EDITORIAL COMMENTARY

Radiofrequency catheter ablation of cardiac arrhythmias: Don't get burned

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Over the last 4 decades, radiofrequency catheter ablation (RFA) has revolutionized the field of cardiac electrophysiology. RFA delivers a sinusoidal high-frequency current that traverses from the ablation electrode through the intervening tissue to a large dispersive pad placed on the patient's skin, termed the "indifferent electrode."[1] Extramyocardial thermal injury is a rare but recognized complication of RFA and includes direct injury to structures surrounding the myocardium (such as to a coronary artery or the esophagus) through resistive and conductive heating, and indirect injury to distant areas (such as skin burns caused by electrical arcing at the site of the dispersive pad). As RFA technologies and techniques advance, understanding and mitigating the risk of thermal injuries has become integral to refining procedural protocols, with the ultimate aim of ensuring optimal safety while improving procedural efficacy.

In this issue of *Heart Rhythm Case Reports*, Pansuriya and colleagues[2] present the case of a 68-year-old woman who developed a full-thickness skin burn at the site of the dispersive pad during re-do RFA of atrial fibrillation (AF). Pertinent factors in this case include the patient's body mass index (BMI) of 38 kg/m^2, the placement of the dispersive pad on the patient's lower back, the use of general anesthesia (GA), the relatively long duration (25 minutes) of high-power (50 W) RFA, and the use of a "drag" technique[3] rather than point-by-point ablation. The authors cite the relatively long duration of high-power RFA, excessive subcutaneous fat at the indifferent electrode site, and possible malapposition of the pad as potential contributors toward this severe complication. This case serves as a reminder of the perils of RFA and provides the opportunity to explore strategies aiming to eliminate this risk.

In the published literature, reports of skin burn following RFA of cardiac arrhythmias are extremely rare. Indeed, we identified only 5 other published reports on this subject, with a total of 12 patients sustaining burns.[4–8] In reality, this complication is likely under-reported, and the true incidence is difficult to ascertain. The most comprehensive publication, to our knowledge, reported a skin burn incidence of 0.28% (6 out of 2167 consecutive RFA procedures).[7] Patients sustaining burns had higher BMI (mean 36.6 vs 30.6 kg/m^2; $P = .044$), longer procedural times (mean 225 vs 123 minutes; $P = .035$), and higher maximum power (mean 60 vs 50 W; $P = .325$).[7] This incidence, a little over 1 in 400, may surprise some electrophysiologists, given the lack of reporting of this complication in large RFA studies and meta-analyses.[9] The aforementioned registry does not give information on burn severity, and in our experience these complications are generally mild as well as rare.

Pansuriya and colleagues postulate that high-power short-duration (HPSD) ablation may result in a higher incidence of skin burns compared with standard RFA (eg, 20–30 W for 30–60 seconds), although there is currently no evidence to support this since the introduction of HPSD ablation in the mid-to-late 2010s, or the introduction of very HPSD ablation (90 W for 4 seconds) over the last few years. Although high powers (of up to 160 W) are often cited as a causative factor toward the high incidence (of up to 3%) of severe skin burns following solid tumor RFA, these are likely owing to the combination of very high powers and long ablation delivery times (of up to 2 hours),[10] conditions that are not re-created during cardiac ablation procedures. Modern HPSD AF ablation is guided by indices such as ablation index, lesion size index, and impedance drop targets. This obligatorily limits the RFA time to typically 12–15 minutes for de novo AF ablation at 50 W.[11] As such, the 25 minutes of RFA used in the case by Pansuriya and colleagues seems excessive, especially for a redo case where only 2 pulmonary veins (PVs) were reconnected. It seems that most of the additional ablation performed in this case was extra-PV; in the absence of proven benefits of extra-PV ablation,[12] the risk-benefit ratio of delivering any ablation outside the PVs should be carefully considered.

The observation that the majority of reported patients sustaining skin burns exhibit an elevated BMI should prompt additional caution in this cohort. This association is logical, as higher BMI is generally associated with higher circuit impedance, resulting in increased temperature at the dispersive pad, predisposing to burns. In this group, alternative ablation modalities (such as cryoablation or pulsed field ablation) could be considered, if available and technically feasible. If not, meticulous skin preparation and pad

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apposition should be sought, alternate dispersive pad placement should be considered (eg, leg or chest rather than lower back[13]), and mild conscious sedation may be considered over GA, so that pain at the dispersive pad site during ablation can be reported. Indeed, this lack of pain feedback with GA has also been postulated as being a plausible contributor to the observation that esophageal injury, including the dreaded atrioesophageal fistula, has been almost exclusively described following procedures performed under GA. The placement of multiple dispersive pads, activated either simultaneously or in sequence, has been shown to reduce current at the pad site, allowing distribution of heating between the pads.[14,15] The incorporation of a thermochromic liquid crystal layer into the dispersive pad to measure underlying skin temperature has previously shown promise,[16] although detailed temperature monitoring protocols are lacking, and this technology is not routinely available.

In summary, our take-home messages from this case report are as follows: (1) although the reported incidence of skin burns following RFA is low, this is likely underestimated owing to under-reporting; (2) electrophysiologists should remain mindful of the possibility of skin burns, especially in patients with higher BMI, and consider strategies to minimize risk; and (3) future RFA registries and trials should seek to carefully document these events in order to facilitate optimal prevention strategies.

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