

Surgical treatment of lone atrial fibrillation by mid-sternotomy Maze procedure under standard cardiopulmonary bypass

Tratamento cirúrgico da fibrilação atrial paroxística em esternotomia mediana usando procedimento de Maze sob circulação extracorpórea padrão

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Abstract

The aim of article is to give a brief description to the surgical strategies for patients with lone atrial fibrillation without associated cardiac operations, and present the possible indications of on-pump Maze procedures through a mid-sternotomy approach.

Keywords: Arrhythmias, cardiac. Atrial fibrillation. Cardiovascular surgical procedures.

Resumo

O objetivo do artigo é fazer uma breve descrição das estratégias cirúrgicas para pacientes com fibrilação atrial isolada sem operações cardíacas associadas, e apresentar possíveis indicações de procedimentos Maze com circulação extracorpórea por meio de esternotomia mediana.

Descritores: Arritmias cardíacas. Fibrilação atrial. Procedimentos cirúrgicos cardíacos.

INTRODUCTION

Lone atrial fibrillation (LAF) was defined as atrial fibrillation in patients younger than 60 (or 70) years old in the absence of an underlying structural heart disease, such as dilated cardiomyopathy, coronary heart disease, hypertension, and occult thyrotoxicosis [1-4]. LAF can be chronic paroxysmal, persistent or permanent [5]. The prevalence of atrial fibrillation is 0.4% in the general population, increasing to 9% of people over the age of 80 [6]. Palpitations, dizziness, dyspnea, angina and worsening heart failure were the clinical presentations of patients with LAF [6]. Atrial fibrillation now remains the most frequent cause of embolic event, stroke and death

[7-10]. The drugs used to lower the ventricular rate are digitalis, verapamil, propranolol and diltiazem. Electric cardioversion is used in serious cases [11].

Catheter ablation has a risk of stroke associated with thrombus produced when tissue impedance increases, heating the blood pool. Left atrial appendage exclusion is impossible with catheter-based ablation. It is often associated with postoperative atrial tachyarrhythmias that might be caused by incomplete and nontransmural ablation lines [12]. Some patients could not tolerate prolonged antiarrhythmic or anticoagulant medications, and percutaneous ablation has brought about some major complications including pulmonary vein stenosis, thromboembolism, and atriopharyngeal fistula [2]. The

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major indications for surgical treatment of LAF were intolerance for antiarrhythmic or anticoagulant medication, and medically refractory arrhythmia [2]. We hereby report our experiences with on-pump mid-sternotomy Maze procedure in three LAF patients without associated cardiac operations.

METHODS

From October 2004 to June 2008, three patients were diagnosed as LAF and were scheduled only for Maze procedure without associated cardiac operations by mid-sternotomy approach (Table 1).

Patient 1

A 54-year-old male patient had a persistent atrial fibrillation for 4 years with hyperlipidemia and transient ischemic attack. He was diagnosed as LAF and received percutaneous pulmonary vein isolation (PVI). However, atrial fibrillation persisted after the procedure during the follow-up. He was thus referred to the Department of Cardiac & Thoracic Surgery for a surgical treatment. He was undergone an open-chest Maze procedure under standard cardiopulmonary bypass and aortic root infused cold blood cardioplegia. After induced cardiac arrest, left atrial appendage was excised.

An irrigated bipolar radiofrequency ablation system (Cardioblate BP, Medtronic, Minneapolis, MN, USA) and a Medtronic Cardioblate™ pen (Medtronic, Minneapolis, MN, USA) were used to make transmural lesions, including encircling radiofrequency lesion on right pulmonary vein, left atriotomy in the interatrial groove, a radiofrequency lesion and a cryolesion at the mitral annulus, left atrial appendage excision and a perpendicular radiofrequency lesion to the anteromedial tricuspid valve annulus, and another encircling the left pulmonary vein. After the operation, his heart rhythm was sinus with incomplete right

bundle branch block (Figure 1). No cardioversion was necessary, and antiarrhythmic drugs were gradually withdrawn 3 months after the operation. He was complicated with post-pericardiotomy syndrome and was treated with nonsteroidal anti-inflammatory agents.

Patient 2

A 51-year-old male patient had a persistent atrial fibrillation for 4 years with hyperlipidemia and diabetes mellitus. He was diagnosed as LAF but he had intolerance prolonged oral anticoagulant therapy. He received Maze procedure via port access. However, atrial fibrillation persisted after the procedure, and he came to us for an open-chest Maze procedure under standard cardiopulmonary bypass and aortic root infused cold blood cardioplegia as described above. After the operation, his heart rhythm recovered to sinus but with first degree atrioventricular block. No cardioversion was necessary, and antiarrhythmic drugs were gradually withdrawn 3 months after operation. He was uncomplicated.

Patient 3

An obese 67-year-old female patient had a paroxysmal atrial fibrillation for 7 years presenting with syncope. She was diagnosed as LAF and received percutaneous PVI but the procedure turned to be a failure. She was referred to our department for an open-chest Maze procedure under standard cardiopulmonary bypass and aortic root infused cold blood cardioplegia as described above. After the operation, her heart rhythm was junctional (Figure 2). She was uncomplicated. She was then transferred to the cardiologist for antiarrhythmic treatment, but her rhythm was still junctional at a 2-year follow-up.

This study was approved by the Ethical Committee of the Institute where the work was conducted. An informed consent was obtained from each patient.

Table 1. A comparison of the clinical features of the patients undergoing open-chest Maze procedure.

Patient	Sex	Age	Nature of atrial fibrillation	Associated disorder	Surgical indication	Complication	Postoperative heart rhythm
1	Male	54	Persistent	Hyperlipidemia, cerebrovascular accident	Failed pulmonary vein isolation	Post-pericardiotomy syndrome	Sinus rhythm, incomplete right bundle branch block
2	Male	51	Persistent	Hyperlipidemia, diabetes	Failed Maze procedure via port access	None	Sinus rhythm, 1 st degree atrioventricular block
3	Female	67	Paroxysmal	Syncope	Failed pulmonary vein isolation and obesity	None	Accelerated junctional rhythm

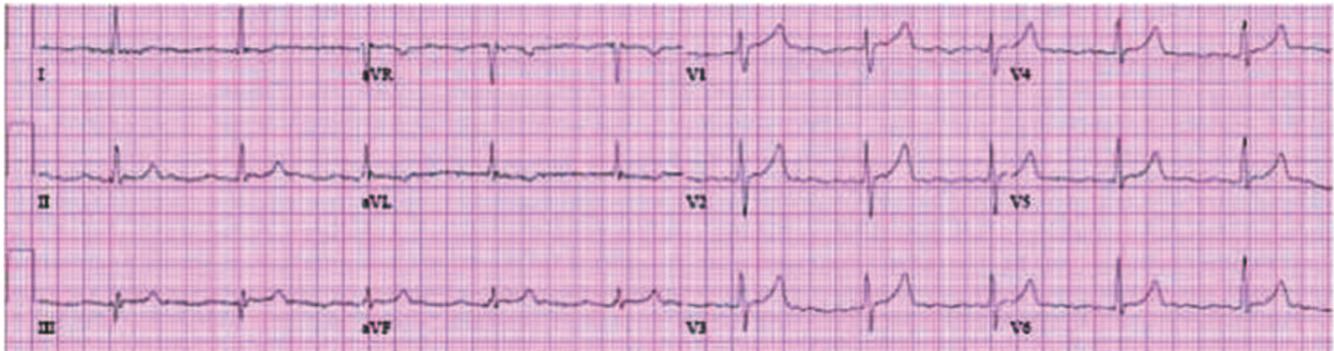


Fig. 1 - Postoperative electrocardiogram of patient 1 showing sinus rhythm with first degree atrioventricular block 3½ years after Maze procedure

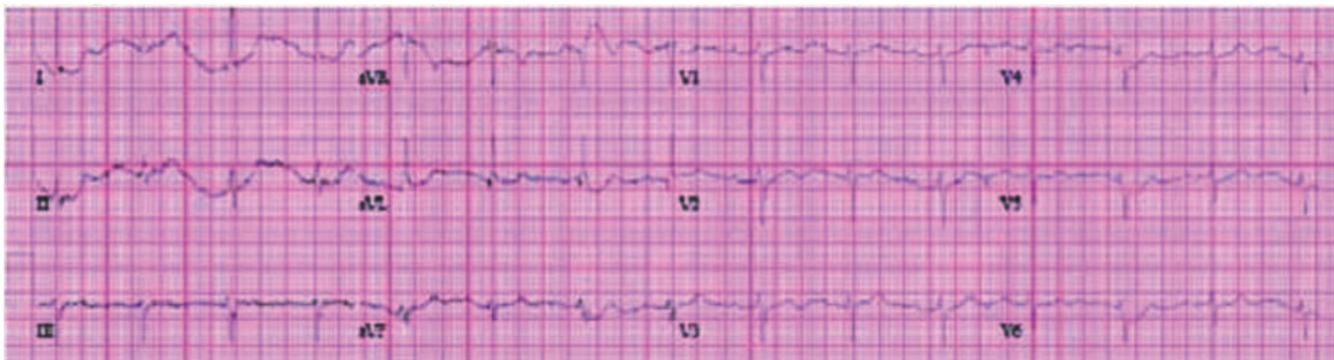


Fig. 2 - Postoperative electrocardiogram of patient 3 showing accelerated junctional rhythm 6 months after Maze procedure

DISCUSSION

Maze has been popularly used as an alternative of anti-arrhythmic procedure [13]. Maze procedures can be classified into 2 types: surgical procedures (Cox-maze/cut-and-sew, and mini-partial maze) and energy-based procedures with radiofrequency, microwave, or cryotherapy, etc. [14]. However, we prefer a classification in view of the application of cardiopulmonary bypass (Table 2).

Table 2. Classification of Maze procedures.

Classification	Procedures
Off-pump	<ul style="list-style-type: none"> • Video-assisted epicardial pulmonary vein isolation (Guidant Microwave Surgical Ablation System AFx FLEX 10) • Bilateral small (mini-)thoracotomy for bipolar epicardial pulmonary vein isolation (Medtronic AtriCure Bipolar System) • Mid-sternotomy epicardial pulmonary vein ablation
On-pump	<ul style="list-style-type: none"> • Mid-sternotomy Maze (cut-and-sew, bi-atrial) • Mid-sternotomy left or left and right atrial surgical ablation

Most of the surgical procedures were carried out under the aid of cardiopulmonary bypass, and therefore they were performed endocardially [15]. The minimally invasive procedure with bipolar radiofrequency devices was developed to achieve bilateral PVI and excision of left atrial appendage through bilateral mini-thoracotomies and thoracoscopy, namely, an epicardial approach [15,16]. This could avoid sternotomy or rib-spreading thoracotomy, and cardiopulmonary bypass [12], and has minimized morbidity of surgical treatment of atrial fibrillation [16]. PVI alone might be effective for most patients with paroxysmal atrial fibrillation and some of the patients with persistent atrial fibrillation [16]. However, the right-sided approach has the drawback of not dealing with the left atrial appendage, and the uncertainty of transmuralty of the lesions with microwave energy on the beating heart [2].

No complication was noted concerning bipolar radiofrequency in six patients with off-pump video-assisted PVI, and all six patients were in sinus rhythm within 6-month observation as reported by Bisleri et al. [17]. Video-assisted bilateral PVI with endoscopic stapling of the left atrial appendage has achieved an atrial fibrillation-free rate

of 91.3% at 3-month follow-up [12]. The classic Maze procedure could obtain a sinus rhythm in more than 90% of the patients with atrial fibrillation [18]. In this report, two patients were in sinus rhythm and one was in conjunctival at a 1-45-month follow-up.

Debates exist on the mechanisms of atrial fibrillation on whether macro reentry circuits in the atria or the drivers within the pulmonary veins [14]. Cox-Maze III surgery was developed on basis of the concept of macro reentry circuits in the atria [14]. Others believe that an atrial fibrillation driver predominates within the pulmonary veins thereby solely PVI was introduced for chronic atrial fibrillation, and it has proved that PVI incorporating the antrum of the pulmonary veins would increase the success rate of ablation [14]. However, this approach was technically complex and invasive [16]. Besides, the postoperative pacemaker implantation rate and postoperative atrial fibrillation rate were high [19].

Energy source approaches including radiofrequency, microwave, cryoablation were developed as alternatives to Cox-Maze III surgery. Continuous linear transmural atrial lesions made by these energy sources may produce heart block [19]. With a unipolar probe, energy disperses in multiple directions, and thus may damage the adjacent structures, such as the esophagus and coronary arteries [14]. With bipolar, the energy produces a transmural lesion, both epicardial and endocardial, within shorter ablation time [14].

Nevertheless, the Maze procedure by mid-sternotomy approach still plays an important role in patients with LAF in several occasions, especially in patients with failed percutaneous PVI. Currently, the Maze procedure for LAF is quite suitable for the patients with previous cardiac surgery and previous catheter ablation [12]. It does not lose its function as an alternative to antiarrhythmic medical treatment, long-term anticoagulation, electrical cardioversion, or catheter-based ablation [12,17]. In the near future, off-pump PVI with additional interatrial lesion and left atrial appendage exclusion or hybrid approaches incorporating both surgical and percutaneous techniques are favored for the surgical treatment of LAF [14]. Even though, the importance of open-chest Maze could not be overlooked.

CONCLUSIONS

Our experiences with on-pump mid-sternotomy Maze procedure was indicated for the patients with failed percutaneous PVI, failed heart port Maze procedure, and obesity patients either for left or right Maze. We suggest this procedure should be used in patients older than 70 years, a history of atrial fibrillation of over one year, a history of aortic valve replacement, and failed or repeatedly failed percutaneous PVIs.

REFERENCES

1. Engel TR, Topalian SK. The pathology of lone atrial fibrillation. *Chest*. 2005;127(2):424-5.
2. Yilmaz A, Geuzebroek GS, Van Putte BP, Boersma LV, Sonker U, De Bakker JM, et al. Completely thoracoscopic pulmonary vein isolation with ganglionic plexus ablation and left atrial appendage amputation for treatment of atrial fibrillation. *Eur J Cardiothorac Surg*. 2010;38(3):356-60.
3. Scardi S, Mazzone C, Pandullo C, Goldstein D, Poletti A, Humar F. Lone atrial fibrillation: prognostic differences between paroxysmal and chronic forms after 10 years of follow-up. *Am Heart J*. 1999;137(4 Pt 1):686-91.
4. Jessurun ER, van Hemel NM, Defauw JA, Stofmeel MA, Kelder JC, de la Rivière AB, et al. Results of maze surgery for lone paroxysmal atrial fibrillation. *Circulation*. 2000;101(13):1559-67.
5. Jahangir A, Lee V, Friedman PA, Trusty JM, Hodge DO, Kopecky SL, et al. Long-term progression and outcomes with aging in patients with lone atrial fibrillation: a 30-year follow-up study. *Circulation*. 2007;115(24):3050-6.
6. Ninio DM. Contemporary management of atrial fibrillation. *Aust Prescr*. 2000;23(5):100-2. <http://www.australianprescriber.com/magazine/23/5/100/2/>.
7. Grandmougin D, Tiffet O. Video-assisted thoracoscopic epicardial ablation of left pulmonary veins for lone permanent atrial fibrillation. *Interact Cardiovasc Thorac Surg*. 2007;6(1):136-8.
8. Breda JR, Ragnette RG, Breda ASCR, Gurian DB, Horiuti L, Machado LN, et al. Avaliação inicial da ablação operatória biatrial por radiofrequência de fibrilação atrial. *Rev Bras Cir Cardiovasc*. 2010;25(1):45-50.
9. Breda JR, Breda ASCR, Meneguini A, Freitas ACO, Pires AC. Ablação operatória da fibrilação atrial por radiofrequência. *Rev Bras Cir Cardiovasc*. 2008;23(1):118-22.
10. Breda JR, Ribeiro GCA. Tratamento operatório da fibrilação atrial: revisão integrativa da literatura. *Rev Bras Cir Cardiovasc*. 2011;26(3):447-54.
11. Larsen SR. Lone atrial fibrillation. http://www.afibbers.org/atrial_fibrillation.htm.
12. Zollino M, Lecce R, Selicorni A, Murdolo M, Mancuso I, Marangi G, et al. A double cryptic chromosome imbalance is an important factor to explain phenotypic variability in Wolf-Hirschhorn syndrome. *Eur J Hum Genet*. 2004;12(10):797-804.
13. Flores DM, Kalil RA, Lima GG, Abrahão R, Sant'anna JR, Prates PR, et al. Chronotropic response to exercise after

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- pulmonary veins isolation or Cox-maze operation. *Rev Bras Cir Cardiovasc*. 2008;23(4):474-9.
14. Harling L, Athanasiou T, Ashrafian H, Nowell J, Kourliouros A. Strategies in the surgical management of atrial fibrillation. *Cardiol Res Pract*. 2011;2011:439312.
15. Wolf RK, Schneeberger EW, Osterday R, Miller D, Merrill W, Flege JB Jr, et al. Video-assisted bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation. *J Thorac Cardiovasc Surg*. 2005;130(3):797-802.
16. Khargi K, Keyhan-Falsafi A, Hutten BA, Ramanna H, Lemke B, Deneke T. Surgical treatment of atrial fibrillation: a systematic review. *Herzschrittmacherther Elektrophysiol*. 2007;18(2):68-76.
17. Bisleri G, Manzato A, Argenziano M, Vigilance DW, Muneretto C. Thoracoscopic epicardial pulmonary vein ablation for lone paroxysmal atrial fibrillation. *Europace*. 2005;7(2):145-8.
18. Gillinov AM, Wolf RK. Surgical ablation of atrial fibrillation. *Prog Cardiovasc Dis*. 2005;48(3):169-77.
19. Suwalski P, Suwalski G, Wilimski R, Kochanowski J, Scis3o P, Gaca H, et al. Minimally invasive off-pump video-assisted endoscopic surgical pulmonary vein isolation using bipolar radiofrequency ablation: preliminary report. *Kardiol Pol*. 2007;65(4):370-4.