Frequency of atrial arrhythmias after atrial flutter ablation and the effect of presenting rhythm on the day of ablation

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ABSTRACT

Radiofrequency catheter ablation of the cavotricuspid isthmus is a proven therapy for typical atrial flutter (AFL); however, in some patients, new atrial arrhythmias (AA) may occur after AFL ablation. This study explored the difference in the occurrence of spontaneous AA after AFL ablation as a function of the patient's presenting rhythm on the day of the AFL ablation. A retrospective study of consecutive patients who underwent AFL ablation at Baylor University Medical Center at Dallas was performed. A total of 188 subjects were included; 50% (94) presented in AFL (Group AFL) on the day of the ablation procedure and 94 presented in sinus rhythm (SR; Group SR). Group AFL patients were older ($P < 0.001$), more likely to have diabetes ($P = 0.03$), and more likely to have undergone previous heart surgery ($P = 0.03$). The median size of the left atrium was 4 cm (range 2.8–6.8) in Group AFL compared with 3.8 cm (range 2.6–5.6) in Group SR ($P = 0.009$). Atrial fibrillation was induced during the ablation procedure in 7.5% and 21.3% of patients in Groups AFL and SR, respectively ($P = 0.007$). Overall, 29 of 188 (15.4%) patients developed new AA within 1 year of the procedure, 13.8% in Group AFL vs 17.0% in Group SR ($P = 0.57$). In conclusion, patients presenting for AFL ablation in SR were younger and healthier but had more atrial fibrillation induced during their ablation procedure, with a trend toward more postablation AA due to additional arrhythmia substrate.

KEYWORDS Ablation; atrial arrhythmias; atrial flutter; cavotricuspid isthmus; sinus rhythm

The incidence of atrial flutter (AFL) in the United States is approximately 88 per 100,000 person-years, with a higher incidence in men and the elderly.¹ Typical AFL is a stable macro reentrant arrhythmia involving clockwise or counterclockwise rotation of the wavefront around the tricuspid valve annulus. Due to the rapidity of the arrhythmia, only more rapid arrhythmias such as atrial fibrillation (AF) may usurp control of the atrial rhythm. AF may then persist or terminate to sinus rhythm (SR). Therefore, patients without a tendency to AF would be more likely to present for ablation still in AFL. Linear radiofrequency catheter ablation across the cavotricuspid isthmus produces a cure in about 95% of patients.² Usually block persists but there is a recurrence rate of AFL postablation of approximately 5%³ due to gaps in the ablation line. However, even if AFL does not recur, it is not uncommon to diagnose new atrial arrhythmias such as AF in 8% to 82% of patients depending

on the duration of follow-up and the type of population studied.^{4,5} High-risk patients may have a higher degree of electrical remodeling of the atria leading to AF after AFL ablation.⁶ Reported risk factors include reduced left ventricular ejection fraction,⁷ presence of structural heart disease, increased left atrial dimension and volume, inducibility of AF,⁸ and number of radiofrequency applications.⁹ Women and patients treated with antiarrhythmic drugs were also at higher risk of AF after ablation.¹⁰ Because AFL is such a stable circuit in the heart, it tends to persist unless the faster arrhythmia actually takes over and becomes AF. We therefore hypothesized that patients presenting in SR had a faster heart rhythm and would have more AF. However, the meaning of presenting rhythm on the day of AFL ablation remains undefined. The purpose of this study was to characterize the differences in patients as a function of their presenting rhythm.

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METHODS

This retrospective study examined consecutive patients who underwent radiofrequency catheter ablation for AFL at Baylor University Medical Center at Dallas over a 4-year period. Those who had their AFL converted by antiarrhythmic drugs/cardioversion prior to their scheduled ablation procedure as well as patients whose electrocardiogram was not available on the day of the ablation were excluded from the analysis. The patients included in the analysis were either in AFL or SR on the day of ablation. Data on demographic characteristics, comorbidities, and occurrence of prior atrial tachycardia or AF were collected for all patients. Details on the ablation procedure were recorded, including inducible isthmus-dependent flutter and the occurrence of inducible sustained AF/AFL during the electrophysiology study. We then reviewed patients' follow-up visits and recorded any occurrence of atrial arrhythmia (AA) defined as AF or AFL for 1 year after the procedure. Transesophageal echocardiography was generally performed if the patients were not in SR. Catheters were used to record atrial activation around the tricuspid annulus and the coronary sinus at a minimum. Typical AFL was defined as linear atrial activation around the tricuspid annulus with activation of the proximal coronary sinus before more distal sites. When possible, entrainment from the tricuspid annulus was performed. Typical flutter was diagnosed if atrial activation was identical during entrainment and if the postpacing interval approximated the AFL cycle length. Ablation was performed during AFL or in SR with atrial pacing at the discretion of the physician. Attempts to induce other arrhythmias were performed. Bidirectional block was defined by site-specific atrial pacing from each side of the line, showing latest activation on the opposite side of the line.

Statistical analyses were done using STATA 14.2. Categorical variables are reported as frequencies and proportions and continuous variables as mean $\pm$ standard deviation or median (range), as appropriate. Comparisons between the groups were performed with chi-square/Fisher's exact test for proportions and Student's *t* test or the Wilcoxon rank sum test for continuous variables. Kaplan-Meier survival curves for the endpoint of spontaneous AA 1-year postablation were constructed, and the two groups were compared using a log-rank test.

Table 1. Patient demographics and clinical characteristics

Variable	Atrial flutter group (n = 94)	Sinus rhythm group (n = 94)	P value
Mean age $\pm$ SD, years	66.3 $\pm$ 11.4	58.9 $\pm$ 12.5	<0.001
Male	73 (77.7%)	69 (73.4%)	0.49
Female	21 (22.3%)	25 (26.6%)	
White	86 (91.5%)	79 (84%)	0.38
Hypertension	69 (73.4%)	70 (74.5%)	0.87
Coronary artery disease	47 (50%)	36 (38.3%)	0.11
Chronic obstructive pulmonary disease	14 (14.9%)	8 (8.5%)	0.17
Chronic kidney disease	18 (19.2%)	13 (13.8%)	0.33
Diabetes mellitus	26 (27.7%)	14 (14.9%)	0.03
Cerebrovascular accident	3 (3.2%)	4 (4.3%)	NA
Obstructive sleep apnea	9 (9.6%)	7 (7.5%)	0.6
Prior heart surgery	31 (32.9%)	18 (19.2%)	0.03
Echo-valve disease	13 (13.8%)	14 (15.6%)	0.74
Medications for flutter	16 (17.0%)	18 (19.2%)	0.71
Cardioversion fibrillation	9 (9.7%)	9 (9.6%)	0.98
Prior atrial fibrillation	38 (40.4%)	35 (37.6%)	0.69
Median left atrial size (range), cm	4.2 (2.8–6.8)	3.8 (2.6–5.6)	0.009
Median ejection fraction (range)	55% (10%–70%)	55% (10%–75%)	0.29

RESULTS

A total of 188 subjects were included in this study. Their clinical and demographic characteristics are presented in *Table 1*. Group AFL included 94 patients who presented in AFL, and Group SR included 94 patients who presented in SR. Group AFL patients were older (66.3 $\pm$ 11.4 years) than those in Group SR (58.9 $\pm$ 12.5 years; *P* < 0.001). Group AFL patients were more likely to have diabetes and to have undergone previous heart surgery. The median size of the left atrium by surface

Table 2. Findings during electrophysiology testing

Finding	Atrial flutter group (n = 94)	Sinus rhythm group (n = 94)	P value
Spontaneous atrial fibrillation	2 (2.1%)	4 (4.3%)	0.68
Inducible atrial fibrillation	7 (7.5%)	20 (21.3%)	0.007
Atrial fibrillation requiring cardioversion	5 (71.4%)	8 (40%)	0.15
Median flutter cycle length (range), ms	258 (180–370)	252.5 (183–370)	0.34
Bidirectional block	93 (98.9%)	94 (100%)	NA
Isthmus dependent	85 (95.5%)	63 (90%)	0.29
Antiarrhythmic drugs prescribed at discharge	20 (21.3%)	15 (15.9%)	0.35

Figure 1. Kaplan-Meier survival estimates showing maintenance of sinus rhythm during follow-up.

echocardiography was 4.2 cm (range 2.8–6.8) in Group AFI compared to 3.8 cm (range 2.6–5.6) in Group SR ($P = 0.009$).

Table 2 depicts the findings during the electrophysiology study. AF was induced during the ablation procedure in 7.5% and 21.3% of patients in Group AFI and Group SR, respectively ($P = 0.007$). Of those with AF induced during the electrophysiology study, 71.4% in Group AFI and 40% in Group SR had a cardioversion performed ($P = 0.15$).

Figure 1 shows the occurrence of spontaneous AA during the 1-year follow-up period. Overall, 29 of 188 patients (15.4%) developed spontaneous AA within 1 year of the ablation; 13 patients (13.8%) in Group AFI experienced AA postablation compared to 16 patients (17.0%) in Group SR. AF (68.9%) was the most commonly deducted AA postablation (Figure 2). The log-rank test showed no difference in the occurrence of AA between patients who had the procedure while in AFI vs SR ($P = 0.57$).

DISCUSSION

We hypothesized that patients who presented for their AFI ablation procedure in SR would have different clinical features than those presenting in AFI. Typical AFI involves a stable macro

Figure 2. Proportion of atrial flutter (black bar) and atrial fibrillation (white bar) after ablation by presenting rhythm.

reentrant circuit in the right atrium.^{11,12} Although a fully excitable gap exists whereby the reentrant circuit can be reset or terminated, it typically requires the presence of a more rapid arrhythmia like AF to do this. If patients presenting in SR had more substrate for AF, then identifying them ahead of time would allow them to undergo a combined ablation procedure for AFI and AF, potentially avoiding a second ablation procedure. We hypothesized that patients with AFI who presented for their ablation in SR would have more electrical substrate for AF, perhaps manifested by a higher incidence of AA after their AFI ablation. Between 7% and 50% of the patients who have radiofrequency ablation of their AFI develop AA postprocedure.^{6,10,11,13-16} Risk factors for the occurrence of AF after ablation of AFI include female gender, treatment with antiarrhythmic drugs, and a history of AF.^{17,18}

In our study, equal numbers of patients presented in AFI and SR on the day of the ablation procedure. Patients who presented in SR had more AF during their ablation for AFI. About 15% of all patients experienced spontaneous AA after AFI ablation, which is consistent with other studies. There was a trend for more AF after AFI ablation in patients who presented in SR, but it was not statistically significant.

This study has obvious limitations. Because this is a retrospective analysis, there may be some confounding due to unmeasured factors. Secondly, the small sample size of this study may have limited the power to detect a measure of association when indeed it exists. The follow-up information for this study was obtained from the clinical records, and some patients may have been followed up in a different institution. Further, information on the type of AF was not recorded, and those with subclinical AA may not have been captured during the follow-up. Lastly, this was a single-center study, which may also limit the generalizability of the findings.

New atrial arrhythmias occur in a significant proportion of patients who undergo cavotricuspid isthmus ablation for typical AFI. Patients presenting for their AFI ablation in SR were younger and healthier but had more AF induced during their ablation procedure, and there was a trend toward more postablation AA due to additional arrhythmia substrate. If a larger study revealed the difference to be statistically significant, then perhaps it would be justified to recommend adjunctive ablation for AF during the AFI ablation procedure.

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