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Optimized Technical and Electrophysiological Approach for Treatment of Atrial Fibrillation

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ABSTRACT

The maze procedure initially proposed by Cox for primary atrial fibrillation treatment somehow, in its complexity, increases the morbidity risk associated with mitral valve surgery.

Objective. We sought to describe a surgical technique that considers the concepts of electrophysiology and to describe the initial results of a new surgical and electrophysiological approach that blocks the main atrial circuits as defined by Frame, and to optimize the surgical tactic for treatment of atrial fibrillation.

Material and Methods. Eight patients with chronic atrial fibrillation and mitral valve dysfunction, with tricuspid valve regurgitation in 1 case, were operated on. The following modifications of the classic Cox procedure were employed: (1) exclusion of the left atrium appendage with an inner suture that closed the left atrial ostium, (2) exclusion of the right atrium appendage by 1 purse-string suture used for fixation of the superior vena cava draining cannula, (3) a single atrial incision, (4) transendocardium electrocauterization in the left atrium wall around all pulmonary vein ostia, and (5) substitution of the incisions and sutures in the left atrium with transendocardium electrocauterization.

Results. The extracorporeal circulation time varied from 64 min to 133 min (mean, 107.5 min), and the cardioplegia time varied from 40 min to 105 min. (mean, 76.7 min). All patients were in regular atrial rhythm at the end of surgery. The postoperative period was uneventful, and all patients were discharged from the hospital showing regular atrial rhythm, without definitive pacemaker implantation. In the postoperative period 6 months after surgery, 6 patients (75%) were in regular atrial rhythm with preserved atrial contractions, and 2 (25%) with atrial fibrillation, clinically controlled (New York Heart Association class II). There were no embolic complications or evidence of thrombosis in the echodopplercardiography control.

Conclusion. It is concluded from this initial series of cases that the electrophysiolgical approach and the surgical technique employed improved the surgical treatment of atrial fibrillation, making possible the correction of mitral and tricuspid valve lesions without additional morbidity.

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INTRODUCTION

In 1991, Cox initially described his technique for surgical treatment of primary atrial fibrillation based on multiple incisions and sutures in both the right and left atrium, demonstrating satisfactory results in the atrial synchronism recovery [Cox 1991]. Jatene et al confirmed the benefits of the "maze" technique in patients with rheumatic valve disease also and Gregori et al reduced the operative complexity by excluding the use of cryoablation [Jatene 1992; Gregori 1993].

Aiming to reduce the risk and morbidity associated with the Cox operation, surgical alternatives have been proposed by numerous studies [Jazbik 1993; Benussi 2000; Kottkamp 1999; Kalil 2000], limiting the approach to the left atrium as originally proposed by previous reports [Coumel 1973; Williams 1980]. However, the existence of arrhythmogenic focus in the right atrium, interatrial septum, and right atrium free wall is well documented [Wyndham 1980; Graffigna 1992] (Figure 1). Special contribution came from the studies of Frame et al in 1987, which accurately defined the electrophysiological anatomy and displayed 4 re-entry circles in the right atrium: 2 encircling the superior and inferior vena cava atrial connections, 1 around the midportion of the right atrium and interatrial septum proximal portion, and 1 close to the right atrium and tricuspid valve annulus connections (Figure 2). The present study describes the initial results of an optimized bi-atrial approach in patients with rheumatic valve disease, based on some electrophysiological concepts not yet employed in surgical procedures for treatment of chronic atrial fibrillation.

MATERIAL AND METHODS

Eight symptomatic patients (New York Heart Association [NYHA] class II/III) with mitral valve dysfunction, associated with tricuspid valve regurgitation in 1 case, presenting atrial fibrillation lasting more than 1 year and complicating rheumatic disease were submitted to anesthesia, longitudinal sternotomy, and treatment of valve dysfunction and atrial fibrillation. There were 6 women (75%) and 2 men, aged 21 to 67 years (mean, 35.1 years).

Hypothermic (30°-32°C) extracorporeal circulation was employed with total venous drainage, and a purse-string suture for the superior vena cava cannula was used 5 mm from the right appendage base (Figure 3). Arterial blood return was done through a cannula inserted distally into the ascending aorta, and the cannula for arterial cardioplegia perfusion was introduced into the aortic root. Hypothermic (30°-32°C) continuous blood potassium (25 mEq/L) cardioplegic perfusion

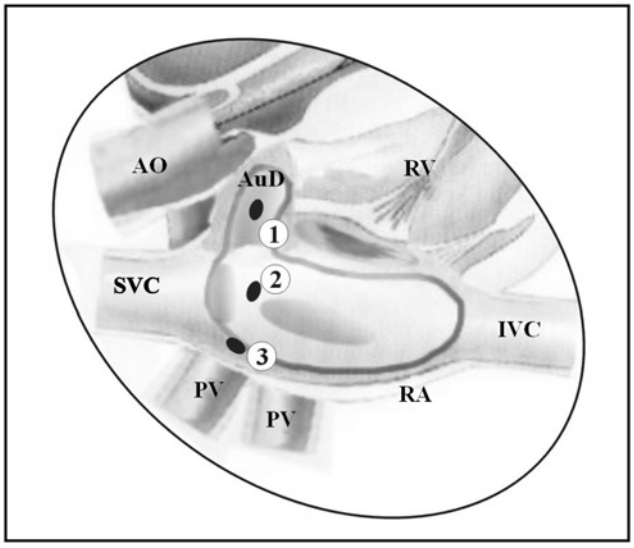

Figure 1. Ectopic atrial tachycardia in the (1) right atrium posterior wall, (2) superior septal portion, and (3) in the right atrium free wall [Lewis 1920; Frame 1983]. SVC indicates superior vena cava; PV, pulmonary vein; RA, right atrium; IVC, inferior vena cava; RV, right ventricle; AO, aorta.

was maintained with 60 to 90 mmHg pressure using a disposable cardioplegia delivery set (Comex Ind. Com. Ltd., Belo Horizonte, Brazil), independent of the systemic perfusion line.

A single atrial incision was employed to expose both the right and left atrium, the tricuspid and mitral valves, and the pulmonary vein ostia, and to section the atrial and septal conduction pathways [Dubost 1966]. The incision started 5 mm above the atrioventricular junction and extended 15 mm in the anterior contour of the right superior pulmonary vein, sectioning the interatrial septum to 10 mm above the tricuspid valve annulus (Figure 3).

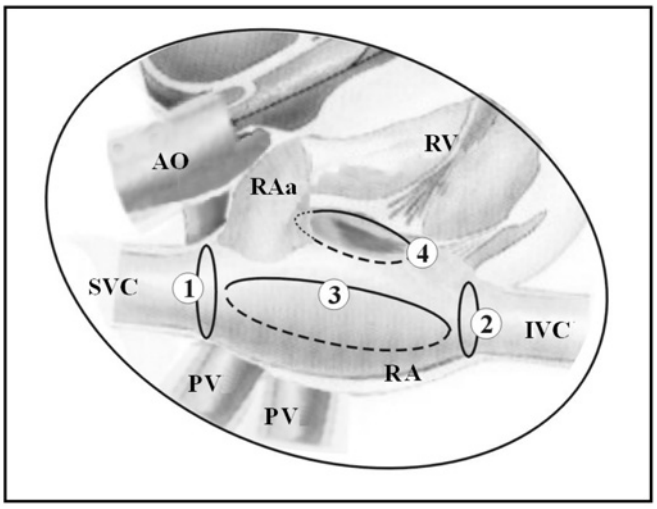

Figure 2. Atrium activation pathway circles according to Frame et al [1983]. SVC indicates superior vena cava; PV, pulmonary vein; RA, right atrium; IVC, inferior vena cava; RV, right ventricle; RAa, right atrium appendage.

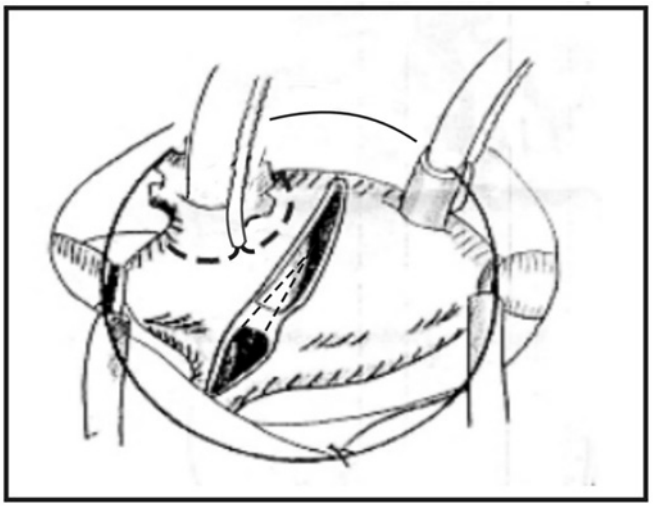

Figure 3. The purse-string suture around the right atrium appendage and the atriotomy sectioning the interatrial septum, modified from Dubost et al [1966].

The left atrium isolation was done according to the systematization proposed by Williams et al [1980] and modified by Brick [2000] (Figure 4). Isolation was done by sectioning and 3-0 polypropylene running sutures in the first 2 cases and with transendocardium electrocauterization in the others, with special care taken to maintain a minimum margin of 5 mm around each pulmonary vein ostium to avoid postoperative stenosis. The left atrium appendage was not resected but isolated with running sutures that closed its communication

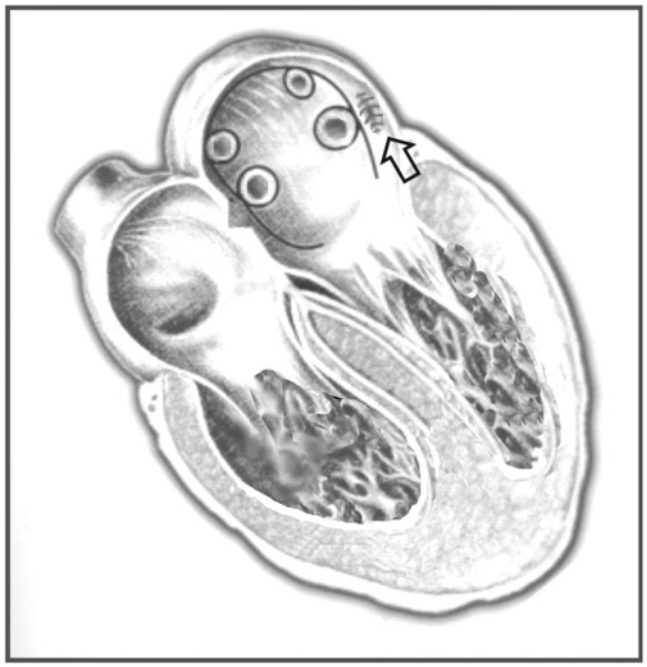

Figure 4. The exclusion of the left atrium appendage by suture (arrow) in the connection with the atrial chamber and ablation lines around each pulmonary vein ostium, modified from Brick [2000].

Patients Data*

OBS NO	Sex	Age	Diagnostic	Surgery	Aortic Occlusion, min	ECC, min	Temp, °C
1	M	21	ME+AF	MVP+AFS	50	90	32
2	F	37	MI+AFS+TA	TM+AFS+TE	05	133	31
3	F	67	CME+AF	MR+AFS	90	122	32
4	F	22	CME+AF	MR+AFS	40	64	32
5	F	43	ME+AF	MR+AFS	53	73	32
6	M	46	MI+TR+AF	MR+TA+AFS	98	129	32
7	F	38	MRE+AF	MR+AFS	94	127	31
8	F	31	MI+AF	MR+AFS	84	122	31

*OBS NO indicates observation number; ECC, extracorporeal circulation time; ME, mitral stenosis; AF, atrial fibrillation; MVP, mitral valvoplasty; AFS, atrial fibrillation surgery; MI, mitral regurgitation; TA, tricuspid annuloplasty; TE, thrombectomy; CME, calcified mitral stenosis; MR, mitral replacement; TR, tricuspid regurgitation; MRE, mitral restenosis.

with the left atrium. The associated tricuspid regurgitation was treated with simplified De Vega annuloplasty [Gomes 1986], shortening only 1/4 of the tricuspid annulus contour. Single running polypropylene 3-0 sutures were used to close the interatrial septum, superior pulmonary vein, and right atrium. The right appendage was not resected but was excluded by closing the purse-string suture after removal of the superior vena cava cannula.

RESULTS

Reversion to regular atrial rhythm with recovery of the atrial contractions occurred in all patients, with circulatory hemodynamic stabilization occurring at the end of the extracorporeal bypass. The pump perfusion time ranged from 64 min to 133 min (mean, 107.5 min). Aortic cross-clamping time ranged from 40 min to 105 min (mean, 76.7 min) (Table), and all patients were discharged from the ICU with regular atrial rhythm. Atrial fibrillation recurred in 2 patients and was reversed by treatment with digitalin and amiodarone, and all patients were discharged from the hospital in good clinical condition, presenting regular atrial rhythm and P waves with varied morphology.

At the 6-month follow-up, all patients were in NYHA class II clinical condition. Atrial fibrillation returned in 2 patients, and all others (75%) remained in regular atrial rhythm, preserving atrial contractions and showing no evidence of thrombosis in the echocardiographic control.

DISCUSSION

The historical landmark of modern surgical treatment for chronic atrial fibrillation may be recognized in the work of Rauschel in 1836 and Elischer in 1869, which showed the presence of striated muscle fibers extending from the left atrium to the pulmonary veins, and in the work of Rothberger and Winterberg in 1914, which introduced the concept that even a single ectopic focus would generate total atrial fibrillation. Lewis in 1920 [Lewis 1920; Frame 1983], postulated the importance of circus movements in re-entry circuits and Garrey [1924] investigated atrial segmentation to block anormal stimulus and prevent atrial fibrillation propagation, as adopted in the Cox maze surgical procedure. In 1973, Coumel et al performed the first surgery treating arrhythmogenic ectopic focus in the left atrium, motivating subsequent development of left atrium surgical isolation techniques.

New investigations also demonstrated the possibility of treating tachyarrhythmias by focus ablation in right atrium walls and the proximal portion of the interatrial septum [Wyndham 1980; Graffigna 1992; Josephson 1982] and studies by Frame et al [1987] described main circuits involved in sustained tachyarrhythmias. Consideration of these electrophysiological pathways as evidence for arrhythmogenesis and the advantages of better surgical exposition of the pulmonary veins and left atrium appendage isolation led to the realization [Gomes 2002] that Dubost's bicameral incision proposed for mitral valve surgery [1966] would make electroablation procedures easier by blocking arrhythmogenic circuits in the right atrium wall and isolating the proximal portion of the interatrial septum.

The relative complexity and increased risk of morbidity in the maze procedure [McCarthy 1993; Jatene 1995; Kawaguchi 1996] has motivated surgeons to prefer procedures restricted only to the left atrium with ultrasound [Brick 1999] or radiofrequency [Wanderley 2003] application, reducing sections and sutures in the atrial walls with 70% to 80% efficacy in conversion of atrial fibrillation to regular atrial rhythm. In 6 cases of the present study, electrocautery was used as defined by Bath [2000], taking special care to keep a margin of at least 5 mm around each pulmonary vein ostium to avoid postoperative scar stenosis [Robbins 1998].

The technical operative approach employed in this investigation optimizes surgery for atrial fibrillation, substituting the right atrial appendage resection with 1 purse-string suture, commonly used in superior vena cava cannulation for extracorporeal circulation, and substituting the left atrial appendage resection with a running suture, commonly used to close the connection with the left atrium chamber to prevent thromboembolic complications. Also, a single incision [Dubost 1966] makes access to the mitral valve and pul-

monary vein ostia easier and reduces the number of right atrium incisions.

Regarding the electrophysiological approach, the single right atrium incision excluded an important circle for atrial arrhythmia re-entry and septal pathways. As the circuits near atrial connections where the superior and inferior vena cava are incapable of tachyarrhythmia generation [Frame 1987], ablation can be easily accomplished by epicardial radiofrequency or diathermy application in cases with persistent atrial fibrillation at the end of the surgery. Another option in refractory cases is the interruption of the circuit near the tricuspid valve annulus [Frame 1987], which can be blocked by extending the interatrial septum section to the tricuspid ring or by externally prolonging the right atrial incision to the atrioventricular junction, avoiding harm to the right coronary artery. Blocking this circuit, however, can hinder the function of the atrioventricular node, requiring an implant of a definitive artificial pacemaker.

In recent studies, Chiappini et al [2004] and Cox [2003] proved the convenience and advantage of procedures with a lower morbidity rate and less surgical complexity in the general context of treatment of atrial fibrillation, supporting the potential benefits of the optimized approach defined in the present study.

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