Right Ventricular Pacing for Assessment of Cavo-Tricuspid Isthmus Block

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Abstract

Background: Cavo-tricuspid isthmus (CTI) dependent atrial flutter is typically treated with cardiac ablation. Standard techniques to assess CTI block after ablation can be technically challenging. Right ventricular (RV) pacing may allow for another technique to assess CTI block after ablation.

Objective: The purpose of this study was to evaluate RV pacing as a method to assess CTI block after ablation of CTI dependent atrial flutter, and define endpoints of ablation using this technique.

Methods: 28 patients undergoing ablation of CTI dependent atrial flutter with intact ventriculoatrial (VA) conduction were prospectively enrolled in this study and underwent the RV pacing protocol, as well as standard coronary sinus (CS) pacing techniques to assess CTI block.

Results: The mean trans-isthmus conduction interval during CS pacing (TICICS) at 600 and 400ms after CTI ablation was 168 +/- 9ms and 175 +/- 18ms, respectively. The mean trans-isthmus conduction interval during RV pacing (TICIRV) at 600ms and 400ms after CTI ablation was 109 +/- 5ms and 111 +/- 5ms, respectively. A TICIRV >100ms was associated with a successful outcome after CTI ablation.

Conclusions: RV pacing may add incremental value in the assessment of CTI block in patients undergoing ablation of CTI dependent atrial flutter.

Introduction

Typical atrial flutter dependent on the cavo-tricuspid isthmus (CTI) is a common arrhythmia frequently treated with radiofrequency (RF) ablation. Bidirectional CTI block is the standard endpoint for ablation of atrial flutter. Methods to assess bidirectional CTI block, including changes in electrogram (EGM) polarity, measurement of trans-isthmus conduction interval (TICI), and an interval between double potentials (DPs) > 110ms along the ablation line can be difficult to assess. Right ventricular (RV) pacing has been shown to be helpful in assessing CTI block, but this technique has not been validated and specific endpoints to determine CTI block have not been defined. The purpose of this study was to evaluate the utility of RV pacing in patients undergoing ablation for CTI-dependent atrial flutter and to define specific endpoints associated with bidirectional CTI block.

Methods

Study Population

A total of 33 consecutive patients who underwent radiofrequency (RF) catheter ablation of CTI-dependent atrial flutter were prospectively enrolled in this study. Patients were excluded from the study if they were under 18 years of age, pregnant, or had undergone a previous CTI ablation. Patients without ventriculoatrial (VA) conduction, identified during the ablation procedure, were subsequently excluded. The protocol was approved by the Medstar Institutional Review Board. Patients provided written informed consent for all procedures.

Atrial Flutter Ablation: Study Protocol

Sedation was provided by electrophysiology (EP) laboratory nursing staff or an anesthesiologist. Access was obtained via the right femoral vein. A 7F deflectable duo-decapolar catheter (Boston Scientific, San Jose, CA; M004 20SL22025 with 2/20/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2mm spacing) was positioned around the tricuspid annulus (TA) in the right atrium (RA) with the distal electrode pair (RA 1-2) placed in the coronary sinus (CS) ostium. Electrode pair RA 3-4 was located lateral to the planned CTI ablation line (Figure 1). Through an 8F 60cm sheath (St. Jude Medical, St. Paul, MN; RAMP, 406898), a 10mm RF ablation catheter (Boston Scientific, San Jose, CA; Blazer II XP, M004 4790T/HMK20) was positioned on the CTI. A 5F quadripolar catheter (St. Jude Medical, St. Paul, MN; M0045404S0) was positioned in the RV apex (Figure 1).

Patients presented to the EP laboratory in either sinus rhythm or atrial flutter. Patients in atrial flutter underwent pacing with concealed entrainment to confirm CTI dependence of the atrial flutter. Patients in atrial flutter were cardioverted to sinus rhythm with a 200J synchronized shock. RV pacing was performed to ensure

Key Words:

Atrial Flutter Ablation, Cavo-Tricuspid Isthmus, Right Ventricular Pacing, Bidirectional Block.
intact retrograde VA conduction.

Once in sinus rhythm, pacing at two different cycle lengths (600ms and 400ms) from the CS ostium and RV apex was performed. When pacing from the CS ostium, the trans-isthmus conduction interval (TICI\textsubscript{CS}) was measured from the pacing stimulus to the local EGM on the pair of electrodes of the duo-decapolar catheter (RA 3-4) located immediately lateral to the planned ablation line on the CTI. When pacing from the RV apex, the trans-isthmus conduction interval (TICI\textsubscript{RV}) was measured from the local EGM on the distal electrode pair (RA 1-2) of the duo-decapolar catheter located at the CS ostium to the pair of electrodes (RA 3-4) located immediately lateral to the planned ablation line on the CTI.

Endpoints

The TICI\textsubscript{RV} after CTI ablation was the primary endpoint. Secondary endpoints included the TICI\textsubscript{CS}, differences in TICI\textsubscript{CS} and differences in TICI\textsubscript{RV} pre- and post- CTI ablation, as well as differences in TICI\textsubscript{CS} and differences in TICI\textsubscript{RV} when pacing at two different cycle lengths.

Follow up

All patients were followed until hospital discharge. At one month, patients were evaluated for symptoms at an office visit, and an ECG was obtained. A Holter or event monitor was performed if symptoms suggested recurrent atrial flutter.

Statistical Analysis

28 patients undergoing atrial flutter ablation were included in the analysis. Five patients were excluded due to the absence of retrograde VA conduction during RV pacing, which is required for this diagnostic maneuver. Continuous data were expressed as the mean +/- standard deviation. Univariate comparisons were performed on all continuous variables with either unpaired T test or analysis of variance, as appropriate. Categorical variables were compared with Chi-square analysis. All statistical analyses were performed using SAS version 9.1 (SAS Institute, NC). A p value < 0.05 was considered statistically significant.

Results

Clinical Characteristics

Twenty-eight of 33 (84.9%) patients undergoing ablation of CTI dependent atrial flutter had intact retrograde VA conduction and were included in this analysis. The mean age was 60.7 +/- 15.0 years.
Baseline clinical characteristics of patients undergoing atrial flutter ablation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean +/- STD</th>
</tr>
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<tbody>
<tr>
<td>Age (years)</td>
<td>60.7 +/- 15.0</td>
</tr>
<tr>
<td>Male sex (%)</td>
<td>78.6</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>31.2 +/- 7.6</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>39.3</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>89.3</td>
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<tr>
<td>Coronary disease (%)</td>
<td>25.0</td>
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<tr>
<td>Prior CVA (%)</td>
<td>17.9</td>
</tr>
<tr>
<td>Ejection Fraction (%)</td>
<td>49.7 +/- 15.8</td>
</tr>
<tr>
<td>Medications (%)</td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>53.6</td>
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<tr>
<td>Beta-blocker</td>
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<tr>
<td>ACE-I/ARB</td>
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<tr>
<td>Warfarin</td>
<td>17.9</td>
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<tr>
<td>Anti-arrhythmic</td>
<td>10.7</td>
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</tbody>
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Comparison of TICI\textsubscript{RV} with Previous Endpoints

Right ventricular (RV) pacing overcomes these challenges of coronary sinus pacing, allowing for stable and reliable pacing, eliminates the issue of latency with atrial capture, and provides an accurate measurement of TICI\textsubscript{RV}; hence, it is helpful in assessing CTI block. Previous studies have shown that RV pacing can aid in the assessment of CTI block, but have not provided specific endpoints for ablation.\textsuperscript{7}

In the current study, we defined TICI\textsubscript{RV} as the interval between the distal pair of electrodes on the duo-decapolar catheter located at the CS ostium. Hence, methods to assess CTI block with CS pacing have limitations.
the CS ostium and the pair of electrodes positioned on the CTI just lateral to the planned ablation line. Once CTI block is achieved, the distance between the medial and lateral electrodes is slightly shorter with the TICI$_{RV}$ as opposed to that of DPs, where the medial and lateral potentials are recorded on the CTI ablation line. Therefore, it is expected that with CTI block, less time is required to inscribe the medial and lateral electrodes with TICTRV than when recording DPs. In the current study, a TICI$_{RV}$ > 100ms after ablation of CTI dependent atrial flutter is shorter than the duration expected with DPs, i.e., > 110ms$^6$ and was associated with excellent outcomes.

Limitations

RV pacing to assess CTI block has at least three limitations. First, patients without intact retrograde VA conduction cannot utilize RV pacing in the assessment of CTI block. In this study, this occurred 15% of the time and the use of RV pacing was precluded. Isoproterenol may have improved VA conduction and allowed for the use of RV pacing in the assessment of CTI block, but was not administered to patients in this study. Second, DPs were not measured during RV pacing. Electrophysiologically, this is likely the gold standard to assess bidirectional block. However, DPs are difficult to assess after CTI ablation with a 10mm tip RF ablation catheter. Third, data regarding partial but not complete CTI block was not collected. However, a comparison of the TICI$_{RV}$ before and after the achievement of complete CTI block was performed, and as expected, was slightly less than DPs. Finally, lateral RA pacing was not performed pre- and post-CTI ablation to confirm true bidirectional block. However, after CTI ablation, unidirectional block is not common.

Clinical Implications

Data evaluating the use of RV pacing as a method to assess CTI block during ablation of CTI dependent atrial flutter have been limited. RV pacing allows for accurate assessment of TICI$_{RV}$ along the CTI ablation line. These results demonstrate that a TICI$_{RV}$ > 100ms is associated with excellent outcomes after ablation of CTI dependent atrial flutter, and should be considered for verification of bidirectional CTI block.

References