Characteristics of recurrent clockwise atrial flutter after previous radiofrequency catheter ablation for counterclockwise isthmus-dependent atrial flutter

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Received 22 November 2011; accepted after revision 29 February 2012; online publish-ahead-of-print 23 March 2012

Aims

Isthmus-dependent (ID) clockwise (CW) atrial flutters (AFl) are rare in comparison with counterclockwise (CCW) AFl. Little is known about clinical and electrophysiological characteristics of CW AFl occurring after previous radiofrequency (RF) catheter ablation of CCW AFl. We sought to compare CW AFl de novo vs. CW AFl occurring after previous CCW AFl RF ablation.

Methods and results

A total of 246 procedures of RF catheter ablation for AFl from January 2009 to January 2011 were reviewed. Clinical and electrophysiological data were analysed. Patients were excluded if they were in sinus rhythm at the beginning of the procedure, if they had concomitant/previous atrial fibrillation ablation, or if AFl was not ID. Twenty-seven patients presented CW AFl (10.9% of all ID AFl), including 10 CW AFl occurring after a previous RF catheter ablation for CCW AFl. Mean time for recurrence after the previous procedure of CCW AFl RF ablation was 3.5 years. They were younger (61.6 ± 11 years) than patients with CW AFl de novo (74.0 ± 7.2 years; P = 0.005). Bidirectional isthmus block was obtained in all patients. There was a significant difference in terms of double potential separation after ablation (155 ± 31 ms for CW AFl de novo vs. 111 ± 7 ms for recurrent CW AFl; P = 0.028). No differences were observed concerning CHADS score, AFl cycle length, and electrocardiogram typical pattern for CW AFl between the two groups.

Conclusion

Patients with CW AFl occurrence after CCW AFl RF catheter ablation are younger than patients with CW AFl de novo. They also have a smaller interspike interval after block completion.

Keywords

Clockwise atrial flutter • Radiofrequency ablation

Introduction

Radiofrequency (RF) catheter ablation has become the standard treatment for isthmus-dependent (ID) atrial flutter (AFl). According to their rotation in the right atrium (RA), ID AFl may be counterclockwise (CCW) or clockwise (CW). The second variety is far less frequent than CCW AFl (10–15%). Clockwise atrial flutter (also called ‘reverse’ AFl) has the same circuit as CCW AFl, but in a reverse direction and shares the same anatomical and functional barriers. The electrocardiogram (ECG) pattern for CW AFl includes broad positive deflections in the inferior leads, but more specifically, wide negative deflections in V1.6 Radiofrequency catheter ablation of ID AFl has a high success rate and the rate of recurrence is very low (5%) if a persistent bidirectional isthmus block has been achieved. Recurrence after ablation of CCW ID AFl may have either of the two forms. But little is known about clinical and electrophysiological characteristics of CW AFl, occurring after a previous procedure of CCW AFl RF catheter ablation.
We sought to compare clinical and electrophysiological features of ‘recurrent’ CW AFI with de novo CW AFI.

Methods

Files of all consecutive patients ablated for ID AFI from January 2009 to January 2011 in our institution (University Hospital La Timone, Marseille, France) were reviewed. Patients with concomitant/previous atrial fibrillation (AF) ablation (pulmonary vein isolation) were not included in this analysis.

Any antiarrhythmic medication was stopped at least five half-lives before AFI ablation. Ablation procedures were performed in a fasting state under local anaesthesia; mild sedation by intravenous bolus of midazolam (1–2 mg) was administered. During RF delivery, pain was controlled by the intravenous administration of one and up to two boluses of 10 mg of nalbuphine. A right femoral venous catheterization was performed. All patients had three catheters inserted: a duodecapolar halo catheter (Cosio, Bard) placed on the tricuspid annulus with its distal tip in the antero-inferior right atrium (AIRA), a 8 mm tip ablation catheter (Therapy Dual-8, Irvine Biomedical Inc., Irvine, CA, USA), and a diagnostic quadripolar catheter inserted in the coronary sinus (Dynamic, Xtrem, Sorin Group). Ablation was performed by creating a line in the cavo-tricuspid isthmus (CTI) from its ventricular aspect towards the inferior vena cava ostium. Radiofrequency was delivered with an EP Shuttle (Stockert GmbH, Freiburg, Germany) generator in a temperature-controlled mode (programmed parameters 60°, 60 W). The success of the procedure was defined by the presence of a persistent complete bidirectional isthmus block, as proved by the CW direction by AIRA activation sequence when pacing at coronary sinus ostium, and by the presence of a corridor of separated double potentials along the ablation line. Double potential intervals were calculated as the mean value between three measurements along the ablation line at three sites during coronary sinus ostium pacing; the middle of the line, the ventricular site, and the vena cava edge (Figure 1).

Clinical data were analysed: age, gender, body mass index (BMI), body surface area (BSA), CHADS score, the presence of arterial hypertension, and a history of AF. Electrophysiological and procedural data were also analysed: RR intervals, AFI cycle length, double potential intervals after isthmus block completion at the end of the procedure, double potential intervals indexed to BSA, procedure time, RF application time, and time since the first RF ablation procedure for CCW AFI. The typical ECG pattern for CW AFI was defined as flutter waves negative in lead V1 and a ‘sawtooth’ pattern, a shorter plateau phase, and a widening of the negative component of the F-wave in the inferior leads (or notched positive F-waves with a distinct isoelectric segment inferiorly)²⁶ (Figure 2). All the patients underwent a standard clinical follow-up including rest ECG and ECG realization in case of palpitations recurrence, and a 24-hour Holter ECG every 6 months.

Statistics

The statistical analysis was made with Stata 9.1 (Statacorp 2005, College Station, TX, USA). Numerical variables were expressed as mean ± SD. Comparison between the two groups using continuous variables utilized an unpaired Student’s t-test. Categorical data were compared by the χ² test with Yate’s correction. A P value <0.05 was considered significant.

Results

Clinical characteristics

From January 2009 to January 2011, 246 procedures of RF catheter ablation for AFI were reviewed. Patients were excluded if they were in sinus rhythm at the beginning of the procedure (n = 70), or if entrainment manoeuvres failed to demonstrate ID circuit (n = 118). A bidirectional isthmus block was obtained in all patients with ID AFI. Among these patients, 27 patients presented CW AFI (10.9% of all ID AFI), including 10 CW AFI occurring after a previous RF catheter ablation for CCW AFI. Mean time for recurrence after the previous procedure of CCW AFI RF ablation was 3.5 ± 2.1 years.

They were significantly younger (61.6 ± 11 years) than patients with CW AFI de novo (74.0 ± 7.2 years; P = 0.005). No difference was observed concerning the CHADS score (2 ± 1.16 in CW AFI de novo group vs. 1.16 ± 0.9 in recurrent CW AFI group), the presence of arterial hypertension, nor a previous history of AF (Table 1). No differences were found concerning BMI and BSA between the two groups (Table 1).

Electrophysiological characteristics

There was a significant difference in terms of double potential separation measured after ablation (111 ± 7 ms for recurrent CW AFI group vs. 155 ± 31 ms for CW AFI de novo group; P = 0.028). When indexed to BSA, double potential intervals were still found significantly lower in the recurrent CW AFI group (P < 0.001). No significant differences were observed concerning RR intervals (81 ± 22 b.p.m. in CW AFI de novo group vs. 97 ± 15 b.p.m. in recurrent CW AFI group), AFI cycle length (257 ± 26 ms in CW AFI de novo group vs. 259 ± 29 ms in recurrent CW AFI group), nor the typical ECG pattern for CW AFI (10/17 in CW AFI de novo group vs. 8/10 in recurrent CW AFI group) (Table 2). No significant differences were observed between the two groups concerning procedure time (108 ± 11 min in CW

Figure 1 Double potential intervals measurements along the ablation line, after block completion: vena cava edge (A); middle of the ablation line (B); ventricular site (C). The grey zone represents the ablation line (cavo-tricuspid isthmus). CS, coronary sinus; IVC, inferior vena cava; TV, tricuspid valve.
AFl de novo group vs. 97 ± 19 min in recurrent CW AFl group), nor RF application time. During the follow-up, one patient had a recurrence in the CW AFl de novo group and underwent a successful redo procedure. No recurrence was observed in the recurrent CW AFl group.

**Discussion**

Our main finding is two-fold. First, patients with CW AFl occurring after previous CCW AFl ablation are younger than patients with CW AFl de novo. Second, after RF catheter ablation of RA isthmus and block completion, they have a smaller interspike interval.

Diagnosis of CW ID AFl is important, since easily amendable by RF catheter ablation. In our population, we found the same prevalence of CW AFl (10.9% of ID AFl) than previously reported in the literature.3,4 Cavo-tricuspid isthmus RF catheter ablation has a high success rate, when endpoints have been achieved,5,6 with no known difference between the two forms.7,8 Atrial flutter recurrence is due to

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**Table 1** Clinical characteristics of patients with clockwise atrial flutter

<table>
<thead>
<tr>
<th></th>
<th>CW AFl de novo</th>
<th>CW AFl after CCW AFl ablation</th>
<th>P</th>
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<tbody>
<tr>
<td>Number of patients</td>
<td>17</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Age of patients (years)</td>
<td>74 ± 7</td>
<td>61 ± 9</td>
<td>0.005</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>16/1</td>
<td>8/2</td>
<td>n.s.</td>
</tr>
<tr>
<td>CHADS score</td>
<td>2 ± 1.16</td>
<td>1.16 ± 0.9</td>
<td>0.31</td>
</tr>
<tr>
<td>Hypertension</td>
<td>10/17</td>
<td>5/10</td>
<td>n.s.</td>
</tr>
<tr>
<td>History of atrial fibrillation</td>
<td>8/17</td>
<td>8/10</td>
<td>n.s.</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>27.7 ± 3.0</td>
<td>26.8 ± 2.5</td>
<td>0.06</td>
</tr>
<tr>
<td>Body surface area (m²)</td>
<td>1.97 ± 0.14</td>
<td>1.83 ± 0.18</td>
<td>0.69</td>
</tr>
</tbody>
</table>

AFl, atrial flutter; CCW, counterclockwise; CW, clockwise.

**Table 2** Electrophysiological data of patients with clockwise atrial flutter

<table>
<thead>
<tr>
<th></th>
<th>CW AFl de novo</th>
<th>CW AFl after CCW AFl ablation</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>RR intervals (b.p.m.)</td>
<td>81 ± 22</td>
<td>97 ± 15</td>
<td>0.16</td>
</tr>
<tr>
<td>AFl cycle length (ms)</td>
<td>257 ± 26</td>
<td>259 ± 29</td>
<td>0.91</td>
</tr>
<tr>
<td>Double potential interval after block completion (ms)</td>
<td>155 ± 31</td>
<td>111 ± 7</td>
<td>0.028</td>
</tr>
<tr>
<td>Double potential interval/body surface area (ms/m²)</td>
<td>75.4 ± 12.2</td>
<td>58.8 ± 7.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Electrocardiographic pattern of CW AFl</td>
<td>10/17</td>
<td>8/10</td>
<td>n.s.</td>
</tr>
<tr>
<td>Procedure time (min)</td>
<td>108 ± 11</td>
<td>97 ± 19</td>
<td>0.35</td>
</tr>
<tr>
<td>Radiofrequency application time (s)</td>
<td>1007 ± 118</td>
<td>845 ± 233</td>
<td>0.49</td>
</tr>
<tr>
<td>Time since first ablation of CCW AFl (years)</td>
<td>3.5 ± 2.1</td>
<td>3.5 ± 2.1</td>
<td>n.s.</td>
</tr>
<tr>
<td>Follow-up (months)</td>
<td>21 ± 7</td>
<td>17 ± 2</td>
<td>n.s.</td>
</tr>
<tr>
<td>Recurrences after CW AFl ablation</td>
<td>1/17</td>
<td>0/10</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

AFl, atrial flutter; CCW, counterclockwise; CW, clockwise.

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Figure 2 A typical pattern of a clockwise isthmus-dependent atrial flutter with a ‘sawtooth’ pattern and a shorter plateau in the inferior leads. Flutter waves are negative in V1.
a persistent gap in CTI, often due to anatomical difficulties and reablation may require an irrigated tip or a sheath to improve catheter stability. One would assume that recurrent CW AFI is more difficult to ablate than CW AFI de novo; however, in our series no difference was found in terms of procedure time or RF application time between the two groups of CW AFI.

To the best of our knowledge, no study has been performed to explain why AFI recurrences occur with a CW or a CCW rotation. Concerning the smaller double potential interval found in the recurrent CW AFI group, an incomplete CTI block is unlikely because the mean value (111 ms) is higher than the cut-off definition for complete CTI block. One hypothesis would be that this specific population may have a smaller or possibly more rapidly conducting RA. No differences were observed concerning BMI and BSA between the two groups. Nevertheless, when indexed to BSA, double potential intervals were found significantly lower in the recurrent CW AFI group than in the CW AFI de novo group. In the literature, there is no clear correlation between BMI or BSA and RA volume, irrespective of the underlying cardiopathy. Echocardiographic assessment of RA size was seldom available since this exam was not systematically performed before ablation. An anatomic study of CTI would have been interesting in the two groups to identify possible anatomical discrepancies likely to explain a smaller interspike interval in the recurrent CW AFI group. Nevertheless, an incomplete isthmus block cannot be 100% ruled out, even in cases of descending activation patterns of the AIRA while pacing septally to the ablation line. Thus, in very few cases, an incomplete block may be responsible for a smaller interspike separation in recurrent CW AFI patients. Nevertheless, even if incomplete block was responsible for the smaller double potential intervals in this group, this was not associated with a higher rate of recurrence during the follow-up, in comparison with the CW AFI de novo group.

Limitations

Our study includes a limited number of patients with CW AFI, but a prevalence is lower than CCW AFI. Furthermore, the low rate of recurrence associated with ID AFI ablation (5%) explains the small number of patients with recurrent CW AFI. Mapping the complete circuit would have been interesting in order to explain electrophysiological characteristics of CW ID AFI, but costs of electroanatomical mapping are rarely justified in this setting. Since the study is retrospective and echocardiographic evaluation not systematically performed for all patients, RA size data were not available for comparison.

Conclusion

Patients with CW AFI occurrence after CCW RF catheter ablation are younger than patients with CW AFI de novo. They have a smaller interspike interval after block completion. Further (electro)-anatomical studies will be needed to explain the exact mechanism responsible for the smaller double potential intervals in this group.

Conflicts of interest: none declared.

References