39°C was measured in more than 75% of patients studied although radiofrequency power output at the posterior aspects of the left atrium was reduced to 25 W. The high incidence of oesophageal temperature rise observed despite moderate radiofrequency power application may be due to the ablation technology applied: the remote robotic catheter navigation system allows intense contact between the ablation electrode and left atrial tissue. In 6 out of 42 patients (14%) that underwent post-ablation endoscopy an oesophageal lesion was observed. Comparing data from patients with and without oesophageal lesion multivariate analysis revealed that patients with a body mass index (BMI) below 26 had increased risk for developing oesophageal injury. The authors' explanation for this finding seems reasonable: patients with a lower BMI may have less adipose tissue at the posterior wall of the left atrium protecting the oesophagus from radiofrequency induced injury. Interestingly, in the study by Rillig *et al.*, maximal temperature rise measured in the oesophagus was only moderately and statistically not significantly higher in patients with compared with patients without oesophageal injury.

Thus, what is the real value of oesophageal temperature monitoring to prevent oesophageal damage during radiofrequency ablation of atrial fibrillation? Considering the data published by Rillig *et al.* and the results of the previous studies, it is obvious that temperature monitoring in the oesophagus may reduce the risk of oesophageal injury but certainly may not completely avoid oesophageal damage. In our own series of more than 1500 procedures of radiofrequency ablation of atrial fibrillation with temperature probes placed in the oesophagus, fatal atrio-oesophageal fistula occurred in one patient without documented significant temperature rise during the ablation procedure (unpublished data). One of the limitations of oesophageal temperature measurement to prevent oesophageal injury is that the oesophageal temperature probes must be meticulously replaced many times during the ablation procedure to ensure an optimal placement of the probe, i.e. a position in the closest possible proximity to the ablation site. Further improvements in fluoroscopy technology and/or electroanatomical mapping systems enabling to detect the best and safest position of temperature probes in the oesophagus to ablation sites or any other technology are warranted to reduce the risk of oesophageal damage and atrio-oesophageal fistula. However, in animal studies the oesophageal tissue temperature exceeded the luminal temperature by far (39°C luminal was associated with >80°C tissue temperature[12] indicating further limitations of temperature monitoring.

Overall, risk reduction to prevent oesophageal damage during ablation of atrial fibrillation is a key issue to make atrial fibrillation ablation procedures safer. Despite all limitations mentioned above temperature monitoring may help to further reduce the risk. However, at least with current technologies it seems not to be the solution of the problem. The observation by Rillig *et al.* that the BMI may be another important risk factor is valuable and new information. However, considering that the incidence of atrio-oesophageal fistula is very rare (app. 0.1–0.5%),[13] it is very hard to generate convincing data in controlled clinical studies for the efficacy of any safety measure aiming to prevent oesophageal complications. Currently, we have to accept that despite all preventive measures and technologies there is a residual risk for the oesophagus.

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