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Surgical ablation for atrial fibrillation using the Ex-Maze III procedure on the beating heart in patients undergoing mitral valve surgery

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Abstract

Background: The Ex-Maze III procedure is a recently developed surgical method for ablation of atrial fibrillation (AF). The procedure uses epicardial approach and can be performed on the beating heart.

Aim: To evaluate the efficacy and safety of Ex-Maze III ablation in patients undergoing mitral valve (MV) surgery.

Methods: The study group consisted of 20 consecutive patients (8 males, mean age 67 years) who underwent MV surgery and had concomitant AF. Eighteen patients were diagnosed with long-standing permanent AF and 2 patients with paroxysmal AF. The mean duration of AF was 9.5 years prior to surgery. All the patients underwent the Ex-Maze III procedure on the beating heart immediately before the MV surgery (MV replacement in 17 patients and MV repair in 3 patients). The patients were followed 1, 3, 6 and 12 months after procedure with ECG and 24-h ambulatory ECG monitoring (at 12 months).

Results: There were no serious complications in the study group. All the patients were in AF immediately after the procedure and underwent electrical or pharmacological cardioversion (4 and 16 patients, respectively). The proportion of patients remaining in sinus rhythm was 15 (75%) patients at 1 month, 16 (80%) patients at 3 months, 17 (85%) patients at 6 months and 12 months after procedure.

Conclusions: The Ex-Maze III procedure for ablation of AF on the beating heart is safe and effective in patients with AF undergoing concomitant MV surgery. In order to better evaluate the outcomes of the procedure a prospective randomised multicentre study is needed.

Key words: atrial fibrillation, ablation, Ex-Maze III

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INTRODUCTION

Atrial fibrillation (AF) is a common cardiac arrhythmia affecting about 1–2% of the general population [1, 2]. The AF is associated with a two-fold increase in mortality [3, 4] and a five-fold increase in the risk of stroke compared to the population without this arrhythmia [5]. The AF may also lead to tachycardia-mediated cardiomyopathy and decreased quality of life [6, 7]. Cardiac surgery plays a role in the treatment of AF in addition to pharmacological treatment and percutaneous interventions.

In cardiac surgery the "cut and sew" maze procedure developed by James Cox is currently considered the gold standard in the treatment of AF. The method is very effective and offers an almost 100% chance of restoration of sinus rhythm (SR). The results published by Cox indicate a rate of SR restoration of up to 99% in patients undergoing this procedure [8].

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This technique is, however, highly invasive and puts the patient at an additional risk, as it requires opening the chest, using cardiopulmonary bypass and arresting the circulation. It is also technically difficult and is associated with a considerable number of perioperative complications, especially haemorrhagic complications. Due to these limitations a number of alternative surgical methods of treatment of AF have recently been developed, especially intraoperative ablation performed during cardiac surgery for another reason.

In an attempt to find an optimal solution for patients undergoing surgery at our facility we used various systems of left atrial ablation. Due to its universality, we most commonly used a system manufactured by nContact, a monopolar, irrigated system utilising radiofrequency (RF) current.

The system is fitted with integrated suction which provides an uninterrupted contact of the ablated tissue with the electrode. This provides opportunity for performing a complete transmural ablation line. The RF current generator connected to the electrode is fitted with a specially prepared programme for continuous measurement of tissue impedance, delivered power and temperature of the ablated tissue, which allows for an optimal automatic selection of power of the RF generator. Additionally, the system automatically discontinues ablation if contact with the ablated cardiac tissue is lost.

Mimicking the Cox-Maze III method initiated by Dr Cox, we created our own ablation protocol in collaboration with Dr Andy C. Kiser, the US cardiac surgeon, which was called 'Ex-Maze III' (extracardiac Maze III procedure performed totally on the epicardium) (Fig. 1). We used this procedure during cardiac surgery in patients with co-existing AF.

The aim of our study was to assess the efficacy and safety of ablation performed using the Ex-Maze III procedure in patients with AF undergoing mitral valve (MV) surgery.

METHODS

We used the Ex-Maze III procedure in 20 consecutive patients with AF undergoing MV surgery. The demographic and clinical details are given in Table 1. No significant modifications were made to the patients' medical treatment during the study. The ablation lines in all the patients were performed using the Ex-Maze III pattern (Fig. 1). The ablation lines were performed on the beating heart, without using cardiopulmonary bypass, directly before MV surgery. After the ablation procedure was complete, cardiopulmonary bypass was instituted and the remaining steps of the operation were completed.

The patients were followed for up to one year. Follow-up assessments at 1, 3, 6 and 12 months post-procedure included clinical evaluation, resting ECG and, at 12 months, additionally 24-h ambulatory ECG monitoring.

RESULTS

Seventeen patients had advanced changes in the valve cusps and required MV replacement. Only in 3 patients, the anatomy made it possible to safely perform MV repair. The postoperative course in all the patients was not associated with any serious complications. Two patients were diagnosed with low-output syndrome which was successfully controlled with medical treatment and 3 patients required prolonged ventilation. Five patients required blood transfusions due to incre-

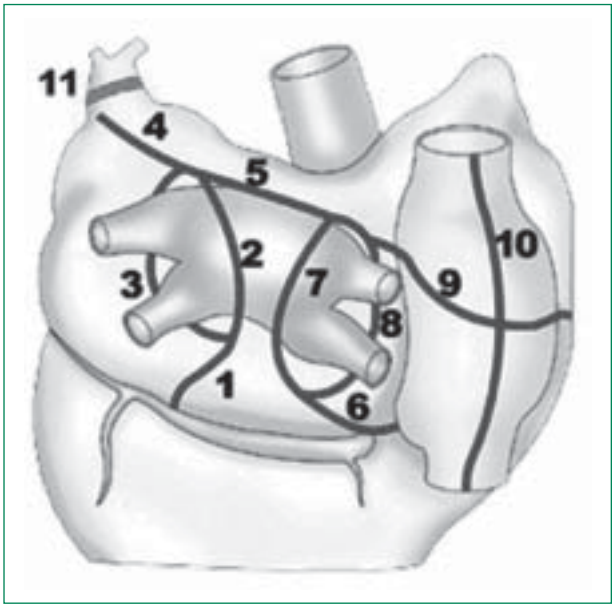

Figure 1. A diagram of ablation lines in the Ex-Maze III procedure

Table 1. Study group characteristics

Women	12 (60%)
Age [years]	Mean: 67 (range: 56–78)
Persistent AF	18 (90%)
Paroxysmal AF	2 (10%)
Ischaemic heart disease	2 (10%)
Type 2 diabetes mellitus	5 (25%)
Hypertension	4 (20%)
Aortic valve disease	1 (5%)
Echocardiographic parameters:	
Left atrial dimesion [mm]	Mean: 52 (range: 45–78)
Left ventricular ejection fraction [%]	Mean: 48.6 (range: 23–70)
Pharmacotherapy:	
Propafenone + sotalol	15 (75%)
Amiodarone + beta-blocker	5 (25%)
Statin	15 (75%)
ACE inhibitor	5 (25%)
Digoxin	2 (10%)

AF — atrial fibrillation; ACE — angiotensin converting enzyme

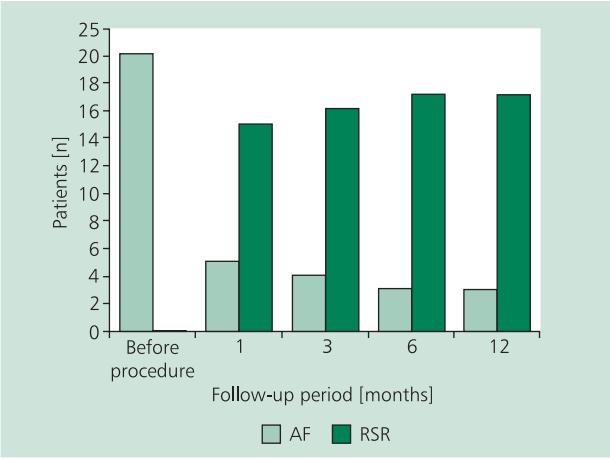

Figure 2. Cardiac rhythm during the follow-up period after the Ex-Maze III procedure; AF — atrial fibrillation; RSR — regular sinus rhythm

ased postoperative drainage. None of the patients required repeat thoracotomy due to bleeding and none of the patients required repeat surgery. All the patients had AF in the early postoperative period, which resolved in 16 patients following pharmacological treatment, while 4 patients required electrical cardioversion.

One month after procedure resting ECG revealed SR in 15 (75%) patients (Fig. 2), AF in 3 (15%) patients and atrial flutter (AFl) in the remaining 2 (10%) patients. Patients with irregular rhythm (i.e. 5 patients with AF and AFl) had long-standing persistent AF (permanent AF) before the surgery.

Three months after procedure ECG revealed SR in 16 (80%) patients, AF in 3 (15%) patients and AFl in one (5%) patient. All the 4 patients without SR had permanent AF before the surgery.

Six months after procedure as many as 17 (85%) patients were in SR. Two (10%) patients were still in AF and one (5%) had AFl. All the 3 patients who were not in SR at 6 months had been classified as patients with permanent AF before the surgery.

The follow-up assessments at 12 months after the procedure did not show any changes in the number of patients who maintained SR. None of the 17 (85%) patients in SR on ECG had AF on the 24-h ambulatory ECG monitoring (Fig. 2). Two (10%) patients with preoperative permanent AF were still in AF, although periods of SR had occurred in both of them. Both patients continued to receive pharmacological treatment (amiodarone) throughout the follow-up period. One (5%) patient continues to suffer from AFl refractory to medical treatment.

All the 3 patients in whom irregular rhythm was identified (15% of the failures) were considered eligible for endocardial ablation. In two cases the endocardial ablation was successful and one patient is still awaiting the procedure.

DISCUSSION

Atrial fibrillation affects about 30–40% of patients with significant mitral stenosis and about 75% of patients with severe mitral insufficiency. In most of the patients the very procedure of MV replacement or repair does not result in resolution of the arrhythmia [9]. Hence it is justified to provide the patient with ablation treatment complementing cardiac surgery [10]. Myrdko et al. [11] showed that intraoperative RF ablation from the endocardial approach performed in patients with persistent AF undergoing on-pump MV replacement significantly increased the chances of restoring and maintaining SR. In our study we used the Ex-Maze III procedure [12], which is performed on the beating heart without the use of cardiopulmonary bypass. Our results indicate a high efficacy and safety of the method. The percentage of patients with SR increased from 75% to 85% during the 6 months of follow-up and did not change over the subsequent 6 months. It may therefore hypothesised that during the 6 months following ablation atrial remodelling is reversed.

The results reported in the literature are similar to ours. Cui et al. [13] performed a modified Cox mini-Maze procedure in patients with persistent AF undergoing open heart surgery, achieving elimination of AF in 94% of the patients at 6 months and 87% of the patients at 12 months. This method involved performing ablation lines both from the endocardial and epicardial approaches, which may explain its slightly higher efficacy compared to our method. Sie et al. [14] performed ablation lines in both atria during MV surgery, achieving a success rate of 80% after 12 months of follow-up. Mohr et al. [15] achieved a success rate of 69% in a similar patient group. In a study by Williams et al. [16], SR was present in 78% of the patients 9 months following ablation.

It should be noted that our group of patients had a long-standing history of AF before the surgery. In all the patients AF had been present for at least 3 years before the surgery, so according to the most recent classification [6], these were cases of long-standing persistent AF. Some studies by other authors included patients with a shorter history. The group reported by Williams et al. [16] also included patients with AF of less than 6 months duration.

Our results suggest that ablation performed using the Ex-Maze III method is characterised by a high efficacy and is worth recommending to patients with advanced atrial remodelling. As pharmacological treatment remained unchanged during the follow-up period, it may be assumed that our results are mainly the effect of ablation and the MV surgery (repair or replacement). It remains to be determined how long antiarrhythmic drugs should be used after the procedure. In order to address this question it seems justified to conduct a randomised study.

Another unanswered question is to what extent MV repair affects the restoration of SR compared to the procedure combined with ablation. In addition, due to the potential occurrence of asymptomatic AF episodes following ablation, some of AF recurrences might have gone undetected during follow-up assessments.

CONCLUSIONS

1. The Ex-Maze III procedure for ablation on the beating heart is safe and effective in patients with persistent AF undergoing concomitant MV surgery.
2. In order to fully evaluate the efficacy of the method a prospective randomised multicentre study is needed.

Conflict of interest: *none declared*

References

1. Stewart S, Hart CL, Hole DJ, McMurray JJ. Population prevalence, incidence, and predictors of atrial fibrillation in the Renfrew/Paisley study. Heart, 2001; 86: 516–552.
2. Go AS, Hylek EM, Phillips KA et al. Prevalence of diagnosed atrial fibrillation in adults: national implications for rhythm management and stroke prevention: the Anticoagulation and Risk Factors in Atrial Fibrillation (ATRIA) Study. JAMA, 2001; 285: 2370–2375.
3. Kirchhof P, Auricchio A, Bax et al. Outcome parameters for trials in atrial fibrillation: executive summary. Recommendations from a consensus conference organized by the German Atrial Fibrillation Competence NETwork (AFNET) and the European Heart Rhythm Association (EHRA). Eur Heart J, 2007; 28: 2803–2817.
4. Stewart S, Hart CL, Hole DJ, McMurray JJ. A population-based study of the long-term risks associated with atrial fibrillation: 20-year follow-up of the Renfrew/Paisley study. Am J Med, 2002; 113: 359–364.
5. Friberg L, Hammar N, Rosenqvist M. Stroke in paroxysmal atrial fibrillation: report from the Stockholm Cohort of Atrial Fibrillation. Eur Heart J, 2010; 31: 967–975.
6. Camm AJ, Kirchhof P, Lip GYH et al. Guidelines for the management of atrial Fibrillation. The Task Force for the Management of Atrial Fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA), endorsed by the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J, 2010; 31: 2369–2429.
7. Thrall G, Lane D, Carroll D, Lip GY. Quality of life in patients with atrial fibrillation: a systematic review. Am J Med, 2006; 119: 448 e1–e19.
8. Cox JL, Schuessler RB, D'Agostino HJ Jr et al. The surgical treatment of atrial fibrillation. III. Development of a definitive surgical procedure. J Thorac Cardiovasc Surg, 1991; 101: 569.
9. Probst P, Goldschlager N, Selzer A. Left atrial size and atrial fibrillation in mitral stenosis. Circulation, 1973; 48: 1282–1287.
10. Obaida JF, el Farra M, Bastieno OH et al. Outcome of atrial fibrillation after mitral valve repair. J Thorac Cardiovasc Surg, 1997; 114: 179–185.
11. Myrdko T, Śnieżek-Maciejewska M, Rudziński P et al. Efficacy of intra-operative radiofrequency ablation in patients with permanent atrial fibrillation undergoing concomitant mitral valve replacement. Kardiol Pol, 2008; 66: 932–938.
12. Kiser AC, Wimmer-Greinecker G, Kapelak B et al. Achieving metrics during beating-heart ex-maze procedures improves outcomes. Heart Surg Forum, 2008; 11: E237–E242.
13. Cui YQ, Sun LB, Li Y et al. Intraoperative modified Cox mini-maze procedure for long-standing persistent atrial fibrillation. Ann Thorac Surg, 2008; 85: 1283–1289.
14. Sie H, Beukema W, Misier A et al. Radiofrequency modified Maze in patients with atrial fibrillation undergoing concomitant cardiac surgery. J Thorac Cardiovasc Surg, 2001; 122: 249–256.
15. Mohr FW, Fabricius AM, Falk V. Curative treatment of atrial fibrillation with intraoperative radiofrequency ablation: short-term and midterm results. J Thorac Cardiovasc Surg, 2002; 1232: 919–927.
16. Williams MR, Stewart JR, Bolling SF et al. Surgical treatment of atrial fibrillation using radiofrequency energy. Ann Thorac Surg, 2001; 71: 1939–1941.

Chirurgiczna ablacja migotania przedsionków metodą Ex-Maze III na bijącym sercu u pacjentów poddawanych operacji zastawki mitralnej

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Streszczenie

Wstęp: Ostatnio obserwuje się rozwój nowych kardiochirurgicznych sposobów leczenia migotania przedsionków (AF). Jedną z metod ablacji kardiochirurgicznej u pacjentów z AF jest procedura Ex-Maze III, którą wykonuje się z dostępu epikardialnego na bijącym sercu.

Cel: Celem pracy była ocena skuteczności i bezpieczeństwa ablacji metodą Ex-Maze III u chorych poddawanych zabiegowi kardiochirurgicznemu na zastawce mitralnej (MV).

Metody: Metodę Ex-Maze III zastosowano u 20 kolejnych pacjentów (8 mężczyzn, śr. wiek 67 lat) poddawanych operacji MV ze współistniejącym AF. U 18 osób rozpoznano przetrwałe (> 12 miesięcy) AF, a u 2 pacjentów napadowe AF. Czas trwania AF przed operacją wynosił śr. 9,5 roku, wymiar lewego przedsionka (LA) — śr. 5,2 cm, a frakcja wyrzutowa lewej komory (LVEF) — śr. 49%. U wszystkich pacjentów wykonano ablację Ex-Maze III na bijącym sercu, bezpośrednio przed operacją MV. U 17 chorych wymieniono MV, a u 3 osób przeprowadzono plastykę MV. Pacjenci byli poddawani badaniom kontrolnym po upływie 1, 3, 6 i 12 miesięcy po operacji. Podczas wizyt kontrolnych wykonywano spoczynkowe badanie EKG, a po 12 miesiącach — 24-godzinne EKG metodą Holtera.

Wyniki: W badanej grupie nie stwierdzono poważnych powikłań zabiegu. U wszystkich pacjentów we wczesnym przebiegu pooperacyjnym występowało AF, które umiarowiono, stosując kardiowersję elektryczną (4 chorych) lub farmakologiczną (16 chorych). W rytmie zatokowym pozostawało 15 (75%) pacjentów po 1 miesiącu, 16 (80%) — po 3 miesiącach, 17 (85%) osób — po 6 i 12 miesiącach od operacji.

Wnioski: Metoda ablacji Ex-Maze III na bijącym sercu jest skuteczna i bezpieczna u pacjentów z przetrwałym AF poddawanych zabiegowi chirurgicznemu na MV. W celu pełnej oceny skuteczności metody konieczne jest przeprowadzenie wielośrodkowego prospektywnego badania randomizowanego.

Słowa kluczowe: migotanie przedsionków, ablacja, Ex-Maze III

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