Atrio-ventricular conduction following radiofrequency ablation for atrio-ventricular node reentry tachycardia in children

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Aims
The study was designed to assess atrio-ventricular (AV) conduction with non-invasive methods at least 1 year after radiofrequency ablation (RFA) of the slow pathway for AV node reentry tachycardia.

Methods and results
Medical records of all patients who underwent RFA before their 18th birthday were reviewed. Patients were brought back for clinical evaluation, an electrocardiogram, an exercise stress test, and ambulatory Holter monitoring. Radio-frequency ablation of the slow pathway above the ostium of the coronary sinus was done in 106 children. No procedure resulted in high degree AV block. Follow-up evaluation was possible in 67 patients (63% of the total cohort) who were brought back to the clinic 1–13.7 years, mean 4.7 ± 3.0 years after the procedure. Dizzy spells were reported by 36% of examined patients and 2 patients reported syncope. PR intervals were normal in all but two patients when compared with published normal values. One patient presented with persistent, post-procedural first-degree AV block and another developed new onset, symptomatic second degree AV block 2 years after the procedure and required pacemaker implantation.

Conclusion
Non-invasive testing showed normal PR intervals in a cohort of patients who underwent RFA of the slow pathway in childhood or adolescence. Late AV block occurred in one child. Clinical evaluation more than a year after the procedure is warranted in symptomatic patients.

Keywords
Atrio-ventricular reentry tachycardia • Radiofrequency ablation • Atrio-ventricular node • PR interval • Atrio-ventricular block • Children
A two-sample t-test was used to compare our data set with normal values published by Lue.5

Results

Radiofrequency ablation for AVNRT was performed in 106 patients. All patients had normal hearts except for one child with documented viral myocarditis in the past and another with non-obstructive hypertrophic cardiomyopathy. All patients underwent RFA of the slow pathway at or above the ostium of the coronary sinus (CS) with a 4 mm tip electrode catheter. The endpoint for RFA was non-inducibility of AVN reentry of more than one echo beat. No RFA procedure resulted in AV conduction defect or any other ECG abnormality except for one patient with new I° AV block and two patients with new right bundle branch block (RBBB). These three patients are included in the follow-up group.

Follow-up group

Sixty-seven patients at the age of 10–28.7 years (mean 17.7 ± 4.9 years) were brought back to the clinic for evaluation (63% of the total cohort). Twelve patients could not be reached because of unavailable contact information, 9 refused to enter the study, and 18 could not present to the study centres for investigations due to a long distance to travel. The follow-up time was 1–13.7 years, mean 4.7 ± 3.0 years.

Seven patients underwent two procedures and one patient underwent three procedures. At follow-up, two patients gave a history of rapid paroxysmal tachycardia. Atrio-ventricular node reentry tachycardia was documented in one patient and new ectopic right atrial tachycardia in another. No patient presented with recurrent tachycardia more than 6 months after the procedure. Junctional rhythm was induced by RFA application in 68/77 (88%) procedures.

All six patients with transient AVB from RFA or catheter trauma at the time of the procedure had normal ECGs prior to discharge home. None of them gave history of syncope or dizzy spells and all PR intervals were normal at the time of follow-up evaluation.

Table 1 shows characteristics of the study group and the total cohort.

Table 1 Characteristics of the study group and the total atrio-ventricular node reentry tachycardia cohort

<table>
<thead>
<tr>
<th></th>
<th>Study group (n = 67)</th>
<th>Total cohort (n = 106)</th>
</tr>
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<tbody>
<tr>
<td>Male gender</td>
<td>22 (33%)</td>
<td>39 (37%)</td>
</tr>
<tr>
<td>Age range (mean)</td>
<td>5.1–18 (13.1)</td>
<td>4–18 (13.5)</td>
</tr>
<tr>
<td>Patients younger than 10 years</td>
<td>14 (21%)</td>
<td>17 (16%)</td>
</tr>
<tr>
<td>Number of RFA procedures (per patient)</td>
<td>77 (1.15)</td>
<td>119 (1.12)</td>
</tr>
<tr>
<td>RFA success after redo procedures</td>
<td>94%</td>
<td>93%</td>
</tr>
<tr>
<td>Number of RFA applications (mean ± SD)</td>
<td>1–28 (9 ± 7)</td>
<td>1–28 (9 ± 6)</td>
</tr>
<tr>
<td>Intra-procedural complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete AV block</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I° AV block</td>
<td>1 (1.5%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Right bundle branch block</td>
<td>2 (3%)</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Transient AV block</td>
<td>6 (9%)</td>
<td>8 (8%)</td>
</tr>
</tbody>
</table>

Table 1

General symptoms

Syncope was reported by two patients. One patient reported syncope with recurrent paroxysmal tachycardia and one child presented with syncope produced by new onset AV block.

Lightheadedness or dizzy spells were reported by 24 patients (36%). These symptoms accompanied recurrent paroxysmal tachycardia (two), palpitations (three), anxiety (one), migraine headaches (one), and new onset AV block (one). Sixteen patients (24%) gave history typical for orthostatic or vasovagal hypotension.

Exercise tolerance was reported as normal by 58 patients (87%), better than average by 8 patients, and worse than average by 1 patient.

PR interval evaluation

ECG, Holter, and stress test PR interval measurements are summarized in Table 2.

An ECG was normal in 57 patients (85%). The PR interval was normal in 65 patients (97%). Radiofrequency ablation induced I° AVB persisted in one patient (PR 260 ms) and RBBB in two patients. There were no new ECG abnormalities when compared with the post-procedural recordings except for the child with new onset AVB and syncope (PR 210 ms).

A treadmill exercise stress test was done in 55 patients (82%). Five patients refused stress testing and seven patients missed a scheduled test. All but two patients reached 85% predicted maximum heart rate for age. The PR interval was normal in all patients except for the patient with persistent post-procedural I° AVB (PR 260–270 ms at baseline and in recovery, and 150 ms at peak exercise), and the child with new AVB and syncope (PR 240 ms at baseline and in recovery, and 120 ms at peak exercise).

An ambulatory Holter monitor was done in 57/67 patients (85%). Seven patients refused testing and three patients missed a scheduled test. Holter monitors showed minimum heart rates 35–63 bpm (51 ± 8 bpm), maximum heart rates 125–202 bpm (156 ± 21 bpm), and average heart rates 64–104 bpm (82 ± 34 bpm).
10 bpm). These values were normal for age in all patients. Infrequent, brief periods of Wenckebach AV block during sinus bradycardia while asleep were recorded in five patients. One of them, a competitive hockey player, presented with infrequent orthostatic lightheadedness. All five patients had normal PR measurements by all diagnostic tests.

The only patient with abnormal Holter results and PR prolongation by all diagnostic tests was the young boy presenting with new onset daily lightheadedness and syncpe 2 years after RFA at 9 years of age (weight 32 kg). The underlying cardiac anatomy was significant for a dilated coronary sinus (CS) draining a left superior vena cava (SVC). Three Holter monitors showed frequent episodes of I\(^\text{st}\) and II\(^\text{nd}\) type I AVB and 2:1 AVB which correlated with symptoms. Symptoms resolved after implantation of a dual chamber pacemaker.

**Discussion**

This study evaluated patient symptoms and PR intervals at mid-term follow-up after RFA of the slow pathway for AVNRT in children and adolescents. Results showed normal resting PR intervals in 65/67 patients when compared with the published standard values for adolescents.\(^5–7\) Based on normal PR intervals recorded by non-invasive testing, we conclude that AV node conduction was normal in 97% enrolled patients.

One female patient had persistent, asymptomatic, RFA produced I\(^\text{st}\) AV block 4.7 years after the procedure. Wang et al.\(^8\) showed that a prolonged PR interval following RFA for AVNRT in adults was not associated with late development of high grade AV block at 38 ± 12 months follow-up. Adult patients with PR prolongation prior to the procedure are not at risk of progression to higher grade AV conduction defect following RFA for AVNRT.\(^9\)

Six patients had documented type I second degree AV block by Holter monitoring. In all but one patient, infrequent brief periods of Wenckebach AV block could have been produced by increased parasympathetic tone. Only one patient presented with syncpe and new onset I\(^\text{st}\) and II\(^\text{nd}\) AV block recorded by all diagnostic tools 2 years after RFA. In this child, clinical evaluation with an ECG, a Holter monitor, and an exercise stress test 10 weeks after the procedure showed normal PR intervals. By that time, healing of all RFA lesions should have been complete.\(^10\) The only patient with abnormal Holter results and PR prolongation by all diagnostic tests was the young boy presenting with new onset daily lightheadedness and syncpe 2 years after RFA at 9 years of age (weight 32 kg). The underlying cardiac anatomy was significant for a dilated coronary sinus (CS) draining a left superior vena cava (SVC). Three Holter monitors showed frequent episodes of I\(^\text{st}\) and II\(^\text{nd}\) type I AVB and 2:1 AVB which correlated with symptoms. Symptoms resolved after implantation of a dual chamber pacemaker.

**Table 2 PR interval measurements compared to published normal values**

<table>
<thead>
<tr>
<th>Test</th>
<th>Study group</th>
<th>Davignon et al.</th>
<th>Garson</th>
<th>Lue</th>
<th>t-test</th>
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<tbody>
<tr>
<td>ECG</td>
<td></td>
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<tr>
<td>PR range</td>
<td>80–172</td>
<td>92–175</td>
<td>80–220</td>
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<tr>
<td>Mean ± SD</td>
<td>134 ± 17</td>
<td>135</td>
<td>140</td>
<td>140 ± 17.94</td>
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<tr>
<td>Holter</td>
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<td>PR minimum</td>
<td>80–140</td>
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<tr>
<td>Mean ± SD</td>
<td>109 ± 17</td>
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<tr>
<td>PR maximum</td>
<td>120–220</td>
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<tr>
<td>Mean ± SD</td>
<td>155 ± 22</td>
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<tr>
<td>Stress test</td>
<td></td>
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<tr>
<td>Resting PR</td>
<td>90–180</td>
<td>81–207</td>
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<tr>
<td>Mean ± SD</td>
<td>137 ± 18</td>
<td>130</td>
<td>137 ± 18.53</td>
<td>ns</td>
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<tr>
<td>Peak stress PR</td>
<td>80–120</td>
<td>57–138(^b)</td>
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<tr>
<td>Mean ± SD</td>
<td>96 ± 12</td>
<td>108(^b)</td>
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<tr>
<td>Recovery PR</td>
<td>110–200</td>
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<tr>
<td>Mean ± SD</td>
<td>138 ± 19</td>
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</tbody>
</table>

\(^a\)Both patients with I\(^\text{st}\) and II\(^\text{nd}\) AV block were excluded from this group.

\(^b\)PR intervals at different heart rates were not obtained by exercise stress testing.
Radiofrequency ablation for AVNRT in children

None of our six patients with transient AVB from catheter trauma or trauma to the AV node during RFA presented with syncope or PR prolongation at follow-up. A prospective study on catheter trauma in patients aged 9–92 years showed that such trauma is relatively common especially in younger patients.22 Transient AV conduction block at the time of RFA was not associated with late onset AV block in the report by the Pediatric Radiofrequency Ablation Registry.15 However, late occurrence of high-grade AV block following RFA trauma to the AV node was described in an adult patient.23

Conclusions

Non-invasive testing showed normal PR intervals in a cohort of patients who underwent RFA of the slow pathway for AVNRT in childhood or adolescence. Late onset AV block occurred in one child. Clinical evaluation more than a year after the procedure is warranted in symptomatic patients.

Limitations

Partial enrolment of the target study cohort might not have allowed for identification of all patients with AV conduction defects. Nevertheless the total patient cohort and the study group were very similar in regards to demographic and procedural characteristics. Not all patients in the study group had all diagnostic tests done. Function of the AV node was inferred from PR interval measurements by non-invasive methods only.

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Conflict of interest: none declared.

References