

# Surgical biatrial ablation of atrial fibrillation: initial results

## *Avaliação inicial da ablação operatória biatrial por radiofrequência de fibrilação atrial*

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### *Abstract*

**Objective:** The aim of this study is to evaluate the initial results of intraoperative radiofrequency ablation using biatrial procedure to treat chronic atrial fibrillation in patients with associated cardiac disease.

**Methods:** Between February 2008 and May 2009, 15 consecutive patients were underwent mitral valve procedure plus modified radiofrequency biatrial ablation of chronic atrial fibrillation. The mean age was  $47.73 \pm 9.85$  years and 60% were male. The mean left atrial diameter was  $55.06 \pm 7.56$  mm.

**Results:** There were no hospital mortality or complications related to radiofrequency ablation. The mean follow-up period was  $7 \pm 4$  months. At the time of hospital discharge 9 (60%) patients were in sinus rhythm. After a mean follow-up period 11 (73.3%) were in sinus rhythm.

**Conclusion:** Intraoperative biatrial radiofrequency ablation is a safe and effective technique for the treatment

of chronic atrial fibrillation, with satisfactory midterms outcomes in terms of conversion to sinus rhythm.

**Descriptors:** Catheter ablation. Atrial fibrillation. Mitral valve. Cardiac surgical procedures.

### *Resumo*

**Objetivo:** Apresentar o resultado inicial da ablação operatória de fibrilação atrial (FA) por radiofrequência irrigada, aplicada em ambos os átrios, para reversão e manutenção do ritmo sinusal, a curto e médio prazo, nos pacientes submetidos à operação cardíaca concomitante da valva mitral.

**Métodos:** Entre fevereiro de 2008 e maio de 2009, 15 pacientes consecutivos portadores de FA permanente foram submetidos à ablação intraoperatória da taquiarritmia por radiofrequência irrigada, aplicada de forma biatrial, com operação cardíaca concomitante (plastia ou troca valvar

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mitral). O grupo era constituído de nove (60%) pacientes do sexo masculino, com idades variando de 25 a 59 anos (média de  $47,73 \pm 9,85$  anos). O diâmetro do átrio esquerdo variou de 44 a 70 mm (média de  $55,06 \pm 7,56$  mm).

**Resultados:** Não houve mortalidade hospitalar ou complicações relacionadas à radiofrequência. Na alta hospitalar, 9 (60%) pacientes estavam em ritmo sinusal. No tempo médio de seguimento de  $7 \pm 4$  meses, 11 (73,3%) pacientes estavam em ritmo sinusal.

**Conclusões:** A ablação operatória por radiofrequência irrigada da fibrilação atrial crônica, aplicada em ambos os átrios, é efetiva na reversão e manutenção do ritmo sinusal, no seguimento a curto e médio prazo. A inclusão de maior número de pacientes e a continuidade do seguimento pós-operatório são necessárias para confirmar a efetividade da técnica empregada.

**Descritores:** Ablação por cateter. Fibrilação atrial. Valva mitral. Procedimentos cirúrgicos cardíacos.

## INTRODUCTION

Atrial fibrillation (AF) represents the most common sustained cardiac rhythm disorder and its prevalence increases with age. AF may occur or not occur in the presence of structural heart disease. AF occurrence might lead to increases in mortality, morbidity (related to thromboembolic events and hemodynamic compromise), and in health care costs as well [1].

The maze III procedure, described by Cox et al. [2], represents the most effective method to treat AF. It has been considered as the gold standard of care. However, its effectiveness is inversely proportional to its applicability. Thus, several alternative energy sources (cryoablation, microwaves, radiofrequency) have been used in an attempt to create a lesion set similar to that obtained by the “cut-and-sew” technique [3-5].

The role of pulmonary veins and posterior left atrium in the genesis of AF is well established. Some authors who have chosen to employ alternative energy sources have reported favorable results involving only the left atrium [6]. In our cardiovascular surgery service, we have adopted radiofrequency ablation for AF involving only the left atrium and the results obtained were inferior to those previously published in other studies with a rate of success in reversion and maintenance of sinus rhythm ranging from 75% to 85% [7]. This fact motivated a change in the line of conduct and since then we have employed the biatrial radiofrequency ablation procedure.

The aim of the present study is to present the initial result of surgical ablation of atrial fibrillation with radiofrequency applied to both atria in order to revert and maintain sinus rhythm, in a short- and midterm, in patients undergoing concomitant cardiac surgery.

## METHODS

Between February 2008 and May 2009, 15 consecutive patients with permanent atrial fibrillation (all cases diagnosed at least 12 month prior to procedure) underwent

intra-operative irrigated biatrial radiofrequency ablation of tachyarrhythmia with concomitant cardiac surgery (either mitral repair or replacement). The study protocol was considered by the ABC Medical School Research and Ethics Committee, under number 105/2008. All participating patients gave written informed consent.

Exclusion criteria were the left ventricular ejection fraction (LVEF) lower than 35%, active infectious endocarditis, contraindication for anticoagulant therapy, and emergency or urgent procedures.

The study population included 9 (60%) male patients with age ranging from 25 to 59 years (mean age  $47.73 \pm 9.85$  yrs). Among the potential rheumatic etiologies the following were most significant: mitral valvopathy, 9 cases (60%); degenerative, 5 cases (33.3%), and mitral stenosis after surgical repair using a ring, 1 case (7.7%). Left atrium diameter measured by transthoracic echocardiography ranged from 44 to 70 mm ( $55.06 \pm 7.56$  mm).

Patients presented congestive signs and symptoms at the moment of operatory indication. Regarding the *New York Heart Association* (NYHA) functional classification (FC) 33.4% and 66.6% of the patients had a NYHA FC II and III, respectively. The clinical and demographic characteristics are depicted in Table 1. Follow-up time after the operation ranged from 1 to 14 months (mean length of follow-up  $7 \pm 4$  months).

Table 1. Clinical and demographic features of patients

Variables	Batrial Group
Gender (%)	36.7
Female	63.3
Male	60.0±8.07
Age (yrs)	86.7
NYHA Functional Class (%)	
II	33.4
III	66.6
Thromboembolism history (%)	20
Left atrium diameter (mm)	55.06 ± 7.56

### Operative technique

The operation began with hemodynamic monitoring and measurements of mean arterial pressure, central venous pressure, and urinary output, besides respiratory monitoring and pulse oximetry.

The access route was median sternotomy with cannulation of aorta, superior and inferior vena cava after intravenous administration of heparin (440 IU/kg) and moderate hypothermia (32°C).

Hypothermic antegrade sanguineous cardioplegia (at about 18°C) was the method of myocardial protection employed with addition of potassium (15 mEq/L) during induction. In the subsequent doses, blood perfusate (32°C) was administered without any other substance addition at 15-minute intervals.

The approach of mitral valve was obtained transeptally followed by valve repair or replacement (using metal or biological prosthesis).

After valvar procedure, surgical treatment of atrial fibrillation was performed with excision of left and right auricular appendages (LAA and RAA) plus a 4 cm-excision of the midportion of LAA removed towards the opening of superior vena cava. Then, irrigated radiofrequency was administered (using Medtronic Cardioblate® Surgical Ablation System device – Medtronic Inc, Minneapolis, MN) in the right atrial epicardium, connecting the cannulation site of superior and inferior vena cava (Figure 1).

In the left atrial endocardium, isolation of both pulmonary veins was performed on either side with an additional line connecting both isolation islands previously created. Another ablation line was employed horizontally in the middle of left atrium, in addition to other two lines connecting both left pulmonary veins, the obliterated

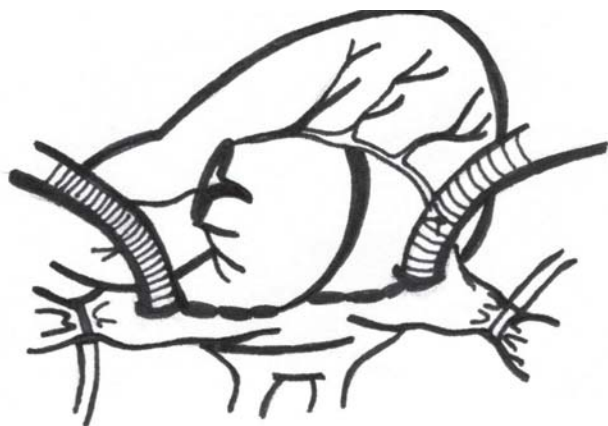


Fig. 1 - Application of irrigated radiofrequency in the epicardium of right atrium, joining the cannulation site of the superior and inferior vena cava

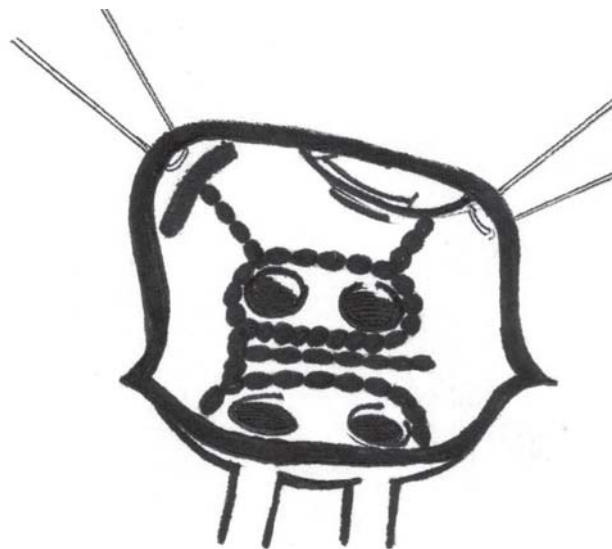


Fig. 2 - Procedure schematic view in the left atrium

opening of the left auricular appendage, and the base of the posterior mitral valve annulus (Figure 2).

A complementary procedure was performed using lines in the left atrium involving the midportion of interatrial septum, the base of tricuspid valve passing around the coronary sinus towards the opening of inferior vena cava and a line connecting the occluded right auricular appendage and the tricuspid annulus (Figure 3).

On completion of the surgery, the patients under normothermia were taken to the Post-operative Unit, where they kept being continuously monitored, with clinical and electrocardiographic evaluation every 12 hours. After hospital discharge, clinical, electrocardiographic, echocardiographic, and 24-hour Holter follow-up was carried out (at least one month post-operatively).



Fig. 3 - Procedure complementation carried out with line application in the right atrium

All the patients were followed-up during clinical evolution by a surgical staff member with protocol fulfillment in order to compare pre-and postoperative data.

Protocol of Antiarrhythmic and Anticoagulant Drugs and Electrical Cardioversion.

Treatment protocol after application of irrigated radiofrequency involved, at first, the use of amiodarone (100-400 mg daily) aiming at to control atrioventricular nodal conduction and atrial stabilization before hospital discharge. The use of amiodarone was tailored to each patient taking into consideration this drug potential side effect.

Besides, we have performed oral anticoagulation to maintain the international normalized ratio (INR) between 2.0-3.0. If sinus rhythm reversal and maintenance occurred, anticoagulant therapy was sustained for at least 4 weeks. If patients did not revert to sinus rhythm two more electrical cardioversion were scheduled with 4 to 6-week interval between the first and the second attempt. On occasional failure, patients were kept under oral anticoagulant and drugs in order to control heart rate and were referred to perform an electrophysiological study (after a gradual withdrawal of amiodarone).

## RESULTS

There were no in-hospital mortality or complications related to radiofrequency. The mean time to perform ablation was  $7 \pm 0.63$  minutes. Patients underwent the following procedures: mitral repair (commissurotomy) one patient (6.7%); biological prosthesis implant one patient (6.7%); metal prosthesis implant 13 (86.6%) patients. CPB mean time was  $100 \pm 23.52$  minutes and anoxia mean time was  $72.33 \pm 22.95$  minutes (Table 2).

On immediate post-operative period, 12 (80%) patients were in sinus rhythm, two patients (13.3%) in junctional rhythm, and 1 patient (6.7%) was in complete atrioventricular block. The latter required artificial cardiac stimulation through a provisory pacemaker. From post-operative course up to hospital discharge, three patients presented AF, including the one who reverted the complete atrioventricular

block. Thus, on discharge, we have observed the following rhythms and percentages: nine (60%) = sinus rhythm, 4 (26.7%) = AF and two (13%) = junctional rhythm.

During post-operative follow-up, of 4 patients who were in AF, two reverted to sinus rhythm after electrical cardioversion. During the mean follow-up, we have obtained the following outcomes: 11 patients (73.3%) had sinus rhythm, 2 (13.35%) had junctional rhythm, and two (13.35%) has AF (Table 3). Among the patients who remained on AF, one will be referred to electrophysiological study due to the failure of two attempts of electrical cardioversion. The other patient is waiting adequate oral anticoagulation (INR between 2.0-3.0) for an attempt of electrical cardioversion. In both cases, left atrium diameters were  $> 65$  mm.

Table 3. Changes in cardiac (heart) rhythm during post-operative period

Variables	
<b>Immediate Post-Operative (%)</b>	
Sinus rhythm	80
AF	13.3
Junctional rhythm	---
Provisory Pacemaker	6.7
<b>On Hospital Discharge (%)</b>	
Sinus rhythm	60
AF	26.7
Junctional rhythm	13.3
Permanent Pacemaker	---
<b>Os post-operative follow-up (%)</b>	
Sinus rhythm	73.3
AF	13.35
Junctional rhythm	13.35
Permanent Pacemaker	---

## DISCUSSION

The use of radiofrequency to surgical treatment of FA has been shown with good outcomes and fewer complications in several studies. Sie et al. [8] have obtained reversal to sinus rhythm in 79% of the patients who underwent application of biatrial radiofrequency in a mean follow-up of 40 months. Sueda et al. [9] with isolation the left atrium only, without right atrium incisions in patients with permanent AF, have obtained an AF-free rate of 74% during a 3 year-follow-up period. In 2008, we have published an initial experience using uniaxial radiofrequency in 15 patients with a successful rate of 60% at hospital discharge and 46.7% during mean follow-up of these patients [7]. This outcome has triggered a change of conduction, and we have begun to use the application of this biatrial source of energy. Wang et al. [1] have compared the effectiveness

Table 2. Surgical Data

Variables	Biatrial Group
<b>Procedure (%)</b>	
Mitral valve replacement	93.3
Mitral valve repair	6.7
Anoxia Time (minutes)	$72.33 \pm 22.95$
Perfusion Time (minutes)	$100 \pm 23.52$
Ablation Time (minutes)	$7 \pm 0.63$

and safety of radiofrequency ablation involving left atrium only with biatrial radiofrequency ablation in 299 patients. The authors have concluded that both procedures showed similar outcomes in reversal to sinus rhythm (78.2% vs 75.9% for left atrium only and biatrial, respectively), in spite of lower CPB time in left atrium group. In addition, they have added that left atrium diameters > 80 mm represented a positive predictive factor in the recurrence of AF [1]. In 2007, Deneke et al. [10] published a study comparing both radiofrequency techniques for treatment of AF and they were successful in reverting to sinus rhythm in 82% of biatrial cases and 75% in left atrium only, without statistical difference ( $P=0.571$ ) between the two groups. The follow-up period of this study ranged from 1 to 50 months. Besides, there were statistical difference between anoxia and perfusion times, with a greater time in the biatrial group. Abreu Filho et al. [11] have published the outcome of ablation technique similar to that study and they have obtained a reversal rate to sinus rhythm of 72.7% in a mean follow-up of 11.7 months. In our study, there was no significant increment in operative time due to the biatrial radiofrequency and we have obtained better outcome in terms of reversal and maintenance of sinus rhythm than that obtained with left atrium technique. However, these outcomes are initial and rely on a small amount of patients.

The need to use a provisory pacemaker after conventional maze procedure can vary from 6 to 23%. In the present study, in accordance with other previously published articles, the incidence of provisory pacemaker usage with biatrial approach is higher, although there was no need to implant a permanent device in either of the study patient, likewise with our patients [12,13].

In spite of the breakthrough in the knowledge of AF producer mechanisms, surgical treatment should be optimally tailored to each individual. Failure in application of radiofrequency in left atrium only needs additional investigation, but could be directly related to the lines of ablation, or the producer focus of arrhythmia is not in the left atrium. In 9 to 19% of the cases, the origin of arrhythmia would be the right atrium and these cases would present additional benefit with biatrial lines [14-16].

Because our mitral valve approach procedure is exclusively transeptal (involving right atriotomy) and as we have not noted additional increase in anoxia and perfusion times due to application of right atrium radiofrequency, biatrial treatment of AF is justified, avoid an occasional failure of therapy in cases where the tachyarrhythmia is not in the left atrium. Besides, there was more success with the biatrial technique when compared to our left atrium outcome previously published. Guden et al. [17] have recommended a biatrial approach in patients with atrial flutter history or whenever the access route of choice is transeptal, otherwise, they use radiofrequency

only in the left atrium. During the follow-up period which ranged from 2 to 24 months, they have presented success in the maintenance of sinus rhythm in 79.6% of the patients in biatrial group vs 75.6% of the patients in the left atrium group.

The irrigated radiofrequency technique to treat AF can reach an 80% success rate in studies of late follow-up. It is important to note that this success rate is infrequently obtained before 3 to 6 month post-operatively. Thus, patients who remained in AF before this period should not be considered as a failure of the procedure. One of the patients of our study who is now in AF presents only one month of follow-up waiting electrical cardioversion. Therefore, we can expect an improvement in our success rate with the procedure.

The majority of the patients who underwent this ablation technique leave the operating theatre in sinus rhythm; however, around 70% of the patients will have AF episodes in the immediate post-operative period. The main factor involved is the likely neurohormal imbalance and the pericardial inflammation as well [18]. The expected outcome is that around 50% of the patients who underwent irrigated radiofrequency ablation leave the hospital in sinus rhythm, while the remaining patients would probably in a process of "reverse atrial remodeling", which will facilitate an occasionally spontaneous or clinical reversal (pharmacological or electrical) to normal sinus rhythm during post-operative follow-up.

## CONCLUSION

The initial outcomes of this study suggest that surgical ablation of chronic atrial fibrillation with irrigated radiofrequency involving both atria is more effective in reversal and maintenance of sinus rhythm in short-term and midterm outcomes in comparison with the technique involving one atrium only. The inclusion of a greater number of patients and the continuity of post-operative follow-up will be necessary to confirm these outcomes.

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