Original Article

Isolation of the Pulmonary Veins in Patients with Permanent Atrial Fibrillation Secondary to Mitral Valve Disease

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Objective

To assess the efficacy of surgical isolation of the pulmonary veins for re-establishing sinus rhythm in patients with atrial fibrillation secondary to mitral valve disease.

Methods

Thirty-three (67% were women) patients with permanent atrial fibrillation and indication for surgical correction of the mitral valve underwent surgical isolation of the pulmonary veins. Their mean age was 56.3±10 years, preoperative NYHA functional class was 3.2±0.6, left atrial size was 5.5±0.9 cm, and ejection fraction was 61.3±13%. The surgical technique consisted of a circumferential incision surrounding the 4 pulmonary veins, excision of the left atrial appendage, and a perpendicular incision originating in the inferior margin of the circumferential incision isolating the pulmonary veins down to the mitral valve. Early arrhythmias were aggressively treated with cardioversion.

Results

The mean follow-up was 23.9±17 months, and 3 patients died in the postoperative period. Ten patients required electrical cardioversion in the postoperative period; 87% had sinus rhythm in the last medical visit, and 33% were using amiodarone.

Conclusion

Isolation of the pulmonary veins associated with mitral valve surgery is an effective and safe technique for maintaining sinus rhythm in patients with permanent atrial fibrillation.

Key words

cardiac arrhythmia, maze procedure, atrial fibrillation

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Permanent atrial fibrillation is the most prevalent arrhythmia in the general population, and frequently occurs in patients with mitral valve disease [1,2]. Some surgical techniques, such as the one developed by Cox et al [3], the Maze procedure, have proved to be effective in the treatment of atrial fibrillation, even when the arrhythmia is secondary to valvular heart disease [4,5].

The pathophysiological mechanism responsible for atrial fibrillation associated with mitral valve disease is not totally understood. Harada et al [6] suggested that this association could be triggered by electric discharges originating in the left atrium. In a previous experimental study, in which chronic atrial fibrillation was induced in dogs, Morillo et al [7] showed that cryoablation restricted to the left atrial posterior wall was sufficient to eliminate atrial fibrillation and to prevent its reinduction.

Based on this knowledge, Sueda et al [8,9] reported a modification in the Maze procedure in association with valvular correction, with surgical incisions restricted to the posterior part of the left atrium, electrically isolating the pulmonary veins and performing cryoablation in the isthmus between the inferior vena cava and the tricuspid valve. Using this technique, 86% of the patients were in sinus rhythm when discharged from the hospital, 94% of them having effective atrial contraction. Melo et al [10] reported their experience with the technique of pulmonary vein isolation in association with correction of the mitral valve disease, and atrial fibrillation was corrected in two thirds of their series of 34 patients. Recent studies have shown triggering zones inside the pulmonary veins responsible for starting paroxysmal atrial fibrillation [11]. These facts led to the development of several techniques directed to the left atrium, including catheter ablation.

Due to the current limitation of catheter procedures and the complexity of the incisions necessary for performing the Maze procedure, simplified variations of this surgery have been reported. These variations proved to be successful. The mini-Maze procedure, restricted to the left atrium, or even greater simplifications comprising only pulmonary vein isolation are among those variations [12-15].

This study aimed at reporting our experience at the Instituto de Cardiologia - Fundação Universitária de Cardiologia with pulmonary vein isolation in patients with permanent atrial fibrillation secondary to mitral valve disease, who underwent surgical valvular correction.

Methods

From July 1999 to December 2002, 33 patients with perma-

nent atrial fibrillation (duration > 6 months) and mitral valve disease with surgical indication, who had sought the Instituto de Cardiologia/Fundação Universitária de Cardiologia do Rio Grande do Sul, were selected to undergo the procedure after a detailed explanation about the surgery and signing the written informed consent. The exclusion criteria for surgery were as follows: age < 18 years; paroxysmal atrial fibrillation; ventricular ejection fraction < 20%; previous cardiac surgery; pregnancy; pericardial adhesions; or lack of concordance with inclusion in the research protocol. Our institution's ethics committee approved the study.

In the preoperative period, all patients underwent electrocardiography, anamnesis, and physical examination, and the electrocardiographic tracings were reviewed. Echocardiographies (M mode and Doppler) were performed by the same operator prior to surgery, aiming at assessing atrial dimensions, presence of intracavitary thrombi, severity of the valvular disease, and ventricular ejection fraction.

The preoperative clinical characteristics are shown in table I. Sixteen patients had isolated mitral stenosis, 13 had mitral valve insufficiency, and 4 had double mitral valve lesion. The mean age was 56±10 years, 66.7% were women, the preoperative NYHA functional class was 3.2±0.6, the left atrial size was 5.5± 0.9 cm, and the ventricular ejection fraction was 61.3±13%. Thirty-three per cent of the patients were in functional class IV, 48% in functional class III, and 18% in functional class II. The median time of arrhythmia prior to surgery was 22 (6 to 240) months.

After aortic clamping, the surgical procedure of pulmonary vein isolation consisted of left atriotomy with an incision line parallel to the interatrial sulcus. This incision was extended to surround the 4 pulmonary veins. This way, the mitral valve was examined and treated according to the lesion found. After repairing the valve, the incision surrounding the pulmonary veins was finished, isolating this region from the rest of the heart. Then, a perpendicular incision was performed, beginning in the inferior margin of the incision that isolates the pulmonary veins and extending to the mitral valve ring, taking care not to damage the coronary sinus or the circumflex coronary artery. An electrocautery was applied to the tissues next to the mitral valve ring. After finishing the valvular repair and all incisions, these were continuously sutured with a monofilament thread of 3-0 polypropylene in a single layer. Then, the aortic clamp was removed during myocardial reperfusion, and the left atrial appendage was resected and externally sutured with the same thread and in the same way. Differently from the Maze procedure, no incision was performed between the suture line of the left atrial appendage and the circular suture line surrounding the pulmonary veins. Neither cryoablation nor radiofrequency were used during the performance of this technique. No incision was performed in the right atrium or in the interatrial septum (fig. 1).

All patients were followed up in an ambulatory unit dedicated to research. During follow-up, electrocardiograms were performed at 1, 2, 6, 12, 24, 30 and 36 months after surgery. Additional medical visits occurred according to clinical need. The left atrial function was echocardiographically assessed by measuring the

Table I - Clinical characteristics in the preoperative period and late cardiac rhythm

Pt	Age (years)	Sex	NYHA functional class	Valvular lesion	Other associated lesion	Rheumatic heart disease	Type of valvular surgery	Follow-up (months)	Rhythm on the last medical visit
1	60	F	3	MS	DAL	yes	PL	36	SIN
2	36	M	4	MI	-	yes	PL	24	SIN
3	53	M	4	MI	TI	no	PL	36	SIN
4	50	F	4	MI	-	yes	PL	36	SIN
5	47	F	3	MI	-	yes	PL	12	SIN
6	64	F	3	MI	-	yes	PL	30	SIN
7	43	F	4	MS	-	yes	PL	36	SIN
8	71	F	4	MI	-	yes	PL	30	SIN
9	79	F	3	MS	-	yes	PL	30	AF
10	61	F	3	MS	TI	yes	PR	30	SIN
11	64	M	2	MI	-	no	PL	36	AF
12	57	F	3	DML	-	yes	PR	36	SIN
13	44	M	3	MS	-	no	PL	24	SIN
14	44	F	4	DML	-	yes	PL	24	SIN
15	55	M	4	MS	-	no	PL	12	SIN
16	56	F	2	MS	-	yes	PR	24	SIN
17	64	M	4	MS	-	yes	PL	12	SIN
18	42	F	4	MS	-	yes	PL	16	SIN
19	51	F	3	MI	DAL	yes	PL	18	SIN
20	57	F	4	MS	-	no	PR	18	AF
21	66	M	3	MI	-	yes	PL	18	SIN
22	67	M	2	MI	-	no	PL	18	SIN
23	54	F	3	MS	-	yes	PL	12	SIN
24	45	F	3	MS	TI	yes	PL	18	SIN
25	62	M	3	MI	DAL	yes	PL	12	SIN
26	72	F	3	MI	-	yes	PL	<1	SIN
27	67	F	3	DML	-	yes	PR	*	*
28	52	F	3	MS	-	yes	PR	6	SIN
29	62	F	4	MS	-	yes	PR	6	SIN
30	43	M	2	MS	-	yes	PL	6	AF
31	51	M	3	MI	-	no	PL	1	AF*
32	71	F	3	MI	-	no	PR	<1	SIN*
33	49	F	3	DML	-	yes	PR	2	SIN

Pt - patients; F - female; M - male; PL - plasty; PR - prosthesis; DAL - double aortic lesion; TI - tricuspid insufficiency; MS - mitral stenosis; MI - mitral insufficiency; DML - double mitral lesion; SIN - sinus; AF - atrial fibrillation; * - death.

atrial contractile function, measuring the greatest and smallest volumes with the area-length method and using the formula: (greatest volume – smallest volume)/greatest volume.

In the immediate postoperative period (hospital phase), arrhythmias were aggressively treated. Bradycardias were treated with a transient pacemaker and atrial tachyarrhythmias were treated with electric cardioversion. The use of antiarrhythmic medications and oral anticoagulation were up to the attending physician, the researchers being informed about the respective managements.

A databank was built and stored in EPI-INFO (version 6.0 WHO). The statistical analysis was performed with SSPS (SSPS inc, Chicago, IL). Continuous variables were expressed as mean ± standard deviation and median and were categorized when necessary. The pre- and postoperative periods were compared with the chi-square test for categorical variables and the Student *t* test for continuous variables. For these comparisons, the value of alpha = 0.05 was adopted as statistically significant.

Results

Three of the 33 patients studied died in the postoperative period: 1 due to uncontrolled bleeding with reintervention, 1 due to septic shock, and another due to refractory heart failure. During follow-up, 1 patient required implantation of a definitive pacemaker (DDD) because of total atrioventricular block, but remained in sinus rhythm. Table II summarizes the data about the population studied, including the cardiac rhythm during follow-up.

During surgery, the mean time of aortic clamping was 66±23 minutes and that of extracorporeal circulation was 91±33 minutes. Twenty-four patients underwent mitral valvuloplasty, and 9 underwent prosthetic valve implantation (7 biological and 2 mechanical). Associated surgery was performed in 7 patients. In 25 patients, the valvular heart disease was rheumatic, and, in the remaining, it was degenerative.

In the immediate postoperative period, sinus rhythm was evidenced in 78% of the patients (25), atrial fibrillation (3), and flutter (3) in 9%, and atrial tachycardia in 1 patient. During the last ambulatory unit visit, with a mean follow-up time of 24 months, 87% (26/30) of the patients were in sinus rhythm. Figure 2 shows the prevalence of sinus rhythm on the postoperative ambulatory follow-up of patients.

Antiarrhythmic therapy with amiodarone was administered to 33% (n=11) of the patients between the second postoperative month and the last clinical review, and no other antiarrhythmic drug was used. Ten patients underwent electrical cardioversion after 4 weeks of anticoagulation (INR 2-3), which was successful in all cases. No episode of spontaneous reversion to sinus rhythm was observed among the patients with atrial fibrillation in the postoperative period.

In the last medical visit of the postoperative follow-up, only 3 patients were receiving oral anticoagulation. None of the patients experienced thromboembolic phenomena during follow-up.

The echocardiographic analysis evidenced a left atrium of middle size in the postoperative period (4.8 cm), representing a 0,7 cm reduction as compared with that in the preoperative period (5.5 cm) (P = 0.008).

Left atrial function was assessed by measuring atrial contractile function, as previously described, and with a mean left atrial ejection fraction of 39±13% in the postoperative period. We chose not to assess the atrial wave because most patients had rheumatic mitral stenosis and an elevated diastolic flow velocity to be measured on pulsed Doppler or because of the impossibility of distinguishing the E and A waves.

No improvement in the ventricular ejection fraction occurred with surgery.

Discussion

Atrial fibrillation was present in 30% to 60% of the patients undergoing valvular surgery [16-18]. In addition, approximately 75% of the patients with atrial fibrillation prior to surgery remain with the arrhythmia [2,19-22], especially when it was a long-term arrhythmia. So, despite the hemodynamic improvement after surgery, the tendency toward atrial fibrillation remain. Valvular replacement or surgical repair improved cardiac function [23], but did not prevent atrial fibrillation from occurring [19,20,22].

Table II - Surgical data of the patients undergoing isolation of the pulmonary veins

Surgical data	(n=33)
Mitral prosthesis	9
Mitral valvuloplasty	24
Associated aortic correction	3
Associated tricuspid correction	4
Associated ASD correction	1
Time of extracorporeal circulation	90.8 ± 33.12 minutes
Time of aortic clamping	65.6 ± 23.1 minutes

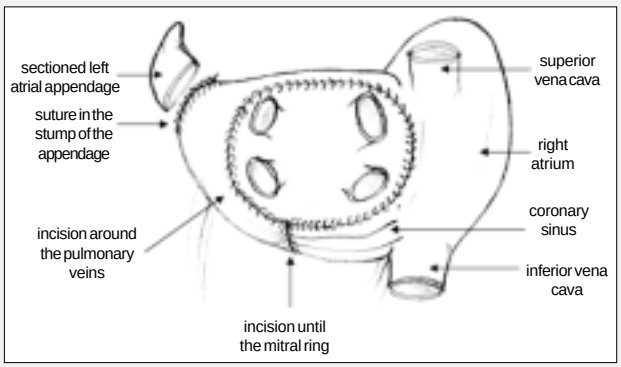

Fig. 1 - Posterior view of the heart after the procedure showing isolation of the pulmonary veins, which includes incision around the 4 pulmonary veins, resection of the left atrial appendage and a perpendicular incision from the circular incision until the mitral valve ring to prevent reentrant macrocircuits of atrial flutter.

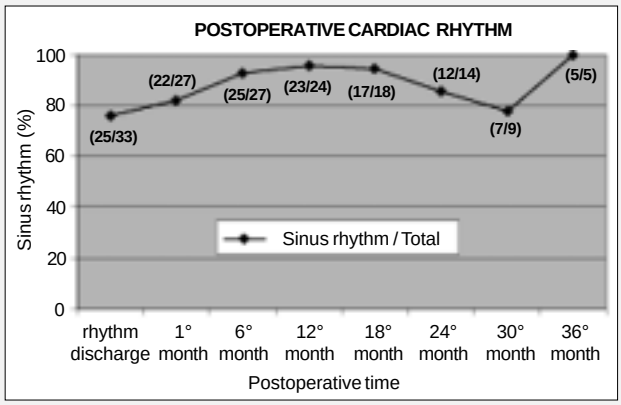

Fig. 2 - Prevalence of sinus rhythm during postoperative follow-up.

The Maze procedure developed by Cox et al [24] showed that the nonpharmacological treatment of primary atrial fibrillation is possible. The association of the Cox technique with mitral valve disease correction became attractive due to the high prevalence of this disease, and it has proved to be effective [4,5,25,26]. However, the complexity of the incisions necessary for performing the Maze procedure and the need for additional instrumentation (cryoablation) hindered its diffusion, leading the researchers to develop simplified alternative techniques [14, 15, 27].

With a better understanding of the electrophysiological mechanisms responsible for triggering and maintaining atrial fibrillation [6-11], the posterior region of the left atrium and pulmonary veins became targets for nonpharmacological approaches to this arrhythmia.

Current studies assessing the control of cardiac rhythm or heart rate in atrial fibrillation [28,29] did not show any benefit of one strategy in relation to the other. However, a representative number of patients with heart failure and severe mitral valve disease were not assessed, and few patients were treated with nonpharmacological techniques.

Thus, we report the long-term results of a technique for electrical isolation of the posterior region of the left atrium and the pulmonary veins, without using cryoablation or radiofrequency, for treating permanent atrial fibrillation in patients undergoing mitral valve correction. The results are similar to those already reported by our group with the Maze procedure [30].

Flugelman et al [31] reported that, after surgery for valve correction in patients with atrial fibrillation for more than 3 years and with atria larger than 5.2 cm, the chances of reversion and maintenance of sinus rhythm are very small. On the other hand, in our case series, even patients with a large left atrium and long-term atrial fibrillation (> 6 months) remained in sinus rhythm for a long follow-up period.

Sueda et al [32] reported recovery of sinus rhythm with an even simpler procedure without resection of the left atrial appendage and without the incisional line down to the mitral valve ring. We excised the left atrial appendage to reduce the risk of formation of intracavitary thrombi and performed the incision in the left atrial posterior wall until reaching the mitral ring to prevent the formation of reentrant macrocircuits around the circumferential incision involving the pulmonary veins.

The technique described is simpler than the Maze procedure and does not require additional instruments or specific training. Despite the reduced number of patients in this study, we believe that isolation of the pulmonary veins in patients with atrial fibrillation undergoing mitral correction is effective and safe for maintaining sinus rhythm.

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