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

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Aims

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

Methods and results

A total of 246 procedures of RF catheter ablation for AFI 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 AFI was not ID. Twenty-seven 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 years. They were younger (61.6 ± 11 years) than patients with CW AFI 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 AFI de novo vs. 111 ± 7 ms for recurrent CW AFI; \( P = 0.028 \)). No differences were observed concerning CHADS score, AFI cycle length, and electrocardiogram typical pattern for CW AFI between the two groups.

Conclusion

Patients with CW AFI occurrence after CCW AFI RF catheter ablation are younger than patients with CW AFI 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 (AFI).1 According to their rotation in the right atrium (RA), ID AFI may be counterclockwise (CCW) or clockwise (CW).2 The second variety is far less frequent than CCW AFI (10–15%).3,4 Clockwise atrial flutter (also called ‘reverse’ AFI) has the same circuit as CCW AFI, but in a reverse direction and shares the same anatomical and functional barriers. The electrocardiogram (ECG) pattern for CW AFI includes broad positive deflections in the inferior leads, but more specifically, wide negative deflections in V1.5,6 Radiofrequency catheter ablation of ID AFI has a high success rate and the rate of recurrence is very low (5%) if a persistent bidirectional isthmus block has been achieved.7,8 Recurrence after ablation of CCW ID AFI may have either of the two forms. But little is known about clinical and electrophysiological characteristics of CW AFI, occurring after a previous procedure of CCW AFI RF catheter ablation.

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We sought to compare clinical and electrophysiological features of ‘recurrent’ CW AFl with de novo CW AFl.

**Methods**

Files of all consecutive patients ablated for ID AFl 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 AFl 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 catheter was inserted in a large vein, 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, Xtem, 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, AFl 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 AFl. The typical ECG pattern for CW AFl was defined as: 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) (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 AFl 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 AFl. Among these patients, 27 patients presented CW AFl (10.9% of all ID AFl), including 10 CW AFls 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 ± 2.1 years.

They were significantly younger (61.6 ± 11 years) than patients with CW AFl de novo (74.0 ± 7.2 years; P = 0.005). No difference was observed concerning the CHADS score (2 ± 1.16 in CW AFl de novo group vs. 1.16 ± 0.9 in recurrent CW AFl 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 AFl group vs. 155 ± 31 ms for CW AFl de novo group; P = 0.028). When indexed to BSA, double potential intervals were still found significantly lower in the recurrent CW AFl group (P < 0.001). No significant differences were observed concerning RR intervals (81 ± 22 b.p.m. in CW AFl de novo group vs. 97 ± 15 b.p.m. in recurrent CW AFl group), AFl cycle length (257 ± 26 ms in CW AFl de novo group vs. 259 ± 29 ms in recurrent CW AFl group), nor the typical ECG pattern for CW AFl (10/17 in CW AFl de novo group vs. 8/10 in recurrent CW AFl group) (Table 2). No significant differences were observed between the two groups concerning procedure time (108 ± 11 min in CW AFl de novo group vs. 118 ± 24 min in recurrent CW AFl group).

![Figure 1](https://example.com/figure1.png)

**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.6,9 Atrial flutter recurrence is due to
a persistent gap in CTI, often due to anatomical difficulties \(^{10,11}\) and reablation may require an irrigated tip or a sheath to improve catheter stability.\(^ {12,13}\) 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.\(^ {14}\) 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 cardio-pathy. 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 their 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 AFI 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**