Comparison of remote magnetic versus manual catheter navigation for ablation of atrioventricular nodal reentry tachycardia

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Objective  The purpose of this study was to compare remote magnetic catheter navigation with manual navigation for the ablation of atrioventricular nodal reentry tachycardia (AVNRT). Methods  From November 2007 to November 2009, 30 consecutive patients with AVNRT received radiofrequency ablation in the Institute of Geriatric Cardiology. Of them, 14 were treated with remote magnetic navigation (RMN) and 16 with manual catheter navigation (MCN). Total fluoroscopic time, procedure time, procedural success rate, and complication rate were compared between the two groups. Results  Total fluoroscopy time and precise orientation time were reduced in RMN group compared to MCN group (7.5 ± 0.3 min vs 13.9 ± 5.3 min, and 1.0 ± 0.3 min vs 3.2 ± 0.6 min, respectively, both P < 0.05). Procedural success rates in both groups were 100% and no AVNRT recurred in all patients during 3 months’ follow-up. The number of lesions delivered was less for RMN group (3.4 ± 1.1 vs 6.3 ± 2.2, P < 0.05). Total procedure time (25.6 ± 7.5 min vs 27.5 ± 6.2 min, P > 0.05) was similar between the 2 groups. No procedural complications occurred in both groups. Conclusions  RMN for mapping and ablation of AVNRT significantly reduce precise orientation time, total fluoroscopy time and number of lesions delivered compared to the conventional technique of manual steering of deflectable catheters. Remote magnetic control mapping and ablation of AVNRT is more safe and feasible (J Geriatr Cardiol 2010; 7:7-9).

Key words  magnetic navigation; radiofrequency ablation; atrioventricular nodal reentry tachycardia

Introduction

Catheter ablation of atrioventricular nodal reentry tachycardia (AVNRT) has steadily progressed since it was introduced in the 1980s. Although considerable improvements have been made in computerized mapping and cardiac imaging, traditional ablation methods still rely upon manual manipulation to move the catheters within the heart. Recently, a novel remote magnetic navigation (RMN) system has been introduced that allows the use of magnetic fields to position a specific-designed mapping and ablation catheter precisely to any desired site within the cardiac chambers. Early studies have established safety and feasibility of performing catheter ablation via magnetic navigation in a variety of clinical contexts, including AVNRT, accessory pathways, atrial flutter, and atrial fibrillation. We report our initial experience in 30 consecutive cases of AVNRT treated with RMN and manual catheter navigation (MCN) methods for the ablation of AVNRT and compare the safety and efficacy.

Study population

From September 2007 to September 2009, 30 consecutive patients with documented AVNRT admitted in the Institute of Geriatric Cardiology, Chinese PLA General Hospital, for catheter radiofrequency ablation were recruited. Of them, 14 were treated with remote magnetic navigation (RMN group) and 16 with manual catheter navigation (MCN group). The study protocol was approved by the Ethics Committee of the PLA General Hospital and written informed consent was obtained from all patients.

Electrophysiological procedure

In both groups, the electrophysiology procedures were performed when patients were in the fasting state, and all antiarrhythmic drug therapy was discontinued at least five half-lives before the procedure. Multipolar electrode catheters were inserted via a femoral or subclavian vein and positioned in the high lateral right atrium, coronary sinus, His bundle, and right ventricle, respectively. Pacing was performed at twice the diastolic threshold with a programmable stimulator using stimuli that had a duration of 2 ms. Standard techniques were used to measure conduction proper
ties and to induce tachycardia. In all patients, typical AVNRT was induced either before or after the use of isoprenaline. The presence of dual AV-nodal conduction was assessed, and accessory pathways were excluded.

Magnetic navigation
Stereotaxis Niobe II system was implemented in our electrophysiology laboratory equipped with a flat-panel mono-plane fluoroscopy system (Philips Medical Systems). A uniform magnetic field of 0.08 Tesla is created between two large magnets, one on each side of the patient and diametrically opposed. When engaged, the navigation system changes the orientation of the magnets in response to user command and the result is a new magnetic field vector. A catheter containing three small permanent magnets near its tip is introduced into the heart and responds to the applied magnetic field vectors in three dimensions (3D). The tip of the catheter can be deflected or straightened, and in conjunction with a translational system (Cardiodrive, Stereotaxis), can be steered in a versatile fashion within cardiac chambers. The controls for magnetic field modulation include a joystick for catheter translation and keyboard commands for incrementing or decrementing the magnetic field vector in 3D. Precision is on the order of 1 mm for catheter distance control and 1 degree for vector changes in three axes.

Ablation procedures
For the MCN group, 4-mm tip ablation catheter was used. The investigator used manual manipulation to advance, retract, and deflect the tip of the catheter to reach the endocardial target locations. For the RMN group, the Cardiodrive system was used to advance and retract the 4-mm magnetic ablation catheter in the body from a remote workstation. The catheter manipulation was performed under fluoroscopic and electrocardiographic guidance. The prespecified endpoints for procedural success were defined elimination of AV nodal reentrant tachycardia inducibility, or achievement of complete AV block for AV junctional ablation. The complete elimination of single echo beats and discontinuous AV nodal conduction curves were not required endpoints for ablation of AV nodal reentrant tachycardia.

Definition of outcomes
The procedural time charted typically began with physician application of lidocaine to the groin and ended when catheters were removed from the body. Fluoroscopy time directly reflected operator activation of the fluoroscopy beam via foot pedal. Precise orientation time began from inserting ablation catheter and ended when obtaining stable target electrogram.

Follow-up
After the procedure, all antiarrhythmic medications were stopped in all patients. All patients were seen in an outpatient clinic 3 months after the procedure.

Statistical analysis
Continuous variables are expressed as median with range values and compared using the Student’s t-test. For categorical variables, the Pearson chi-square test (or the exact Fisher test when applicable) was performed. A P value < 0.05 was considered significant. Statistical tests were performed with SPSS for Windows (version 13.0, SPSS, Inc., Chicago, IL, USA).

Results

Baseline clinical characteristics
Baseline clinical characteristics are shown in Table 1. There were no significant differences between the two groups in baseline characteristics.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>RMN group</th>
<th>MCN group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>14</td>
<td>16</td>
<td>0.0001</td>
</tr>
<tr>
<td>Age (years)</td>
<td>50.2±10.5</td>
<td>48.3±9.2</td>
<td>0.60</td>
</tr>
<tr>
<td>Male (n, %)</td>
<td>4(28.6)</td>
<td>5(31.3)</td>
<td>0.12</td>
</tr>
<tr>
<td>Heart Disease (n, %)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>11(78.6)</td>
<td>12(75.0)</td>
<td></td>
</tr>
<tr>
<td>Ischemic</td>
<td>1(7.1)</td>
<td>1(6.3)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>2(14.3)</td>
<td>3(18.7)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Procedural characteristics
Total fluoroscopy time was reduced in RMN group compared to MCN group (7.5±0.3 min vs 13.9±5.3 min, P<0.05). Precise orientation time was also reduced in RMN group compared to MCN group (1.0±0.3 min vs 3.2±0.6 min, P<0.05). The number of lesions delivered was less for RMN group (3.4±1.1 vs 6.3±2.2, P<0.05). Actual power was less for magnetic navigation (16.3±7.6 vs 25.7±8.4, P<0.05). Total procedural time (25.6±7.5 vs 27.5±6.2, P>0.05) was similar between RMN and MCN groups. No complications occurred in both groups (Table 2).

Procedural success rate and 3-month clinical outcomes
Procedural success rate in both groups were 100% and no AVNRT reoccurred in all patients during 3 months follow-up.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>RMN group</th>
<th>MCN group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>14</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Fluoroscopy time (min)</td>
<td>7.5±0.3</td>
<td>13.9±5.3</td>
<td>0.0001</td>
</tr>
<tr>
<td>Total procedure time (min)</td>
<td>25.6±7.5</td>
<td>27.5±6.2</td>
<td>0.454</td>
</tr>
<tr>
<td>Number RF lesions</td>
<td>3.4±1.1</td>
<td>6.3±2.2</td>
<td>0.0001</td>
</tr>
<tr>
<td>Actual power (watts)</td>
<td>16.3±7.6</td>
<td>25.7±8.4</td>
<td>0.0034</td>
</tr>
</tbody>
</table>
Discussion

The main finding of the study is that magnetic navigation for mapping and ablation of common supraventricular arrhythmias significantly reduces precise orientation time, total physician fluoroscopy time, and number of ablation lesions compared to the conventional technique of manual steering of deflectable catheters.

Precise orientation of ablation catheter depends mostly on operators experience when using the conventional technique of manual steering of deflectable catheters. However, it is possible to move the ablation catheter in extremely small increments of 1 degree or 1 mm within the heart using magnetic navigation. So this system can supply extremely high accuracy in positioning and repositioning of the catheter tip within 1 mm of the desired location in cardiac chambers. This characteristic may reduce precise orientation time and total physician fluoroscopy time.

Physician fluoroscopy time is also related to stability of the ablation catheter. Fluoroscopy is particularly important during RF application to verify stability of the ablation catheter and avoid inadvertent damage to adjacent structures. Magnetic catheter position is extremely stable when compared with standard catheters, even when patients tend to take deep breaths, and during junctional ectopy or accelerated junctional rhythm. These characteristics also decrease the number of RF applications.

The results of this study also demonstrated similar acute and 3 months success rates of catheter ablation with magnetic navigation compared to the manual technique. Wood et al. compared remote magnetic catheter navigation to manual navigation for the ablation of common supraventricular arrhythmias in a multicenter, randomized trial. Their results showed magnetic navigation for mapping and ablation of SVT requires less fluoroscopy and fewer RF applications compared to conventional manual catheter manipulation with equivalent success rates, procedural duration, and safety. Kerzner et al. retrospectively compared the results of mapping and ablation with magnetic navigation versus conventional manipulation for AV nodal reentrant tachycardia. Total procedure time, fluoroscopy time, and success rates were similar in the two groups.

In agreement with previous reports, we have seen no complications using magnetic catheter navigation for ablation of AVNRT in our previous studies. Most important complications of ablation of AVNRT are cardiac perforation and atrioventricular nodal block. Since the tip of the magnetic catheter is soft and stable, there are reduced risks of perforation and atrioventricular nodal block during the catheter manipulation.

There were several limitations in this study. First, this study was retrospective and non-randomized design. Second, the relatively small number of patients was another limitation of this study. Third, long-term follow-up is needed to further determine if the efficacy is different between the two groups.

In conclusion, magnetic navigation for mapping and ablation of AVNRT requires shorter time to reach the RF target, less fluoroscopy and fewer RF applications compared to conventional manual catheter manipulation with equivalent success rates, procedural duration, and safety.

References