Efficacy of an additional MAZE procedure using cooled-tip radiofrequency ablation in patients with chronic atrial fibrillation and mitral valve disease

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Aims This study is the first prospective randomized trial evaluating the efficacy of an antiarrhythmic surgical procedure in patients with chronic atrial fibrillation undergoing mitral valve replacement.

Methods and Results Thirty consecutive patients with chronic atrial fibrillation undergoing mitral valve replacement were randomized for an additional modified MAZE-operation using intra-operatively cooled-tip radiofrequency ablation (group A) or mitral valve replacement alone (group B). Biatrial contraction was studied and functional capacity was evaluated in spiro-ergometry 6 months after surgery. Thirty-day mortality was 0% in both groups. After 12 months, sinus rhythm was reinstituted significantly more often in patients of group A (cumulative rate of sinus rhythm 0.800) compared to patients in group B (0.267) (P<0.01). 66.7% of patients in sinus rhythm of group A had documented biatrial contraction. Electrocardioversion showed long-term success in only 17% of patients in group A and 0% in group B. Maximal aerobic uptake at the 6-month spiro-ergometry revealed no significant difference (9.3 vs 8.5 ml . min⁻¹ kg⁻¹, P=0.530).

Conclusions A modified MAZE operation using cooled-tip radiofrequency ablation can be safely combined with mitral valve surgery and is highly effective in restoring sinus rhythm. Biatrial contraction is found in 66.7% of patients with sinus rhythm undergoing mitral valve replacement plus the MAZE operation.

Key Words: MAZE surgery, cooled-tip radiofrequency ablation, sinus rhythm, atrial fibrillation, biatrial contraction, functional results

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Introduction

Atrial fibrillation as the most common arrhythmia has a prevalence of 0.4% which increases to 9% in patients aged 80 years and older¹,². In patients undergoing mitral valve surgery the prevalence of atrial fibrillation is reported to be as high as 80%³. Therapeutic strategies (pharmacological, catheter ablation, antiarrhythmic surgery) for atrial fibrillation aim to diminish uncomfortable symptoms, such as tachycardias and palpitations, by restoring sinus rhythm, improving haemodynamics, reinstituting atrioventricular synchrony and reducing thromboembolic risk by reproducing biatrial contraction⁴–⁹.

The MAZE operation, as an open heart surgical procedure, was introduced by James L. Cox in 1987 as a 'cut-and-suture' technique, a technique based on a multiple wavelet theory, which proposes that different depolarizing wave-fronts circle the atria. MAZE incisions should reduce the atrial mass below the critical reentry circuit size, so preventing atrial fibrillation⁴–⁷,¹⁰.

MAZE surgery has been proven to be highly effective in restoring sinus rhythm. In patients with concomitant mitral valve disease, sinus rhythm can be restored in
80% to 90%. In patients with lone atrial fibrillation, 93% of the patients may be converted to sinus rhythm without additional antiarrhythmic drug therapy. Atrial transport function, as demonstrated by Doppler echocardiography, can be restored in 70% to 100% of these patients[4–7,11,12]. Also, there seems to be a significant improvement in health-related quality of life in patients in whom the MAZE operation has been performed for paroxysmal or chronic atrial fibrillation as the indication[13].

The major drawbacks of these studies are inhomogeneity of patients (patients with and without structural heart disease, chronic and intermittent atrial fibrillation), diversity and modification of surgical methods (cut and suture, cryoablation, radiofrequency ablation) leading to data which is hard to reproduce.

We developed the first randomized, prospective trial so far to evaluate the effectiveness of intra-operative radiofrequency cooled tip ablation in a modified MAZE procedure during mitral valve surgery. In a randomized fashion we evaluated the efficacy and functional outcome of patients undergoing a modified MAZE procedure, in addition to mitral valve replacement, in patients with chronic atrial fibrillation and mitral valve disease. Is there a rationale for the addition of antiarrhythmic surgery in patients undergoing open heart surgery?

**Methods**

The primary end-point of this study was sinus rhythm at postoperative follow-up. Secondary end-points were defined as clinical outcome, survival, atrial transport function and functional capacity at follow-up.

**Patients**

Between February 1998 and October 1999, 30 consecutive patients (of all 49 patients with mitral valve replacement alone) in whom mitral valve replacement and chronic atrial fibrillation were indicated (permanent atrial fibrillation for 1 year or at least two non-successful medical or electrical cardioversions 6 months before surgery) were included in the Clinic for Cardio-Thoracic Surgery at the University Hospital Bergmannsheil Bochum, Germany. Of the 30 patients, nine were male (30%) and 21 female (70%) with a mean age of 68 years (range 49 to 77 years). The primary indication for mitral valve replacement was mitral valve regurgitation in 18 patients, mitral valve stenosis in five patients and combined mitral valve disease in seven patients. The mean duration of permanent atrial fibrillation before surgery was 3.1 years (range between 1 to 30 years). The underlying heart disease was degenerative in 14, documented mitral valve prolapse in one patient, rheumatic heart disease in five, and unknown in 10.

After informed consent was obtained in all patients, they were consecutively randomized to undergo either mitral valve surgery and antiarrhythmic surgery (modified MAZE operation) (group A) or mitral valve surgery without antiarrhythmic surgical intervention (group B).

**Surgical procedure**

All patients received prosthetic mitral valve replacement and in patients randomized to group A an additional modified MAZE operation was performed using intra-operative cooled-tip radiofrequency ablation as previously described by Sie et al. (manuscript in preparation). The MAZE procedure includes biatrial appendectomy, right atrial radiofrequency ablation of the isthmus, intercaval and appendage–tricuspid anulus lines, left atrial isolation of each pulmonary vein ostium and interconnection lines, and a line connecting the mitral valve anulus and left atrial appendage by radiofrequency ablation (modification by Khargi et al., in press) (see Fig. 1). Compared to the original Cox MAZE-III procedure, the right atrial suture lines have been changed to ablation lines (except the incision to enter the right atrial cavity) and the left atrial lines have been modified as described above (see Fig. 1)[4–6]. As a major modification, ablation lines in the right and left atrium were performed in addition to cut and suture lines to open both atria[14,15].

The duration of the surgical procedure in patients of group A (270 min vs 205 min) and aortic clamp duration (103 min vs 85 min) were longer compared to patients who did not undergo the MAZE procedure.

**Follow-up**

All survivors were followed-up closely at the Department of Cardiology and Angiology of the University Hospital Bergmannsheil Bochum, Germany. Follow-up dates of data acquisition were postoperative day 1, day 12 (before discharge), and at 3, 6, 9 and 12 months after the operation. Antiarrhythmic drug therapy using sotalol (at least 80 mg twice a day) was constituted for 6 months and was then switched to metoprolol (at least 95 mg metoprololsuccinate). All patients received anticoagulant therapy constituting an INR value of 2.5 to 3.5. When patients were in atrial fibrillation at follow-up, electrical cardioversion (direct current shock up to twice 360 Joule and two different defibrillator pedal positions) was performed up to twice during the follow-up period. At each follow-up date a medical and clinical history and an electrocardiogram (ECG) was performed. Holter ECG analysis was performed at the 6 and 12 month follow-up. After 12 days and at 6 and 12 months an additional echocardiographic study (including transmitral and transtricuspidal Doppler) was conducted. Spiro-ergometry (using bicycle ergometry and a ramp protocol with a workload rise of 10 Watts every minute) was performed at the 6 month follow-up (see Table 1).
All data was collected in between February 1998 and October 2000.

**Statistical analysis**

Continuous variables were expressed as mean ± standard deviation (median). Student’s unpaired t-test (two-tailed) was used for comparison between the two groups. Differences were considered significant at a P-value <0.05. A highly significant difference was postulated at a P-value of <0.01. The survival rate and maintenance rate of sinus rhythm were calculated according to the Kaplan–Meier method and groups were compared using the Log rank-test (significant difference postulated at a P-value <0.05).

**Results**

The cardiothoracic surgical procedure was completed in all patients. Patients in group A (n=15) and patients in group B (n=15) did not differ in regard to age, pre-operative duration of atrial fibrillation, left atrial size in echocardiography, and pre-operative left ventricular ejection fraction, as assessed during cardiac ventriculography (see Table 2). The 12-month follow-up was completed in all but two surviving patients from group

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**Figure 1** Schematic view (looking from behind) of the modified MAZE pattern of the left atrium (surgical access via inter-atrial groove): Dots=endocardial RF-ablation lines; LAA=excised left atrial appendage; LSPV=left superior pulmonary vein ostium; LIPV=left inferior pulmonary vein ostium; RSPV=right superior pulmonary vein ostium; RIPV=right inferior pulmonary vein ostium.

**Table 1 Data acquisition during follow-up period (*up to twice)**

<table>
<thead>
<tr>
<th>Post-op follow-up</th>
<th>1 day</th>
<th>12 days</th>
<th>3 months</th>
<th>6 months</th>
<th>9 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Clinical history</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Echocardiography</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Holter-ECG</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardioversion*</td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sotalol therapy</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Metoprolol</td>
<td>+</td>
</tr>
<tr>
<td>Spiro-ergometry</td>
<td></td>
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</tbody>
</table>

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B, who were unable to attend the hospital but had documented (on an outclinic ECG) atrial fibrillation (one patient unable to travel to our hospital, one patient with severe psychosis). Mean postoperative follow-up duration was 22/25 (21) months in group A and 21/26 (20) months (P=0·698).

Cardiac rhythm

At postoperative day 1, eight patients from group A and four patients from group B were in sinus rhythm. The first electric cardioversion was performed before discharge at day 12. In group A, six of the remaining seven patients in atrial fibrillation underwent electric direct current shock cardioversion (successful in three), one patient spontaneously cardioverted. In group B, two patients were electrically cardioverted (not successful).

At the 3-month follow-up, nine patients out of group A and four patients out of group B were in sinus rhythm. In group A, one patient spontaneously converted from atrial fibrillation to sinus rhythm, whereas two patients after previously successful cardioversion converted back to atrial fibrillation. No patient from group B spontaneously converted but two patients were electrically cardioverted without success. At the 6-month follow-up, one patient in group A spontaneously converted to sinus rhythm; this increased to 10 patients. In Group B, 11 patients were in atrial fibrillation and three were cardioverted with two successful conversions to sinus rhythm. After 9 months, nine patients in group A were in sinus rhythm. In group B, one patient previously successfully cardioverted, converted back to atrial fibrillation. This resulted in 10 patients in atrial fibrillation. At the 12-month follow-up in group A, nine patients were in sinus rhythm and two in atrial fibrillation, whereas in group B, 11 were in atrial fibrillation (one patient previously successfully cardioverted, converted back to atrial fibrillation) and three in sinus rhythm (see Fig. 2).

Table 2 Patient characteristics in group A (mitral valve replacement plus modified radiofrequency MAZE procedure) and in group B (mitral valve replacement without modified MAZE procedure)

<table>
<thead>
<tr>
<th></th>
<th>Group A MAZE+ n=15</th>
<th>Group B MAZE− n=15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female vs male</td>
<td>9 vs 6</td>
<td>12 vs 3</td>
</tr>
<tr>
<td>Age (years)</td>
<td>mean (median)</td>
<td>64·7 (63)</td>
</tr>
<tr>
<td></td>
<td>49 to 75</td>
<td>64 to 77</td>
</tr>
<tr>
<td>AF pre-op (years)</td>
<td>mean (median)</td>
<td>3·6 (2)</td>
</tr>
<tr>
<td></td>
<td>1 to 10</td>
<td>3·7 (2)</td>
</tr>
<tr>
<td>LA pre-op (mm)</td>
<td>mean (SD)</td>
<td>59·8 (5·3)</td>
</tr>
<tr>
<td></td>
<td>1 to 10</td>
<td>57·8 (6·4)</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>mean (SD)</td>
<td>64 (11)</td>
</tr>
<tr>
<td></td>
<td>61 (9)</td>
<td>0·595</td>
</tr>
<tr>
<td>Mitral valve insufficiency (n)</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Mitral valve stenosis (n)</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Combination (n)</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

AF=atrial fibrillation; LA=left atrial; LVEF=left ventricular ejection fraction.

Table 3 Cardioversion and conversion to sinus rhythm (SR) in group A (mitral valve replacement plus modified radiofrequency MAZE procedure) and group B (mitral valve replacement without modified MAZE procedure)

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC-shock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate success</td>
<td>50%</td>
<td>33%</td>
</tr>
<tr>
<td>Long-term success</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td>Spontaneous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-op</td>
<td>8 pts</td>
<td>4 pts</td>
</tr>
<tr>
<td>&lt;6 months</td>
<td>3 pts</td>
<td>0 pts</td>
</tr>
</tbody>
</table>

DC-shock=direct current shock electric cardioversion using up to twice 360 Joule and two different defibrillator pedal positions.

In the first 6 months postoperation, six patients in group A were electrically cardioverted with an immediate success rate of 50%, and long-term success of 17%.

Three patients spontaneously converted to sinus rhythm. In group B, seven patients were electrically cardioverted with an immediate success rate of 33%, but long-term success was 0%, with all converted patients reverting back to atrial fibrillation. No spontaneous conversion to sinus rhythm occurred after post-operative day 1 (see Table 3).

All patients in permanent sinus rhythm in group B converted to sinus rhythm spontaneously on the first post-operative day. Twelve months post-surgery, 81·8% of surviving patients in group A and 21·4% of surviving patients in group B were in sinus rhythm.

Cumulative frequencies of sinus rhythm were 0·733 in group A and 0·267 in group B after 6 months and after 12 months, cumulative frequencies of sinus rhythm were 0·800 in group A compared to 0·267 in group B with a significant difference (P=0·005) (see Fig. 3).

Holter–ECG analysis revealed permanent sinus rhythm in all but three patients (two in group A and one
in group B). In these patients short runs of atrial tachycardias were found in less than 10% of the Holtered time interval.

Doppler-echocardiography

Echocardiographic study was performed in all patients available for follow-up. The mean pressure gradient of the prosthetic mitral valve was $5 \pm 2$ (4) mmHg in group A and $4 \pm 1$ (4) mmHg in group B without mitral valve regurgitation in either group ($P=0.812$).

Doppler-echocardiography revealed left atrial contraction (transmitral A-wave) at post-operative day 12 in 5/8 (62.5%) patients in sinus rhythm (group A) and in 4/4 (100%) patients in sinus rhythm in group B. At 6 months follow-up, 7/10 (70%) patients in sinus rhythm (group A) and 4/4 (100%) patients in sinus rhythm (group B) and after 12 months 6/9 (66.7%) patients in sinus rhythm (group A) and 3/3 (100%) patients in sinus rhythm (group B) and after 12 months 6/9 (66.7%) patients in sinus rhythm (group A) and 3/3 (100%) patients in sinus rhythm (group B).
rhythm (group B) demonstrated left atrial contraction. Right atrial contraction (transtricuspid A-wave) was detected in all patients in sinus rhythm in groups A and B (100%) during the complete follow-up period (see Table 4).

**Functional parameters**

Clinical parameters of functional capacity were evaluated at each follow-up but were consistent over the follow-up period from postoperative month 3 onwards. Mean NYHA classification was considered 2·5 (2·5) in group A and 2·6 (3·0) in group B ($P=0·531$) (see Table 4).

Spiro-ergometry was performed at the 6-month follow-up in 11/12 (91·7%) patients in group A and 11/15 (73·3%) patients in group B. In group A, one patient with severe gonarthrosis and in group B, four patients (one severe coxarthrosis, one bronchial carcinoma under chemotherapy unable to attend hospital, one patient with tracheostoma, one patient with severe psychosis unable to attend hospital) were unable to perform the bicycle stress test.

**Spiro-ergometry**

Spiro-ergometry was performed using bicycle ergometry under standardized conditions with a workload increase of 10 Watts per minute. Maximum workload achieved by patients in group A was 73 ± 29 (76) Watts vs 43 ± 16 (38) Watts in group B ($P=0·008$).

Mean resting heart rates were 74 ± 10 (73) beats . min$^{-1}$ (beats . min$^{-1}$) in group A and 68 ± 13 (71) beats . min$^{-1}$ in group B, increasing to 96 ± 16 (94) beats . min$^{-1}$ and 99 ± 17 (96) beats . min$^{-1}$ under maximum workload ($P=0·247$, $P=0·666$).

Mean aerobic capacity or maximal oxygen uptake ($V_{O2max}$) was measured as 9·3 ± 3·2 ml . min$^{-1}$ kg$^{-1}$ in group A and 8·5 ± 3·0 ml . min$^{-1}$ kg$^{-1}$ in group B ($P=0·530$). Anaerobic threshold could be determined in all but two patients from each group and corresponded to an oxygen uptake of $7·2 ± 1·8$ ml . min$^{-1}$ kg$^{-1}$ and $6·4 ± 2·3$ ml . min$^{-1}$ kg$^{-1}$ ($P=0·551$) (see Table 4).

**Pacemaker implantation**

Due to postoperative sinus bradycardia one patient from group A (6·7%) received a permanent DDD pacemaker and one patient in group B (6·7%) postoperatively received a VVI pacemaker due to bradyarrhythmia.

**Survival and complications**

Overall survival at 12 months was 83%, in group A 73% vs 93% in group B ($P=0·131$). One patient from group A died after 40 days due to renal bleeding under standard anticoagulation as performed after prosthetic mitral valve implantation (INR 2·5 to 3·5). One patient died after 45 days from mediastinitis. One sudden cardiac death occurred after 4 months (group A) and one death due to respiratory insufficiency following severe lung fibrosis after 7 months (group A). One patient from group B died of respiratory insufficiency due to severe chronic obstructive bronchial disease 10 months after the surgical procedure (see Fig. 2).

No systemic thromboembolic complications occurred in any of the patients of group A or B during follow-up.

**Discussion**

To our knowledge this is the first prospective, randomized trial evaluating the efficacy and clinical effect of an antiarrhythmic surgical procedure on atrial fibrillation.

The aim of any atrial fibrillation surgery is to diminish uncomfortable symptoms of the arrhythmia by restoring sinus rhythm, to reinstitute atrioventricular synchrony, to regain atrial transport function to improve haemodynamics, and to reduce the risk of thromboembolic complications.
During the duration of this study, 30 consecutive patients with indications for mitral valve surgery alone and chronic atrial fibrillation were included, whereas 19 patients were indicated for mitral valve surgery but had documented sinus rhythm. Sixty-one percent of our pre-mitral valve surgery patients had chronic atrial fibrillation, which is comparable to data published by Melo et al. (80% atrial fibrillation)[3].

The efficacy of the MAZE procedure[11,12] or a modified MAZE procedure using cryoablation[16] or using radiofrequency left atrial ablation[17] in patients with mitral valve disease undergoing mitral valve surgery has already been documented. In our study, the additional MAZE operation was performed using intra-operative cooled-tip radiofrequency ablation and ablation lines different from the proposed Cox-MAZE III procedure. Whereas the right atrial ablation was performed using the scheme used by Sie et al. the left atrial procedure was modified to encircle each single pulmonary vein and to interconnect these lines. The addition of this procedure produced a significantly higher rate of restored sinus rhythm compared to mitral valve replacement alone. At the 1-year follow-up, the rate of sinus rhythm was found to be 80% vs 26-7% in the control group. Reports about rates of sinus rhythm ranking, is in between 60% and up to 90% in patients with mitral valve heart disease, using either the classical MAZE procedure or the modified versions[3,12,17,18]. This indicates that the modified procedure used in our study as is effective as other modified MAZE procedures. In patients with atrial fibrillation as a primary indication for open heart surgery, restoration of sinus rhythm was found to be as high as 100% under antiarrhythmic therapy[19,20]. These data are achieved in patients with only 33% underlying heart disease, in contrast to patients with mitral valve disease.

Sinus rhythm was restored in our study by antiarrhythmic surgery alone in eight patients. Spontaneous conversion to sinus rhythm occurred only during the first 6 months after surgery (three patients). Electric cardioversion using direct current shock was effective in restoring sinus rhythm in 50% of patients who underwent electro-shock, but long-term success was seen in only 17% of all patients. From this experience we decided to wait 6 months post surgery for a spontaneous conversion to sinus rhythm. In patients without spontaneous sinus rhythm, direct current shock cardioversion should be performed after 6 months at least once.

In our series of patients, we found a spontaneous conversion to sinus rhythm after mitral valve surgery alone in 26-7% of the patients. This is equivalent to data published by Handa et al. or Melo et al. who stated that the percentage of patients with sinus rhythm after mitral valve surgery was between 8% and 27%[17,21]. All patients regaining sinus rhythm did so directly after the surgical procedure. No further cardioversions during follow-up were successful in establishing long-term sinus rhythm.

These results are comparable to the data discussed by Sueda et al. and Kawaguchi et al. In these retrospective reports, the outcome of patients after mitral valve surgery, plus modifications of the MAZE procedure, was compared to a carefully selected control group of patients without MAZE surgery. In both studies, results were similar with a rate of sinus rhythm in the MAZE group of 86% to 88% compared to sinus rhythm in only 26-7% to 14% in patients undergoing only mitral valve surgery. No higher rates of mortality were seen due to the additional antiarrhythmic procedure. Sueda et al. have restricted their MAZE approach to the left atrium due to their experience in activation mapping in patients with mitral valve disease and chronic atrial fibrillation, suggesting that the origin of the arrhythmia was in the left atrium. We performed biatrial modified MAZE surgery using radiofrequency ablation, as shown to be effective by the excellent results of Cox et al., in patients with chronic and intermittent atrial fibrillation due to different underlying heart diseases. Our method is a first step in extending its use to patients with atrial fibrillation due to different causes and so with possibly different underlying mechanisms. In a second step, the procedure should be minimized to the least invasive but most effective procedure[19,22,23].

We found no difference in resting or maximum heart rate between the two groups of patients, even though maximum heart rate was quite low in both groups (96 beats · min⁻¹ in the MAZE group and 99 beats · min⁻¹ in group B). This low heart rate may be explained by the use of high-dosed beta-blockers in both groups. Cox modified his initial procedure (MAZE I procedure) — due to the high incidence of sinus node dysfunction under exercise — finally to the MAZE III procedure with only a 25% rate of postoperative sick sinus syndrome. Modifications using cryoablation in some parts of the atra (preserving all patterns of blood supply to the sinus node region) further reduced the risk of iatrogenic sinus node dysfunction and the need for permanent pacemaker implantation to 3-5%[12,19,20]. In the modified strategy used in this study the sinus node region and its blood supply is left in its original state and so far there has been no sinus node dysfunction, except for one patient with postoperative sinus bradycardia receiving a permanent pacemaker (6-7%).

As seen in our study, mitral valve replacement can safely be combined with a modified MAZE operation using a radiofrequency cooled-tip. There was a 30-day mortality of 0%. One death due to complicated mediastinitis, which occurred 6 weeks after the procedure, might be related to the longer than usual operation time (mean of 65 min longer in group A patients). The overall survival rate (83%) at 1 year seems lower than the survival rate reported by Izumoto et al. (95-1%). The survival rate in group A (mitral valve replacement plus MAZE) at 1 year was found to be 73% with no significant difference to group B. This mortality rate includes one death due to renal bleeding (effect of anticoagulation and not MAZE operation related) and one respiratory insufficiency (not MAZE related) with severely impaired pulmonary function pre-operation[11].

After 6 months we switched postoperative sotalol therapy to a standard beta-blocker (metoprolol)
due to one sudden cardiac death possibly related to proarrhythmia.

Patients included in our study had a mean 3-1 year history of chronic permanent atrial fibrillation. Also mean left atrial size was found to be large with a mean of almost 60 mm in the MAZE group, which included a giant left atria. These patient characteristics are two factors predicting poor outcome after antiarrhythmic surgery[12,16,24].

Another goal of antiarrhythmic surgery is to restore the atrial transport function and by this means, on the one hand, reduce the risk of thrombembolism and on the other improve haemodynamics. In our study, biatrial contraction, as detected via the Doppler-flow profile (biphasic transmitral and transtricuspidal flow pattern) was evident in 67% of patients in sinus rhythm 12 months after completed MAZE surgery. Right atrial contraction was found in all patients with restored sinus rhythm (100%). These findings are consistent with findings by Isobe et al. and Kosakai et al. (66-7 to 71% left atrial transport function) but are lower than data collected by Cox et al. in patients with lone atrial fibrillation undergoing a MAZE III procedure (94% left atrial contraction). This difference may be explained by different patient selection: all our patients had concomitant structural heart disease whereas only 33% of the patients operated on by Cox et al. underwent an additional cardiac surgical procedure. Concomitant structural heart disease may involve structural alterations of the atria by left atrial dilation and potentially left atrial myocardial fibrosis and lead to impaired left atrial function even when atrial contraction is restored[13]. On the other hand, transthoracic Doppler studies may not be the most effective method to detect biatrial contraction, and transoesophageal Doppler echocardiography may reveal biatrial systole in a higher percentage of patients.

Melo et al. proposed a so-called Santa Cruz Score to report results of surgery on atrial fibrillation. This score is based on two findings after surgery: (1) the rhythm and (2) haemodynamic activity of the atria. A successful operation is defined as a Santa Cruz Score of 4, meaning sinus rhythm and biatrial contraction. In our study in the MAZE group, 54-5% of patients (6/11) scored a 4, 27-3% a 2 (3/11) meaning absence of atrial fibrillation but only right atrial transport and 18-2% of patients (2/11) scored a 0, indicating atrial fibrillation 12 months postoperatively. These data are consistent with the data published by Melo et al. after mitral valve surgery and concomitant modified MAZE surgery[3].

A secondary objective of our study was to determine the effect of the MAZE surgery on clinical and functional results. Even though there was a significantly higher maximum workload during spiro-ergometry after 6 months in group A patients we found no significant differences concerning NYHA class, maximum oxygen uptake and measures at the anaerobic threshold reflecting degrees of cardiac disability. There seems to be a tendency towards a higher functional capacity in those patients who underwent additional antiarrhythmic surgery but the study was not designed to elaborate these differences.

In our study most patients had an aerobic threshold related to a moderate to severe functional impairment, resulting in a depressed cardiac ability to perform exercise[23].

It has been recently shown that the MAZE operation significantly improves health-related quality of life in patients undergoing surgery for paroxysmal and chronic atrial fibrillation[15]. In our study a successful MAZE surgery produced a tendency towards improved functional capacity when compared to patients after mitral valve replacement without antiarrhythmic surgery.

Our study is limited by the small number of patients analysed which has decreased over follow-up duration. The trend of our data is consistent with data obtained in larger patient collectives. Further development in ablative techniques (epicardial approach, radiofrequency ablation) and surgical skill will improve outcome and make the MAZE procedure a more widely used therapy.

Conclusions

1. Mitral valve surgery can safely be combined with a modified MAZE procedure using intraoperative cooled-tip radiofrequency ablation catheters. Postoperative bradycardia with the need for permanent pacemaker implantation is rare.

2. An additional MAZE procedure using cooled-tip radiofrequency ablation significantly more often restores sinus rhythm in patients with chronic atrial fibrillation compared to patients undergoing mitral valve surgery alone. Sinus rhythm is usually restored within the first 6 months after surgery and direct current shock cardioversion has only a slight effect on rates of sinus rhythm.

3. Complete success, determined by a biatrial transport function in Doppler-echocardiographic evaluation, is found in about 67% of patients with sinus rhythm after a combined procedure.

4. The MAZE procedure, in combination with mitral valve replacement, produced a tendency towards better functional performance on exercise tests or clinical evaluation in our small number of patients.

Therefore long-term follow-up studies, including more patients comparing functional capacities of patients undergoing the MAZE operation using radiofrequency ablative techniques, have to be performed before this therapy can be universally recommended.

References


