Surgical treatment of atrial fibrillation using radiofrequency ablation
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Concomitant anti-arrhythmic procedures to treat permanent atrial fibrillation in CABG and AVR patients are as effective as in mitral valve patients\textsuperscript{11, 12}

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Abstract

Background: concomitant anti-arrhythmic procedures, to treat permanent atrial fibrillation, are not routinely performed in non-mitral valve surgery, such as coronary artery bypass grafting (CABG) and aortic valve (AVR) procedures. This study evaluated the sinus rhythm (SR) conversion rate of a concomitant anti-arrhythmia procedure in non-mitral valve surgery compared to mitral valve surgery.

Methods: Between 1997 and 2003, 128 patients with a documented permanent atrial fibrillation had a concomitant anti-arrhythmic procedure using unipolar endocardial radiofrequency ablation; 65 mitral valve surgery (group I) and 63 aortic valve surgery or CABG (group II). Follow-up was complete and included standard ECG and echocardiogram at 3, 6, 12 months and each consecutive year. Stability of SR was confirmed with a 24-hour ECG registration. Results: Type of procedures was MVR 42 (32.8%), MVP 23 (18.0%), CABG 40 (31.2), AVR 21 (16.4%), other 2 (1.6%). Thirty-day mortality for group I and II were 4.6% (3/65) and 3.2% (2/63). Group II patient were distinctly older (69.3 versus 64.8 years; p=0.04), but the size of the left atrium was smaller (45.9 versus 52.4 millimeters; p=0.0001) and the aortic cross clamp time was shorter (91 versus 99 minutes; p=0.05). The cumulative postoperative SR percentages for the group I and II patients at 12 months were 71% versus 79%. A bi-atrial contraction was observed in 65.6% (21/32) and 68.3% (28/41) of the group I and II patients, who had a stable SR. The mean (SD) follow-up for group I and II was 24.4 (19.4) and 21.0 (17.2) months. The cumulative survival rate at 1, 2 and 3 years for group I and II were 85% versus 88%, 83% versus 85%, 79% versus 85% (log rank test p=0.60). Conclusion: A concomitant ant arrhythmic procedure in CABG and AVR patients is as effective as in mitral valve patients, although these patients tend to be older, but with a smaller left atrial size.

1. Introduction

Anti-arrhythmic surgery to treat atrial fibrillation (AF) is predominantly combined with mitral valve surgery. The advent of alternative sources of energy, such radiofrequency ablation, facilitated the surgical technique to perform a concomitant anti-arrhythmic procedure (1). We used the saline irrigated cooled tip monopolar radiofrequency ablation (SICTRA), which was applied endocardially, to create linear lesions in order to abolish AF. Our results in mitral valve surgery patients were encouraging with a sinus rhythm rate of 76-80% at 12 months follow-up (2;3). Therefore, we extended our indication to non-mitral valve diseased patients such as AVR and CABG procedures. However, the atria in this subset of patients had to be opened intentionally to perform the various intra-atrial lesions. Whether an extension of the operative procedure to treat AF, in this subset of patients, was justified will eventually be determined by the induced additional morbidity and mortality, balanced against the success of the obtained sinus rhythm (SR) conversion rate. The aim of this study was to assess the efficacy of concomitant anti-arrhythmic surgery, using SICTRA, in non-mitral valve patients compared to mitral valve patients.

2. Patients and Methods

2.1. Methods

This study was approved by the local ethical committee at the Bergmannsheil University Hospital Bochum. Between April 1997 and December 2003, 128 patients with a documented permanent atrial fibrillation had a concomitant anti-arrhythmic procedure using monopolar endocardial radiofrequency ablation. Patients who had combined valves with or without CABG procedures or those who experienced

14 Keywords: atrial fibrillation, radiofrequency, maze, electrophysiology, valve surgery.
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Cumulative SR rate
Mitral (n=65) versus non-mitral (n=63)
Permanent AF

Cumulative survival rate
Mitral (n=65) versus non-mitral (n=63)
Permanent AF

Cumulative survival rate
Postoperative SR (n=87) versus AF (n=41)
Preoperative permanent AF

Cumulative survival rate
SR (n=74) versus AF (n=30)
Minimum 3 month Follow-up; Permanent AF

Figure 1.

Figure 2.

Figure 3.

Figure 4.
Table 7.1 Patients' characteristics

<table>
<thead>
<tr>
<th></th>
<th>Mitral (Group I, n=65)</th>
<th>Non-mitral (Group II, n=63)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.8</td>
<td>9.6</td>
<td>69.3</td>
</tr>
<tr>
<td>LA (millimeters)</td>
<td>52.4</td>
<td>9.7</td>
<td>45.9</td>
</tr>
<tr>
<td>Duration of AF (months)</td>
<td>60.1</td>
<td>49</td>
<td>68</td>
</tr>
<tr>
<td>Ao-X (minutes)</td>
<td>99</td>
<td>27</td>
<td>91</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>61</td>
<td>12</td>
<td>56</td>
</tr>
<tr>
<td>Euroscore</td>
<td>6.2</td>
<td>2.9</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Legends: AF = Atrial fibrillation; LA = Left atrial diameter; Ao-X = Aortic cross clamp time; LVEF = left ventricular ejection fraction.

preoperative haemodynamic instability were excluded from this study. The patients' characteristics are shown in table 1. Informed consent was obtained from each patient. The definition of permanent AF was in accordance with the guidelines the AHA/ESC. Each patient had a preoperative standard- and extended ECG registration. If, on the ECG, an episode of saw-tooth atrial wave pattern or an episode of regularity was observed, then a bi-atrial lesion pattern was conducted to abolish a possible right atrial flutter. Otherwise, only a left atrial lesion pattern was performed. A preoperative transthoracic echocardiography was performed, on admission to our department. The left ventricular ejection fraction (LVEF) was determined and the size of the left atrium was measured in the parasternal long axis view with M-mode. Our operative technique, including the creation of the ablation lines, has been previously described in detail (2;3).

2.2. Postoperative Care

The patients were kept on AAI or DDD pacing if the heart rate was below 75 beats per minute during the first 7 postoperative days. The first 28 patients received metoprolol 40 mg twice a day on the 1st postoperative day (pod), 80 mg twice a day on the 2nd and 160 mg twice a day after the 7th pod. This medication protocol was changed after the 28th patient, because 2 patients experienced a sudden cardiac death during late follow-up. We changed to metoprolol 47.5 mg per day starting on the 1st pod. The dose was increased to 95 mg retard per day on the 3rd postoperative day and eventually to 190 mg per day if no Brady arrhythmia was noticed. The first 50 patients had a cardioversion at the 12th pod and the 3rd postoperative month. But this strategy was abandoned, because no beneficial effect, in our opinion, was noticed. Therefore, no cardioversion was performed before the 6th postoperative month in the last 74 patients. If the patient remained in AF after the 6th postoperative month than one cardioversion with 240 to 360 Joule was performed. All patients received coumadine, starting on the 1st pod, targeting an INR value around 2.2 for solitary CABG patients and 2.8 to 3.5 for valve patients. Coumadine was continued for at least 6 months and was stopped if a stable SR was documented on a 24-hour Holter ECG and if an atrial contraction was visualized on echo Doppler examination.

2.3. Follow-up

Primary rhythm endpoint was a stable SR, defined as 95-100% SR on a 24-hour Holter registration. Secondary endpoint was atrial contraction, visualized as an A-wave on an echo Doppler parasternal long axis image using M mode or on a four chamber apical view.

Data acquisition was obtained for each patient on the 1st pod, 12th pod (pre-discharge) and after the 3rd, 6th, 9th, 12th month and after each consecutive year. The medical history, clinical examination and an electrocardiogram (ECG) were obtained at each visit. A 24-hour Holter registration was performed
to assess the SR stability. A transthoracic echo Doppler cardiography, as previously mentioned, was obtained on the 3rd, 6th and 12th month and after each consecutive year. Primary endpoint for follow-up was death or last patients' visit. Secondary endpoints were postoperative complications including a temporary respiratory insufficiency, low cardiac output, myocardial infarct, cerebral event, wound infection, rethoracotomy, and sternal dehiscence. Survival information was complete.

2.4. Statistic analysis
Continuous variables with a normal distribution were compared with the student's t-test. The binary logistic regression was used to assess predictors of postoperative SR. Categorical data comparisons were made with the Fisher exact test. The cumulative survival- and the postoperative sinus rhythm rates were calculated according to the Kaplan-Meier method. Descriptive statistics were expressed as means +/- SD. Differences were calculated with the log-rank test. P values <0.05 were considered significant. The SPSS 11.5 for Windows statistic software program was used for analysis.

3. Results
Group I consisted of 65 mitral valve surgery patients and group II of 63 aortic valve surgery or CAGB patients. Types of procedures were MVR 42 (32.8%), MVP 23 (18.0%), CAGB 40 (31.2), AVR 21 (16.4%), other 2 (1.6%). Postoperative complications for group I and II are shown in table 2. Thirty-day mortality for group I and II were 4.6% (3/65) and 3.2% (2/63). The cause of death in group I was a pulmonary embolus, a pancreatitis, and an atrioventricular dehiscence. The cause of death in group II was a cerebral vascular event and a low cardiac output. The cumulative postoperative SR percentages for the group I and II patients at 12 months were 71% versus 79%. An echo Doppler examination focusing on the atrial contraction was available in 76.1% (32/42) group I and in 91.1% (41/45) of the group II patients, who had a stable SR. In group I a bi-atrial contraction was observed in 65.6% (21/32), a solitary right atrial contraction in 12.5% (4/32) and no atrial contraction in 21.9% (7/32). For the group II patients these figures were 68.3% (28/41), 14.6% (6/41) and 17.1% (7/41). The mean (SD) follow-up for group I and II was 24.4 (19.4) and 21.0 (17.2) months. The cumulative survival rate at 1, 2 and 3 years for group I and II were 85% versus 88%, 83% versus 85%, 79% versus 85%. The estimated mean (SE) survival for group I and II were 59.1 (3.6) and 50.1 (2.6) months. Table 3 shows the patients' characteristics for patients who converted into SR and those who remained in AF. No relationship between the postoperative SR conversion rate and the performed lesion pattern (Fischer exact test p=0.517) or type of surgery (p=0.262) was observed. A relationship between SR and death was inconsistent (Fisher exact test one sided 0.037, two sided 0.060).

### Table 7.2 Non-fatal postoperative complications

<table>
<thead>
<tr>
<th></th>
<th>Group I (n=65)</th>
<th>Group II (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary complications</td>
<td>7.7% (5/65)</td>
<td>7.9% (5/63)</td>
</tr>
<tr>
<td>Rethoracotomy</td>
<td>6.2% (4/65)</td>
<td>1.6% (1/63)</td>
</tr>
<tr>
<td>Sternal dehiscence</td>
<td>1.5% (1/65)</td>
<td>3.2% (2/63)</td>
</tr>
<tr>
<td>Temp LCO</td>
<td>3.1% (2/65)</td>
<td>3.2% (2/63)</td>
</tr>
<tr>
<td>Neurological event</td>
<td>1.5% (1/65)</td>
<td>0</td>
</tr>
<tr>
<td>Dialysis</td>
<td>1.5% (1/65)</td>
<td>0</td>
</tr>
<tr>
<td>Superficial wound infection</td>
<td>1.5% (1/65)</td>
<td>1.6% (1/63)</td>
</tr>
</tbody>
</table>

Legends: Temp LCO= temporary low cardiac output
Table 7.3 Patients’ characteristics SR (n=87) versus AF (n=41)

<table>
<thead>
<tr>
<th></th>
<th>SR (n=87)</th>
<th>AF (n=41)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (SD) mean; years</td>
<td>66.8 (9.1)</td>
<td>67.6 (9.5)</td>
<td>0.6</td>
</tr>
<tr>
<td>Left atrial diameter (SD) mean; millimeter</td>
<td>48.2 (8.9)</td>
<td>51.4 (9.5)</td>
<td>0.07</td>
</tr>
<tr>
<td>Duration AF (SD) mean; months</td>
<td>61 (64)</td>
<td>73 (63)</td>
<td>0.37</td>
</tr>
<tr>
<td>Ao-X (SD) mean; minutes</td>
<td>93 (23)</td>
<td>98 (27)</td>
<td>0.36</td>
</tr>
<tr>
<td>LVEF (SD) mean;%</td>
<td>58 (12)</td>
<td>59 (159)</td>
<td>0.7</td>
</tr>
<tr>
<td>Euroscore (SD) mean</td>
<td>5.9 (2.7)</td>
<td>6.3 (2.8)</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Legends: AF = Atrial fibrillation; Ao-X = Aortic cross clamp time; LVEF = left ventricular ejection fraction.

4. Discussion

The incidence of AF in surgically treated mitral valve diseased patients varies between 26% and 58% (4-6). AF in aortic valve diseased patients, who are over 70 years of age, is about 16% (115/7171) (7). The incidence of AF in association with coronary artery disease is much lower, less than 2%. Nevertheless, the presence of AF in CABG patients was associated with older age, male gender and congestive heart failure (8;9).

In our surgical practice the absolute number of CABG patients exceeds the number of mitral valve diseased patients, indicating that the total number of CABG with AF is steadily growing and momentarily has reached 25% (59/230) of our surgical AF practice. Mitral valve diseased patients with AF constituted 36.5% (84/230) of our practice.

The international literature revealed a distinct effect of AF on the event-free survival and the overall survival. Kvidal reported decreased event-free-survival rates at 5 and 10 years after AVR. The risk for at least one hemorrhage, due to coumadine use, was increased in patients with a pre-operative history of atrial fibrillation (10;11). Bessel and associates observed a reduced long-term survival in 1322 AVR patients (12). Quader reported that preoperative AF was a high risk factor in CABG patients, which substantially reduced survival at 30 days, 5 and 10 years compared to patients without AF; 97% versus 99%, 68% versus 85%, and 42% versus 66%. (13). So, AF in non-mitral valve surgery is associated with increased morbidity and mortality. Whether a postoperative SR conversion will positively influence the postoperative morbidity and mortality can only be evaluated if our present surgical technique, to convert permanent AF into SR, proves to be efficacious.

4.1. Sinus rhythm and atrial contraction

In this series, the cumulative postoperative SR percentages for the group I and II patients at 12 months were 71% versus 79%. So, the type of surgical pathology, in our study, apparently did not adversely affect the success rate. Harada and associates, who performed intraoperative electrophysiological mapping in mitral valve patients and a single CABG patient with chronic atrial fibrillation found similar regular and repetitive activation originating from the left atrial appendage and/or the left pulmonary vein orifice. All patients were successfully ablated with cryoablation on the epicardium of the left atrial appendage (15-17). Konings and associates, however, suggested that perpetuation of the fibrillatory process has several aspects which potentially have a relationship with the type of cardiac pathology (18). So, the electrophysiological pattern of AF for mitral diseased- and CABG patients tend to have an overlap.

The mean size of the left atrium in the mitral valve patients was 6.5 millimeters larger than in the CABG and AVR patients; 52.4 versus 45.9 millimeters. So, the extent of electrical- and mechanical remodeling of the left atrium was probably more profound in the mitral valve group than in the AVR and CABG group (19). This would theoretically adversely affect the SR conversion rate, although the difference in
SR conversion rate for both groups was not statistically different; 71% versus 79%.

In our series 65.6% and 68.3% of the group I and II patients, who had a stable SR showed a biatrial contraction. Therefore, the coumadine was stopped 6 months postoperatively in all these patients who had a CABG, a mitral valve plasty or biological valve prosthesis. The cessation of coumadine in this subset of old-aged patients is, in our opinion, a major advantage.

The mean age for the group I and II patients differed 4.5 years; 64.8 versus 69.3 years. This observation corroborated the assumption that mitral valve disease is related to an earlier occurrence of AF than in non-mitral valve diseased patients, in whom age is an important risk factor for the occurrence of AF (20;21).

4.2. Morbidity and mortality

The incidence postoperative complications including pulmonary complications, revisions and neurological events were similar for both groups. The euroscore for group I and II were similar; 6.2 and 5.9, although group II patients were in mean 4.5 years older. So, no additional or disproportionate induced morbidity was observed in our series.

4.3. Survival

The cumulative survival rates at 3 years were similar; 79% versus 85%. However, we observed a difference in survival of patients, who remained in AF versus those who converted into SR. The mean estimated survival times (SE) for AF and SR patients were 64.3 (2.5) versus 45.1 (4.3) months (P=0.03). However 8.0% (7/87) of the patients, who had a stable SR and 19.7% (8/41) of the AF patients died within the first 6 postoperative months. The interpretation of this observation remains unclear. The mean age, left atrial diameter, euroscore, left ventricular ejection fraction, aortic cross clamp time did not reveal any difference (Table 3). But, the limited number of study patients potentially impedes the detection of any difference. The type of procedure, mitral- versus non-mitral surgery, was also not associated with the SR conversion rate (Fischer Exact test; p=0.45). Nevertheless, it still remains possible that patients who remained in AF might have been more sick and morbid and therefore did not convert into SR. or AF was, indeed, associated with a higher mortality rate due to its complications. Figure 4 shows the cumulative survival rates of patients in SR and AF, who had a minimal follow-up of 3 months; 0.94 versus 0.81.

In conclusion, a concomitant anti-arrhythmic procedure in CABG and AVR patients is as effective as in mitral valve patients, although these patients tend to be older, but with a smaller left atrial size.
Acknowledgments

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References


