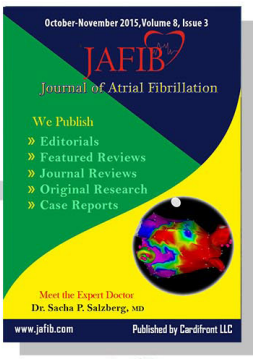
JAFIB
Original Research
Journal of Atrial Fibrillation
www. jafib.com



Development Of A Novel Scoring System That Determines The Success Of Atrial Fibrillation Ablation As Part Of Cardiac Surgery

Norton A[1], Schlosshan D[2], Ahmed I[3], Tayebjee MH[2]

[1]Brighton and Sussex Medical School, Royal Sussex County Hospital, Eastern Road, Brighton. [2]Department of Cardiology, Leeds General Infirmary. [3]Royal Sussex County Hospital, Eastern Road, Brighton.

Abstract

Background: Radiofrequency ablation therapy for the treatment of atrial fibrillation (AF) can be performed as a concomitant procedure alongside cardiac surgery, but carries the risks of increased bypass time and damage to the sinoatrial node. This study aims to assess the efficacy of concomitant surgical AF ablation and develop a novel scoring system to predict post-procedural return to sinus rhythm.

Methods: A review of the Leeds General Infirmary surgical database was conducted to list all patients who had undergone valvular or coronary bypass surgery with concomitant AF ablation between Jan 2012 – Dec 2013 (n = 76). Follow-up was obtained retrospectively using patient notes, clinic letters and echocardiographic data. Primary outcome was freedom from AF at median follow up (383 days). A novel scoring system was created through analysis of previous literature and evaluated using a receiver operating characteristic (ROC) curve.

Results: At median follow up 50.9% of patients undergoing the procedure were free from AF. The novel scoring system was shown to adequately predict post-procedural return to sinus rhythm (ROC AUC = 0.7708).

Conclusion: A novel scoring system was shown to predict procedural success in patients undergoing concomitant AF ablation alongside cardiac surgery. These results can be further validated using larger patient cohorts.

Introduction

Atrial Fibrillation (AF) is the most common sustained cardiac arrhythmia in the western world and affects approximately 1-2% of the UK population. The number of patients admitted to NHS hospitals in AF has risen by 60% in the past 20 years, with an approximate healthcare expenditure of 2.2 billion pounds per annum.[1]

Surgical AF ablation by the creation of a 'Maze' of lines within the atria and around the pulmonary veins can be used to treat patients who have AF undergoing cardiac surgery. The rationale of this lesion set is to interrupt arrhythmogenic macro-reentry circuits.[2] However, surgical ablation is not appropriate for all patients as it carries a certain degree of risk. This is partially linked to an increase in bypass and crossclamp time.[3] There is also a risk of damage to the sinoatrial node; retrospective studies have estimated a 7.2% median risk of pacemaker requirement following the procedure.[4] Identifying predictive factors for procedural success can enable clinicians to identify subgroups where medium to longer-term maintenance of sinus rhythm (SR) is an achievable goal and prevent patients from being exposed to unnecessary risk. A number of previous publications have investigated individual preoperative variables that have an effect on predicting procedural success.[2] However, few previous studies have proposed a scoring system combining these variables to predict restoration of SR following concomitant AF ablation. This study aimed to create a score system based on the results from previous literature and evaluate its efficacy on a small patient dataset.

Key Words:

AF, Concomitant, Surgical, Ablation, Score.

Disclosures:
None.

Corresponding Author:
Dr MH Tayebjee
Department of Cardiology,
Leeds General Infirmary,
Leeds
LS1 3EX

Aims

i) To assess rates of return to sinus rhythm following concomitant AF ablation alongside cardiac surgery

ii) To evaluate a novel scoring system designed to predict medium to longer term maintenance of sinus rhythm

Material And Methods

Patient Population

A review of the Leeds General Infirmary surgical database was conducted to list all patients who had undergone valvular or coronary bypass surgery with concomitant AF ablation between Jan 2012 – Dec 2013 (n = 76).

Patients with no prior ablative procedures and a preoperative diagnosis of AF ≥6 months prior to surgery were eligible to be included in the study. Follow up requirements were one or more documented rhythm checks at ≥3 months post procedure. Patients who died prior

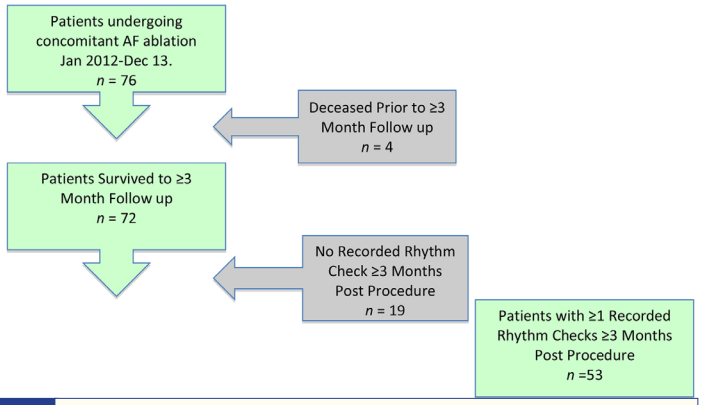


Figure:1 **a) Surface ECG of a patient in sinus rhythm with activated CCM. The corresponding CCM algorithm is pictured at the bottom of the figure. Abbreviations: RA= right atrial, RV= right ventricular. b) Illustration of the CCM device Optimizer IV with the external charging system. (The illustration was provided from Impulse Dynamics).**

to 3-month follow up were not included in data analysis (Fig. 1).

All patients were classified according to HRS guidelines in Paroxysmal, Persistent or Longstanding Persistent AF; in further analysis the two latter categories were combined to form a binary result of 'Paroxysmal' or 'Nonparoxysmal' AF.[2]

Primary Outcomes

The primary endpoint was freedom from AF at median follow up post surgery (383 days). AF was defined as ≥1 documented episode of atrial fibrillation lasting for ≥30 seconds during the follow up period. A three-month 'blanking' period was maintained post surgery when any AF occurrences were not classified as treatment failure.[2]

Surgical Procedure

Procedures were performed over a two-year period by two separate surgeons. Radiofrequency lesions were created using an Atricure Standard Jaw Isolator Synergy clamp at a frequency of 460kHz and amplitude of 0-30 Watts. An Atricure Isolator Linear pen was used to provide any additional lesions and test for entrance and exit block. The standard lesion set involved a left atrial incision followed by semilunar line of ablation around the right pulmonary ostia. The left pulmonary veins were identically ablated and a line was drawn to connect the 2 encircling lesions, the left atrial appendage and the mitral valve annulus. No right-sided lesions were performed.

A small subset of patients (n=2) underwent cryoablation of the isthmus line using an Atricure cryoICE ablation probe. One surgeon consistently used an Atriclip Gillinov-Cosgrove device (n=10) for closure of the left atrial appendage. The other opted for complete amputation (n=43).

Post Operative Care

Postoperative care was similar to that of routine heart surgery. All patients received prophylactic anti-arrhythmic therapy and constant rhythm monitoring. Intravenous amiodarone was introduced after weaning from cardiopulmonary bypass at 5 mg/kg up to a maximum of 1.2g in 24 hours. After discharge from intensive care, this was changed to a 200 mg/d oral dosage and adjusted according to heart rate.

Anti arrhythmic medication (mainly amiodarone) was continued for three months after surgery with the aim of stopping at the three month follow up appointment.

Follow Up

Data was obtained from a combination of patient notes, clinic letters and echocardiographic data.

All patients underwent a 12 lead ECG prior to discharge. This was followed by a minimum of one 24 ambulatory ECG (n=38) or 12 lead outpatient ECG (n=18). Median follow up time was 383 days.

Scoring System

Based on previous studies, a number of predictors for maintenance of sinus rhythm were documented (Table 1). Parameters were weighted differentially according to their relative contribution to procedural success. Increasing patient age has been identified as significant predictor of ablation failure in three separate case series.[5–7] Patients were categorized into low (age <65 years), medium (age 65-74 years) or high-risk (age > 74 years) categories.

The presence of nonparoxysmal AF was given a higher weighting as patients are at a higher risk of treatment failure due to well established and self perpetuating macro-reentry circuits.[8–10] A number of studies have demonstrated increasing left atrial size to be a negative predictor for return to sinus rhythm.[11,12] Weighting of this variable was defined in accordance to results from Chen et al. who reported that every 1mm increase in left atrial diameter corresponded to a 12.7% increase in risk of postoperative recurrence of AF.[13]

Two previous studies have shown that surgical ablation for AF is less effective in patients with a decreased left ventricular ejection fraction (LVEF).[6,14] Patients were again categorized into low (LVEF ≥50%), medium (LVEF 30-49%) or high (LVEF < 30%) risk. Lastly the presence of mitral stenosis was deemed to be a significant but lower risk variable and therefore was assigned a reduced weighting.[14]

The score system was evaluated on a subgroup of 46 patients who had undergone surgical ablation. Seven patients were excluded from the initial cohort due to incomplete echocardiographic data.

The novel predictive score was compared against two risk stratification scores commonly used in cardiac surgery for predicting mortality; Euroscore and Parsonnet Score.[15,16]

Statistical Analysis

Continuous data is presented as mean ± standard deviation and categorical data is presented as frequency and percentage unless otherwise stated. Univariate analysis of continuous data was performed

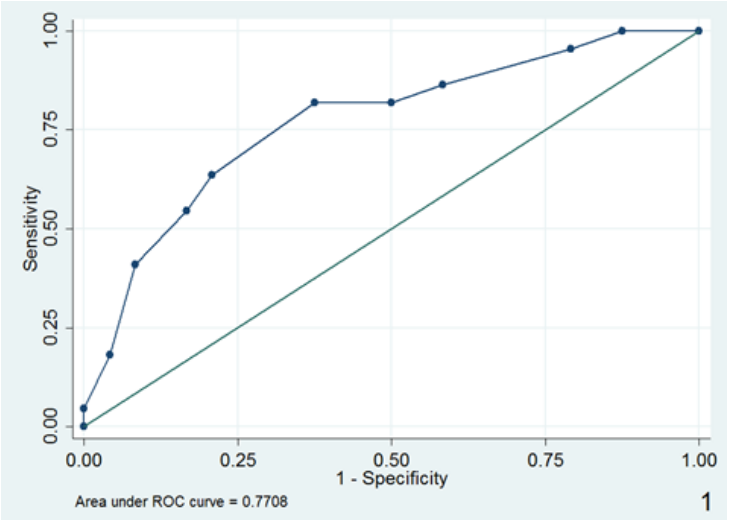


Figure:2 **Receiver operating characteristic (ROC) curve for a novel predictive scoring system for concomitant surgical ablation.**

Table 1: Outline of a novel scoring system to predict return to sinus rhythm following concomitant AF ablation

Score	Weighting (points)
Patient Age (Years)	65-74→ 1 ≥75 →2
Type of AF	Non Paroxysmal → 3
Left Atrial Diameter (mm)	40-44 → 1 45-49 → 2 50-54 → 3 55-59 → 4 60-65 → 5 ≥65 → 6
Ejection Fraction	30-49% → 1 >30% → 2
Mitral Stenosis	Present → 1

using either Students two-sample t test or Wilcoxon Rank Sum. Normality was tested using the Shapiro Wilk test. Group comparisons for categorical variables were conducted using Chi square or Fisher's exact test. Statistical significance was set at $P<0.05$.

Scoring systems shown to be significant on univariate analysis were analysed using a receiver operating characteristic (ROC) curve. This was used to determine cutoff points that yield the highest combined sensitivity and specificity for distinguishing procedural success and failure. Area under the graph was used to represent predictive power of the test.

Statistical analysis was performed using Stata SE version 12.1.

Ethical Approval

This study is in compliance with the Declaration of Helsinki. All data was collected as part of service evaluation.

Results

Rate Of Return To Sinus Rhythm

A total of 50.9% (n = 27) of patients were recorded to be free from AF at median follow up. Twenty-six patients did not reach the primary endpoint as ≥1 episode(s) of atrial fibrillation lasting for ≥30 seconds were documented during the follow up period.

Success Vs. Failure Characteristics

A greater proportion of patients who failed to reach the primary outcome were in nonparoxysmal AF (80.8% vs. 40.7% respectively, p=0.009). No other predictors of success in reaching the primary end point were statistically significant (Table 2).

Scoring Systems

Results show both the novel predictive score (p=0.002) and the Parsonnet score (p=0.02) predict success in reaching the primary outcome. Euroscore was not shown to be a significant predictor (p=0.134) (Table 3).

ROC curve analysis is shown in figure 3. Area under curve (AUC) values show that the novel predictive scoring system has a predictive power of 0.7708. This was shown to be superior to Parsonnet score (0.6998). From this curve, a score of 8 points has the highest combined sensitivity and specificity and could potentially be used to distinguish between high and low risk of procedural failure.

Discussion

Of 53 patients who received concomitant ablation therapy, 27 (50.9%) were recorded to be in sinus rhythm at a median follow up time of 12.6 months. This is consistent with randomised controlled trial data from Doukas et al. who found a 44.4% return at 12 months.[18] However, a 2006 meta analysis by Barnett et al. (3225 patients) assessing the efficacy of concomitant surgical ablation found a higher mean of 84.5% freedom from AF at 1-year follow up.[3]

Lower rates of procedural success in this study could be linked to use of a restricted lesion set. All patients underwent pulmonary vein isolation with left atrial ablation and removal of the left atrial appendage. This is a safe and widely used method, as it requires only a single atriotomy, minimizing a patient's time on bypass. Meta analysis has shown more complex biatrial ablation strategies are more effective in achieving long-term freedom from AF. Barnett et al. compared the results of 24 studies showing mean freedom from AF at one year post procedure was 88.9% in patients who had received biatrial ablation compared to 75.9% in those with left only.[3]

There was no difference in reduction of NYHA score between patients who succeeded or failed in reaching the primary endpoint. This may indicate that any symptomatic improvement is related to the primary procedure alone. It is however difficult to draw firm conclusions from NYHA score as it is a generalised score of functional capacity non-specific to AF.

The principle goals of returning patients to sinus rhythm are relieving the symptoms of AF and the reduction of thromboembolic risk.

Table 2: Preoperative characteristics and perioperative results in patients who have succeeded vs. patients who have failed in meeting the primary outcome.

Demographic	Primary Outcome: Success (n=27)	Primary Outcome: Failure (n=26)	P Value
Mean Age	64.2 ± 10.3	68.3 ± 9.2	0.165
Female	11 (40.7%)	10 (38.5%)	0.865
BMI	28.7 ± 3.6	28.6 ± 3.7	0.957
*Left Atrial Diameter (mm)	49.1 ± 6.7 (n=18)	52.3 ± 6.5 (n=17)	0.098
Type of AF	Paroxysmal: 16 (59.3%) Persistent: 4 (14.8%) Longstanding Persistent: 7 (25.9%)	Paroxysmal: 5 (19.2%) Persistent: 6 (23.1%) Longstanding Persistent: 15 (57.7%)	0.009
NYHA Score	2.4 ± 0.7	2.7 ± 0.6	0.094
Ejection Fraction	>50%: 22 (81.5%) 30-49%: 4 (14.8%) <30%: 1 (3.7%)	>50%: 15 (57.7%) 30-49%: 10 (38.5%) <30%: 1 (3.8%)	0.112
Valve Disease	25 (92.6%)	26 (100%)	0.236
Haemodynamic Pathology	Stenosis: 2 (8.0%) Regurgitation: 14 (56.0%) Mixed: 9(36.0%)	Stenosis: 6 (23.1%) Regurgitation: 18 (69.2%) Mixed: 2(76.9%)	0.270
Hypercholesterolemia	5 (18.5%)	3 (11.5%)	0.704
Diabetes	Insulin Controlled: 4 (14.8%) Total: 4 (14.8%)	0	0.111
Hypertension	8 (29.6%)	10 (38.5%)	0.497
Procedure	Mitral Valve: 23 (85.2%) Aortic Valve: 1 (3.7%) CABG: 2 (7.4%) Combination: 1 (3.7%)	Mitral Valve: 23 (88.5%) Aortic Valve: 3 (11.5%) CABG: 0 Combination: 0	0.356
Mean Bypass Time (min)	114.0 ± 41.9	116.8 ± 24.2	0.124
Mean Cross Clamp Time (min)	91.0 ± 45.3	88.1 ± 16.6	0.091
Mean Post Op Stay (days)	7.8 ± 3.9	8.9 ± 4.7	0.118
Post Op. Stroke/TIA	Stroke: 1 (3.7%) TIA: 0 Total: 1 (3.7%)	Stroke: 0 TIA: 1 (3.8%) Total: 1 (3.8%)	1.00

*Mean left atrial diameter was calculated from a smaller cohort (n=46) due to a lack of echocardiographic data. Left ventricular failure (LVF), New York Heart Association (NYHA), Myocardial Infarction (MI), transient ischaemic attack (TIA), estimated glomerular filtration rate (EGFR), deep vein thrombosis (DVT).

Table 3: Results of univariate analysis comparing a novel predictive score for Procedural success against Euroscore and Parsonnet Score (pre-existing operative risk scores)

Score	Primary Outcome: Success (n=24)	Primary Outcome: Failure (n=22)	P Value
Median Novel Predictive Score	4.6 ± 2.6	7.4 ± 2.7	0.002
Median Parsonnet Score	11.0 ± 7.2	15.9 ± 8.2	0.020
Median Euroscore	5.1 ± 2.5	6.0 ± 2.0	0.134

From the limited evidence presented here it could be suggested that the outcome of concomitant ablation has no effect on patient symptoms. In order to draw firm conclusions in future studies it would be necessary to use a more thorough score system with emphasis on symptoms related to AF.

Univariate analysis demonstrated that a larger proportion of patients who remained in sinus rhythm after a concomitant ablation procedure were originally suffering from paroxysmal AF. The reason for this is likely to be two-fold. Firstly it has been established that patients in nonparoxysmal AF are more treatment resistant due to more extensive changes in the electrophysiological substrate of the atria. Secondly due to the nature of paroxysmal AF, it is far more difficult to detect during follow up. Without the use of long term rhythm monitoring it is not possible to prove that paroxysms of AF are not present.

The novel scoring system proved to be superior to two well-established operative risk scores commonly used prior to cardiac surgery. It has the advantage of being based on a set simple criteria and can be applied to all patients in whom medical records and results of a preoperative echocardiogram are available.

Both univariate and receiver operating statistic analysis demonstrated the predictive power of our novel score system to be adequate. The next step in the evaluation of this system would be to test its use either prospectively, or in a larger retrospective cohort.

Limitations

Levels of postoperative freedom from AF are likely to be overestimated. Due to poor attendance, only 27% of the total patients enrolled in the study received a 24-hour ECG or pacemaker rhythm check at their latest follow up. The remaining 73% were assessed using 12 or 3-lead ECG's. A study by Ad et al. found that 12 lead ECG's overestimated rates of procedural success by 12% when compared to 5 day rhythm monitoring. In the same trial 24-hour ECG's were also shown to overestimate success by 7%. Long term rhythm monitoring (≥5 days) is the recommended strategy for accurately detecting paroxysms of AF.[19] Some authors have suggested that internal loop recorders are the most accurate tool to assess AF burden.[20] In a future prospective study longer term monitoring would be required to form a precise estimation of freedom from AF.

Conclusions

A novel scoring system was shown to predict procedural success in this small dataset. These results can be further validated through cooperation with other surgical centres and application of this score to larger patient cohorts.

References

1. Camm AJ, Kirchhof P, Lip GYH, Schotten U, Savelieva I, Ernst S, et al. Guidelines for the management of atrial fibrillation The Task Force for the Management of Atrial Fibrillation of the European Society of Cardiology (ESC). Eur Heart J [Internet]. 2010 Oct 1 [cited 2014 Apr 20];31(19):2369–429. Available from: http://eurheartj.oxfordjournals.org/content/31/19/2369
2. Calkins H, Kuck KH, Cappato R, Brugada J, Camm AJ, Chen S-A, et al. 2012 HRS/EHRA/ECAS Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation: Recommendations for Patient Selection, Procedural Techniques, Patient Management and Follow-up, Definitions, Endpoints, and Research Trial Design. Heart Rhythm [Internet]. 2012 Apr [cited 2013 Nov 12];9(4):632–96.e21. Available from: http://linkinghub.elsevier.com/retrieve/pii/S1547527111015013
3. Barnett SD, Ad N. Surgical ablation as treatment for the elimination of atrial fibrillation: a meta-analysis. J Thorac Cardiovasc Surg. 2006 May;131(5):1029–35.
4. Robertson JO, Cuculich PS, Saint LL, Schuessler RB, Moon MR, Lawton J, et al. Predictors and Risk of Pacemaker Implantation After the Cox-Maze IV Procedure. Ann Thorac Surg [Internet]. 2013 Jun [cited 2013 Nov 20];95(6):2015–21. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0003497513006450
5. Lee SH, Kim JB, Cho WC, Chung CH, Jung SH, Choo SJ, et al. The influence of age on atrial fibrillation recurrence after the maze procedure in patients with giant left atrium. J Thorac Cardiovasc Surg. 2011 Apr;141(4):1015–9.
6. Bakker RC, Akin S, Rizopoulos D, Kik C, Takkenberg JJM, Bogers AJJC. Results of clinical application of the modified maze procedure as concomitant surgery. Interact Cardiovasc Thorac Surg [Internet]. 2012 Oct 26 [cited 2013 Nov 20];16(2):151–6. Available from: http://icvts.oxfordjournals.org/cgi/doi/10.1093/icvts/ivs440
7. Gillinov AM, Bhavani S, Blackstone EH, Rajeswaran J, Svensson LG, Navia JL, et al. Surgery for permanent atrial fibrillation: impact of patient factors and lesion set. Ann Thorac Surg. 2006 Aug;82(2):502–13; discussion 513–4.
8. Oral H, Knight BP, Tada H, Özaydın M, Chugh A, Hassan S, et al. Pulmonary Vein Isolation for Paroxysmal and Persistent Atrial Fibrillation. Circulation [Internet]. 2002 Mar 5 [cited 2014 Apr 24];105(9):1077–81. Available from: http://circ.ahajournals.org/content/105/9/1077
9. Themistoclakis S, Schweikert RA, Saliba WI, Bonso A, Rossillo A, Bader G, et al. Clinical predictors and relationship between early and late atrial tachyarrhythmias after pulmonary vein antrum isolation. Heart Rhythm Off J Heart Rhythm Soc. 2008 May;5(5):679–85.
10. Cheema A, Vasamreddy CR, Dalal D, Marine JE, Dong J, Henrikson CA, et al. Long-term single procedure efficacy of catheter ablation of atrial fibrillation. J Interv Card Electrophysiol Int J Arrhythm Pacing. 2006 Apr;15(3):145–55.
11. Chen M-C, Chang J-P, Chang H-W. Preoperative atrial size predicts the success of radiofrequency maze procedure for permanent atrial fibrillation in patients undergoing concomitant valvular surgery. Chest. 2004 Jun;125(6):2129–34.
12. Chaiyaroj S, Ngarmukos T, Lertsithichai P. Predictors of Sinus Rhythm after Radiofrequency Maze and Mitral Valve Surgery. Asian Cardiovasc Thorac Ann [Internet]. 2008 Aug 1 [cited 2014 Apr 17];16(4):292–7. Available from: http://aan.sagepub.com/content/16/4/292
13. Chen M-C, Chang J-P, Chang H-W, Chen C-J, Yang C-H, Chen Y-H, et al. Clinical Determinants of Sinus Conversion by Radiofrequency Maze Procedure for Persistent Atrial Fibrillation in Patients Undergoing Concomitant Mitral Valvular Surgery. Am J Cardiol [Internet]. 2005 Dec 1 [cited 2014 Apr 17];96(11):1553–7. Available from: http://www.ajconline.org/article/S0002-9149(05)01440-2/abstract
14. Szalay ZA, Skwara W, Klövekorn WP, Brunner-La Rocca H-P, Knez I, Graves K, et al. Predictors of Failure to Cure Atrial Fibrillation with the Mini-Maze Operation. J Card Surg [Internet]. 2004 Jan 1 [cited 2014 Apr 17];19(1):1–6. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.0886-0440.2004.04001.x/abstract
15. Roques F, Nashef SA, Michel P, Gauducheau E, de Vincentiis C, Baudet E, et al. Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients. Eur J Cardio-Thorac Surg Off J Eur Assoc Cardio-Thorac Surg. 1999 Jun;15(6):816–22; discussion 822–3.
16. Parsonnet V, Dean D, Bernstein AD. A method of uniform stratification of risk

for evaluating the results of surgery in acquired adult heart disease. Circulation. 1989 Jun;79(6 Pt 2):I3–12.

17. Doukas G, Samani NJ, Alexiou C, Oc M, Chin DT, Stafford PG, et al. Left atrial radiofrequency ablation during mitral valve surgery for continuous atrial fibrillation: a randomized controlled trial. JAMA J Am Med Assoc. 2005 Nov 9;294(18):2323–9.
18. Ad N, Henry L, Hunt S, Barnett S, Stone L. The Cox-Maze III Procedure Success Rate: Comparison by Electrocardiogram, 24-Hour Holter Monitoring and Long-Term Monitoring. Ann Thorac Surg [Internet]. 2009 Jul [cited 2014 Apr 19];88(1):101–5. Available from: http://www.annalsthoracicsurgery.org/article/S0003-4975(09)00643-2/abstract?refuid=S0022-5223(10)00199-6&refissn=0022-5223
19. Kapa S, Epstein AE, Callans DJ, Garcia FC, Lin D, Bala R, et al. Assessing arrhythmia burden after catheter ablation of atrial fibrillation using an implantable loop recorder: the ABACUS study. J Cardiovasc Electrophysiol. 2013 Aug;24(8):875–81.
20. Pokushalov E, Romanov A, Cherniavsky A, Corbucci G, Pak I, Kareva Y, et al. Ablation of paroxysmal atrial fibrillation during coronary artery bypass grafting: 12 months' follow-up through implantable loop recorder. Eur J Cardio-Thorac Surg Off J Eur Assoc Cardio-Thorac Surg. 2011 Aug;40(2):405–11.