INNOVATIVE TECHNIQUES

RESEARCH ARTICLE

Voltage-directed Cavo-tricuspid Isthmus Ablation using Novel Ablation Catheter Mapping Technology

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ABSTRACT. Mini electrodes within the ablation tip of the catheter more accurately identify the electrical properties of the tissue directly beneath the ablation surface. Recordings from such mini electrodes allow more precise identification of conducting bundles of the cavo-tricuspid isthmus and thus assist in the voltage-directed isthmus ablation strategy.

KEYWORDS. Atrial flutter, mini electrodes, voltage-directed ablation.

Introduction

Catheter ablation of the cavo-tricuspid isthmus (CTI) is a well-established and curative first-line therapy for patients with typical atrial flutter with success rates ~90%.1 Recurrence of CTI-dependent flutters postablation is due to reconnection through the CTI.2 One potential mechanism for this conduction recovery is insufficient effective ablation of the conducting fibers and with lack of appreciation of this due to attendant tissue edema associated with ablation. In an attempt to avoid unnecessary edema, voltage-directed CTI ablation has been developed and verified.3–6 A novel catheter with three mini electrodes within the ablation tip (IntellaTip MiFi, Boston Scientific, Boston, MA) may enhance the available data for such a signal dependent technique (Figure 1A). In this catheter, bipolar signals can be recorded between the three 0.8-mm-wide electrodes that are arranged radially 1.3 mm from the end of the catheter alongside the standard distal and proximal bipolar recordings. Animal studies have already demonstrated that the mini electrodes in this novel catheter are more accurate in identifying conducting gaps in linear ablations than conventional electrode recordings.7 Therefore, this technical paper reports on the use of mini electrodes in voltage-directed CTI ablation.

Method

The concept of the voltage-directed technique is to ablate the conducting bundles of the CTI whilst avoiding ablating the intervening non-conducting fibrous tissue (Figure 2A). In this technique, the operator first maps across the CTI by pulling back from the tricuspid valve annulus to the inferior vena cava at the 6 o’clock position. The signal voltage is noted during this pullback, and the highest voltage is identified. The operator then returns to this location and ablates it with an 8-mm dry tip for 40–60 s (60–70 W, 60–70°C); this process is then repeated until bidirectional block is achieved.

With conventional bipolar ablation catheters, the highest voltage from the distal bipole is measured over a comparatively large surface area, the midpoint of which lies at the proximal end of the ablation area (Figure 1B(i)). Theoretically, this will result in the lesion being applied slightly ahead of the highest signal. By comparison, the mini electrodes are within the ablating surface; thus, the lesion will be applied exactly where the highest signal is measured (Figure 1B(ii)). In the procedure, the mini electrodes identified the target ablation spots of maximal voltage.
Results

In all three patients included in this report, the highest voltage in pullback interrogation of the CTI was recorded in a more limited area as shown in Figure 2B. As expected, the highest voltage on the mini electrodes was slightly more proximal than the spot suggested by the conventional recordings. There was also quicker signal diminution on ablation as shown in Figure 2B. Figure 3 demonstrates that there was greater diminution of the mini electrode recordings at the end of the ablation compared to the conventional distal bipole (mean amplitude reduction 77 ± 21% versus 57 ± 26%, p<0.05). After the first three ablations, the signals on the conventional electrodes were low amplitude across the 6 o’clock position. At this point, the mini electrodes became a very useful adjunct for identifying remaining viable tissue on the line. Figure 4 shows the spot of the fourth ablation where sustained bidirectional block was obtained. The mini electrodes clearly show sharp viable tissue that would not have been detected by the conventional distal bipole signal. If anything, the proximal bipole in this location represents a more attractive ablation target, and the operator would have tried to pull back onto this without the mini electrodes.

Discussion

First line management of symptomatic atrial flutter with catheter ablation is standard. The more efficient technique of voltage-directed CTI ablation is becoming more widespread in its application. This report shows the potential value of a novel catheter with mini electrodes in a technique that relies on signal amplitude. The mini electrodes allowed more precise localization of the points with the highest amplitude, potentially allowing more effective RF application. The mini electrodes also facilitated the identification of viable tissue in previously ablated areas, which is in agreement with prior animal research7 and a clinical case report.8 As observed in animal studies,7 the mini electrodes exhibited greater diminution of the signal amplitude compared to conventional electrodes.

Summary

The mini electrodes within the ablation tip provide greater spatial resolution and facilitate the detection of gap signals, which could improve the outcomes of voltage-guided CTI ablation.
Figure 2: Panel A depicts the bundles within the CTI. Panel B shows the recording during pullback from the TV to IVC. There is diminution of the signal amplitude recorded from the mini electrode recordings, while the signal amplitude of the conventional ablation distal bipole recording appears to increase (ABL: ablation; CS: coronary sinus; D: distal; IVC: inferior vena cava; ME: mini electrodes; M: middle; P: proximal; RV: right ventricle; TV: tricuspid valve).
Figure 3: Panel A shows the recording during ablation, which reveals quicker amplitude reduction during ablation in mini electrodes than in conventional ablation bipoles. Panel B shows the amplitude in bipolar recordings at the start (red) and end (white) of the ablation. (Con: Conventional distal bipolar recording; 1–2: recording between mini electrode 1 and 2; 2–3: recording between mini electrodes 2 and 3; 3–1: recording between mini electrodes 3 and 1).
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References


Figure 4: Recordings pre-ablation at the position where bidirectional block was obtained. The conventional distal bipole shows a lower amplitude and slurred signal consistent with a previously ablated site. By comparison, the recordings from the mini electrodes showed a sharp, larger amplitude identifying the surviving fibers within the remaining bundle.