Effects of the Maze Operation on Health-Related Quality of Life in Patients With Atrial Fibrillation

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Background—Maze surgery for atrial fibrillation (AF) is a curative therapy, but its effect on health-related quality of life has not been studied.

Methods and Results—Maze operations were performed in 48 patients with drug-refractory AF. The majority of patients (80%) had lone AF, and the primary indication for surgery in all patients was AF. The SF-36 Health Survey was used to assess quality of life before operation and at 6 months and 1 year after surgery. Twenty-five patients were available for the 1-year follow-up and completed all questionnaires. Before maze surgery, the SF-36 scores were significantly lower than in the general Swedish population, reflecting significant impairment in well-being, physical and social functioning, and mental health. After maze surgery, the quality of life was significantly improved at 6 months and at 1 year on all scales except for bodily pain, which, however, was not significantly decreased before surgery. At both 6 months and 1 year after maze surgery, quality of life, measured by the SF-36, reached the levels of the general Swedish population.

Conclusions—The maze operation can significantly improve the health-related quality of life in selected groups of patients with both paroxysmal and chronic AF refractory to antiarrhythmic therapy. (Circulation. 2000;101:2607-2611.)

Key Words: maze operation • fibrillation • quality of life

Atrial fibrillation (AF) is the most common sustained arrhythmia, with an overall prevalence of 0.4%. Its prevalence increases with age, being 9% in patients >80 years old. In addition to such symptoms as palpitation and dizziness, AF is associated with a 2-fold increase in cardiac mortality and, in the absence of adequate anticoagulation therapy, with a 5-fold increased risk of stroke. Paroxysmal AF is associated with a lower risk of stroke and mortality but represents a frequent and costly healthcare problem with significant morbidity. Episodes of paroxysmal AF are frequently difficult to prevent with medical antiarrhythmic therapy, either because of inadequate effect or intolerable side effects. Efforts have therefore been made to find nonpharmacological treatment modalities. Although a variety of surgical methods have been developed to alleviate or control the symptoms of AF, only the maze operation has the ability to cure AF. The maze operation, developed by Cox and coworkers in 1987, ameliorates AF in the vast majority of patients, restores AV synchrony and atrial transport function, and thereby eliminates the risk of thromboembolism. The theory behind the operation is that multiple depolarizing reentrant circuits are active during the arrhythmia and that reduction of the atrial mass between the incisions below the critical reentry circuit size will prevent AF. Concern has been raised, however, about performing such an extensive and complicated procedure for a disorder, such as AF, with a low mortality risk. Therefore, the maze operation has until now been performed primarily in combination with other heart surgery and in patients with chronic AF. However, because of the significant morbidity in many patients with paroxysmal or permanent AF and the lack of other curative nonpharmacological therapies, we decided to perform the maze operation in a group of patients with mostly lone AF. AF was the primary indication for surgery in all patients. The aim of this prospective study was to measure quality of life before surgery as well as 6 and 12 months after surgery in patients undergoing the maze procedure to evaluate the benefit of this treatment.

Methods

Patients
Between February 1996 and January 1999, 49 patients underwent the maze III operation at the University Hospital of Uppsala, Sweden. The primary indication for surgery in all 49 patients was AF with intolerable symptoms. Of the 49 patients included, 39 were men (80%) and 10 women (20%), with a mean age of 52 years (range, 27 to 72 years). Included in the study population were 1 patient with paroxysmal atrial flutter and another 3 with both paroxysmal atrial flutter and AF. All 4 patients with atrial flutter had been treated unsuccessfully with catheter ablation. The remaining 45 patients had AF only, which was paroxysmal in 18 (37%), persistent in 11 (22%),
and permanent (chronic) in 20 (41%). The mean duration of paroxysmal or persistent AF/atrial flutter before the operation was 8.0 years, and that of permanent AF/atrial flutter was 8.9 years.

Concomitant diseases were hypertension (n=6), ischemic heart disease (n=4), stroke (n=4), valvular disease (n=2), hypertrophic cardiomyopathy (n=2), congestive heart failure (CHF, n=1), and sinus bradycardia requiring a permanent pacemaker (n=1). After extensive evaluation, it was concluded that 39 patients had lone AF.

All patients had failed to respond to extensive antiarrhythmic medical therapy. They had tried a mean of 5±1.4 (SD) antiarrhythmic drugs, which had failed to control the arrhythmia or had had to be withdrawn because of intolerable side effects. This included treatment with amiodarone in 30 patients (61%).

Patients with significantly increased risk of surgical complications, such as severely depressed left ventricular ejection fraction and chronic obstructive lung disease, were not referred for surgery.

One patient did not complete the quality-of-life questionnaire at baseline, so the baseline measurements are based on the remaining 48 patients.

Definitions
Paroxysmal AF was defined as an episode of AF that spontaneously converted to sinus rhythm within 48 hours. Persistent AF was defined as AF that did not revert to sinus rhythm within 48 hours and generally needed DC energy for conversion to sinus rhythm. Permanent or chronic AF was defined as AF that could not be converted to sinus rhythm.

Surgical Procedure
All patients underwent the standard maze III operation described by Cox et al.7 Seven patients underwent concomitant surgical procedures in addition to the maze procedure: coronary artery bypass graft (n=3), patch closure for the secundum atrial septal defect (n=1), septic myectomy (n=1), and tricuspid valvuloplasty (n=1). Except for the hypertrophic cardiomyopathy, all these cardiac diseases were unknown before the preoperative investigation. The cardiopulmonary bypass time averaged 177 minutes (range, 98 to 280 minutes), and the aortic cross-clamping time averaged 70 minutes (range, 39 to 134 minutes).

Quality-of-Life Measurements
Quality of life was assessed with a self-administered questionnaire handed out by a research nurse before the maze operation and 6 months and 1 year after surgery. The Swedish SF-36 Health Survey was used.9 This questionnaire was produced within the framework of the International Quality of Life Assessment (IQOLA) project to match the original US Medical Outcomes Study Short-Form Health (SF-36) Survey Manual and Interpretation Guide.10 The SF-36 Health Survey is a generic instrument that is validated,11 covers a broad range of quality-of-life dimensions, and has been widely used in quality-of-life studies. Furthermore, normative data for the Swedish population have been published.12 The health questionnaire measures 8 variables: physical functioning, role limitations owing to physical problems, role limitations owing to emotional problems, social functioning, mental health, general health perceptions, vitality, and bodily pain. Scores were transformed into a scale ranging from 0 to 100, with a higher score representing better quality of life. Missing data (0.7% at baseline, 0.4% at 6 months, 0.0% at 1 year) were handled as suggested by the developers of the SF-36. They suggest that ≥50% of all questions related to a specific item must be answered to calculate a scale score for that item. If questions are left out but >50% of the item-specific questions are answered, the total of the scores from the answered questions are divided by the number of answered questions. Considering the small amount of missing data in this study, we are convinced that it does not influence the result.

Follow-Up
At this time, 37 patients have reached the 6-month follow-up. Three of these patients, however, were lost to follow-up with regard to quality of life because they are not Swedish citizens. Another 4 patients failed to return ≥1 of the questionnaires and were excluded from this study. After the initial 6 months, no additional patients were lost to follow-up. Follow-up at 6 months with regard to quality of life is therefore based on the remaining 30 patients (81%). For 25 of these 30 patients, 1-year data are also available.

Statistical Analysis
Student’s paired and unpaired t tests (2-tailed) were used for comparison between the groups. Differences were considered significant at P<0.05. Unless otherwise specified, results are expressed as mean±1 SD.

Results
The maze III operation was completed in all patients. Sinus rhythm was restored and maintained without antiarrhythmic medication in 30 patients (100%) had AV synchrony after surgery. Complications were seen in 12 patients: sinus node dysfunction requiring temporary pacemaker treatment (n=3), sick-sinus syndrome requiring a permanent pacemaker (n=2), postoperative bleeding requiring reoperation (n=2), pericardial effusion (n=2), perioperative retinal arterial emboli (n=1), perioperative myocardial infarction (n=1), and recurrent pleural effusion (n=1). There were no perioperative deaths.

Quality of Life
Quality of life before surgery was markedly and significantly lower on all scales, except for bodily pain, than for the age-matched general Swedish population (see Figure 1). The lowest scores were obtained for role limitation owing to physical problems (24.5±36.7) and vitality (42.6±20.2). Patients with permanent AF tended to have lower scores on the physical axis than the group of patients with paroxysmal or persistent AF, reaching statistical significance for physical functioning (Table 1).

The SF-36 scores obtained at 6 months after MAZE surgery were compared with the preoperative scores for the same population (Table 2). All scores improved significantly except for bodily pain. Bodily pain, however, was the only score that did not differ from the values for the age-matched general Swedish population before maze surgery. The most marked improvements from before to 6 months after the operation were observed for role limitation owing to physical problems (17.2 versus 69.0), vitality (41.0 versus 74.2), and role limitation owing to emotional problems (36.8 versus 88.9).

The improvements in quality of life were maintained 1 year after the maze operation, with no significant changes between 6 months and 1 year after the maze operation (Table 2). The quality-of-life measurements obtained at 1 year after surgery reached normal values and did not differ significantly from the values for the age-matched general Swedish population (Figure 2).

Discussion
To the best of our knowledge, this is the first study to measure the effect of the maze operation on perceived health-related quality of life. Previous studies regarding maze surgery have
focused primarily on mortality, morbidity, the need for pacemaker implantation, and whether atrial contractions return after the operation. The maze operation is generally used in combination with mitral valve surgery or other open-heart surgery if permanent AF is present. The role of maze surgery as therapy for lone AF or paroxysmal AF is thus less clear. To the best of our knowledge, Cox et al are the only group to have presented a fairly large group of patients who underwent maze surgery with AF as the primary indication for surgery. However, the results of the operation in these patients were not presented separately. To evaluate the maze procedure as a primary indication for surgery in AF patients, objective measurements of the impact on the quality of patient’s lives are needed.

The present study was therefore designed to measure what effect an extensive but curative treatment like the maze operation has on quality of life. The use of the SF-36 questionnaire permitted a comparison to be made with published information from the general Swedish population regarding quality of life. In the present study, improvements in quality of life after surgery were remarkable. All scores were significantly improved except for bodily pain, which, however, was already normal before surgery. The quality-of-life measurements 6 months and 1 year after the maze operation reached the levels for the aged-matched general Swedish population.

Our study of the maze operation is difficult to compare with studies of other therapies for drug-refractory AF, such as His-bundle ablation, because different quality-of-life instruments have been used and comparison with the general population has rarely been made. Bubien et al published a study of 159 patients evaluating quality of life with the SF-36 instrument at baseline and after catheter ablation for various supraventricular arrhythmias. That study included 22 patients with AF treated with His-bundle ablation. The patients improved on all dimensions of quality of life after His-bundle ablation, but reported values were far from those of the general population and much lower than in our patients.

### TABLE 1. Preoperative Health-Related Quality of Life in Different Subgroups of AF

<table>
<thead>
<tr>
<th>SF-36 Variable</th>
<th>Paroxysmal/Persistent AF (n=30)</th>
<th>Permanent AF (n=18)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>66.0±26.1</td>
<td>52.3±17.0</td>
<td>0.05</td>
</tr>
<tr>
<td>Role limitation, physical</td>
<td>29.3±39.6</td>
<td>18.4±31.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>68.8±31.6</td>
<td>72.4±25.8</td>
<td>0.7</td>
</tr>
<tr>
<td>General health</td>
<td>54.6±17.8</td>
<td>52.3±18.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Vitality</td>
<td>47.0±21.5</td>
<td>36.1±15.9</td>
<td>0.06</td>
</tr>
<tr>
<td>Social functioning</td>
<td>63.1±25.1</td>
<td>64.1±20.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Role limitation, emotional</td>
<td>51.7±43.3</td>
<td>57.4±44.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Mental health</td>
<td>69.7±19.3</td>
<td>70.5±14.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Values are mean±SD.
However, the results are not directly comparable, because a part of this difference is probably due to higher comorbidity in the population studied by Bubien et al. A good comparison with other nonpharmacological therapies is not possible, because few authors have used the same quality-of-life instrument. Studies published so far all used quality-of-life measurements to show improvements in quality of life achieved for a particular therapy rather than as a way of comparing different treatment modalities. We chose the SF-36 instrument because it is well validated, scores for the general population have been published, and an increasing number of researchers are using this instrument.

Randomized, prospective studies comparing various nonpharmacological therapies for AF with regard to mortality, morbidity, freedom from AF, and quality of life are needed in the future.

The quality of life in our study population at baseline was markedly lower than in the general population. Poor quality of life was found not only on scores relating to physical functioning but also on such items as social functioning and mental health. Our patients reported a poorer quality of life than patients in the Medical Outcome Study, which included patients with serious cardiac conditions, such as CHF, reporting edema, orthopnea, or dyspnea on exertion; hypertensive patients with severe CHF symptoms and/or a history of stroke; survivors of myocardial infarction with severe angina and/or severe symptoms of CHF; and diabetic patients with secondary manifestations of the disease.

The quality of life in a nonselected patient population with AF has not been evaluated. Three studies have evaluated the impact of AF on quality of life using validated instruments, but the patient populations were small and highly select-

### Table 2. Health-Related Quality of Life Before and at 6 Months and 1 Year After the Maze Operation

<table>
<thead>
<tr>
<th>SF-36 Variable</th>
<th>Baseline (n=30)</th>
<th>6-Mo Follow-Up (n=30)</th>
<th>P*</th>
<th>1-Yr Follow-Up (n=25)</th>
<th>P†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>56.8±25.5</td>
<td>83.3±23.0</td>
<td>&lt;0.001</td>
<td>91.0±11.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Role limitation, physical</td>
<td>17.2±33.5</td>
<td>69.0±43.1</td>
<td>&lt;0.001</td>
<td>85.0±33.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>70.2±29.8</td>
<td>82.7±26.3</td>
<td>0.07</td>
<td>83.0±25.6</td>
<td>0.09</td>
</tr>
<tr>
<td>General health</td>
<td>56.1±15.6</td>
<td>76.7±21.1</td>
<td>0.001</td>
<td>84.0±19.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Vitality</td>
<td>41.0±19.1</td>
<td>74.2±20.0</td>
<td>&lt;0.001</td>
<td>81.0±17.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Social functioning</td>
<td>58.5±24.4</td>
<td>87.2±21.0</td>
<td>&lt;0.001</td>
<td>92.0±17.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Role limitation, emotional</td>
<td>36.8±42.9</td>
<td>88.9±28.1</td>
<td>0.001</td>
<td>87.0±32.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mental health</td>
<td>64.8±18.3</td>
<td>78.3±20.0</td>
<td>0.008</td>
<td>86.0±17.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are mean±SD.

*SF-36 scores at 6-month follow-up vs baseline.
†SF-36 scores at 1-year follow-up vs baseline.

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**Figure 2.** Comparison of quality of life 1 year after maze surgery (n=25, ◆) with that of general Swedish population assessed by SF-36 (mean, ▲). Error bars show 95% CI. Abbreviations as in Figure 1.
ed.\textsuperscript{14,17,18} Only the study by Bubien et al evaluated quality of life with the SF-36 health survey.\textsuperscript{15} In that study, the 22 patients with AF had very poor quality of life at baseline, and overall, they reported lower values at baseline than the patients in our study. Possible explanations include the higher average age and the higher comorbidity already mentioned. Two large, ongoing trials will evaluate quality of life in patients with AF by use of validated and standardized instruments.\textsuperscript{19,20}

There are several limitations of the present study that must be recognized. First, this is a selected group of patients with symptomatic, drug-refractory AF willing to undergo a new therapy for AF with the potential for significant complications. This patient selection probably accounts for the low quality of life measured at baseline.

Second, there is no placebo group in this study. A significant placebo effect of the surgical intervention is unlikely, because the quality of life at 1 year was essentially the same as that at 6 months.

Conclusions

Patients with drug-refractory AF who are treated with the maze operation report significant improvement in physical, mental, and social indexes of their quality of life after the procedure. The quality of life measured 6 months after the maze operation does not differ significantly from that of the age-matched general Swedish population. These improvements measured at 6 months after surgery are maintained at 1-year follow-up. This study indicates that the maze operation can be used in selected patients with drug-refractory paroxysmal or permanent AF as a primary indication for heart surgery. However, further studies are needed to provide the best choice of nonpharmacological therapy in the individual patient.

Acknowledgment

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