Coalescence of splines on a basket mapping catheter during ablation using a closed-loop irrigation catheter

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Case report
We performed pulmonary vein isolation (PVI) for treatment of symptomatic drug-refractory atrial fibrillation (AF) in a 52-year-old man by using the Constellation™ basket mapping catheter (Electrophysiology Technologies, Boston Scientific, Natick, MA, USA), which consists of 64 bipoles on 8 splines. The catheter was placed in the ostium of each pulmonary vein (PV). A 4 mm Chilli II™ internal irrigation radiofrequency (RF) catheter (Boston Scientific) was used to deliver RF energy to each PV. The irrigation rate was 36 mL/min. The target bipole was the earliest activation point of the PV ostium adjacent to the splines, with the splines placed on the atrial side of the PV antrum. Location of the catheter tip relative to the mapping catheter was confirmed by using the EnSite NavXTM three-dimensional mapping system (St Jude Medical, St Paul, MN, USA) to determine the position of the ablation catheter relative to the bipole. Furthermore, a ‘bumping’ artefact, resulting from manipulation of the ablation catheter, could be visualized on the mapping catheter. We applied RF energy at a maximum power of 32–35 W and a maximum temperature of 39–40°C. To confirm the ablation catheter’s position, we assessed for the presence of ‘bumping’ artefacts before and after RF application.

Radiofrequency applications were performed at the junction of each spline’s ostial bipole until all PV potentials disappeared. A total of 32 RF applications (446 s) were delivered, with an average power of 27.5 W and temperature of 37.6°C. Energy application was discontinued on demonstration of a >10-ohm change in impedance. By means of a heparin bolus and continuous infusion, the activated clotting time (ACT) was maintained at 303 to 322 s (blood was drawn within 20 min after the initial heparin bolus and at 20 min intervals thereafter). Intracardiac echocardiography (ICE) was performed with the ACCUSON AcuNav™ Ultrasound Catheter (Siemens Medical Solutions USA, Inc, Malvern, PA, USA).

During ablation of the left lower PV, both fluoroscopy and the NavX display of the Constellation showed that four of the splines had converged at the bipoles (i.e., the fifth and sixth bipoles on adjacent splines). In this vein, the ablation time had been 118 s, with a mean power of 22.4 W, mean temperature of 36.3°C, and maximum temperature of 37.2°C. The average impedance had been 88.5 ohms, and no fluctuation greater than 7 ohms had occurred during ablation. On detecting the spline convergence, we immediately withdrew the basket and ablation catheters and inspected them. An adherent mass of char was found to have caused four of the splines to coalesce (Figure 1). Manual manipulation of the splines dislodged multiple fragments of the char before the splines could be separated from each other.

The patient tolerated the procedure well and had no perioperative or postoperative thromboembolic events or other complications. Successful isolation of all PVs was achieved by using an external irrigation catheter (these data are not included here). At 12-month follow-up evaluation, the patient remained free of AF.

Discussion
One of the serious complications of PVI is thromboembolism, which typically occurs within 24 h of the ablation procedure but remains a high risk for the first 2 weeks.1 Factors that can potentially lead to this complication include char formation at the tip of the ablation catheter and at the site of the ablation. Such char formation has been described in previous studies. In 69 (35.5%) of 194 patients, Wazni et al.,2 detected char on the ablation catheter at the end of the procedure.

We used the Constellation catheter, a multielectrode circumferential basket mapping catheter,3 for mapping the PV ostia. With this device, multielectrode catheters are positioned at the ostium of the PVs. They simultaneously record electrical potentials from the muscular sleeves of the PVs and are currently used at many centres to verify electrical isolation of the PVs.5 Ablation energy is delivered at the proximal (atrial) side of the most proximal electrodes on a given spline.

During our procedure, ICE was not helpful in identifying char formation, which presumably preceded the coalescence of the splines. Indeed, a large amount of char was observed despite ICE monitoring, aggressive anticoagulation, and very conservative power outputs. The char formation led to coalescence of four of the splines. This phenomenon has not previously been reported. It can have serious mechanical and embolic consequences.
If we had had difficulty retracting the Constellation catheter into its sheath, the potential for surgical removal would have become manifest, especially if we had continued the ablation. Of particular concern is the fact that no specific changes in impedance or other parameters occurred to warn us of the spline convergence, which we discovered only through fluoroscopic observation.

We were fortunate that fluoroscopy and NavX mapping quickly showed the spline convergence, prompting immediate removal of the basket catheter. Quite possibly, contact between the ablation catheter and the electrodes on the basket catheter, though intermittent, created enough local power delivery and secondary thermal tissue damage to create the large amounts of char. This event is not predicted by ICE monitoring or prevented by anticoagulation. Additionally, although increased power delivery from the RF generator can potentially lead to char formation, we found no problems with our RF generator. Lower maximum settings frequently limit power delivery, even in the absence of changes in impedance. In our case, the maximum temperature achieved in the target vein was only slightly higher than 37°C. Thus, it is unlikely that the char formation would not have occurred at a lower maximum power setting (unless it was below 37°C).

During PVI, we have found the basket catheter to be extremely helpful, as it is a very stable mapping catheter that helps to further define the PV ostium. However, we now utilize only external irrigation catheters for all left atrial and ventricular procedures in which a basket catheter is used.

References
1. HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation: recommendations for personnel, policy, procedures and follow-up. A report of the Heart Rhythm Society (HRS) on Catheter and Surgical Ablation of Atrial Fibrillation developed in partnership with the European Heart Rhythm Association (EHRA) and the European Cardiac Arrhythmia Society (ECAS); in collaboration with the American College of Cardiology (ACC), American Heart Association (AHA), and the Society of Thoracic Surgeons (STS). Endorsed and approved by the governing bodies of the American College of Cardiology, the American Heart Association, the European Cardiac Arrhythmia Society, the European Heart Rhythm Association, the Society of Thoracic Surgeons, and the Heart Rhythm Society. Europace 2007;9:335–79.