Modified Cox Maze Procedure for Atrial Fibrillation with Mitral Valve Disease†

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Abstract

Objective : To determine early term results of the modified Cox maze procedure for curing atrial fibrillation (AF) associated with mitral valve disease.

Method : Between January and December 2000, 10 consecutive patients with AF underwent the modified Cox maze procedure with mitral valve repair in 2 and replacement in 8. The associated procedure included 3 aortic valve replacements, 1 tricuspid annuloplasty, and 2 atrial septal defect closures.

There were 5 males and 5 females, with ages ranging from 19 to 52 years (mean = 38.3 years).

Pre-operative-existing AF time varied from 4 to 146 months (mean = 41.1 months), and left atrial dimension varied from 4.50 to 6.89 cm (mean 5.51 cm).

The authors modified the maze atriotomies to preserve the sinus node artery and used cryo-ablation, incision and suture to simplify the procedures.

Results : Seven cases (70%) regained sinus rhythm and 3 cases (30%) still remained in AF. Two cases (double valve replacement) needed intraaortic balloon pump.

Two of them developed cardiac tamponade 1 month post-operatively, (one in sinus rhythm case and another one in AF).

Those 3 patients who remained in AF had a longer pre-operative existing AF-time and larger left atrial dimension but it was insignificant ($p = 0.227$ and $p = 0.187$ respectively). There was no early or late mortality.

Conclusion : The pertaining results suggest that the modified Cox maze procedure has satisfactory effectiveness to cure atrial fibrillation, restore atrioventricular synchrony and preserve atrial transport function in the patients having AF associated with mitral valve disease.

Key word : Atrial Fibrillation, Cox Maze Procedure, Mitral Valve Disease

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The Cox maze procedure is one of the surgical treatments for symptomatic patients with drug-resistant chronic and paroxysmal atrial fibrillation, developed by Cox in 1991(1). The aim of this procedure is to block the macroreentrant circuit by multiple atrial incisions of maze-like configuration and to cure atrial fibrillation (AF). A significant number of patients undergoing mitral valve surgery are associated with chronic drug-resistant atrial fibrillation in Asian countries. The Cox maze procedure has been concomitantly performed with valve surgery in an attempt to improve the quality of life after surgery, by eliminating the morbidity associated with atrial fibrillation. In 1994, Kosakai et al reported a modification of Cox maze III procedure(2). One of the modifications is the use of cryoablation to replace atriotomies of original Cox maze III procedure for shortening the cross clamp-time and saving blood loss during surgery. There have been some reports describing early results after the modified procedure combined with other cardiac surgery(3-5). In this retrospective study, the authors evaluated the early results (including changes of rhythm status and incidence of cerebrovascular accident) in patients with atrial fibrillation and mitral valve disease who underwent the modified Cox maze procedure by using cryoablations, incision and suture combined with other cardiac surgery at Ramathibodi Hospital.

PATIENT AND METHOD

Patients

Between January 2000 and December 2000, 10 consecutive patients with atrial fibrillation underwent the modified Cox maze procedure with mitral valve repair in 2 and replacement in 8 at Ramathibodi Hospital. The associated procedure included 3 aortic valve replacements, 1 tricuspid annuloplasty and 2 atrial septal defect closures. There were 5 males and 5 females, with ages ranging from 19 to 52 years (mean = 38.3 years). The causes of the mitral valve disorder were rheumatic heart disease (n = 7) and myxomatous degeneration (n = 3). Pre-operative-existing AF time varied from 4 to 146 months (mean = 41.1 months). The left atrial dimension ranged from 4.50 to 6.89 cm (mean = 5.51 cm). Informed consent was obtained from all patients, including the possible benefits and risks after the combined procedure.

Surgical procedure

The current modification is illustrated in Fig. I which is the first study to use cryoablation, incision and suture. Median sternotomy was performed. Cardiopulmonary bypass was instituted with arterial cannulation of distal part of ascending aorta and bicaval venous drainage, *via* the superior vena cava directly and the inferior vena cava *via* the lower right atrium after heparinization (Fig. 1A). The right atrial appendage

was amputated. From the incision the right atriotomy was extended in a curvilinear fashion to the junction of the inferior vena cava (Fig. 1A). From the midpoint of this atriotomy, an additional incision was started toward the tricuspid annulus, which was cryoablated (at -60°C for 2 minutes) later. The left atrium appendage was ligated with silk. After institution of cardiac arrest, the left atrium was entered in front of the right pulmonary veins in the usual manner. The procedures for the mitral valve were then carried out. Continuous suture with 2-0 polyester (Ti-cron) was done to encircle the orifices of pulmo-nary veins except at the front of the right pulmonary veins and toward the left and right atrial appendages (Fig. 1A), cryoablation (at -60°C for 2 minutes) was applied toward the mitral valve annula (Fig. 1B). Con-tinuous suture with 2-0 polyester (Ti-cron) was performed on the interatrial septum from the fossa ovalis to the right atrial appen-

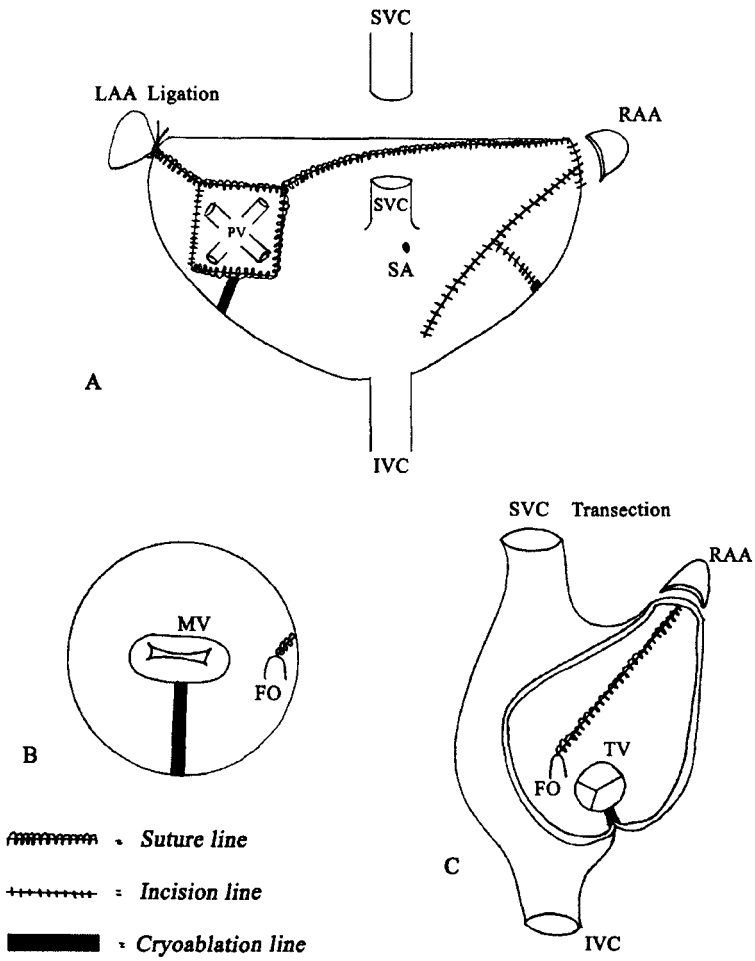

Fig. 1. Modification of the Maze procedure. The right and left atrium seen from behind (A) and from inside (B, C).

LAA = left atrial appendage, RAA = right atrial appendage, SVC = superior vena cava, IVC = inferior vena cava, SA = sinus node, FO = fossa ovalis, PV = pulmonary vein, TV = tricuspid valve, MV = mitral valve.

dage (Fig. 1C) and the atrial septal defect was closed if it still existed. The left atrium was closed. Aortic valve surgery or tricuspid annuloplasty was performed if necessary. Transec-tion of the superior vena cava and closure of the right atrium were usually completed after the aortic cross clamp was released. The heart resumed contraction and cardiopulmonary bypass terminated. The chest was closed with a temporary pacemaker wire left in place on the right ventricle.

Surgical technique of the classical Cox maze procedure includes excision of the right atrial appendage, incision between the right atrial appendage and stopping short of the SA node artery at the posterolateral right atrium, incision between the right atrial appendage and left atrial appendage, incision of the interatrial septum, isolation of pulmonary veins by cutting, incision between the pulmonary veins isolation and mitral valve annulus with cryoablation at coronary sinus, excision of the left atrial appendage and incision of the right atrial wall between the superior vena cava and the tricuspid valve annulus[1].

After surgery, the patients were transferred to the ICU unit. Inotropes were administered to every patient post-operatively and cardiac rhythm was monitored continuously. Antiarrhythmic drugs were given when atrial tachyarrhythmia induced unstable hemodynamic status.

Follow-up

All patients were followed-up monthly for cardiac medication and anticoagulation and rhythm assessment. Electrocardiography (ECG) was recorded every 3 months after operation. Anticoagulation was discontinued in patients with sinus rhythm except valvular replacement cases. Antiarrhythmic agents were tapered gradually after regaining sinus rhythm.

Statistical analysis

Continuous variables were compared by the difference *t*-test. Difference was considered statistically significant when the p-valve was less than 0.05.

RESULTS

No early or late deaths occurred. Cardiac arresting time ranged from 81-202 minutes (mean = 136 minutes) and cardiopulmonary bypass time varied from 190-288 minutes (mean = 186 minutes). Most patients could be weaned off bypass without right ventricular pacing for stabilization of hemodynamics. Two patients (double valve replacement) (20%) required intra-aortic balloon pumping due to severe myocardial dysfunction and low cardiac output. Two patients (20%) developed cardiac tamponade, one in sinus rhythm underwent subxiphoid pericardial window with drain and another one in AF underwent pericardiocentesis. No patient required permanent pacemaker implantation and there were no neurologic problems. Restoration of sinus rhythm or freedom for AF after operation is illustrated in Table 1.

Seven cases (70%) regained sinus rhythm and 3 cases (30%) still remained in AF after operation. Five of seven patients who regained sinus rhythm needed continuous antiarrhythmic drugs for stabilization of the sinus rhythm for 3-6 months. Those 3 patients who remained in AF had longer pre-operative-existing AF time and larger left atrial dimension

Table 1. Comparison between patients with AF or sinus rhythm after operation.

Sex	Age (year)	Type of operation	Pre-operative existing AF (months)	Left atrium dimension (CM)	Cardiac rhythm after operation
Male	29	MVR, AVR	45	4.5	Sinus
Female	39	MVR	47	6.52	Sinus
Female	42	MV repair	146	5.95	AF
Male	52	MVR	4	4.90	Sinus
Female	29	MVR, AVR	24	5.19	Sinus
Male	50	MVR	6	4.99	Sinus
Female	19	MVR	15	6.89	AF
Male	33	MVR, AVR	34	5.03	Sinus
Female	46	MVR, ASD closure	85	5.24	AF
Male	44	MV repair, TA, ASD closure	5	5.90	Sinus

MV repair = mitral valve repair, MVR = mitral valve replacement, AVR = aortic valve replacement, ASD = atrial septal defect, TA = tricuspid annuloplasty, AF = atrial fibrillation

but all were insignificant (p = 0.227, and p = 0.187 respectively). In latter follow-up, no patient had signs of myocardial ischemia on the electrocardiography, and blood chemistry.

DISCUSSION

Patients with a mitral valve disorder often have many factors predisposing to AF, such as advanced age[6], cardiomegaly[6] and increased atrial size[7]. These factors which include a long history of AF[6, 7] tend to result in persistent AF after a successful mitral valve operation[2,3,5] and electric cardioversion[8]. Therefore, specific surgical intervention is mandatory to reverse AF resulting from mitral valve disease. Restoration of sinus rhythm is expected to improve long-term prognosis. The authors started the modified Cox maze procedure for patients undergoing mitral valve operation.

To decrease the risk by reducing operative time, bleeding tendency and heart block, the authors used suture and cryoablation to replace left atriotomy, with reanastomosis and dissection at the valvular annuli[1,2]. The suture can block the conduction pathway which was observed by electrocardiography after the repair of the ventricular septal defect[9,10]. Moreover, tricuspid valve lesions are often associated with mitral disorders, necessitating a right atriotomy for surgical intervention. Thus, combining the maze procedure with a mitral valve operation does not require as much added time and complexity. Nonetheless, the combined maze procedure needed an additional 40 minutes for cardiac arresting time and an extra 70 minutes for cardiopulmonary bypass time compared to the valvular procedure alone[11].

Because atriotomies in the classical maze procedure could induce bleeding and heart block, the authors modified this procedure from incision the left atrial wall and the interatrial septum and excision of the left atrial appendage (LAA) in the classical maze procedure by using suture, cryoablation and ligation to reduce the left atrial cavity, bleeding and heart block.

However, 25 per cent of patients who regained sinus rhythm after maze operation failed to detect atrial contraction from Doppler echocardiography[2]. It may have resulted from fibrotic and calcific degeneration of the atrial myocardium in severe dilatation or rheumatic myocarditis[2]. This modified maze procedure achieved 70 per cent of the defibrillation rate, and 98 per cent of the defibrillation rate in the classical Cox maze procedure because the suture could not completely interrupt the conduction pathway which induced atrial fibrillation. The defibrillation rate in the patients who underwent mitral valve operation alone was 15 per cent[2].

Univariate analysis on pre-operative varibles identified that the pre-operative existing AF time and left atrial dimension were not predisposing factors while some reports did[2,6,9] due to the small sample size. In the follow-up, restoration of the sinus rhythm and contraction might abolish stagnation and reduce risk of thromboembolism complications.

The authors believe that the modified Cox maze procedure is effective to cure atrial fibrillation, restore atrioventricular synchrony and preserve atrial transport function in the patients having AF associated with mitral valve disease.

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Modified Cox Maze procedure สำหรับ Atrial fibrillation กับ Mitral valve disease†

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วัตถุประสงค์ : ศึกษาผลในระยะเริ่มต้นของการผ่าตัด modified Cox Maze procedure สำหรับการรักษา atrial fibrillation (AF) ที่ร่วมกับโรค mitral valve

วิธีการ : ศึกษาในผู้ป่วยตั้งแต่ มกราคม ถึง ธันวาคม พ.ศ. 2543 ในผู้ป่วย 10 ราย ที่มี AF ทำการผ่าตัด modified Cox Maze procedure กับ mitral valve repair 2 ราย และ mitral valve replacement 8 ราย โดยมีการผ่าตัดอื่นร่วมด้วย คือ aortic valve replacement 3 ราย, tricuspid annuloplasty 1 ราย, และ atrial septal defect closure 2 ราย

ผู้ป่วยเป็นชาย 5 ราย และหญิง 5 ราย อายุระหว่าง 19–52 ปี (เฉลี่ย = 38.3 ปี)

ระยะเวลา AF ก่อนผ่าตัดระหว่าง 4–146 เดือน (เฉลี่ย = 41.1 เดือน) และขนาดของ left atrium ระหว่าง 4.50–6.89 เซนติเมตร (เฉลี่ย = 5.51 เซนติเมตร)

การผ่าตัดใช้ modified Maze atriotomies เพื่อหลีกเลี่ยงอันตรายแก่ sinus node artery และการใช้ cryoablation, incision และ suture เพื่อให้การผ่าตัดง่ายและสะดวก

ผลการศึกษา : 7 ราย (70 %) กลับมาเป็น sinus rhythm และ 3 ราย (30 %) ยังเป็น AF อยู่ 2 ราย ที่ทำ double valve replacement ต้องใช้ intraaortic balloon pump

2 รายเกิด cardiac tamponade หลังผ่าตัด 1 เดือน โดย 1 รายเป็น sinus rhythm และอีกราย ยังเป็น AF

3 รายคงเป็น AF พบว่า มีระยะเวลา AF ก่อนผ่าตัดนานกว่า และขนาดของ left atrium ใหญ่กว่า แต่ไม่มีความแตกต่างทางสถิติ (p = 0.227 และ p = 0.187 ตามลำดับ) ไม่มีผู้ป่วยเสียชีวิต

สรุป : จากการศึกษาผลของ modified Cox Maze procedure ได้ผลเป็นที่น่าพอใจในการรักษา AF, ช่วย atrio-ventricular synchrony และการทำงานของ atrium กลับมาเป็นปกติในผู้ป่วยที่มี AF ร่วมกับโรค mitral valve

คำสำคัญ : หัวใจเต้นผิดปกติที่เอเทรียม, วิธีการผ่าตัดที่ตัดกระแสไฟฟ้าที่ระดับเอเทรียม, โรคลิ้นหัวใจมัยตรัล

มณเฑียร งดงามทวีสุข, สมบูรณ์ บุญเกษม วิเศษ สุพรรณชาติ, สุกษม อัตนวานิช, วรวิทย์ ศุภกุล, พรพิมล มาศนรากรณ์
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