



Original Article

Atrial Fibrillation Ablation in Brazil: Results of the Registry of the Brazilian Society of Cardiac Arrhythmias

Guilherme Fenelon, Maurício Scanavacca, Jacob Atié, Leandro Zimmerman, Luiz Pereira de Magalhães, Adalberto Lorga Filho, Henrique Maia, Martino Martinelli Filho

Escola Paulista de Medicina – Universidade Federal de São Paulo – São Paulo, SP - Brazil

Summary

Background: Aiming to define the profile of curative atrial fibrillation (AF) ablation in Brazil, the Brazilian Cardiac Arrhythmia Society [Sociedade Brasileira de Arritmias Cardíacas] (SOBRAC) created the Brazilian Registry of AF Ablation [Registro Brasileiro de Ablação da FA].

Objective: To describe the results of this registry.

Methods: A questionnaire was sent to SOBRAC members asking about data on patients submitted to AF ablation between September 2005 and November, 2006.

Results: A total of 29 groups from 13 states completed the forms. Of these, 22 (76%) had performed AF ablations. Between 1998 and 2001, 7 groups (32%) initiated AF ablations and between 2002 and 2006, 15 groups began to perform them (68%). From 1998 to 2006, 2,374 patients were submitted to ablation, 755 (32%) of them during the registry period. Most (70%) were males and 89% presented with paroxysmal or persistent AF. Ancillary imaging methods (intracardiac echocardiography and electroanatomic mapping) were used by 9 groups (41%). During an average five-month follow-up period, total success was 82% and success without use of antiarrhythmic agents was 57%. Nevertheless, 35% of the patients required two or more procedures. There were 111 complications (14.7%) and 2 deaths (0.26%).

Conclusion: Curative AF ablation has been increasing significantly in our country, with success rates comparable to international indexes, but often more than one procedure is necessary. Despite promising results, AF ablation still results in significant morbidity. Supplementary imaging methods have been used more and more in an effort to increase efficacy and safety of the procedure. These findings should be considered by public and private funding agencies. (Arq Bras Cardiol 2007;88(5):258-262)

Key words: Atrial fibrillation/ epidemiology; arrhythmia; societies medical; Brazil.

Introduction

Atrial fibrillation (AF) is the most frequent sustained cardiac arrhythmia in clinical practice. Epidemiological data show that AF is associated with expressive morbidity and mortality, leading to high medical and hospital costs¹. The disappointment generated by the modest impact of antiarrhythmic drugs in the natural history of AF motivated the development of non-drug methods seeking curative treatment of this arrhythmia. In this context, over the last decade, catheter ablation with percutaneous techniques evolved considerably, and has been established as a treatment option in selected patients with AF². Currently, several different approaches are used for curative AF ablation³⁻¹⁶. The most important of these have the objective of electrical isolation of pulmonary veins in regard to the left atrium³⁻¹¹, associated or

not with modifications of the atrial substrate by the creation of linear lesions in the left atrium,^{10,16} elimination of fragmented potentials¹² and AF nests,¹³ or the ablation of parasympathetic ganglia.^{14,15} Additionally, auxiliary imaging techniques such as intracardiac echocardiography and electroanatomic mapping have been progressively more incorporated with the goal of increasing the efficiency and safety of the method^{8,17}. Despite the approach and technique used, when performed by experienced operators, AF ablation has proved to be a safe method with very satisfactory results²⁻¹⁵. Nevertheless, it is important to point out that AF ablation is a complex procedure not without risks. Several serious complications have been reported including cerebrovascular accidents, stenosis of pulmonary veins, and atrioesophageal fistulae^{18,19}. These aspects of the efficacy and safety of AF ablation are relevant for the clinical indication of the procedure.

In spite of the growing use of curative AF ablation, data on the use of these techniques in our area are scarce²⁰⁻²⁴. Because of the complexity of these procedures, it is important to identify sites, techniques used, and the results of AF ablation

Mailing address: Guilherme Fenelon •

Rua Pedro de Toledo, 781 – 10º andar – 04039-032 - São Paulo, SP - Brazil

E-mail: guilhermefenelon@uol.com.br

Manuscript received March 6, 2007; revised manuscript received March 28, 2007; accepted March 30, 2007.

in our country. With the goal of obtaining this information, the Brazilian Cardiac Arrhythmia Society (SOBRAC) created the Brazilian Registry of AF Ablation intending to outline the profile of curative AF ablation in Brazil. This article describes the results of this survey.

Methods

The Brazilian Registry of Atrial Fibrillation Ablation was entirely organized and implanted by SOBRAC. In September 2006, a standardized questionnaire was sent to all the 692 registered members of SOBRAC by electronic mail, inquiring about the principal data on patients submitted to AF ablation. The questionnaire was comprised of 20 questions covering the following specific aspects: experience of the group; indications and clinical characteristics of the patients submitted to AF ablation; pre- and post-procedure tests; ablation techniques and catheters used; anticoagulation regimes, and the use of post-ablation antiarrhythmic drugs; and, finally, results and complications of the procedure.

With the aim of encouraging compliance with the registry, two more electronic messages were sent, ten and twenty days after the first communication, besides periodic telephone contacts. Only one form was requested per group of electrophysiologists because it did not need to be completed by all members of the team. Since the registry will be periodically updated, special emphasis was given to the results of the previous twelve months. The invitation to participate in the registry underlined that it is owned by SOBRAC and would be used exclusively by this entity. It also stated that all participating groups would receive credit for the project and that no individual results of any patient or team would be divulged, under any circumstance. As an additional guarantee of confidentiality, in this paper all information that could directly or indirectly lead to identification of the institutions was omitted. The forms were to be returned to SOBRAC preferably by electronic mail by the November 20, 2006 deadline. Data were then analyzed, compiled, and posteriorly stored by the registry committee of SOBRAC.

Since this project aims to solely describe the panorama of AF ablation in Brazil, with no intention of elucidating the reasons for procedure outcomes, no correlations were made between the data analyzed. The forms were received between September 22, 2006, and November 20, 2006. Registry information, therefore, based on the preceding 12 months, refers to ablations performed between September 2005 and November 2006. This interval will henceforth be referred to as the registry period.

Continuous variables were expressed as means and categorical variables as percentages.

Results

A total of 29 groups from 13 states in five regions of the country filled in the questionnaire. A complete list of the registry participants may be found in the appendix. Most (n = 16; 55%) were from the Southeast region (6 from São Paulo, 4 from Rio de Janeiro, 4 from Minas Gerais, and 2 from Espírito

Santo), 5 groups (17%) were from the Northeast (Bahia, Ceará, Pernambuco, Piauí, and Rio Grande do Norte), 4 (14%) were from the South region (2 from Paraná and 2 from Rio Grande do Sul), 3 (10%) were from the Central-West (all from the Federal District), and one (4%) was from the North (Pará). All these groups are distinctly representative of their regions and regularly carry out ablation procedures, but only 22/29 (76%) of these teams mentioned performing curative AF ablation. The report of these 22 groups comprised the basis of the registry.

Curative AF ablation in Brazil began in 1998: between this year and 2001, 7 groups (32%) started to perform these procedures, and another 15 groups (68%) began ablations between 2002 and 2006. From 1998 to 2006, a total of 2,374 patients were submitted to AF ablation, 755 (32%) of them during the registry period (the previous 12 months). As to the experience of the groups, the number of patients submitted to AF ablation during the registry period (n = 755) varied from 1 to 125. During this period, 8 groups (36%) carried out between one and 10 cases, totalizing 36 patients (5%); 4 groups (18%), reported between 11 and 20 cases, totalizing 53 patients (7%); 1 group (5%) between 21 and 30 cases, totalizing 26 patients (4%); 6 groups (27%) between 31 and 65 cases, totalizing 327 patients (43%); and only 3 groups (14%) performed more than 65 cases, totalizing 313 patients (41%).

As is illustrated on Table 1, of the 755 patients submitted to ablation in the registry period, most (70%) were males and 89% presented with paroxysmal or persistent AF. As to criteria for indication of the procedure, 91% of the groups referred that the patients had to be refractory to

Table 1 - Clinical presentation and criteria used by the groups to indicate the procedure

Type of atrial fibrillation (n = 755)	
Paroxysmal	436 (58%)
Persistent	235 (31%)
Permanent	84 (11%)
Male patients	528 (70%)
Refractoriness to drugs	
1 drug	2 groups (9%)
2 drugs	20 groups (91%)
Minimum left ventricular ejection fraction	
Normal	5 groups (23%)
40%-50%	7 groups (32%)
30%-40%	8 groups (36%)
< 30%	2 groups (9%)
Maximum diameter of the left atrium	
40 mm-50 mm	8 groups (36%)
50 mm-55 mm	11 groups (50%)
> 55 mm	3 groups (14%)

n - number of patients.

two antiarrhythmic drugs (names of the drugs were not given); 55% stated that only patients with normal or slightly diminished left ventricular ejection fractions were included; and 86% of the groups stated that the diameter of the left atrium could be no larger than 55 mm.

The ages of the 755 patients varied between 18 and 85 years (means were not provided). As to the geriatric population, 19 groups (86%) carried out ablations in patients over 65 years of age; 16 groups (73%), in individuals over 70 years of age; 10 groups (45%), in those over 75 years of age; and only 3 groups (14%) admitted patients over 80 years of age.

As to preoperative tests to evaluate the presence of intracavitary thrombi and/or anatomy of the left atrium, most groups (n = 20; 91%) routinely adopted transesophageal echocardiography. Magnetic nuclear resonance was used by 12 groups (55%) and only 2 groups (9%) performed computed tomography. All of the groups used radiofrequency as the source of energy for ablation and only one group also used ultrasound. Most groups (n = 17; 77%) used ablation catheters with 8 mm tips, 4 groups (18%) used irrigated catheters, and only 2 groups (9%) used catheters with 4 mm tips. In the postoperative period, all 22 groups (100%) adopted anticoagulation with warfarin, 14 (64%) of them for two to four months, and the other 8 (36%) for periods greater than four months.

As to ablation approaches adopted isolatedly or in combination (Table 2), 10 groups (46%) used electrical isolation of pulmonary veins guided by fluoroscopy, as recommended by Haissaguerre et al³⁻⁵; 8 groups (36%) isolated the antra of the pulmonary veins guided by intracardiac echocardiography, as described by Natale et al⁶⁻⁸; and 3 groups (14%) performed circumferential ablation of pulmonary veins guided by electroanatomic mapping systems as per Pappone et al⁹⁻¹¹ and Osil et al¹¹. Other approaches such as fragmented electrogram ablation, described by Nademanee et al¹², ablation of AF nests proposed by Pachón et al¹³, and

ablation of the parasympathetic ganglia, reported by the Oklahoma group¹⁴, were used by fewer groups. The ablation of the cavotricuspid isthmus was carried out by 13 groups (59%), and electrical isolation of the superior cava was done by 4 groups (18%). It is noteworthy that 9 groups (41%) referred having used auxiliary imaging methods (intracardiac echocardiography and electroanatomic mapping) to perform the procedure.

Information on the success of ablation was provided by 18 groups (82%). During an average five-month follow-up period (one to eleven months), the total success of the procedure, defined as maintenance of the sinus rhythm, was 82% (66%-100%). On the other hand, success without the need for antiarrhythmic drugs was 57% (17%-100%). In order to obtain these results, 65% of the patients required one, 30% required two, and 5% required more than two procedures.

A total of 111 complications (14.3%) were reported by 19 groups (86%), as is shown on Table 3. The most frequent

Table 3 - Number of complications in the 755 patients of the registry

Type of complication	Number of complications
Atrioesophageal fistula	1 (0.1%)
Pulmonary vein stenosis/occlusion	3 (0.4%)
Transient ischemic attack	11 (1.4%)
Cerebrovascular accident	8 (1.0%)
Cardiac tamponade	29 (3.8%)
Pericardial effusion	7 (0.9%)
Phrenic nerve lesion	2 (0.2%)
Post-ablation tachycardia	29 (3.8%)
Hematomas or hemorrhages	18 (2.3%)
Anesthesia accidents	3 (0.4%)
Total	111 (14.3%)

Table 2 - Ablation approaches used by the groups

Technique used	Number of groups
Electrical isolation of PV by fluoroscopy	10 (46%)
Ablation of PV antra with intracardiac ECHO	8 (36%)
Circumferential ablation of PV with EAM	3 (14%)
Ablation of fragmented potentials	2 (9%)
Ablation of AF nests	2 (9%)
Ganglion ablation	1 (4%)
Use of auxiliary methods (ECHO or EAM)	9 (41%)

PV - pulmonary veins; ECHO - echocardiography; EAM - electroanatomic mapping; AF - atrial fibrillation.

were cardiac tamponade and post-ablation iatrogenic atrial tachycardias (n = 29; 3.8%). Eight (1.0%) cerebrovascular accidents with sequelae were reported and 11 (1.4%) of them were transient. Significant pulmonary vein stenosis (> 50%) and/or occlusion were detected in three patients (0.4%), and only one (0.1%) atrioesophageal fistula was observed. Two (0.26%) deaths were reported which occurred in the first 30 days (atrioesophageal fistulae) and three months (post-tamponade sepsis) after the ablation procedure.

Discussion

This registry was a pioneer initiative of SOBRAC with the intention of delineating the profile of curative AF ablation in Brazil. This survey shows that, over the last few years, the use of these procedures has been increasing in all regions of the country. Corroborating this observation, between 2002 and 2006, there was a marked increase in the number of centers

initiating AF ablation programs (n = 15; 68%) compared to the early period from 1998 to 2001 (n = 7; 32%). This is also attested by the experience with the technique shown by the teams: 8 groups (36%) carried out less than 11 cases during the year of the registry, suggesting programs under development, while only 9 groups (40%) with more than 30 cases in the year could be considered experienced. Additionally, 755 (32%) of the 2,374 patients submitted to AF ablation between 1998 and 2006 were included during the registry period, i.e., in the 12 months prior to answering the questionnaire. Nevertheless, among the registry participants, 7 groups (24%) had not yet begun AF ablation programs, indicating that there is potential for increasing the use of these procedures in our midst.

Over the last decade, both in other countries and in Brazil, the techniques used in curative AF ablation went through profound transformations evolving from the elimination of ectopic foci inside arrhythmogenic pulmonary veins to total electric isolation of these vessels²⁻¹¹. Furthermore, modern approaches also modified the atrial substrate, primarily in the posterior wall of the left atrium¹⁶. This technological progression and its impact on the results of the procedure were not analyzed by this registry. Since the proposal was to document the present status of AF ablation in Brazil, with no biases introduced by obsolete techniques, the registry period was essentially restricted to the year 2006. Thus, the results of this registry could be directly applied in clinical practice. In conformity with the current nature of this registry, the techniques most reported by the groups in this investigation, i.e., electric isolation of pulmonary vein segments (46%)⁴, intracardiac echocardiographic ablation of pulmonary vein antra (36%)⁸, and electroanatomic mapping-guided circumferential ablation of the pulmonary veins (14%)¹¹, are also the most commonly used in other countries. Additionally, similar to the international situation, recent techniques aiming to modify the atrial substrate (ablation of fragmented potentials and AF nests)^{12,13} and autonomous modulators (ablation of parasympathetic ganglia)^{14,15} have also been used in our country, although on a smaller scale.

Despite the short follow-up period (five months) of patients in this survey, the data are comparable to those of the international survey done by Cappato et al¹⁸. In this important research project, 90 centers from various countries and with different levels of experience provided information on the curative AF ablations performed on 8,745 patients between 1995 and 2002. Comparable to the SOBRAC registry, most patients were males (64%) and from a similar age bracket (16-86 years). They presented with paroxysmal or persistent AF, were refractory to antiarrhythmic drugs, had left atrium diameters of up to 55 mm and at least 40% left ventricular ejection fraction. These authors reported a 76% total success rate and a 52% success rate without antiarrhythmic drugs, results very close to those of the SOBRAC study, 82% and 57%, respectively. The percentages of patients that requiring two or more ablation procedures in the international registry (24% and 3%) and in the national registry (30% and 5%) were also similar, whereas the rate of complications in the SOBRAC registry (14.3%) was higher than that of the international registry

(5.9%). In the latter, however, the post-ablation iatrogenic tachycardia cases²⁵ observed in 3.9% of the patients¹⁸, the occurrence of hematomas, and the anesthesia complications were not counted in the general total. In the SOBRAC registry, these events answered for 45% of all complications. Despite differences in method, both studies showed that AF ablation is associated with serious complications such as cerebrovascular accidents, cardiac tamponade, pulmonary vein stenosis, and atrioesophageal fistulae¹⁹. These outcomes were responsible for the deaths reported in the national (n = 2; 0.26%) and international (n = 4; 0.05%) registries. These aspects indicate that AF ablation, as per Brazilian guideline recommendations,² should be performed by experienced groups in centers with adequate infrastructure and surgical backup. Postoperative care is also important, especially the use of full anticoagulation for several months, a recommendation that was followed by all participants of the registry.

In face of the complexity and risks of curative AF ablation, several imaging techniques have been developed with the purpose of increasing the efficacy and safety of the procedure. Among them, the most widely accepted internationally are the electroanatomic mapping systems and intracardiac echocardiography^{8,17}. The former allow a tridimensional reconstruction of the left atrium and pulmonary vein ostium besides a precise quantification of the radiofrequency lesion application sites, while the latter allows real-time monitoring of transseptal punctures, positioning of the catheters in the pulmonary vein region, and formation of intracavitary thrombi. Data from the national registry demonstrate that these techniques have been incorporated into our midst because 9 groups (41%) reported having used at least one of these auxiliary methods during the registry period.

Limitations - The registry is voluntary and reflects the experience of the participants and not that of all centers in the country. However, the institutions that participated are highly representative in their respective regions and at SOBRAC. A limitation inherent to the registry is that data are not controlled, and verification of information is difficult. Nevertheless, since the results and complications reported are similar to those found in medical literature¹⁸, we believe that the registry figures are trustworthy. As was mentioned before, in order to assure confidentiality, the rates of success and complications were not correlated with the volume of cases from each institution. The techniques for AF ablation evolve quickly^{2,16}. Therefore, the information collected during the registry period (2005-2006) may not entirely mirror current practices. In this regard, the registry should be periodically updated.

Conclusions

The use of curative AF ablation has been increasing significantly in our midst and is available in several Brazilian states. The success rates reported are comparable to those from international registries, but in approximately 40% of the patients, an additional procedure is needed. In spite of very promising results, AF ablation still leads to significant morbidity. Ancillary imaging methods have been used more and more

in Brazil with the objective of increasing the efficacy and safety of the procedure. These findings should be taken into consideration by public and private funding agencies.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

References

1. The effect of low-dose warfarin on the risk of stroke in patients with nonrheumatic atrial fibrillation. The Boston Area Anticoagulation Trial for Atrial Fibrillation Investigators. *N Engl J Med.* 1990; 323 (22): 1505-11.
2. Sociedade Brasileira de Cardiologia. Diretrizes brasileiras de fibrilação atrial. *Arq Bras Cardiol.* 2003; 81 (supl. 6): S3-24.
3. Haissaguerre M, Jais P, Shah DC, Garrigue S, Takahashi A, Lavergne T, et al. Electrophysiological end point for catheter ablation of atrial fibrillation initiated from multiple pulmonary venous foci. *Circulation.* 2000; 101: 1409-17.
4. Haissaguerre M, Sanders P, Hocini M, Jais P, Clementy J. Pulmonary veins in the substrate for atrial fibrillation: the "venous wave" hypothesis. *J Am Coll Cardiol.* 2004; 43: 2290-2.
5. Takahashi Y, O'Neill MD, Jonsson A, Sanders P, Sacher F, Hocini M, et al. How to interpret and identify pulmonary vein recordings with the lasso catheter. *Heart Rhythm.* 2006; 3: 748-50.
6. Themistoclakis S, Erciyes D, Saliba WJ, Schweikert RA, Brachmann J, Raviele A, et al. Embolic events and char formation during pulmonary vein isolation in patients with atrial fibrillation: impact of different anticoagulation regimens and importance of intracardiac echo imaging. *J Cardiovasc Electrophysiol.* 2005; 16: 576-81.
7. Kanj MH, Wazni OM, Natale A. How to do circular mapping catheter-guided pulmonary vein antrum isolation: the Cleveland Clinic approach. *Heart Rhythm.* 2006; 3: 866-9.
8. Wazni OM, Tsao HM, Chen SA, Chuang HH, Saliba W, Natale A, et al. Cardiovascular imaging in the management of atrial fibrillation. *J Am Coll Cardiol.* 2006; 48: 2077-84.
9. Pappone C, Santinelli V. The who, what, why, and how-to guide for circumferential pulmonary vein ablation. *J Cardiovasc Electrophysiol.* 2004; 15: 1226-30.
10. Pappone C, Santinelli V. Substrate ablation in treatment of atrial fibrillation. *J Cardiovasc Electrophysiol.* 2006; 17: S23-7.
11. Oral H, Pappone C, Chugh A, Good E, Bogun F, Pelosi F Jr, et al. Circumferential pulmonary-vein ablation for chronic atrial fibrillation. *N Engl J Med.* 2006; 354: 934-41.
12. Nademanee K, Schwab M, Porath J, Abbo A. How to perform electrogram-guided atrial fibrillation ablation. *Heart Rhythm.* 2006; 3: 981-4.
13. Pachon MJC, Pachon M EI, Pachon MJC, Lobo TJ, Pachon MZ, Vargas RN,

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any graduation program.

- et al. A new treatment for atrial fibrillation based on spectral analysis to guide the catheter RF-ablation. *Europace.* 2004; 6: 590-601.
14. Scherlag BJ, Nakagawa H, Jackman WM, Yamanashi WS, Patterson E, Po S, et al. Electrical stimulation to identify neural elements on the heart: their role in atrial fibrillation. *J Interv Card Electrophysiol.* 2005; 13: S37-42.
15. Scanavacca M, Pisani CF, Hachul D, Lara S, Hardy C, Darrieux F, et al. Selective atrial vagal denervation guided by evoked vagal reflex to treat patients with paroxysmal atrial fibrillation. *Circulation.* 2006; 114: 876-85.
16. Arruda M, Natale A. The adjunctive role of nonpulmonary venous ablation in the cure of atrial fibrillation. *J Cardiovasc Electrophysiol.* 2006; 17: S37-43.
17. Packer DL. Three-dimensional mapping in interventional electrophysiology: techniques and technology. *J Cardiovasc Electrophysiol.* 2005; 16: 1110-6.
18. Cappato R, Calkins H, Chen SA, Davies W, Iesaka Y, Kalman J, et al. Worldwide survey on the methods, efficacy, and safety of catheter ablation for human atrial fibrillation. *Circulation.* 2005; 111: 1100-5.
19. Dixit S, Marchlinski FE. How to recognize, manage, and prevent complications during atrial fibrillation ablation. *Heart Rhythm.* 2007; 4: 108-15.
20. Rocha Neto AC, Farias RL, de Paola AA. Tratamento da fibrilação atrial através da ablação com radiofrequência utilizando mapeamento multipolar simultâneo das veias pulmonares. *Arq Bras Cardiol.* 2001; 77: 407-28.
21. Mehta N, Tavora MZ, Takeschita N, Figueiredo E, Lourenco RM, Germiniani H, et al. Características clínicas úteis para seleção do candidato ideal para mapeamento e ablação de fibrilação atrial. *Arq Bras Cardiol.* 2002; 78: 1-16.
22. Scanavacca M, Sartini R, Tondato F, D'Avila A, Hachul D, Darrieux F, et al. Isolamento das veias pulmonares para tratamento da fibrilação atrial paroxística: resultados clínicos após um único procedimento. *Arq Bras Cardiol.* 2004; 82: 160-4.
23. Scanavacca MI, Sosa E. Ablação por cateter da fibrilação atrial: técnicas e resultados. *Arq Bras Cardiol.* 2005; 85: 295-301.
24. Maciel W, Andréa E, Araújo N, Carvalho H, Belo LG, Siqueira L, et al. Critérios prognósticos de sucesso e recorrência na ablação circunferencial para tratamento da fibrilação atrial. *Arq Bras Cardiol.* 2007; 88: 134-43.
25. Mesas CE, Pappone C, Lang CC, Gugliotta F, Tomita T, Vicedomini G, et al. Left atrial tachycardia after circumferential pulmonary vein ablation for atrial fibrillation: electroanatomic characterization and treatment. *J Am Coll Cardiol.* 2004; 44: 1071-9.