New technical and electrophysiological approach for atrial fibrillation treatment

Novo abordagem técnica e eletrofisiológica para tratamento da fibrilação atrial

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Abstract

Introduction: The maze procedure for primary atrial fibrillation treatment, initially proposed by Cox, is somewhat complex, and it increases the morbidity risk compared to isolated mitral valve surgery.

Objective: To describe the surgical technique, the concepts of electrophysiology adopted and the preliminary results of a new surgical and electrophysiological approach, including specific atrial circuit blocking as defined by Frame and optimization of the surgical tactic for atrial fibrillation treatment.

Method: Eight patients with chronic atrial fibrillation and mitral valve dysfunction, associated in one case with tricuspid valve regurgitation were operated on. The following modifications of the classic Cox procedure were employed: 1- Exclusion of the left atrium appendage by an internal suture closing its left atrial ostium; 2- Exclusion of the right atrium appendage by a purse-string suture used for fixation of the superior vena cava draining cannula; 3- Single atrial incision; 4- Trans-endocardium electrocauterization in the left atrium wall around all pulmonary vein ostia; 5- Substitution of the incisions and sutures in the left atrium by trans-endocardium electrocauterization.

Results: The cardiopulmonary bypass time varied from 64 to 133 min (mean 107.5 min) and the cardioplegic time from 40 to 105 min. (mean 76.7 min). At the end of the surgery all patients were in regular atrial rhythm. The postoperative period was uneventful with all patients discharged from hospital showing regular atrial rhythm, without definitive pacemaker implantation. In the six-month postoperative follow up after surgery, six patients were in regular atrial rhythm (75%) with preserved atrial contractions, and two (25%) with clinically controlled atrial fibrillation (NYHA II). Also there were no embolic complications nor thrombotic evidence in the Doppler echocardiography control.

Conclusion: It is concluded in this initial series of cases that the electrophysiological approach and the surgical technique employed improved the surgical treatment of the atrial fibrillation making correction of mitral and tricuspid valve injuries possible without additional morbidity.

INTRODUCTION

COX [1] in 1991 proposed a technique for surgical treatment of primary atrial fibrillation, based on multiple incisions and sutures in the right and left atria giving satisfactory results in the recover of atrial synchronism.


Aiming at optimizing the reproducibility of the operation and reducing its risk in relation to the multiple atrial incisions and with the increased adherences in reoperations, alternative surgeries were proposed by JAZBIK et al. [4], BENUSSI et al. [5], KOTTKAMP et al. [6] and KALIL et al. [7], limiting the treatment to the left atrium, as in the original proposals by COUMEL et al. [8] and WILLIAMS et al. [9].

However, the existence of arrhythmogenic foci located in the right appendages, in the upper portion of the interatrial septum and the free wall of the right atrium have also been demonstrated[10,11].

A special contribution was seen with the studies of FRAME et al. [12] in 1987, who accurately described the electrophysiologic anatomy of the four main circuits of reentry to the right atrium, which are: two at the outlets of the upper and lower venae cavae to the right atrium, one medium-atrial encircling the medium portion of the free wall of the atri and the interatrial septum and one para-tricuspid circuit, near to the right atrium junction with the tricuspid valve annulus (Figure 2).
This study describes the initial results obtained from an optimized biatrial approach in patients with rheumatic valvar diseases, based on electrophysiologic concepts, which had not been considered previously in the surgical procedures for the treatment of chronic atrial fibrillation.

METHOD

With the study project approved by the Ethics Committee of the Sao Francisco Cardiovascular Foundation of Assis/ServCor, eight symptomatic patients (NYHA II/III) with mitral valve dysfunction of a rheumatic etiology and symptomatic tricuspid valvar insufficiency in one case evolving to chronic arterial fibrillation over a period of at least one year were operated on. The patients were submitted to general anesthesia, longitudinal sternotomy and surgical treatment of the valvar dysfunctions and atrial fibrillation.

Six (75%) patients were female and ages ranged from 21 to 67 years old (mean 35.1 years) – Table 1.

Cardiopulmonary bypass with hypothermia (30 – 32 °C) were employed with total venous drainage by means of cannulae introduced to the superior and inferior vena cava through areas delimited by purse-string sutures in the right atrium with the suture of the superior vena cava positioned about 5 mm from the base of the right appendages (Figure 1).

The cannula for systemic arterial perfusion was introduced in the distal portion of the ascending aorta and the cannula for cardioplegic arterial perfusion was introduced in its proximal portion.

Myocardial protection was achieved with perfusion of continuous, hypothermic (30 -32 °C), hyperkalaemic (25 mEq/L) sanguineous coronary perfusion at 60 to 90 mmHg in a circuit independent of the systemic arterial perfusion (Model Comex Ind. Com. Ltda, BH – MG).

To access the mitral valve, the atrial ostia of the pulmonary veins and left appendages, as well as a sectioning of the, septal and right atrial interatrial conduction zones, a single oblique incision was employed as proposed by DUBOST et al. [13], starting 5 mm above the right atrioventricular groove and stretching 15 mm around the anterior portion of the right superior pulmonary vein, with sectioning of the interatrial septum up to 10 mm above the annulus of the tricuspid valve (Figure 3)

Table 1 – Data of the patients

<table>
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<tr>
<th>OBS</th>
<th>Sex</th>
<th>Age</th>
<th>Diagnosis</th>
<th>Surgery</th>
<th>Occlusion Aortic</th>
<th>CPB (min)</th>
<th>TºC (min)</th>
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<td>MVP + MT</td>
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<td>MVR+MT</td>
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MS = Mitral stenosis  AF = Atrial fibrillation
VPM = Mitral Valvuoplasty  DLM = Double lesion of the mitral valve
MVR = Mitral valve replacement  MT = Maze technique
MRE = Mitral re-stenosis  AT = Atrial thrombosis
TC = Thrombectomy  TA = Tricuspid annuloplasty
TI = Tricuspid insufficiency
Compartmentalization of the left atrium was achieved using running sutures using 3-0 polypropylene thread in the first two cases and using an electric scalpel in the others, attempting to isolate the ostia of the pulmonary veins from the left appendages, similar to the system used by WILLIAMS et al. [9] and modified by BRICK [14] (Figure 4).

The left appendage was excluded by a running suture from its base, in the communication ostium with the left atrium. In the patient with associated tricuspid insufficiency, a De Veja-type annuloplasty was performed [15], with plication a ¼ way around the tricuspid annulus (from 12 o’clock to 3 o’clock).

For the reconstruction of the interatrial septum of the right superior pulmonary vein and the right atrial wall, continuous sutures on a single plane were used with a 3-0 polypropylene thread.

The right appendage was excluded by simply closure using purse-string sutures, after the removal of the superior vena cava cannula.

RESULTS

A regular atrial heart rhythm was achieved in all the patients, with hemodynamic stabilization at the end of the cardiopulmonary bypass.

The perfusion time ranged from 64 to 133 minutes with a mean of 107.5 minutes and the aortic clamping varied from 40 to 105 minutes with an average of 76.7 minutes. All the patients were released from hospital with the regular atrial heart rhythm maintained.

During hospitalization, two patients presented with atrial fibrillation which was reverted using digital and amiodarone. All the patients were released in stable clinical conditions, with a regular rhythm and with the presence of a morphologically varying P-wave. No patients required the permanent implantation of a pacemaker. In the six-month postoperative follow up, two patients returned to an atrial fibrillation rhythm, with the others (75%) continued with regular atrial rhythms, with preservation of the atrial contraction and absence of thrombosis as evidenced by control echocardiograms.

COMMENTS

The historical basis of modern surgical treatment of atrial fibrillation initiated with the demonstration that the presence of left atrial striated musculature extended to the pulmonary veins, reported in 1836 by RAUSCHEL [16] and in 1869 by ELISCHER [17]. In 1914 ROTHBERGER & WINTERBERG [18] postulated electrophysiologic concepts considering that the same single ectopic focus could determine the total atrial fibrillation.

LEWIS [19] and LEWIS et al. [20], in 1920, postulated the importance of the circular movement of the reentry circuits and GARREY [21], in 1924, studied the atrial segmentation to block the propagation of the abnormal stimuli and impede total atrial fibrillation, a concept adopted in the surgical approach of the Cox operation.

However, it was COUMEL et al. [8], in 1973, who performed the first surgery for the treatment of the ectopic focus of arrhythmia located in the left atrial, causing the subsequent...
development of techniques to isolate the left atrial, to treat the atrial fibrillation.

With the right atrium and the interatrial septum, some studies demonstrated the possibility of treating tachyarrhythmias with the ablation of the arrhythmogenic foci located in the walls of the right appendage, in the upper portion of the interatrial septum and/or the free atrial wall [10,11,22] and the studies of FRAME et al. [12,23] defined the main circuits responsible for sustained tachyarrhythmias. Considering this surgical anatomy of arhythmogenesis of the right atrium and remembering that ample surgical exposure facilitates the septation of the left atrium, it is thought that the biatrial incision, proposed by DUBOST et al. [13] for the surgery of the mitral valve, would also facilitate the electroseptation in the right atrium at the same time in which it would block arrhythmogenic circuits in the free wall of the right atrium and in the upper septal portion.

The relative complexity and the potential increase of morbidity of the ‘maze’ surgery [24-26] has motivated the procedure to be restricted to the left atrium and only using an ultrasound scalpel [27], or by applying radiofrequency [28], reducing sectioning and the sutures necessary in the atrial walls, keeping, however, the success of the conversion to regular atrial rhythm in 70 to 80% of the patients.

In this study, we opted for a simple electric scalpel (electrocauterization or diathermic scalpel), as defined by BATH [29] and also based on satisfactory results obtained by BRICK (personal communication). Special care was taken with the atrial electrocauterization, respecting a border of a minimum of 5 mm around the ostia of the pulmonary veins to prevent stenosis [30]. The technique utilized in this work optimized the atrial fibrillation surgery, substituting the resection of the right and left appendages for purse-string suturing of the entry of the cannula in the superior vena cava in the right atrium, and by the closing suture of the left appendage neck through the left intra-atrial membrane, respectively. Also the ample internal exposure of the left atrium was facilitated by the technique of DUBOST et al. [13], reducing the length of the sutures in the right atrium. From the electrophysiologic point of view, the single incision in the right atrium excluded one of the circuits of reentry of the stimuli in the atrial wall and also the septal channels. As the circuits near to the atrium excluded one of the circuits of reentry of the stimuli in the electrophysiologic point of view, the single incision in the right atrium reduces the length of the sutures in the right atrium. From the surgical point of view, the single incision in the right atrium restricted to the left atrium and only using an ultrasound scalpel [27], or by applying radiofrequency [28], reducing sectioning and the sutures necessary in the atrial walls, keeping, however, the success of the conversion to regular atrial rhythm in 70 to 80% of the patients.

In a general analysis of this initial study, we conclude that the technique employed and the electrophysiologic basis considered, simplified the surgery, practically reducing the operation to a single atrial incision and determining the different stages to block the potentially arrhythmogenic circuits, enabling the treatment of the atrial fibrillation and the correction of the mitral and tricuspid valve lesions without additional morbidity. The same criteria of electrophysiologic blocks facilitate the determining of endovascular treatment of atrial fibrillation, when direct intervention of the mitral and tricuspid valves is not necessary.

BIBLIOGRAPHIC REFERENCES


