Concomitant anti-arrhythmic procedures to treat permanent atrial fibrillation in CABG and AVR patients are as effective as in mitral valve patients

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Abstract

Objective: 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-h 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 groups I and II were 4.6% (3/65) and 3.2% (2/63). Group II patients 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 mm; \( P < 0.0001 \)) and the aortic cross-clamp time was shorter (91 versus 99 min; \( P < 0.05 \)). The cumulative postoperative SR percentages for the groups 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 groups I and II patients, who had a stable SR. The mean (SD) follow-up for groups 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 groups I and II were 85 versus 88%, 83 versus 85%, 79 versus 85% (log-rank test \( P = 0.60 \)).

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.

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Keywords: Atrial fibrillation; Radiofrequency; Maze; Electrophysiology; Valve surgery

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 as 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 and technique

This study was approved by the local ethical committee at the Bergmannsheil University Hospital Bochum. Between

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Krishna Khargi, author of this manuscript, has a training and education agreement on the surgical treatment of atrial fibrillation with Medtronic Europe S.A. Switzerland since 15th of November 2001.

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Table 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>Age (years)</td>
<td>64.8 ± 9.6</td>
<td>69.3 ± 8.2</td>
<td>0.004</td>
</tr>
<tr>
<td>LA (mm)</td>
<td>52.4 ± 9.7</td>
<td>45.9 ± 7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Duration of AF (months)</td>
<td>60.1 ± 49.0</td>
<td>68.0 ± 74.7</td>
<td>0.52</td>
</tr>
<tr>
<td>Ao-X (min)</td>
<td>99 ± 27</td>
<td>91 ± 19</td>
<td>0.05</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>61 ± 12</td>
<td>56 ± 14</td>
<td>0.07</td>
</tr>
<tr>
<td>Euroscore</td>
<td>6.2 ± 2.9</td>
<td>5.9 ± 2.6</td>
<td>0.61</td>
</tr>
</tbody>
</table>

AF, Atrial fibrillation; Ao-X, aortic cross-clamp time; LVEF, left ventricular ejection fraction.

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 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 of 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]. We used the saline-irrigated, cooled tip radiofrequency ablation-catheter (Sprinklr-TM, Maze Penn, Cardioblate Medtronic). The catheter was connected via an NaCl 0.9% infusion pump. The flow rate was set at 200–320 ml/h. The catheter was also connected to a radiofrequency generator (CardioRhythm-ATAKR, Cardioblate Medtronic). The energy delivery was set between 28 and 32 W. The generator was also connected to an indifferent electrode, which was attached between both scapulae of the patient, and to a foot pedal to switch the generator on. A standard median sternotomy was performed. The aorta, the superior (SCV) and inferior caval (ICV) vein were dissected and canulated.

2.1.1. Right atrial procedure
The right appendage was excised and a perpendicular incision of 3–4 cm of length was made, starting from the cut edge of the right appendage. A curved incision was made from the AV groove to the postero-cranial area behind the SA node. SICTRA lesions were created into the SCV and ICV. The right atrium was opened through surgical incision. SICTRA lesions were made from the postero-cranial edge of this incision to the posterior rim of the coronary sinus orifice, curving towards the tricuspid annulus going back and posteriorly to the inferior caval vein, while ablatting the so called isthmus and from the AV groove, traversing over the endocard to the tricuspid annulus and from the medial cut edge from the right appendage to the anterosetal commissural area of the tricuspid valve. The aorta was cross-clamped and cold antegrad blood cardioplegia was administered.

2.1.2. Left atrial procedure
The Waterstone’groove was opened. The endocardial rims of the orifices of the right superior and inferior (R6) as well as the left superior and inferior pulmonary veins were ablated and interconnected. SICTRA lesions were made from the left inferior pulmonary vein lesion to the midportion of the posterior mitral annulus and from the left lateral rim of the orifice of the left inferior pulmonary vein to the rim of orifice of the left atrial appendage. The left atrial appendage was respected. The valve- and/or CABG procedure was performed. The left atrium was closed with a prolene 4/0 suture. The heart was de-aired and the cross-clamp was removed. The incisions of the right atrium were closed with a pledget buttressed mattress prolene 4/0 running suture.

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 Sotalol 40 mg twice a day on the first postoperative day (pod), 80 mg twice a day on the second pod and 160 mg twice a day after the seventh pod. This medication protocol was changed after the 28th patient, because two patients experienced a sudden cardiac death during late follow-up. We changed to Metoprolol 47.5 mg per day starting on the first pod. The dose was increased to 95 mg retard per day on the third postoperative day and eventually to 190 mg per day if no bradyarrhythmia was noticed. The first 50 patients had a cardioversion at the 12th pod and the third postoperative month. But this strategy was abandoned, because no beneficial effect, in our opinion, was noticed. Therefore, no cardioversion was performed before the sixth post-operative month in the last 74 patients. If the patient remained in AF after the sixth postoperative month than one cardioversion with 240–360 J was performed. All patients received Coumadine, starting on the first pod, targeting an INR value around 2.2 for solitary CABG patients and 2.8–3.5 for valve patients. Coumadine was continued for at least 6 months and was stopped if a stable SR was documented on a 24-h 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-h Holter registration. Secondary endpoint was atrial contraction. Data acquisition was obtained for each patient on the first pod, 12th pod (pre-discharge) and after the third, sixth, ninth, 12th month and after each consecutive year. The medical history, clinical examination and an electrocardiogram (ECG) were obtained at each visit. If the surface ECG revealed SR, the stability of SR was assessed using a 24-h Holter registration. If a stable SR
was observed a transthoracic echo Doppler cardiography was performed to assess any atrial contraction, visualized as an A-wave on the echo Doppler parasternal long axis image using M mode or on a four chamber apical view.

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 CABG patients. Types of procedures were MVR 42 (32.8%), MVP 23 (18.0%), CABG 40 (31.2), AVR 21 (16.4%), other 2 (1.6%). Postoperative complications for groups I and II are shown in Table 2. Thirty-day mortality for groups 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 groups I and II patients at 12 months were 71 versus 79% (Fig. 1). 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). Coumadine was stopped in 21/28 of the group II patients. Seven patients still had Coumadine because of an impaired left ventricular function (n = 2) or an incomplete 6-months postoperative follow-up (n = 5). The mean (SD) follow-up for groups 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 groups I and II were 85 versus 88%, 83 versus 85%, 79 versus 85% (Fig. 2). The estimated mean (SE) survival for groups 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’s exact test one sided 0.037, two sided 0.060; Fig. 3).

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 compared to patients without AF; 97 versus 99%, 68 versus 85%, and 42 versus 66% [13].

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Patients’ characteristics SR (n = 87) versus AF (n = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SR (n = 87)</td>
</tr>
<tr>
<td>Age (SD) mean (years)</td>
<td>66.8 (9.1)</td>
</tr>
<tr>
<td>Left atrial diameter (SD) mean (mm)</td>
<td>48.2 (8.9)</td>
</tr>
<tr>
<td>Duration AF (SD) mean (months)</td>
<td>61 (64)</td>
</tr>
<tr>
<td>Ao-X (SD) mean (min)</td>
<td>93 (23)</td>
</tr>
<tr>
<td>LVEF (SD) mean (%)</td>
<td>58 (12)</td>
</tr>
<tr>
<td>Euroscore (SD) mean</td>
<td>5.9 (2.7)</td>
</tr>
</tbody>
</table>

AF, Atrial fibrillation; Ao-X, aortic cross-clamp time; LVEF, left ventricular ejection fraction.

Temp LCO, temporary low cardiac output.
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 groups I and II patients at 12 months were 71 versus 79%. All patients, except 1 group II patient, received Metoprolol beta blockade postoperatively. One group II patient, who had an impaired left ventricular function, was treated with Amiodarone, which proved to be effective in maintaining SR.

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 [14–17]. 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 mm larger than in the CABG and AVR patients; 52.4 versus 45.9 mm. 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 groups 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 groups 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 groups 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% (7/70) 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. Fig. 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.

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The cooperation and support of Prof. Dr Axel Laczkovics (director of the department of cardiothoracic surgery), Andreas Mügge, (director of the department of cardiology), Frank Kuschkowitz, Helmut Haardt and Mohammed Ali Falsafi at the Bergmannsheil University Hospital Bochum, Germany, is greatly appreciated.

References

Appendix A. Conference discussion

Dr S. Redzepagic (Melbourne, Australia): You haven’t put in your presentation what the percentage of the patients was undergoing procedures other than mitral valve repair or replacement with having paroxysmal or permanent type of AF. As we know, probably nowadays the approach is more towards the tailored set of lesions to seal tight the permanent or paroxysmal type of AF. What are your comments on that? We actually use cryoablation lately in those really and try to avoid maybe unnecessarily and do more lesions on a beating heart epicardially. What are your comments on that point as well?

Dr Khargi: I intentionally excluded all patients who had paroxysmal atrial fibrillations. The patients in this group had documented permanent atrial fibrillation. So from the type of arrhythmia, it is comparable. If you are looking to the subset of patients in the non-mitral valve group, we had 40 patients who had a CABG procedure and the others had an aortic valve. There was no combined procedure. So either they had a CABG or they had aortic valves. There was no combined procedure in order to avoid any bias and skewing in the interpretation of the data. Concerning the cryo or other type of bipolar or epicardial application, I do agree that using these more sophisticated techniques will be the next step. The aim of this study was to show that it is worthwhile to do a concomitant antiarrhythmic procedure even if you have to open the left atrium intentionally. So I feel that that has been proven by this study. Now we have to move to a situation where we can facilitate and enhance the procedure in non-mitral valve surgery while keeping the atria closed. I do agree with you.

Dr A. Revishvilli (Moscow, Russia): You have a group of mitral valve and ischemic heart disease. You showed that the left atrium was very small. Why did you choose the biatrial approach on the left side only?

Dr Khargi: The biatrial approach is actually the approach which we started with derived from the fact that the Cox- Maze procedure was the golden standard, and, as a consequence, if you would like to do something about arrhythmia, we felt at that time that a biatrial procedure was a necessity. Later on in our experience, we experienced that most probably the biatrial procedure was too aggressive and not necessary, but for the sake of the study, we felt that the biatrial probably was good then.

Dr. J. Melo (Carnaxide, Portugal): We have also been doing these of procedures for quite a number of years, and our results show that in these particular patients the overall success rate is similar to mitrals. In aortics the success rate is higher than in coronaries. My question, regards patients out of atrial fibrillation. The success rates are the same, but regarding sinus rhythm, and non sinus non af rhythms, did you see that in your experience?

Dr. Khargi: Yes. The judgment of the postoperative sinus rhythm is done by our cardiologists and I rely upon their assessments. Concerning atrial and junctional rhythms, we have seen these types of rhythm in a small percentage of patients after 6 months. I do agree that especially atypical atrial arrhythmias and irregular arrhythmias are seen within the first 6 postoperative months. So it’s my impression that you do have atypical atrial arrhythmias but that a majority of them disappear after 6 months and only a small portion remain after 6 months.