The Heart Surgery Forum #2010-1119
14 (5), 2011 [Epub October 2011]
doi: 10.1532/HSF98.20101119

Online address: http://cardenjennings.metapress.com

Comparison of Uniatrial and Biatrial Radiofrequency Ablation Procedures in Atrial Fibrillation: Initial Results

João Roberto Breda, Ana Silvia Castaldi Ragognetti Breda, Ricardo Gitti Ragognette, Leandro Neves Machado, Charles Benjamin Neff, Leandro Luongo de Matos, Adriano Meneghine, Adilson Casemiro Pires

Cardiovascular Surgery Division at ABC Medical School, Santo André, São Paulo, Brazil

ABSTRACT

Background: Atrial fibrillation (AF) is the most commonly sustained cardiac rhythm disturbance. Surgical ablation techniques were developed involving the left atrium only and modifications of the maze procedure in ablating both atria.

Objective: The aim of this study was to compare, in patients with permanent AF, the efficacy of uniatrial versus biatrial radiofrequency ablation procedure in the treatment of chronic atrial fibrillation in patients with associated cardiac disease.

Method: Between September 2003 and May 2009, 30 patients were submitted to the radiofrequency ablation procedure for AF associated with concomitant cardiac surgery; 15 patients underwent a uniatrial procedure, and 15 patients underwent biatrial ablation. The mean age was 47.73 ± 9.85 years, and 53.4% were men. The average follow-up time was 12.16 ± 10.89 months for the uniatrial group and 7.0 ± 4.0 months for the biatrial group.

Results: Neither hospital mortality nor complications related to radiofrequency ablation were was registered. At the time of hospital discharge, 9 patients (60%) were in a state of sinus rhythm in both groups. However, patients undergoing biatrial ablation (range 73.3% versus 46.7%) demonstrated complete freedom from atrial fibrillation at all times.

Conclusion: Biatrial ablation surgical procedures were more effective in controlling atrial fibrillation than procedures limited to the left atrium.

INTRODUCTION

Atrial fibrillation (AF) is the most common sustained sinus rhythm disturbance, and its prevalence increases with age. It may occur in the presence or absence of structural heart disease, and its occurrence increases morbidity and mortality—related to hemodynamic deterioration and thromboembolic events—in addition to increasing hospital costs [Wang 2009].

Received August 30, 2010; received in revised form January 6, 2011; accepted January 13, 2011.

Correspondence: João Roberto Breda, Rua Antonio Bastos, 755 – Apto. 31, Santo André/SP/Brasil 09040-220; +55-11-4345-4011 (e-mail: jrbreda@hotmail.com).

The Maze III procedure, described by Cox et al [Cox 1991], is the most effective method for treatment of AF and is considered the therapeutic gold standard, but its effectiveness is inversely proportional to its applicability [Barnett 2006]. Thus several alternative energy sources (cryoablation, microwave emission, and radiofrequency) have been used in an attempt to create lesions similar to that obtained by the "cut and sew" technique [Cox 1991; Gaynor 2006; Gillinov 2005].

The role of the pulmonary veins and posterior left atrium in the generation of AF is well established, and some authors have adopted the application of energy sources in uniatrial procedure (only in the left atrium), reporting favorable results [Gillinov 2006]. In our department, we applied the AF ablation by uniatrial radiofrequency, obtaining lower results than those previously published referring to other procedures [Breda 2008]. This motivated a change in our conduct, and since then we have been using the biatrial radiofrequency ablation approach.

The purpose of this paper is to present the initial results of the surgical ablation of AF using radiofrequency applied to both atria for the reversal and sustenance of the sinus rhythm at short- or long-term extension to patients who underwent concomitant cardiac surgery.

METHODS

Between September 2003 and May 2009, 30 consecutive patients with permanent AF—all diagnosed at least 12 months before the procedure—underwent intraoperative ablation of tachyarrhythmia by irrigated radiofrequency, applied uniatrially and biatrially, undergoing concomitant cardiac surgery (valvuloplasty or valve replacement). The study protocol was approved by the Ethics Committee of the ABC Medical School, and the patients agreed to participate by signing an informed consent form.

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

The group consisted of 16 male patients (53.4%); ages ranged from 25 to 59 years (average age 47.73 ± 9.85). In 21 cases (70%), the mitral valve disease was of rheumatic etiology; in 8 cases (26.7%) of degenerative origin; and in 1 case (3.3%), mitral stenosis due to valve repair using ring.

Patients had signs and symptoms of congestion at the time of surgical indication. According to the New York Heart Association (NYHA) classification, 46.7% fell in functional class II, and 53.3% in functional class III. Postoperative follow-up time was 12.16 ± 10.89 months for uniatrial cases and 7.0 ± 4.0 months for biatrial cases (Table 1).

Surgical Procedure

All procedures were performed under hemodynamic monitoring with average arterial pressure controls, central venous pressure, urine output, and respiratory monitoring with pulse oximetry.

The procedure was performed by way of median sternotomy and cannulation of the aorta and superior and inferior vena cava after intravenous administration of heparin (400 IU/kg) and moderate hypothermia (32°C).

The method of myocardial protection used was hypothermic antegrade blood cardioplegia (approximately 18°C) with addition of potassium (15 mEq/L) during induction. In subsequent doses, the blood of the perfusate was administered at 15 minute intervals and at 32°C, without addition of other substances.

The mitral valve was accessed transseptally or through left atriotomy, followed by valve repair or replacement (biologic or metallic prostheses).

After the valve procedure, patients underwent surgical treatment for AF. In the uniatrial group, radiofrequency application was then performed in the endocardium of the left atrium with pulmonary vein isolation, in addition to 3 additional incisions: 1 initiated in the left atrial appendage and moving toward the superior left pulmonary vein orifice; another line between the orifices of the superior pulmonary veins, and finally an ablation line from the edge of the mitral ring to the orifice of the left inferior pulmonary vein (Figure 1). In the biatrial group, an excision of the left and right auricular appendix (LAA and RAA) was made, and an incision of 4 cm of the middle portion of the removed RAA in the direction of the superior vena cava orifice was also made. Irrigated radiofrequency was applied (using Medtronic Cardioblate® Surgical Ablation System; Medtronic Inc., Minneapolis, MN, USA) on the right atrium epicardium, linking the site of cannulation of the superior and inferior vena cava (Figure 2). The isolation of the pulmonary veins of both sides was performed at the left atrium endocardium, with an additional line linking the 2 isolation islands created previously. Another ablation line was applied in the

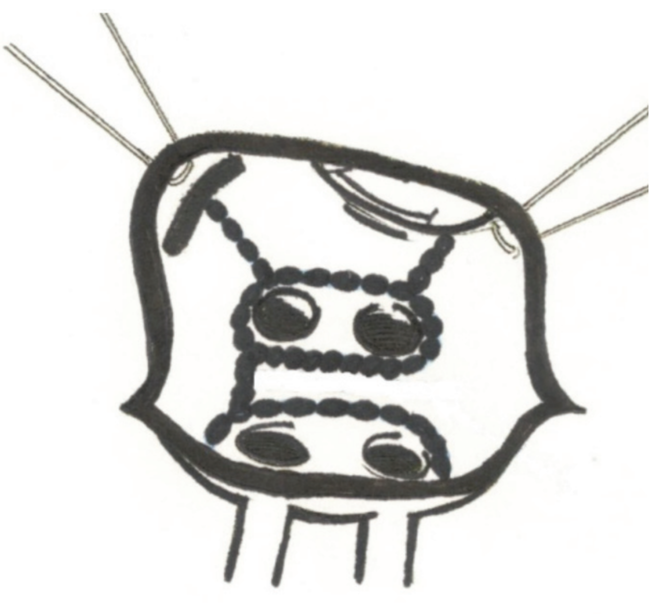

Figure 1. The radiofrequency application was performed in the endocardium of the left atrium with pulmonary vein isolation, in addition to 3 additional incisions: 1 initiated in the left atrial appendage and moving toward the superior left pulmonary vein orifice; another line between orifices of the superior pulmonary veins, and finally an ablation line from the edge of the mitral ring to the orifice of the left inferior pulmonary vein.

Table 1. Preoperative Patient Characteristics

	Uniatrial Group	Biatrial Group
Sex, %*		
Female	66.7	36.7
Male	33.3	63.3
Age, y†	46.3 ± 9.54	60.0 ± 8.07
New York Heart Association Class, %*		
II	58	33.4
III	42	66.6
History of thromboembolism, %	16.7	20
Left atrium diameter, mm†	56.66 ± 6.77	55.06 ± 7.56

*$P > .05$ (Fisher's exact test).
†$P > .05$ (Mann-Whitney U test).

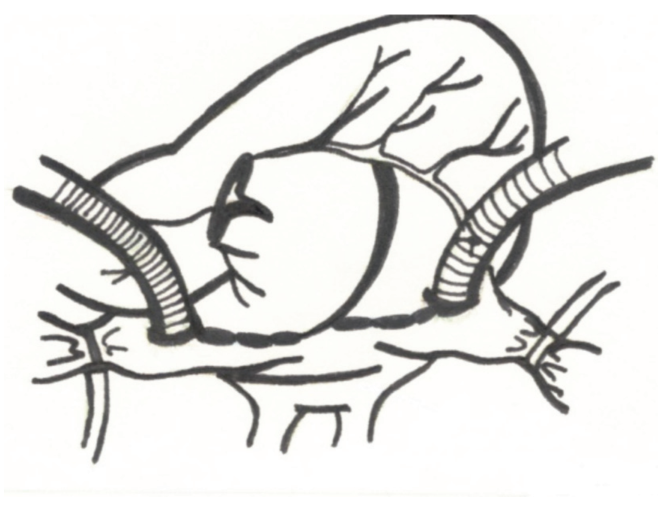

Figure 2. Irrigated radiofrequency was applied on the right atrium epicardium, linking the site of cannulation of the superior and inferior vena cava.

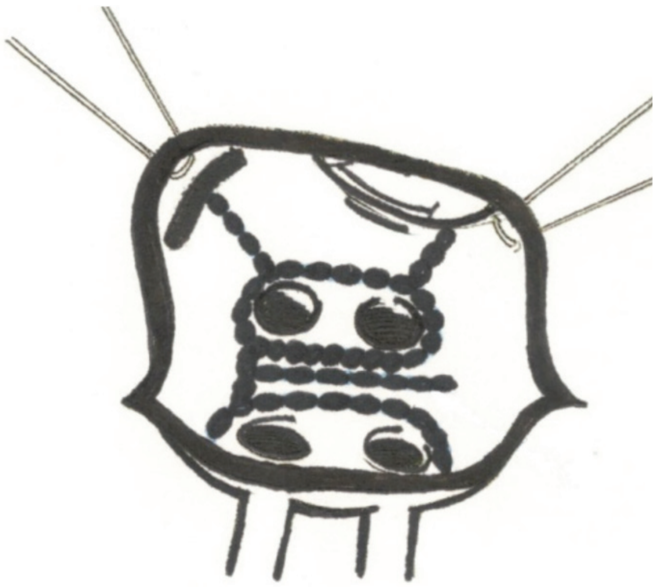

Figure 3. Isolation of the pulmonary veins of both sides was made at the left atrium endocardium, with an additional line linking the 2 islands of isolation created previously. Another ablation line was applied in the horizontal direction in the middle of the left atrium as well as 2 other ablation lines, which connected the left pulmonary veins and the occluded orifice of the left auricular appendage and the base of the posterior mitral ring. The completion of the procedure was done with the application of lines in the right atrium, involving the middle portion of the interatrial septum, the base of the tricuspid valve (by passing around the coronary sinus toward the inferior vena cava orifice), and application of an ablation line connecting the occluded right auricular appendix and the tricuspid ring.

horizontal direction in the middle of the left atrium, as well as 2 other ablation lines, connecting the left pulmonary veins and the occluded orifice of the left auricular appendage and the base of the posterior mitral ring (Figure 3). Completion of the procedure was done with the application of lines in the right atrium, involving the middle portion of the interatrial septum, the base of the tricuspid valve (by passing around the coronary sinus toward the inferior vena cava orifice), and application of an ablation line connecting the occluded right auricular appendix to the tricuspid ring (Figure 3).

At the end of the surgery, patients in normothermia were taken to the Postoperative Unit, where they were continuously monitored, with clinical and electrocardiographic evaluation every 12 hours. Clinical, electrocardiographic, echocardiographic, and 24-hour Holter follow-up were performed after hospital discharge for at least 1 month after surgery.

Follow-up of all patients was done by a member of the surgical team, keeping a protocol in order to compare data before and after surgery.

Protocol: Antiarrhythmic Drugs, Anticoagulation, and Electrical Cardioversion

Treatment protocol—after the application of irrigated radiofrequency—initially involved the use of amiodarone (100-400 mg daily) to control the atrioventricular nodal conduction and atrial stabilization prior to hospital discharge. Amiodarone was indicated on an individual basis, taking into account the potential side effects of this drug.

In addition, we performed oral anticoagulation with coumadin to maintain an International Normalized Ratio (INR) between 2.0 and 3.0. If there was reversion and maintenance of the sinus rhythm, anticoagulant therapy would be maintained for at least 4 weeks. If there was no reversion to sinus rhythm, 2 attempts of electrical cardioversion (ECV) would be scheduled with an interval of 4 to 6 weeks between the first and second attempts. If an eventual failure was encountered, oral anticoagulants and medications to control heart frequency would be used, directing these patients to an electrophysiological study (after gradual discontinuation of amiodarone).

Table 2. Data Related to the Operative Procedures

	Uniatrial Group	Biatrial Group
Procedure, %*		
Mitral valve replacement	66.7	93.3
Mitral valve repair	33.3	6.7
Aortic cross-clamp time, min†	34.04 ± 11.17	72.33 ± 22.95
Cardiopulmonary bypass time, min†	50.65 ± 15.17	100 ± 23.52
Ablation time, min	4 ± 0.78‡	7 ± 0.63

*$P > .05$ (Fisher's exact test).
†$P < .05$ (Mann-Whitney U test).
‡$P = .01$ (Mann-Whitney U test).

Statistical Analysis

The distributions were defined as nonparametric by the Kolmogorov-Smirnov test. The Mann-Whitney test was used to compare the median of 2 nonparametric sample populations. The Fisher's exact test was used for comparisons of the frequency of a phenomenon among groups of categorized variables. For data analysis, SPSS version 13.0 (SPSS Inc; Chicago, IL, USA). A P value less than .05 was considered statistically significant.

RESULTS

There were no hospital deaths or complications related to radiofrequency. Operative data are described in Table 2. The average time to perform ablation was 4 ± 0.78 minutes in the uniatrial group and 7 ± 0.63 minutes in the biatrial group.

Changes in cardiac rhythm during postoperative and follow-up periods are described in Table 3. In the uniatrial group, all patients left the operating room in sinus rhythm; however, during their hospital stay, 6 patients (40%) presented again an AF rhythm. Out of these, 5 patients received an intravenous administration of amiodarone in the loading dose during their stay in the intensive care unit, followed by oral administration over 3 months. One patient received an ECV of arrhythmia after hemodynamic instability, with application of 2 shocks of

Figure 4. Application of lines in the right atrium, involving the middle portion of the interatrial septum, the base of the tricuspid valve (by passing around the coronary sinus toward the inferior vena cava orifice), and application of an ablation line connecting the occluded right auricular appendix and the tricuspid ring.

100 and 200 Joules, respectively, followed by administration of amiodarone at the aforementioned doses. Despite attempts at reversion and maintenance of sinus rhythm, these patients were discharged from the hospital with AF rhythm and were maintained in an oral anticoagulation scheme with the use of dicumarinics. From the 9 patients (60%) who left the hospital in sinus rhythm, 2 presented a relapse of AF rhythm during postoperative follow-up, with left atrium diameters of 65 mm and 68 mm, respectively. Presently, 7 patients (46.7%) are in sinus rhythm in the average follow-up period.

In the biatrial group, in the immediate postoperative period, 12 patients (80%) were in sinus rhythm, 2 (13.3%) in junctional rhythm, and 1 (6.7%) in complete atrioventricular block requiring cardiac pacing with a temporary pacemaker. During the postoperative course until discharge, 3 patients had AF, including the case that reversed the complete atrioventricular block. Thus we observed at discharge the following rhythms and percentages: 9 (60%), sinus rhythm; 4 (26.7%), AF; and 2 (13.3%), junctional rhythm. During the postoperative follow-up of the 4 patients who were in AF, reversion to sinus rhythm occurred in 2 patients after ECV. During the average follow-up time, the following results were obtained: 11 (73.3%), sinus rhythm; 2 (13.35%), junctional rhythm; and 2 (13.35%), AF. Among the patients who remained in AF, 1 patient was directed to an electrophysiological study due to 2 failed ECV attempts. The other patient is awaiting adequate oral anticoagulation (INR between 2.0 and 3.0) to attempt ECV. In both cases, the left atrium diameters were larger than 65 mm.

Table 3. Changes in the Cardiac Rhythm during Postoperative and Follow-Up Periods

	Uniatrial Group	Biatrial Group
Postoperative Period, %*		
Sinus rhythm	60	80
Atrial fibrillation	40	13.3
Node rhythm	—	—
Pacemaker	—	6.7
At discharge, %†		
Sinus rhythm	60	60
Atrial fibrillation	40	26.7
Node rhythm	—	13.3
Pacemaker	—	—
Follow-up period‡		
Sinus rhythm	46.7	73.3
Atrial fibrillation	53.3	13.35
Node rhythm	—	13.35
Pacemaker	—	—

*P = .215 (Fisher's exact test).
†P = .700 (Fisher's exact test).
‡P = .049 (Fisher's exact test).

DISCUSSION

The use of radiofrequency in the treatment of postoperative AF has shown to have given good results and few complications in several studies. Sueda et al isolated the left atrium alone, not performing any incisions in the right atrium in patients with permanent AF, obtaining 74% cure during the follow-up period of three years [Sueda 1996]. In 2008 we published our first experiment with the use of uniatrial radiofrequency on 15 patients, obtaining 60% success at discharge time and 46.7% during the average follow-up time [Breda 2008]. This result prompted a change in conduct, and we are now using the application of this energy source in a biatrial form.

In 2002, Deneke et al compared 2 techniques of radiofrequency for the treatment of AF, obtaining a successful reversion to a sinus rhythm in 82% of biatrial cases and 75% in uniatrial cases, reporting no statistical difference between the groups (P = .571). The patient follow-up period in this study ranged from 1 to 50 months. Moreover, there was a statistical difference in the anoxia and perfusion times, with longer times in the biatrial group [Deneke 2002]. Abreu Filho et al published results referring to an ablation technique similar to this study and obtained a 72.7% reversion rate to a sinus rhythm during a follow-up time of 11.7 months [Abreu Filho 2004] In our study, there was no significant increase in the operative time due to biatrial radiofrequency application. We obtained better results in terms of reversion and maintenance of sinus rhythm than those obtained with the uniatrial technique. However, these are initial results obtained on a small number of patients.

The need for a temporary pacemaker after the conventional Maze operation may vary from 6% to 23%. In this study, as in other published articles, the incidence of the use of a temporary pacemaker with the biatrial approach was higher, although there was no need to implant a permanent device in any patient [Pasic 2001; Ninet 2005].

Despite advances in understanding the mechanisms that generate AF, the surgical treatment should ideally be individualized for each case. The failure shown in results due to application of radiofrequency only in the left atrium requires further research, but may be directly related to the ablation lines or due to the arrhythmia focal point not being in the left atrium. The arrhythmia origin would be in the right atrium of 9% to 19% of cases and these cases would present additional benefit with the application of biatrial lines [Sueda 1997; Ernst 1999; Harada 2000; vonOppell 2009].

Because of the way we access the mitral valve—exclusively by transseptal technique (thereby involving right atriotomy)—and because we did not notice further increase in perfusion and anoxia time due to the application of radiofrequency on the right atrium, the biatrial treatment of AF is justified, avoiding possible therapy failures in cases where the focus of the tachyarrhythmia is not in the left atrium. In addition, there was greater success with the biatrial technique when compared to our previously published uniatrial results. Guden et al advocate a biatrial approach in patients with a history of atrial flutter or when the chosen access route is transseptal, otherwise the radiofrequency is to be applied only in the left atrium. During a follow-up period ranging from 2 to 24 months, they obtained a 79.6% success rate of sinus rhythm maintenance in the biatrial group, versus 75.6% in the uniatrial group [Guden 2003].

The technique of irrigated radiofrequency for treatment of AF can achieve a success rate of 80% in late follow-up studies. It is important to note that this success rate is often not obtained before 3 to 6 months postoperatively. Thus, patients who remain in AF in a shorter period should not be considered to represent a failure of the procedure. One of the patients in our study, who currently is in AF, has only had 1 month of follow-up and is waiting for ECV. Therefore, there may be an improvement in our success rate with the procedure.

Most patients undergoing this ablation technique leave the operating room in sinus rhythm; however, nearly 70% of cases will have episodes of AF in the postoperative period. The main factor involved is the likely neurohormonal imbalance and also pericardium inflammation. The expected result is that about 50% of patients undergoing irrigated radiofrequency ablation receive hospital discharge in sinus rhythm, and other cases will probably be in the process of reverse atrial remodeling, which will facilitate any spontaneous or medical reversion (pharmacological or electrical) to the normal rhythm during the postoperative follow-up.

CONCLUSION

The initial results of this study suggest that surgical irrigated radiofrequency ablation for chronic AF, applied in both atria, is effective in the reversing and the maintenance of sinus rhythm during the short and medium follow-up periods. The inclusion of more patients and follow-up continuity is needed to confirm the efficiency of the technique.

REFERENCES

Abreu Filho CA, Lisboa LA, Dallan LA, et al. 2005. Effectiveness of the maze procedure using cooled-tip radiofrequency ablation in patients with permanent atrial fibrillation and rheumatic mitral valve disease. Circulation 112(9 Suppl):I20-5.

Barnett SD, Ad N. 2006. Surgical ablation as treatment for the elimination of atrial fibrillation: a meta-analysis. J Thorac Cardiovas Surg 131:1029-35.

Breda JR, Breda AS, Meneguini A, Freitas AC, Pires AC. 2008. Surgical ablation of atrial fibrilation using radiofrequency [in Portuguese]. Rev Bras Cir Cardiovasc 23:118-22.

Cox JL, Schuessler RB, D'Agostino HJ Jr, et al. 1991. The surgical treatment of atrial fibrillation: III. Development of a definitive surgical procedure. J Thorac Cardiovasc Surg 101:569-83.

Deneke T, Khargi K, Grewe PH, et al. 2002. Left atrial versus bi-atrial Maze operation using intraoperatively cooled-tip radiofrequency ablation in patients undergoing open-heart surgery. J Am Coll Cardiol 39:1644-50.

Ernst S, Schlüter M, Ouyang F, et al. 1999. Modification of the substrate for maintenance of idiopathic human atrial fibrillation. Circulation 100:2085-92.

Gaynor SL, Byrd GD, Diodato MD, et al. 2006. Microwave ablation for atrial fibrillation: dose-response curves in the cardioplegia-arrested and beating heart. Ann Thorac Surg 81:72-6.

Gillinov AM, McCarthy PM, Blackstone EH, et al. 2005. Surgical ablation of atrial fibrillation with bipolar radiofrequency as the primary modality. J Thorac Cardiovasc Surg 129:1322-9.

Gillinov AM, Bhavani S, Blackstone EH, et al. 2006. Surgery for permanent atrial fibrillation: impact of patient factors and lesion set. Ann Thorac Surg 82:502-13.

Guden M, Akpinar B, Caynak B, et al. 2003. Left versus bi-atrial intraoperative saline-irrigated radiofrequency modified maze procedure for atrial fibrillation. Card Electrophysiol Rev 7:252-8.

Harada A, Konishi T, Fukata M, Higuchi K, Sugimoto T, Sasaki K. 2000. Intraoperative map guided operation for atrial fibrillation due to mitral valve disease. Ann Thorac Surg 69:446-50.

Ninet J, Roques X, Seitelberger R, et al. 2005. Surgical ablation of atrial fibrillation with off-pump, epicardical, high-intensity focused ultrasound: results of a multicenter. J Thorac Cardiovasc Surg 130:803-9.

Pasic M, Bergs P, Müller P, et al. 2001. Intraoperative radiofrequency maze for atrial fibrillation: the Berlim modification. Ann Thorac Surg 72:1484-91.

Sueda T, Nagata H, Shikata H, et al. 1996. Simple left atrial procedure for chronic atrial fibrillation associated with mitral valve disease. Ann Thorac Surg 62:1796-800.

Sueda T, Nagata H, Orihashi K, et al. 1997. Efficacy of a simple left atrial procedure for chronic atrial fibrillation in mitral valve operations. Ann Thorac Surg 63:1070-5.

von Oppell UO, Masani N, O'Callaghan P, Wheeler R, Dimitrakakis G, Schiffelers S. 2009. Mitral valve surgery plus concomitant atrial fibrillation ablation is superior to mitral valve surgery alone with an intensive rhythm control strategy. Eur J Cardiothorac Surg 35:641-50.

Wang J, Meng X, Li H, Cui Y, Han J, Xu C. 2009. Prospective randomized comparison of left atrial and biatrial radiofrequency ablation in the treatment of atrial fibrillation. Eur J Cardiovasc Surg 35:116-22.