The association between early atrial arrhythmia and long-term return to sinus rhythm for patients following the Cox maze procedure for atrial fibrillation

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Abstract

OBJECTIVES: Observational studies identified increased age, left atrial (LA) size, type and duration of atrial fibrillation (AF) as independent predictors for failure of AF surgical ablation. Rhythm at discharge following the Cox maze (CM) procedure for AF was never considered a significant predictor of success. The purposes of this study were to: (i) Determine the association of sinus rhythm (SR) at discharge and maintenance of SR. (ii) Identify the variables associated with discharge rhythm. (iii) Identify the effects of discharge rhythm on health-related quality of life (HRQL) post-CM procedure.

METHODS: A prospective study (n = 534) of CM III/IV patients. Rhythm captured during hospitalization, discharge, 3, 6, 12 and 24 months and verified by electrocardiogram and 24-h holter. Subsequent SR interventions were captured. Logistic regression identified predictors of discharge rhythm. HRQL (Short-Form 12; AF symptom frequency and Severity Checklist V3) obtained during follow-up.

RESULTS: Eighty-eight percent were discharged in SR (n = 469). LA size (OR = 1.36, CI: 1.02–1.82, P = 0.035) and long-standing AF type (OR = 2.68, CI: 1.31–5.50, P = 0.007) were the only independent predictors of non-SR at discharge. Lower rates of SR at 2 years were found in patients discharged in non-SR (75 vs 91%, P = 0.01). Patients discharged in SR had fewer perioperative morbidities [prolonged ventilation >24 h (6 vs 14%, P = 0.03), renal failure requiring dialysis (0.9 vs 5%, 0.04) and pneumonia (2 vs 9%, P = 0.005)]. During follow-up (mean = 43 ± 27 months), patients discharged in SR had fewer cardioversions (15 vs 29%, P = 0.006), similar percutaneous catheter ablations (6 vs 5%, P = 1.00) and no difference in late embolic strokes (1.5 vs 1.1%, P = 0.54).

CONCLUSIONS: In this large prospective cohort study, rhythm at discharge was found to be clinically significant with predicting SR at 24 months. Surgeons should be aware that the prognosis of non-SR patients at discharge remains excellent with high rates of SR at 24 months if managed appropriately using rhythm rather than rate control strategies.

Keywords: Atrial arrhythmia • Surgical ablation • Long-term success • Cox maze procedure

INTRODUCTION

Several observational studies have investigated the variables associated with ‘failure’ of a surgical ablation procedure for atrial fibrillation (AF). These studies overall have identified increased age, large left atrial (LA) size, type as well as duration of AF as independent predictors of failure of the surgical ablation procedure [1–4].

Non sinus rhythm (SR) at discharge or in the early period [first 3 months post-surgery (blanking period)] following percutaneous catheter ablation for AF has been found to be a predictor of failure. This finding was exceptionally predictive for patients with non-paroxysmal AF who underwent percutaneous catheter ablation [5–7]. However, rhythm at discharge post-surgical ablation has not been investigated as a possible variable to predict failure of a surgical ablation procedure.

Therefore, the purposes of this study were to:

(i) Determine the association of SR at discharge and maintenance of SR over time.
(ii) Identify pre- and perioperative variables that may be associated with a patient’s heart rhythm at discharge.
(iii) Identify the effects of discharge rhythm on patients’ health-related quality of life (HRQL).

METHODS

This was a prospective study whereby data of all patients presenting for surgical ablation were entered prospectively using our extensive local AF registry and merged through a statistical platform with data collected and stored through our institutional Society of Thoracic Surgeon’s Adult Cardiac Surgery database...
[8, 9]. All patients underwent a full Cox maze (CM) III/IV procedure as has been previously described in the literature (n = 534) [10–12], performed by multiple surgeons. At the follow-up rhythm time periods of 3, 6, 12, 18, 24 months and then yearly thereafter, rhythm was verified using electrocardiogram's and 24 h holter. The Heart Rhythm Society's definition of success/failure (any monitored atrial arrhythmia event captured and lasting >30 s is considered a failure) was used when determining rhythm at follow-up [13]. In addition, interventions (cardioversion and ablation) that were required post-surgery to obtain or maintain SR were captured as well and verified through our electronic health records or physician notes. Anticoagulation status was also collected at the various time points and determined through physician report to be either clinically indicated (i.e. history of: a clotting disorder, deep vein thrombosis, pulmonary emboli, continual AF) or not clinically indicated (i.e. there were no indications for the anticoagulation other than AF). All patients were treated clinically using our arrhythmia control protocol [14]. This study was approved by our institutional review board (#06.022 and 06.037).

To better understand the impact of the surgery and any subsequent interventions on the patient in terms of HRQL, we assessed patients' HRQL using two tools to measure HRQL [Short-Form 12 (SF-12); AF symptom severity and Frequency Checklist V3] [15, 16]. These tools were administered to our patients prior to surgery and then at 6, 12 and 24 months following surgery.

We chose to use the SF-12 since it has long been considered a reliable and validated instrument for use across many disease populations and is easy to administer, being particularly adept for use in self-report situations [15]. Further, the family of SF instruments has been used and validated in the cardiac surgery population. The instrument measures eight concepts and two summary measures: physical component summary and mental component summary. Scores range from 0 to 100 and the summary scores are standardized to a mean of 50 and a standard deviation of 10 [15]. A higher score means better HRQL and can be compared against age group norms.

The AF Symptom Checklist asks respondents to rate the frequency (from 0 to 4 or never to always) and severity (from 1 to 3, mild, moderate or extreme) of 16 symptoms potentially associated with AF, thereby generating frequency and severity scores ranging from 0 to 64 and from 0 to 48, respectively, with higher scores indicating greater symptomatology. In a previous study, healthy subjects without AF reported mean frequency and severity scores of 10 and 8 points, respectively, whereas patients with AF reported scores more than twice as high as the controls [16]. The SF-12 and AF Symptom Checklist were self-administered at the patients' first preoperative visit and then again at 6, 12 and 24 months postoperatively.

Statistical analysis

Patients discharged with SR and without SR were compared using \( \chi^2 \) tests for categorical variables and Student's t-tests for independent samples for continuous variables. If the data did not meet the assumptions for these tests, alternative tests were used, including two-sided Fisher's exact tests for categorical variables and Mann–Whitney U-tests for continuous variables. To determine the clinical factors that predicted rhythm status at discharge after the maze procedure, multivariate logistic regression was conducted. The variables of interest included age, gender, additive EuroSCORE, duration of AF, LA size (continuous measure), smoking history, hypertension, congestive heart failure, peripheral vascular disease, diabetes, chronic pulmonary disease and long-standing AF type. This set of clinical variables was determined a priori based on clinical and theoretical evidence regarding the factors that may impact outcomes and return to SR.

Cox proportional hazards regression analysis was conducted to evaluate the effect of discharge rhythm on 2-year survival after adjustment for the clinical covariates described above for the logistic regression. Kaplan-Meier survival analysis was conducted to examine the effect of discharge rhythm on freedom from AF interventions post-discharge as well as time to warfarin discontinuation during follow-up. Mixed model repeated measures analysis of variance was used to evaluate changes in HRQL and AF symptom scores by discharge rhythm groups from baseline (presurgery) to 6 months post-surgery. Sample size is not yet sufficient to analyse changes to 12 and 24 months post-surgery because not all patients have responded to requests for HRQL data at all time points and some patients have not yet reached 12 or 24 months of follow-up. For all analyses, a two-tailed \( P < 0.05 \) was used to determine significant differences. Statistical analysis was completed in SPSS Version 17.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

This prospective study consisted of 534 CM III/IV patients. Eighty-eight percent of these patients were discharged in SR (n = 469) and 12% were discharged while still experiencing atrial arrhythmia (n = 65). Patient characteristics were generally similar between patients discharged in SR and those not discharged in SR, such as ejection fraction (55.0 ± 11.3 vs 54.7 ± 12.8, \( P = 0.85 \)) and additive EuroSCORE (5.4 ± 2.6 vs 5.9 ± 2.4, \( P = 0.12 \)). However, the patients discharged in SR were younger, had fewer concomitant coronary artery bypass grafting procedures and shorter duration of AF [Table 1 (patient characteristics)].

Patients discharged in SR experienced fewer perioperative morbidities [Table 1 (perioperative outcomes)] including prolonged ventilation over 24 h (6 vs 14%, \( P = 0.03 \)), renal failure requiring dialysis (0.9 vs 5%, 0.04) and pneumonia (2 vs 9%, \( P = 0.005 \)). The group of patients discharged in SR had a lower proportion that required a cardioversion during their hospital stay (6 vs 26%, \( P < 0.001 \)). Median length of stay was found to be longer in patients discharged with atrial arrhythmia (8 vs 6 days, \( P < 0.001 \)). However, the subgroup of patients who received cardioversion during their hospital stay (n = 44) showed significantly longer median length of stay (13 vs 6 days, \( P = 0.001 \)). When the effect of cardioversion during hospital stay was accounted for, discharge in atrial arrhythmia was still predictive of longer length of stay (8 vs 6, \( P = 0.005 \)). Most patients were discharged on warfarin and did not differ between those discharged in SR and those not in SR (89 vs 89%, \( P = 1.00 \)). A greater proportion of patients in non SR at discharge were on Amiodarone compared to those in SR at discharge (79% vs 60%, \( P = 0.004 \)). Two-year mortality occurred in 18 patients discharged in SR and 6 patients discharged in non-SR. Cox proportional hazards modelling found that 2-year cumulative survival (unadjusted 89.9 vs 95.6%) was not significantly different between the discharge rhythm groups after adjustment for clinical covariates as described in the Methods section (HR = 0.37, 95% CI: 0.11–1.23, \( P = 0.11 \)).
<table>
<thead>
<tr>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.04</td>
<td>0.995–1.08</td>
<td>0.08</td>
</tr>
<tr>
<td>1.12</td>
<td>0.58–2.15</td>
<td>0.73</td>
</tr>
<tr>
<td>2.47</td>
<td>0.44</td>
<td>0.11</td>
</tr>
<tr>
<td>2.68</td>
<td>1.31–5.50</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Table 3: Outcomes and interventions post-discharge by discharge rhythm groups

<table>
<thead>
<tr>
<th></th>
<th>SR at discharge (N = 469)</th>
<th>Non-SR at discharge (N = 65)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR at 3 months</td>
<td>303/324 (94)</td>
<td>26/39 (67)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR at 12 months</td>
<td>311/331 (94)</td>
<td>37/50 (74)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR off AA meds at 12 months</td>
<td>284/321 (89)</td>
<td>25/49 (51)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR at 24 months</td>
<td>208/228 (91)</td>
<td>33/42 (56)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SR off AA meds at 24 months</td>
<td>183/204 (82)</td>
<td>18/32 (56)</td>
<td>0.002</td>
</tr>
<tr>
<td>Catheter ablations</td>
<td>28 (6)</td>
<td>3 (5)</td>
<td>1.00</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>14 (50)</td>
<td>2 (67)</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>2 (7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Atrial tachycardia</td>
<td>5 (18)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>AV nodal</td>
<td>4 (14)</td>
<td>1 (33)</td>
<td></td>
</tr>
<tr>
<td>Unknown atrial arrhythmia</td>
<td>3 (11)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Embolism</td>
<td>8 (1.7)</td>
<td>1 (1.5)</td>
<td>1.00</td>
</tr>
<tr>
<td>TIA</td>
<td>5 (1.1)</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>Major bleed event*</td>
<td>27 (5.8)</td>
<td>5 (7.7)</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Data presented as N/n (%) or n (%).

When examined in a multivariate analysis, greater LA size (OR = 1.36, CI: 1.02–1.82, P = 0.035) and long-standing persistent AF type (OR = 2.68, CI: 1.31–5.50, P = 0.007) were the only independent predictors for non-SR at discharge (Table 2). Each one point increase in LA size as a continuous measure was associated with 36% greater odds of not being discharged in SR. After discharge, lower rates of SR were found at all time points for patients not discharged in SR (Table 3, Fig. 1) including 2 years post-surgery (75 vs 91%, P = 0.01) and 2 years post-surgery off anti-arrhythmic medications (56 vs 82%, P = 0.002). Patients followed by our postoperative rhythm control protocol were more likely to be in SR (Table 4). However, the groups were similar with regard to the percentage of patients treated according to our clinical protocol at 6 months (80 vs 73%, P = 0.31), 12
During follow-up (mean = 43 ± 27 months), the group discharged in SR had fewer patients with at least one cardioversion (15 vs 29%, P = 0.006), but similar incidence of percutaneous catheter ablation [6 vs 5%, P = 1.00; Table 1 (perioperative outcomes)]. Intervention-free survival (cardioversions and ablations) during follow-up was significantly greater in patients discharged in SR (cumulative survival = 75.5 vs 60.7%, log-rank = 5.99, P = 0.01; Fig. 2A). For the group discharged in SR, but which had any atrial arrhythmia relapse during follow-up (n = 63), the odds of returning to SR at 2 years was 2.4 times greater with every intervention received, although the effect was only marginally significant (OR = 2.4, CI: 0.9–6.4, P = 0.08).

Figure 2B demonstrates the pattern of warfarin discontinuation alongside the incidence of major bleeding events and embolic strokes following the blanking period for the full sample of CM III/IV patients. There were no differences between the discharge rhythm groups in the incidence of post-discharge embolic strokes (1.5 vs 1.7%, P = 1.00) or major bleeding events (7.7 vs 5.8%, P = 0.57). A composite measure of morbidity/mortality in the first 3 months following discharge (death, embolic stroke, major bleed, transient ischemic attack) was not significantly higher for those discharged with atrial arrhythmia (8 vs 4%, P = 0.18), although the incidence of events was quite low within this time frame. Kaplan–Meier survival analysis found that patients discharged in SR had their warfarin discontinued significantly earlier than patients discharged with atrial arrhythmia (cumulative survival = 20.1 vs 44.4%, log-rank = 9.83, P = 0.002; Fig. 2C).

Physical composite HRQL score significantly improved from presurgery to 6 months post-surgery within the full sample.
and the two discharge rhythm groups were not significantly different with respect to increases in physical HRQL over this time period ($F = 2.4, P = 0.12$) despite the non-SR group at discharge having had more cardioversions. In addition, AF symptom frequency and severity scores were significantly reduced by 6 months post-surgery within the full sample ($F = 43.6, P < 0.001$ and $F = 32.8, P < 0.001$, respectively). The discharge rhythm groups were not significantly different in reduction of AF symptom frequency ($F = 0.1, P = 0.73$; Fig. 3).

DISCUSSION

This study demonstrated that there is an association between discharge rhythm and the rate of SR 2 years following the CM procedure, with the success rate significantly higher in patients discharged in SR. However, discharge rhythm was not found to be associated with embolic stroke or a major bleeding event. Two-year survival was found to be similar between the groups as well. It is also apparent, as noted through reported HRQL and AF symptom frequency and severity scores over time, that intense post-surgical treatment to include cardioversions and if indicated, percutaneous catheter ablation, is well tolerated by the patients and helps to increase the return to SR rate over time for both groups.

Interestingly, our results correlate with findings following percutaneous catheter ablation as reported by Chang et al. [6]. They studied the significance of early recurrence of AF following percutaneous catheter ablation for AF. They determined that non-paroxysmal AF was a predictor for late recurrence of AF in patients who had very early recurrence. They also found that early recurrence of AF was not associated with long-term recurrence for patients with paroxysmal AF [6]. We, too, found that non-paroxysmal AF was associated with non-SR at discharge as well as large left atrium size. Unlike Chang et al., we did not find that hypertension, procedural time or time on cardiopulmonary bypass were associated with the rhythm at discharge [1, 3].

An encouraging finding from the study was the very low embolic stroke rate regardless of rhythm at discharge or over time. This is probably related to the relatively high rate of SR in both groups, and the fact that the LA appendage was excluded in over 98% of the patients operated on. One of the major benefits of undergoing a CM procedure is the possibility of having anticoagulation therapy discontinued after returning to SR. As noted in this study, very few patients remained on anticoagulation therapy for non-clinically indicated reasons past 12 months regardless of group. The survival free of interventions was significantly better for patients discharged in SR, however, 2-year survival was found to be similar. These findings may suggest that the negative impact of atrial arrhythmia and particularly AF can only be captured through a much longer follow-up and probably in larger cohorts of patients.

Both groups experienced a significant increase in their HRQL, particularly in the reporting of the physical component of their health. These findings were also associated with reduced reporting of their AF symptom frequency at 6 months regardless of rhythm. This finding may be related to the fact that patients not in SR are still experiencing a much reduced burden of AF. Because the definition of success we used is very explicit, exact and focused on rhythm status, the patient may feel differently from what we are reporting.

Our study is unlike other reports and publications related to the potential impact of early rhythm on late success rate since they do not discuss the impact of further interventions on the ability to restore a patient’s rhythm to SR and may report only static time points. In our study, we showed that for patients discharged in SR, there were fewer cardioversions (15 vs 29%). However, the percutaneous ablation rate was similar for the two groups (6 vs 5%). Although the patients discharged in atrial arrhythmia had a smaller proportion in SR at 2 years, the return to SR for this group was still able to reach 75% with assertive management, and their 2-year survival was comparable with the patients discharged in SR. These findings suggest that aggressive treatment for those patients discharged in AF can have a significant impact on their rhythm at 2 years. Therefore, the importance of having a protocol to manage surgical ablation post-procedure seems imperative. We have discussed, in an earlier manuscript, the impact of our protocol on patients’ rhythm at 2 years [14]. Several other investigators have drawn the same conclusion. Chilukuri et al. [17] concluded their study with the statement that earlier cardioversion for recurrent AF following a catheter ablation leads to better success. They also concluded that patients must understand that long-term results may be dependent on a percutaneous catheter ablation procedure [17].
Our study indicates that further research is required in order to better understand the mechanism and the predictors of a successful CM procedure. From our report, we determined that rhythm at discharge is a significant predictor of rhythm at 2 years. However, unlike other reports, we identified a potential association between interventions to restore SR during the follow-up period and rhythm control. Our perception is that patients with advanced stages of the disease, as suggested by long-term persistent status and LA size, should be approached as patients with a chronic state of disease that might require multiple interventions following the surgical ablation in order to improve the odds of maintaining SR [14].

LIMITATIONS

This study was conducted in a large tertiary care centre that has performed over 700 surgical ablation procedures since 2005. Therefore, our results may not be replicable for institutions with a smaller programme. We know that rhythm is not static in patients with arrhythmia heart disease and requires constant follow-up to understand the real impact of any intervention on rhythm over time. Our prospective follow-up system allows us to capture and verify rhythm at multiple time points as well as to capture any breaks in rhythm in a timely fashion, at which time we try to intervene with the cardiologist with recommendations as to how the atrial arrhythmia should be handled. Therefore, our programme is very aggressive in managing patients post-CM procedure, but some of the success or non-success is dependent on the patients’ cardiologists.

CONCLUSION

In this large cohort prospective study, rhythm at discharge was found to be clinically significant with predicting SR at 24 months. However, the known predictors of LA size and duration of AF seem to be most predictive for the return of AF in the early period. Long-term results for return to SR appear to be somewhat dependent on the adherence to the prescribed protocol-guided treatment of any atrial arrhythmia over time. Such that by 24 months, patients who had a recurrence of an atrial arrhythmia and underwent a cardioversion and/or catheter ablation had a 2.4 times greater chance of being in SR at 24 months for each intervention received. Surgeons should be aware that the prognosis of non-SR patients at discharge remains excellent, with high rates of SR at 24 months if managed appropriately using rhythm rather than rate control strategies.

Conflict of interest: none declared.

REFERENCES


APPENDIX. CONFERENCE DISCUSSION

Dr R. Almeida (Cascavel, Brazil): This paper shows a large cohort of patients operated on, with an immediate result of 80% of the patients being in sinus rhythm. In the long term, two years, 93% and 75% of the studied groups were in sinus rhythm, 84% and 56% without any medication in the protocol and in the off-protocol groups, respectively. This is a very good result in any given series. There are some important findings in this study. First, there was a relationship between the incidence of early postoperative atrial tachy-arrhythmias and the late recurrence of atrial fibrillation, after the Cox maze procedure, as well as the health-related quality of life. Secondly, different from other studies that found that the most significant risk factors for the postoperative development of atrial tachy-arrhythmias were age, cross-clamp and cardiopulmonary bypass times, this study found that left atrial size and long-standing atrial
fibrillation type were the only independent predictive factors for non-sinus rhythm at discharge.

There are some flaws in your series due to the fact that the protocol group started with 289 patients and at two years as many as 84, almost 30%, were lost to follow-up. Also, in the off-protocol group, there was a reduction of 48%. I wonder in what type of rhythm these patients were after two years.

As you may know, I come from Brazil, and in my country the main cause of atrial fibrillation is still secondary to mitral valve disease, mainly rheumatic disease. Do you think that these results would be the same in hearts with rheumatic heart disease? If not, why not?

Dr Ad: Very good points. So you are wondering why we lost some patients from follow-up. Well, as you may know, we are basically attracting a lot of patients from across the U.S. and some from Europe, believe it or not, and sometimes it's challenging to follow up those patients.

We have two major issues with follow-up on patients which are not unique to us. One, patients are not local and that's a problem that I accept and we work hard on it. But secondly, since our success rate is so high, patients, after a certain point, which is about the one-year time, don't really want to be followed and be bothered by us anymore. We see this especially with our long-term monitoring programme, that we have fairly high recruitment ability at six months, but almost none at 24 months, which is something we are working on and we try to improve that.

I totally believe that a subgroup of patients with rheumatic heart disease is challenging and should be approached in probably a more careful way and any assessment of them should be done in a more unique way, because most of them have significant fibrosis and a larger left atrium.

Unlike many other studies, we have the ability to work with a large cohort of patients prospectively. And what we see now is probably that some of those predictors for failure are either not stand-alone, independent predictors when you put them in a multivariate model in a prospective way. For instance, we just submitted a paper to the AATS looking at left atrial size and failure rate over time. And to my surprise, left atrial size was a significant predictor in the univariate model. When we put it in a multivariate model, it fell as a non-predictor for failure. So I think this is one of the first studies on the topic. The message is that we need to follow the patients very carefully, especially if they are in atrial arrhythmia. I'm not trying to say anything more than that.

Dr S. Moten (Melbourne, Australia): You showed in your two groups there is a difference in their comorbidities and there were more respiratory complications in the non-sinus rhythm group. Is there maybe some more information you may tease out of the data? Is it the patients maybe, is it pulmonary hypertension, is it sleep apnoea, is that maybe what's contributing to the higher rate of non-sinus rhythm? And is there something we can do about it in this patient population to improve their success rate?

Dr Ad: Well, you saw that there are only 65 patients in that group and obviously they are sicker. Sleep apnoea was not tested here, but pulmonary hypertension didn't stand the multivariate model. But as you saw, there is more long-standing, persistent atrial fibrillation and larger left atria. So I think all-in-all it's a subgroup of patients that is more prone to have atrial arrhythmia anyhow.

Dr F. Wagner (Hamburg, Germany): Particularly intriguing in this very interesting study is the fact that you had such a long follow-up. We have a similar observation that the rhythm at discharge is very important. And I've noticed on one of your slides that you had a significantly higher rate of cardioversion before discharge. So do you think it makes sense to try electrical cardioversion in ablated patients before we discharge them, and has it an influence on the sinus rhythm, is that one of the reasons? Or could you speculate on what you think is the reflection of why we see that?

Dr Ad: I like that you picked up on this point and I'm smiling. I mean, cardioversion is high on this scope because there is selection bias. You only cardiovert in our group if there is a clinical reason to cardiovert. So if a patient has atrial arrhythmia, many of those patients are going to have it with RVR, meaning that ventricular response rate is high or they are symptomatic. If you look at our papers from the past, about 98% of our patients were discharged in sinus rhythm from the hospital. Length of stay was much longer because we insisted.

So to answer your question, I don't see any reason to cardiovert a patient that is asymptomatic, rate controlled, after the maze procedure. We discharge those patients home and see them in six weeks. I don't have the exact statistics, because we are looking at it right now, but close to 85% of them are back in sinus rhythm without cardioversion, just on medication. So if they are asymptomatic and rate controlled, they are being discharged.

Dr T. Hanke (Lübeck, Germany): You did send some patients back to the cath lab again. There was no difference in both groups as I remember the slide. So when do you decide to take those patients back to the cath lab?

Dr Ad: Well, you visited us and you saw the algorithm. We have basically all patients going through three iterations of anti-arrhythmic drugs and cardioversions. And we try to manage those patients for six to nine months without more aggressive intervention, as catheter ablation is not risk-free. And as you know as well, our protocol was developed over time, so we are still not having all the patients in this group treated the same way. But most of our patients having ablation today, have it not before six months and usually before nine months.

Dr Hanke: And did you see a difference in the results of the cath lab procedure in those groups? Were the ones with no sinus rhythm at discharge tougher to treat with EP?

Dr Ad: Not in the particular setup in question. But we published a paper about catheter ablation following surgical ablation and the results are excellent in any group, close to 100% success rate.

Dr M. Castella (Barcelona, Spain): Dr Ad, just a brief question. These cases were all done with the same type of procedure or cut-and-sew? I’m asking this because we see great differences, for example, when we use radiofrequency in which troponin rises up to 13, and with cryo-maze it reaches up to 50. So different types of energy can cause more oedema or necrosis and may influence the first five- or six-day rates of atrial fibrillation, in the end they are going to be all scars or they might be all useful, but they might make a difference in the earlier stage. What do you think about this?

Dr Ad: It's not cut-and-sew. The Cox is a concept. The Cox III and IV are lesion sets. It doesn't matter how you apply it. All our patients were either isolated cryo or bipolar radiofrequency and cryo. And there is no difference between the two groups. Your comment is actually very interesting, because we didn't check the specific energy source in early arrhythmia, but I am almost convinced that it's not going to have any impact whatsoever on long-term results.

Dr Castella: Not in the long-term but in the short-term, in these five-six days.

Dr Ad: Well, the majority of the patients being operated since 2009, if not all of them, are only cryo, and there's over 250 patients. And if there was something, then it would come out. But it's a very interesting comment, and I will look at it again when we have more patients.