ORIGINAL ARTICLE

Comparison of 8-mm-tip and Irrigated-tip Catheters in the Ablation of Isthmus-Dependent Atrial Flutter: A Prospective Randomized Trial

Alejandro Cuesta, Lluís Mont, Nelson Alvarenga, Ulises Rogel, and Josep Brugada

Sección de Arritmias, Instituto Clínico del Tórax, Hospital Clínic, Barcelona, Spain

Introduction and objectives. Both 8-mm-tip and irrigated-tip catheters improve outcomes in typical atrial flutter ablation. However, it is not yet known which is preferable. The objective was to compare the effectiveness of 8-mm-tip (Group 1) and open irrigated-tip (Group 2) catheters in the first ablation attempt.

Methods. A prospective randomized trial with a long-term follow-up was performed in patients with documented typical atrial flutter. For both types of catheter, the power was initially set to 50 W. The primary endpoint was ablation of the cavotricuspid isthmus in a procedure lasting, at most, 600 s.

Results. Group 1 contained 65 patients and Group 2 contained 66, with no significant intergroup difference in baseline characteristics. Their mean age was 63 (12) years, 80% were men, and 65% had structural heart disease.

The primary endpoint was achieved in 48 patients (73.8%) in Group 1 and 49 (74.2%) in Group 2 (P=NS). In the remaining patients, the procedure was continued at the physician's discretion and ablation was finally achieved in all cases. In the intention-to-treat analysis, there was no significant difference between the groups in the number of applications of the ablation device or in the duration of the ablation procedure, radioscopy or the total procedure.

By 16 (5) months of follow-up (>1 year in 98%), 8 (6.3%) patients had experienced recurrence and 95 (74.2%) were free from any arrhythmia. There was no differences between the groups.

Conclusions. No difference was found between the effectiveness of 8-mm-tip and open irrigated-tip catheters in the first attempt at ablation of typical atrial flutter.

Key words: *Catheter ablation. Atrial flutter. Catheters*.

Catéter de 8 mm frente a punta irrigada en la ablación del flutter auricular dependiente del istmo: un estudio prospectivo y aleatorizado

Introducción y objetivos. En la ablación del flutter auricular típico se utilizan catéteres con puntas de 8 mm e irrigadas para mejorar los resultados; sin embargo, la mejor opción aún no está establecida. Quisimos comparar la efectividad de un catéter de 8 mm (grupo 1) y uno irrigado abierto (grupo 2) en el primer intento de ablación.

Métodos. Realizamos un estudio prospectivo, aleatorizado y con seguimiento a largo plazo, incluyendo a pacientes con flutter típico documentado. Para ambos catéteres se programó inicialmente una potencia de 50 W.

El objetivo primario fue lograr la ablación del istmo cavotricuspídeo con 600 s de aplicación como máximo.

Resultados. Se incluyó a 65 pacientes en el grupo 1 y 66 en el grupo 2 sin diferencias significativas en las características basales. La media de edad era 63 ± 12 años; el 80% eran varones y el 65% tenía cardiopatía estructural. Alcanzaron el punto final primario 48 (73,8%) pacientes del grupo 1 y 49 (74,2%) del grupo 2. En los restantes pacientes se continuó según el criterio del operador y la ablación fue efectiva en todos. Por intención de tratamiento no hubo diferencias significativas en el número de aplicaciones ni en los tiempos de aplicación, radioscopia y el total del procedimiento. A los 16 ± 5 meses de seguimiento (el 98%, más de 1 año) hubo 8 (6,3%) pacientes con recurrencia y 95 (74,2%) libres de toda arritmia, sin diferencia entre ambos grupos.

Conclusiones. No encontramos diferencia en la efectividad entre un catéter de 8 mm y uno irrigado abierto en la primera intención de ablación del flutter auricular común.

Palabras clave: *Ablación con catéter. Aleteo auricular. Catéteres.*

INTRODUCTION

Common atrial flutter (AFL) is a macroreentrant arrhythmia in the right atrium, passing through the tricuspid annulus. Ablation of the cavotricuspid isthmus (CTI) is an effective procedure to definitively terminate the arrhythmia.[1-3] The success of ablation ranges between 80% and 100% and

Dr A. Cuesta received a grant from the Fundaciò Clínic per a la Recerca Biomèdica.

Correspondence: Dr. A. Cuesta.
Servicio de Cardiología. Hospital de Clínicas Dr. Manuel Quintela. UDELAR.
José Mazzini 3107. CP 11600 Montevideo. Uruguay.
E-mail: arritmia@yahoo.com

Received January 22, 2009.
Accepted for publication April 15, 2009.

ABBREVIATIONS

AF: atrial fibrillation.
AFL: atrial flutter.
CTI: cavotricuspid isthmus.

recurrence fluctuates around 10%.[3-6] To improve outcomes, catheters able to produce larger lesions are used, in particular catheters with an 8 mm-tip or an irrigated-tip. The superiority of both types has been clearly demonstrated when compared to those with short tips.[6-11]

However, there is little data on comparisons between 8-mm-tip catheters and irrigated-tip catheters. Some randomized studies exist, using different protocols, of differing methodological quality, and yielding inconclusive results.[12-16] Given the frequency of AFL and since both types of catheter differ in cost and in the infrastructure needed for their use, it seems relevant to clarify the situation. This work was conducted and is presented according to the CONSORT standards for randomized studies.[17]

The aim was to compare the effectiveness of 8-mm-tip catheters and open irrigated-tip catheters in the first ablation attempt for common AFL. The following were also analyzed: duration of the procedure, the amount of time required for radioscopy, frequency of complications and the incidence of recurrence during long-term follow-up.

METHODS

Patients

The study included all patients referred to our AFL ablation unit until the recruitment period closed after 2 years. All patients with isthmus-dependent clockwise and counterclockwise AFL were enrolled. The arrhythmia had to be previously documented before electrophysiological study was done. The patients may have had a background of atrial fibrillation (AF), but the predominant arrhythmia had to be AFL. The exclusion criteria were as follows: previous AFL ablation, open-heart surgery, congenital heart disease, absence of femoral access, and the unavailability of some treatments on the scheduled day. A previous echocardiogram was performed in all cases. Once the patient was admitted, we assessed whether he or she fulfilled the selection criteria; the patient was informed of this and written informed consent requested. A questionnaire was administered that included clinical and paraclinical data considered to be of interest. The questionnaire was assessed during the previous stage.

Procedure

All patients fasted for 6 h. Local anesthesia was applied to the right femoral vascular bundle using 10 mL mepivacaine 2%. Two introducers (7 Fr) were positioned in the right femoral vein using the Seldinger technique. A preformed 20-pole deflectable catheter (Halo, Cordis-Biosense-Webster) was used in all the procedures, and positioned around the tricuspid annulus.

The 8-mm-tip catheter used was quadripolar, deflectable, with 2-5-2-mm electrode spacing, and dual sensor temperature control (Celsius DS, Cordis-Biosense-Webster). The irrigated-tip catheter used was also quadripolar, deflectable, with 2-5-2-mm electrode spacing and a 5-mm tip with 6 open irrigation pores (Celsius ThermoCool, Cordis-Biosense-Webster). Saline 0.9% was used for irrigation. The baseline infusion rate was 200 mL/h, which was increased to 999 mL/h during each application. The curve was selected at the discretion of the operator. Long sheath introducers were never used. The radiofrequency source was a Stockert EP Shuttle generator (Cordis-Webster, Baldwin Park, California, USA). Both catheters had temperature control sensors. For the irrigated-tip catheter, ablation was started at a maximum power of 50 W and a maximum temperature of 50ºC. This protocol has been proven safe and has been employed by many researchers.[6,9-11] For the 8-mm-tip catheter, ablation started at the same power and at a maximum temperature of 60ºC. The maximum duration of an application was set at 120 s and those which lasted less than 10 s were not taken into account. Radiofrequency was applied slowly removing the catheter from the annulus to the inferior vena cava (dragging technique).

Before beginning ablation, bidirectional conduction in the CTI was confirmed. The number and total duration of applications were recorded. Temperature, power and impedance were recorded for each application, after 10 s and when stabilized. The total procedure time was recorded from the moment of puncture to the moment when the introducers were withdrawn. The duration of radioscopy was recorded by the radiological equipment.

Ablation was considered effective when bidirectional blockage of the CTI was achieved. This was confirmed by paced activation mapping on both sides of the line and differential pacing. When a complete line was not achieved, the permeable point was sought by analyzing the local electrogram.

The primary endpoint was effective ablation of the CTI in a procedure lasting no more than 600 s. This criterion has already been used by other authors to compare catheters.[7,11] Only after the application had lasted 600 s could the settings or catheter be changed.

Follow-up

The patients were monitored at 1 month, 3 months, and then every 6 months or whenever needed. In addition, if they were referred to another unit, they were asked to provide any electrocardiographic study and contact was attempted with the physician who attended them. All the patients who were referred for palpitations without arrhythmia being recorded underwent Holter monitoring, among other possibilities. Neither the physicians who attended the outpatient service nor the patients knew to what group they had been assigned, such that follow-up was double-blinded.

After ablation all antiarrhythmic agents were interrupted, unless indicated for other arrhythmias other than AFL or AF. When AFL was considered secondary to antiarrhythmic treatment for AF, this was not interrupted. When anticoagulation therapy was indicated, it was not interrupted until several months had passed without clinical or paraclinical evidence of recurrence.

Sample and Randomization

Based on experience in our hospital and in reference to the literature, we hypothesized that the primary outcome would be achieved in 80% of the patients assigned to the 8-mm-tip catheter (8-mm group) and in 96% of the patients assigned to the irrigated catheter (irrigated group). For a power of 80% (1-β) at a 5% significance level (α), the sample size was calculated as at least 64 patients per group. The type of treatment used was determined randomly and provisional analyses were done after completing 50 (25 in each group) and 100 observations (50 in each group). Given the obvious macroscopic differences between the catheters, a blinded-operator study was unfeasible. The recruitment index was estimated at 80% and a recruitment period of 2 years. The analysis was conducted in another hospital.

Statistical Analysis

Analyses were performed using the SPSS statistical package for Windows version 14.0.1 (SPSS) and by intention-to-treat. Continuous variables were expressed as mean (standard deviation [SD]) and compared using the Student *t* test. For the comparison of continuous variables referring to the technical characteristics of the procedures, the Mann-Whitney test was used. Differences between means and their 95% confidence intervals were calculated. Discrete variables are expressed as absolute and relative frequency in percentages. They were compared using the χ^2 test or the Fisher test when appropriate. Non-dichotomous discrete variables were compared using the Fisher-Freeman-Halton test. A *P*-value of <.05 (two-tail) was used as a cutoff for statistical significance.

RESULTS

The study finished after 2 years. During that period, 197 patients were admitted for AFL ablation. A total of 21 patients were excluded due to being treated for atypical flutter, 18 were excluded for recurrences due to previous procedures and 27 for other causes. A total of 131 (66.5%) patients were randomized: 65 patients to the 8-mm group and 66 to the irrigated group. All received the treatment assigned and were included in the analysis.

The baseline characteristics of all the randomized patients and of each group are shown in Table 1. The average age was 63 years and 80% were men. A total of 41% of patients were in New York Heart Association functional class II or III and no patient was in class IV. In addition to flutter, 38% had undergone some AF episode. Most patients (65%) had some underlying structural heart disease, among which hypertensive heart disease and ischemic heart disease were the most frequent. There were no significant differences between the patients assigned to the 8-mm group and those in the irrigated group for any of the variables considered (Table 1).

Immediate Outcome of Ablation

Table 2 shows the number of effective procedures and the technical characteristics for applications lasting no more than 600 s. Within this period, CTI ablation was successful in 48 (73.8%) patients in the 8-mm group and 49 (74.2%) in the irrigated group (no statistically significant difference).

There were no statistically significant differences in the duration of ablation, the number of applications, the power used, duration of radioscopy, and total duration of the procedure. As expected, the temperature attained by the open irrigated-tip catheter was lower (45 [4]º vs 54 [9]ºC; *P*<.001) and impedance was slightly greater (106 [17] Ω vs 98 [10] Ω; *P*<.001).

In each group, there were 17 patients in whom the ablation procedure could not be completed within the maximum time of 600 s. In these cases, the procedure was continued at the discretion of the operator. In the 8-mm group, it was decided to continue the procedure with the same catheter in 14 patients and was changed to the open irrigated-tip catheter in 3. In 2 of these 3 patients the curve was changed. The same catheter was used in 10 patients from the irrigated group, but was changed for an

TABLE 1. **Baseline Characteristics of All the Patients and by Group**

	All (n=131)	8-mm (n=65)	Irrigated (n=66)
Age, y, mean (SD)	63 (12)	65 (11)	62 (13)
Men, n (%)	106 (80.9)	54 (83.1)	52 (78.8)
Arterial hypertension, n (%)	54 (41.2)	24 (36.9)	30 (45.5)
NYHA functional class, n (%)			
I	77 (58.8)	41 (63.1)	36 (54.5)
II	46 (35.1)	20 (30.8)	26 (39.4)
III	8 (6.1)	4 (6.2)	4 (6.1)
Previous atrial fibrillation, n (%)	50 (38.2)	23 (35.4)	27 (40.9)
Structural heart disease, n (%)	85 (64.9)	40 (61.5)	45 (68.2)
Ischemic	21 (16)	13 (20.0)	8 (12.1)
Valvular	12 (9.2)	4 (6.2)	8 (12.1)
Hypertensive	50 (38.2)	21 (32.3)	29 (43.9)
Pulmonary	13 (9.9)	6 (9.2)	7 (10.6)
Dilated cardiomyopathy	5 (3.8)	2 (3.1)	3 (4.5)
Echocardiogram			
Left atrium, mm (mean [SD])	42 (5)	43 (6)	41 (5)
LVEF, % (mean [SD])	56 (12)	55 (13)	57 (11)
Medication, n (%)			
Amiodarone	71 (54.2)	35 (53.8)	36 (54.5)
Beta-blockers	13 (9.9)	8 (12.3)	5 (7.6)
Flecainide	19 (14.5)	12 (18.5)	7 (10.6)
Sotalol	5 (3.8)	3 (4.6)	2 (3.0)
Propafenone	9 (6.9)	4 (6.2)	5 (7.6)
Calcium antagonist	13 (9.9)	6 (9.2)	7 (10.6)
Digoxin	25 (19.1)	12 (18.5)	13 (19.7)
Warfarin	63 (48.1)	28 (43.1)	35 (53.0)
Atrial flutter			
Cycle length, ms (mean [SD])	243 (46)	240 (46)	245 (46)
Counterclockwise rotation, n (%)	118 (90.1)	60 (92.3)	58 (87.9)
Electrocardiogram			
HR, bpm (mean [SD])	88 (29)	90 (28)	87 (29)
PR interval[a], ms (mean [SD])	173 (16)	174 (17)	173 (14)
Normal QRS, n (%)	117 (89.3)	60 (92.3)	57 (86.4)
RBBB, n (%)	11 (8.4)	3 (4.6)	8 (12.1)
LBBB, n (%)	3 (2.3)	2 (3.1)	1 (1.5)
Definitive pacemaker, n (%)	12 (9.2)	6 (9.2)	6 (9.1)
Rhythm during ablation, n (%)			
Sinus	59 (45.0)	29 (44.6)	30 (45.5)
Flutter	68 (51.9)	36 (55.4)	32 (48.5)
Pacemaker	4 (3.1)	0	4 (6.1)

HR, heart rate; LBBB, complete left bundle branch block; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; RBBB complete right bundle branch block.
[a]PR measured in the 59 patients in sinus rhythm.

TABLE 2. **Results Obtained Within 600 s of Cumulative RF Delivery**

	8 mm (n=65)	Irrigated (n=66)	DM (95% CI)	*P*
Effectiveness at 600 s, n (%)	48 (73.8)	49 (74.2)	—	NS
Duration of application, s (mean [SD])	322 (152)	345 (160)	23 (–40 to -86)	NS
Number of applications, n (mean [SD])	4.9 (3.3)	4.6 (2.6)	–0.3 (–1.5 to 0.9)	NS
Duration of radioscopy, min (mean [SD])	12 (7)	13 (5)	1 (–1 to 3)	NS
Duration of procedure, min (mean [SD])	43 (11)	46 (11)	3 (–2 to 7)	NS
Power applied, W (mean [SD])	49 (9)	49 (6)	–1 (–7 to 4)	NS
Temperature, oC (mean [SD]	54 (9)	45 (4)	–9 (–6 to 12)	<.001
Impedance, Ω (mean[SD])	98 (10)	106 (17)	8 (2-13)	<.001

DM (95% CI) indicates difference (irrigated vs 8 mm) between means and their respective confidence interval (CI).

TABLE 3. **Results at the Conclusion of the Procedure**

	8 mm (n=65)	Irrigated (n=66)	DM (95% CI)	*P*
Final effectiveness, n (%)	65 (100)	66 (100)	—	NS
Duration of application, s (mean [SD])	537 (422)	498 (327)	–39 (–169 to 92)	NS
Number of applications, n (mean [SD])	7.6 (6)	6.7 (5.3)	–0.9 (–2.8 to 1.1)	NS
Duration of radioscopy, min (mean [SD])	17 (10)	18 (10)	1 (–2 to 5)	NS
Duration of procedure, min (mean [SD+)	52 (20)	52 (16)	1 (–6 to 7)	NS
Power applied, W (mean [SD])	55 (10)	51 (7)	–4 (–1 to –7)	.024
Temperature, oC (mean [SD])	54 (8)	45 (4)	–8 (–6 to –11)	<.001
Impedance, Ω (mean [SD])	99 (11)	106 (15)	7 (2-11)	<.001

DM (95% CI) indicates difference (irrigated–8 mm) between means and their respective confidence interval (CI).

TABLE 4. **Results During Long-Term Follow-up**

	All (n=128)	8 mm (n=63)	Irrigated (n=65)	*P*
Follow-up, d (mean[SD])	488 (164)	482 (162)	494 (166)	NS
Recurrence, n (%)	8 (6.3)	5 (7.9)	3 (4.6)	NS
Complications				
Major, n (%)	0	0	0	
Minor, n (%)	5 (3.9)	2 (3.2)	3 (4.6)	NS
Atrial fibrillation, n (%)	29 (22.7)	13 (20.6)	16 (24.6)	NS
Atypical flutter, n (%)	3 (2.3)	0	3 (4.6)	NS
NYHA functional class, n (%)				.028
I	114 (89.1)	60 (95.2)	54 (83.1)	
II	14 (10.9)	3 (4.8)	11 (16.9)	
III	0	0	0	
Medication, n (%)				
Amiodarone	14 (10.9)	9 (14.3)	5 (7.7)	NS
Beta blockers	9 (7.0)	3 (4.8)	6 (9.2)	NS
Flecainide	11 (8.6)	5 (7.9)	6 (9.2)	NS
Propafenone	8 (6.3)	3 (4.8)	5 (7.7)	NS
Calcium antagonist	8 (6.3)	4 (6.3)	4 (6.2)	NS
Digoxin	3 (2.3)	2 (3.2)	1 (1.5)	NS
Warfarin	33 (25.8)	15 (23.8)	18 (27.7)	NS
Death, n (%)	4 (3.2)	2 (3.2)	2 (3.1)	NS

NYHA indicates New York Heart Association.

8-mm catheter in 5 and for a standard catheter in 2 patients. The curve was also changed in 1 of the 5 patients for whom the catheter was changed to an 8-mm one and in both patients for whom the catheter was changed to a standard one. In half of the 10 catheter changes the operator also changed the selected curve. The settings were also modified.

Table 3 shows the technical characteristics and outcome of all the procedures. The groups underwent intention-to-treat analysis. Ablation of the CTI was successful in all the patients included in the study. There were no statistically significant differences in the duration of ablation, the number of applications, the total duration of radioscopy, and the total duration of the procedure. In the 8-mm group, a slightly higher power was finally used (55 [10] W vs 51 [7] W; P=.024) and a higher temperature (54 [8] ^{o}C vs 45 [4]^{o}C; P<.001). The difference in impedance was maintained in favor of the irrigated group (106 [15] Ω vs 99 [11] Ω; P<.001).

No major complications occurred due to any procedure (Table 4). In 1 patient in 8-mm group, the PR interval lengthened from 160 ms to 200 ms and another patient presented chest pain that lasted for 10 days. Enzyme levels and echocardiogram studies were normal in all patients. In 3 patients in the irrigated group, a hematoma occurred at the puncture site, but neither transfusion nor intervention were required.

Follow-up

Three patients were lost to follow-up and 98% of the patients were followed up for at least 1 year, without differences between the 2 groups (Table 4). Two patients died in each group in circumstances unrelated to the procedure; 1 or more AFL episodes recurred in 8 (6.3%) patients, without statistically significant differences between the 8-mm group and the irrigated group (7.9% vs 4.6%) (Table 4).

In 29 (22.7%) patients, one or more episodes of AF were documented, without differences between the groups; during the course of the disease 3 patients presented atypical flutter as demonstrated by a new electrophysiological study (Table 4). At the end of follow-up, 95 (74.2%) patients were free from all arrhythmias.

DISCUSSION

The most important aspects of this study lie in the rigor and methodology used for the comparisons. Both catheters can be employed in different ways; if the technical variables of the ablation procedure are not controlled, it is difficult to assign the differences to the type of catheter.

We cannot rule out the possibility that the results would be different if either catheter is used differently. In this series, and with the parameters used, there were no major complications; the incidence of minor complications was very low and with no statistically significant differences between the groups (Table 4).

Neither can we rule out the possibility that the difference in magnitude could be smaller than that in the design. In this case, we consider that it would have little effect in normal clinical practice. The irrigated-tip catheters, in addition to their higher price, require additional infrastructure for their use and have to be operated by trained auxiliary personnel.

It has been demonstrated that it is possible to produce lesions of greater depth and volume with 8-mm tips than with longer tips and with shorter unirrigated-tips.[18-20] The disadvantage would be that the tip is less flexible and more difficult to support on an irregular area of the myocardium. Studies have described its use in which powers of up to 100 W have been employed, but there are doubts concerning safety.[7,21]

It has also been demonstrated that irrigated-tip catheters are capable of producing larger lesions and are superior to standard catheters both in effectiveness and in the duration of the procedure.[6,9-11,22,23] Their superiority is still maintained when compared to studies on 8-mm tip catheters versus standard ones. We believe that this has led to the idea that irrigated catheters are superior to 8-mm tip catheters, although randomized studies works do not unambiguously support this view.

Schreieck et al[12] randomly compared closed cooled-tip catheters and 8-mm ones. The 8-mm catheters were used at higher powers and more often with large sheaths. Despite this, ablation was successful in similar proportions and involved more complications in the 8-mm group. The question remains concerning what would have happened had both catheters had been used in a similar manner. We took this precaution into account in our study without obtaining significantly different outcomes.

Scavée et al[13] reported a similar effect, but found that only half the number of applications were needed with the 8-mm catheter than with the irrigated catheter. They concluded that the irrigated catheter was "less competitive" due to the complexity involved in its use. Later, the authors randomized 80 patients to 4 different catheters: open irrigated-tip; closed irrigated-tip; single temperature sensor, 8-mm tip; and dual temperature sensor, 8-mm tip. The endpoint was to achieve complete CTI block within 12 min of cumulative RF delivery. Their results clearly demonstrate the superiority of the open irrigated-tip catheter compared to the closed irrigated-tip, but the results were less conclusive in relation to the 8-mm tip catheters. There were differences with the open-irrigated-tip catheter, but the only statistically significant difference was in the power output applied, which was related to the settings. Despite this, they suggested that the open irrigated-tip catheter was more effective. Our study used the open irrigation-tip system and included a number of patients sufficient to demonstrate a difference, and was effectively similar in design to that of these authors. We could not demonstrate this difference.[14]

Ventura et al[15] also concluded that the open irrigated-tip catheter was superior to the 8-mm catheter. They considered that the assigned catheter had failed when transitory CTI block was achieved in 2 applications. This occurred in 12% of patients in the 8-mm group and in none in the irrigated group. Our results differ, and this may be due to the endpoint used. Successful ablation within a preestablished time has been used in several comparative studies. This is simple to determine, has clinical relevance, and is easy to replicate. The duration of radioscopy and the duration of the procedure reported by these authors are 2 and 3 times greater than those described in our study, respectively.

As we considered the problem to be unresolved, we designed our study to provide evidence of good methodological quality.[17] Furthermore, long-term double-blinded follow-up was conducted to ensure that the outcome was maintained. In general, recurrences occurred in the first 6 months and all our patients were followed up for more than 1 year. There were no statistically significant differences in the AFL recurrence rate nor in the appearance of other supraventricular arrhythmias (Table 4).

It could be suggested that each type of catheter is better suited to a given anatomy. Da Costa et al[16] selected patients with an isthmus >35-mm long and found no differences between the catheters.[16] If different catheters were better suited to different anatomies, then the anatomy would have to be known in detail to select the best one. Given the

high success rate without additional imaging studies, we do not consider that such studies are strictly necessary.

The appropriate choice of curve in each patient appears to be of relevance to achieve effective ablation with the first catheter selected. In our series, the operator considered it advisable to change the curve half of the times that the catheter was changed. An inappropriate choice of curve had the least impact among the factors preventing effective ablation.

When choosing the catheter to begin AFL ablation, in each case the costs, the infrastructure needed and the experience of the operator should be taken into account. Having both types of catheter available is an advantage and the operator should be careful when selecting the type of curve.

CONCLUSIONS

No difference was found between the effectiveness of 8-mm-tip and open irrigated-tip catheters in the first attempt at ablation of typical isthmus-dependent atrial flutter. With both types of catheter, we achieved the same percentage of effective ablations, in the same amount of time, without major complications, and with a similar number of recurrences. When choosing the type of catheter to use in the first attempt at ablation, logistics, cost and operator experience should all be taken into account.

REFERENCES

1. Feld GK, Fleck RP, Chen PS, Boyce K, Bahnson TD, Stein JB, et al. Radiofrequency catheter ablation for the treatment of human type 1 atrial flutter. Identification of a critical zone in the reentrant circuit by endocardial mapping techniques. Circulation. 1992;86:1233-40.
2. Cosío FG, López-Gil M, Goicolea A, Arribas F, Barroso JL. Radiofrequency ablation of the inferior vena cava-tricuspid valve isthmus in common atrial flutter. Am J Cardiol. 1993;71:705-9.
3. Fischer B, Haissaguerre M, Garrigues S, Poquet F, Gencel L, Clementy J, et al. Radiofrequency catheter ablation of common atrial flutter in 80 patients. J Am Coll Cardiol. 1995;25:1365-72.
4. García-Cosío F, López-Gil M, Arribas F, Goicolea A, Pastor A, Núñez A. Ablación de flutter auricular. Resultados a largo plazo tras 8 años de experiencia. Rev Esp Cardiol. 1998;51:832-9.
5. Fischer B, Jais P, Shah D, Chouairi S, Haissaguerre M, Garrigues S, et al. Radiofrequency catheter ablation of common atrial flutter in 200 patients. J Cardiovasc Electrophysiol. 1996;7:1225-33.
6. Jais P, Haissaguerre M, Shah DC, Takahashi A, Hocini M, Lavergne T, et al. Successful irrigated-tip catheter ablation of atrial flutter resistant to conventional radiofrequency ablation. Circulation. 1998;98:835-8.
7. Tsai CF, Tai CT, Yu WC, Chen YJ, Hsieh MH, Chiang CE, et al. Is 8-mm more effective than 4-mm tip electrode catheter for ablation of typical atrial flutter? Circulation. 1999;100:768-71.
8. Ventura R, Willems S, Weiss C, Flecke J, Risius T, Rostock T, et al. Large tip electrodes for successful elimination of atrial flutter resistant to conventional catheter ablation. J Inter. Card Electrophysiol. 2003;8:149-54.
9. Jais P, Shah D, Haissaguerre M, Hocini M, Garrigue S, Le Metayer P, et al. Prospective randomized comparison of irrigated tip versus conventional tip catheters for ablation of common flutter. Circulation. 2000;101:772-6.
10. Pena Pérez G, Hernández Madrid A, González Rebollo JM, Rodríguez A, Gómez Bueno M, Camino A, et al. Ablación del istmo cavotricuspídeo. Estudio prospectivo aleatorizado sobre ablación mediante radiofrecuencia con catéteres irrigados frente a catéteres estándar. Rev Esp Cardiol. 2002;55:37-44.
11. Atiga WL, Worley SJ, Hummel J, Berger RD, Gohn DC, Mandalakas NJ, et al. Prospective randomized comparison of cooled radiofrequency versus standard radiofrequency energy for ablation of typical atrial flutter. Pacing Clin Electrophysiol. 2002;8:1172-8.
12. Schreieck J, Zrenner B, Kumpmann, Ndrepepa G, Schneider MAE, Deisenhofer I, et al. Prospective randomized comparison of closed cooled-tip versus 8-mm-tip catheters for radiofrequency ablation of typical atrial flutter. J Cardiovasc Electrophysiol. 2002;13:980-5.
13. Scavée C, Georger F, Jamart J, Mancini I, Collet B, Blommaert D, et al. Is a cooled tip catheter the solution for the ablation of the cavotricuspid isthmus? Pacing Clin Electrophysiol. 2003;26:328-31.
14. Scavée C, Jaïs P, Hsu LF, Sanders P, Hocini M, Weerasooriya R, et al. Prospective randomised comparison of irrigated-tip and large-tip catheter ablation of cavotricuspid isthmusdependent atrial flutter. Eur Heart J. 2004;25:963-9.
15. Ventura R, Klemm H, Lutomsky B, Demir C, Rostock T, Weiss C, et al. Pattern of isthmus conduction recovery using open cooled and solid large-tip catheters for radiofrequency ablation of typical atrial flutter. J Cardiovasc Electrophysiol. 2004;15:1126-30.
16. da Costa A, Faure E, Thévenin J, Messier M, Bernard S, Abdel K, et al. Effect of isthmus anatomy and ablation catheter on radiofrequency catheter ablation of the cavotricuspid isthmus. Circulation. 2004;110:1030-5.
17. Altman DG, Schulz KF, Moher D, Egger M, Davidoff F, Elbourne D, et al. for the CONSORT Group. The Revised CONSORT Statement for Reporting Randomized Trials: Explanation and Elaboration. Ann Intern Med. 2001;134:663-94.
18. Petersen HH, Chen X, Pietersen A, Svendsen JH, Haunso S. Lesion dimensions during temperature controlled radiofrequency catheter ablation of left ventricular porcine myocardium. Circulation. 1999;99:319-25.
19. Mehdirad A, Gaiser J, Baker P, West S, Lehmkuhl L, Yong P, et al. Effect of catheter tip length and position on lesion volume in temperature controlled RF ablation in canine tricuspid valve annulus. J Interv Card Electrophysiol. 1998;2:279-84.
20. Otomo K, Yamanashi WS, Tondo C, Antz M, Bussey J, Pitha JV, et al. Why a large tip electrode makes a deeper radiofrequency lesion: effects of increase in electrode cooling and electrode-tissue interface area. J Cardiovasc Electrophysiol. 1998;9:47-54.
21. Weiss C, Becker J, Hoffmann M, Willems S. Can radiofrequency current isthmus ablation damage the right coronary artery? Histopathological findings following the use of a long (8 mm) tip electrode. Pacing Clin Electrophysiol. 2002;25:860-2.
22. Hernández Madrid A, del Rey Sánchez JM, González Rebollo JM, Álvarez Mogollón T, Correa C, Ortiz Chercoles AI, et al. Correlación anatomopatológica y bioquímica de las lesiones producidas por la radiofrecuencia con catéteres estándar e irrigados de 4 mm. Rev Esp Cardiol. 2000;53:1347-55.
23. Madrid AH, Rebollo JM, del Rey JM, Gonzalo P, Socas A, Alvarez T, et al. Randomized comparison of efficacy of cooled tip catheter ablation of atrial flutter: anatomic versus electrophysiological complete isthmus block. Pacing Clin Electrophysiol. 2001;24:1525-33.