

Outcome of Cryomaze Procedure Concomitant to Mitral Valve Surgery in Patients with Rheumatic Heart Diseases: A Retrospective Study

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ABSTRACT

Background: Atrial fibrillation is commonly associated with rheumatic valve disease contributing to significant morbidity and mortality. Although, surgical interventions for treatment of rheumatic valve disease in form of replacement or repair have become common, the problem of associated atrial fibrillation remains largely unaddressed. This retrospective study was undertaken to evaluate the long term results of concomitant surgical treatment of Atrial fibrillation in patients undergoing rheumatic valve surgery. **Methods:** The retrospective study was conducted in the Department of Cardiothoracic and Vascular Surgery, Pt. B.D. Sharma PGIMS, Rohtak from June 2008 to June 2014 in all patients undergoing concomitant surgical correction of Atrial fibrillation with rheumatic mitral valve surgery. Patients were divided into three groups i.e. Group I (left atrial cryomaze); Group II (biatrial cryomaze) and Group III (modified Coxmaze III cut and sew lesions). Cut and sew lesion sets were standard, Coxmaze III lesion on left and right atrium. Preoperative patient data and postoperative follow up data were collected according to guidelines for reporting data and outcomes were analyzed retrospectively using standard statistical methods. **Results:** The study included 91 patients of rheumatic valve disease with associated Atrial fibrillation (paroxysmal 5 persistent 86) who underwent surgical correction. Preoperative demographic and disease profiles were comparable among all three groups except associated tricuspid valve disease which was significantly higher in group II (8/26, 30.77%) and group III (4/9, 44.44%). The mean follow up period was 45.46±18.04 months. During follow up the overall rate of conversion to sinus rhythm was 81.32%. The stroke rate was 4.4% (4/91) and was significantly higher in patients who continued to be in atrial fibrillation after surgery (3/15, 20%) as compared to those who were in sinus rhythm (1/76, 1.31%). One patient (1/91, 1.1%) required permanent pacemaker implantation. **Conclusion:** Atrial fibrillation correction procedure concomitant to rheumatic mitral valve surgery is safe and effective and should be performed in all the patients with atrial fibrillation who undergo surgery for rheumatic mitral valve surgery. Results of cryomaze and coxmaze III cut and sew procedure are comparable. Left atrial cryomaze lesion set give similar results to biatrial cryomaze lesion set in terms of freedom from Atrial fibrillation.

Keywords: Atrial fibrillation, Coxmaze, Cryomaze, rheumatic mitral valve disease, sinus rhythm, ECG.

INTRODUCTION

Although Rheumatic Fever and Rheumatic Heart Disease are rare in developed countries, they are still major public health problems among children and young adults in developing countries.^[1] Patients with rheumatic mitral stenosis or mitral regurgitation are particularly susceptible to the development of atrial fibrillation (AF), because of left atrial dilatation and because of the inflammatory and fibrotic changes caused by the rheumatic process.^[2] Atrial fibrillation is associated with increased rates of thromboembolic events including stroke, tachycardia induced cardiomyopathy, degraded quality of life, and

reduced exercise capacity.^[3] Framingham study has cited 17 times increased rates of stroke in atrial fibrillation associated with rheumatic heart disease.^[4] Although surgical interventions for treatment of rheumatic mitral valve lesions in form of repair or replacement have become common, the problem of associated atrial fibrillation remains largely unaddressed. Also, atrial fibrillation with mitral valve disease often persists despite surgical correction of underlying valvular lesion.^[5] Several surgical techniques have been designed either to ablate atrial fibrillation or to ameliorate its attendant detrimental sequelae. These include the left atrial isolation procedure, catheter fulguration of the His bundle, the corridor procedure and the Coxmaze Procedure. Of these the Coxmaze III and its modification has emerged the treatment of choice as a concomitant procedure to mitral valve surgery.^[6,7] Although there is no significant

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increase in morbidity and mortality when Coxmaze III is added to mitral valve surgery but, due to its complexity and invasiveness, Coxmaze III has not been used commonly and nearly 60% of patients are still left untreated.^[8] In order to simplify the procedure, there have been modifications in terms of creation of ablation lines by various energy sources and decreasing the ablation lines and such procedures have been collectively named as coxmaze IV.^[9] Studies have demonstrated comparable results of coxmaze III and coxmaze IV procedures.^[10]

Studies to evaluate atrial fibrillation surgery concomitant to mitral valve surgery in rheumatic heart disease patients have demonstrated conflicting results with some showing lower success of atrial fibrillation surgery in rheumatic heart disease.^[11,12] At our institute, concomitant atrial Fibrillation surgery (both coxmaze III and coxmaze IV) with mitral valve surgery is being performed since 2007 and the present study was planned to evaluate the outcomes of surgical treatment of atrial fibrillation in patients undergoing rheumatic mitral valve surgery at our institute between June 2008 to June 2014.

MATERIALS AND METHODS

The present study was carried out on the patients operated in the Department of Cardio- Thoraco-Vascular Surgery (CTVS), Pt. B. D. Sharma PGIMS, Rohtak, between June 2008 and June 2014, who underwent concomitant atrial fibrillation correction procedure with surgery of rheumatic mitral valve disease.

Patients were grouped in three exclusive groups according to the atrial fibrillation correction procedure performed:

1. Group I: Cryomaze (left atrial lesion set)
2. Group II: Cryomaze (bi-atrial lesion set)
3. Group III: Modified CoxMaze III procedure (cut and sew lesion set)

Technique of Cryomaze procedure:^[13,14]

All lesions were created by applying the Cryomaze Probe (ATS Medical, Figures 15(i) and (ii)) for 2 minutes directly to myocardial tissue with temperatures reaching -120°C to -160°C . Following lesion creation, the probe was thawed from the surrounding tissue by administering cold saline.

Left atrial lesion set: The left-sided endocardial lesions were performed first. The pulmonary vestibule was isolated as a single island with a wide box lesion around it. The first cryo-lesion was performed on the inferior aspect of the pulmonary vestibule along the atrial ridge that separates the pulmonary vestibule from the mitral valve as shown in figure 1 (i) and (ii). As shown in figure 1(iii) and (iv), the box lesion was completed

by a cryo-lesion across the superior aspect of the pulmonary veins that connected with the left atriotomy incision, which was the only non-cryo-lesion of the pulmonary vein isolation.

As per figure 1(v) and (vi), an endocardial lesion was then created to join the box lesion around the pulmonary veins to the mitral valve annulus at the level of P3. By extending this lesion medially toward P3, the lesion was created while avoiding circumflex coronary artery injury.

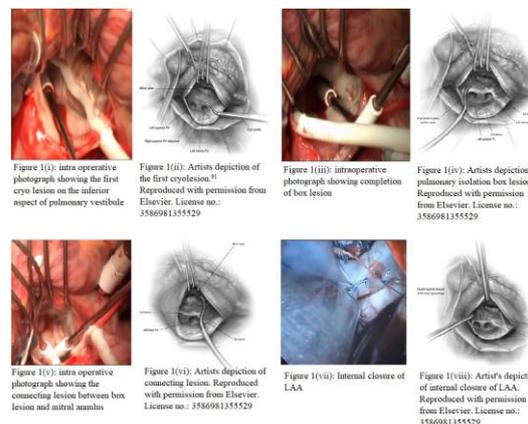


Figure 1(i): intra operative photograph showing the first cryo lesion on the inferior aspect of pulmonary vestibule
Figure 1(ii): Artists depiction of the first cryo-lesion.⁹¹ Reproduced with permission from Elsevier. License no.: 3586981355529
Figure 1(iii): intraoperative photograph showing completion of box lesion
Figure 1(iv): Artists depiction of pulmonary isolation box lesion. Reproduced with permission from Elsevier. License no.: 3586981355529
Figure 1(v): intra operative photograph showing the connecting lesion between box lesion and mitral annulus
Figure 1(vi): Artists depiction of connecting lesion. Reproduced with permission from Elsevier. License no.: 3586981355529
Figure 1(vii): Internal closure of LAA
Figure 1(viii): Artist's depiction of internal closure of LAA. Reproduced with permission from Elsevier. License no.: 3586981355529

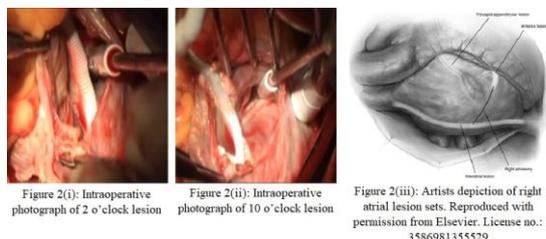
Techniques of closure of left atrial appendage (LAA):

In all patients who underwent the procedure through mid-sternotomy the LAA was excised and the stump was closed in two layers. In all patients who underwent the procedure through limited right anterolateral thoracotomy, the LAA was closed in a 2-layer fashion using a 3-0 polypropylene suture {figure 1(vii) and (viii)}. After completion of left atrial lesion set mitral valve procedure was performed (repair/replacement).

Right atrial lesion set: A small vertical atriotomy was done as an inverted T connecting to the intercaval lesion after securing the caval tapes. Two endocardial or epicardial lesions were created using cryoprobe at temperatures between -120°C to -160°C for one minute towards the tricuspid annulus at the 2 o'clock position figure 2(i), between the right atrial appendage and the tricuspid annulus at the 10 o'clock position figure 2(ii) and (iii), connecting lesion of atriotomy to SVC – IVC lesion (intercaval lesion).

Left atriotomy was closed with continuous 4-0 polypropylene suture in single layer by starting on either end with two suture and tying in center. Right atriotomy was closed with continuous 5-0 polypropylene suture in two layers. Patient was warmed to 36 degree centigrade. Pacing wires were fixed before removing aortic cross clamp on still heart. Left heart was deaired by inflating the lung, filling of heart by perfusionist, compression of heart by hand in standard manner or with soft sucker in case of limited right anterolateral thoracotomy and suction on cardioplegia cannulas. Aortic

cross clamp was removed. Deairing was assessed by TEE. With resumption of normal cardiac function patient was weaned from CPB. Cannulas were removed. Hemostasis was ensured. Mediastinal and pleural drains were placed in cases performed through sternotomy while right pleural drain was inserted in cases performed through limited right anterior thoracotomy. Incision was closed in layers.



Modified Coxmaze III (Cut and Sew Maze):

We used McCarthy's modified coxmaze III procedure which can be used concomitantly with mitral valve procedure.^[15] The lesion sets were same as the original procedure. But the modification was in the sequence of the incisions. In this modification left atriotomy was done first and mitral valve procedure was completed, then the standard left atrial lesion sets of coxmaze III were developed followed by right atrial lesion sets [Figure 3].



Figure 3: The completed maze procedure. When the sinus node fires from the lateral border of the superior vena cave-right atrium junction), the electrical wave front travels medially across the right atrial septum directly to the AV node and inferiorly across the right atrium is innervated from the atrial septal wave front and the wave front traveling medially along the superior right atrium to the dome of the left atrium. Reproduced with permission from Elsevier. License no: 3590910837160.

Pre-operative demographic data and preoperative cardiac disease profile of all the patients of the three

groups were collected and compared. This included age, sex, New York Heart Association (NYHA) class, preoperative AF class (paroxysmal/persistent), predominant mitral valve lesion (stenosis/ regurgitation/ mixed), size of left atrium (LA) on pre-operative echocardiography, presence of clot in left atrial appendage (LAA), associated tricuspid valve lesion.

Post-operative variables analyzed included

- i. Rhythm class of the patients in any of the four classes as shown below:**
 - a. Sinus rhythm
 - b. Supraventricular rhythm
 - c. Rate controlled atrial fibrillation
 - d. Uncontrolled atrial fibrillation
- ii. Echocardiographic demonstration of 'a' wave on continuous wave Doppler, representing atrial contraction.**
- iii. Post-operative morbidities especially stroke, bleeding and thromboembolism.**
- iv. Late mortality.**

All patients were followed up on outpatient basis and relevant clinical data were collected as per guidelines for reporting data and outcomes for the surgical treatment of atrial fibrillation.^[16]

All variables of the three groups were collected and compared.

Collected data were entered in the MS Excel spreadsheet, coded appropriately and later cleaned for any possible errors. Analysis was carried out using SPSS (Statistical Package for Social Studies) for Windows version 20.0 and online GraphPad software (Prism 5 for Windows) version 5.01. Pearson's chi-square test was used to evaluate differences between groups for categorized variables. Paired & unpaired "t" test & ANOVA including repeated measures ANOVA was used to calculate difference of means for quantitative variables. Normally distributed data were presented as means and standard deviation, or 95% confidence intervals (CI). All tests were performed at a 5% level of significance; thus, an association was significant if the p value was less than 0.05.

RESULTS

The present study consisted of 91 patients of rheumatic mitral valve disease with atrial fibrillation who underwent concomitant atrial fibrillation procedure with mitral valve surgery in the Department of CTVS, PGIMS, Rohtak and discharged from hospital during June 2008 to June 2014. There were 49 female patients and 42 male patients. Patients were divided into three groups according to the atrial fibrillation correction procedure they underwent:

1. Group I: Cryomaze (left atrial cryo lesion set) (LA) (n=56, 61.54%)
2. Group II: Cryomaze (bi- atrial cryo lesion set) (BA) (n=26, 28.57%)
3. Group III: Modified CoxMaze III procedure (cut and sew lesion set) (C&S) (n=9,9.89%)

Table 1 showing various types of techniques used for mitral valve repair

Commissurotomy	27
Papillotomy & Fenestration	15
Secondary Chordae Cutting	11
Neochordae/ artificial chordae	5
Leaflet Augmentation	4
Peeling of leaflets/Cusp thinning	2
Cleft closure	4
Chordal transfer/ transposition	12
Annuloplasty	40

Table 2: describes the various types of rings used for mitral valve repair.

	Ring/Prosthesis Type	
Mitral valve repair	Duran Ancore Ring (Medtronic Inc. MN USA)	7
	3D Profile Ring (Medtronic Inc. MN USA)	7
	Cosgrove Edwards Band (Edwards Life Sciences, Irvine USA)	5
	Carpentier Edwards Classic Ring(Edwards Life Sciences Inc. Irvine USA)	16
	SJM Rigid Saddle Ring (St. Jude Medical, Inc. MN USA)	5
Bioprosthetic valve	Perimount Magna Edwards (Edwards Life Sciences Inc. Irvine USA)	3
	SJM Epic(St. Jude Medical, Inc. MN USA)	3
	Hancock II(Medtronic, Inc. MN USA)	5
	Perimount Plus(Edwards Life Sciences Inc. Irvine USA)	32
Mechanical valve	SJM(St. Jude Medical, Inc. MN USA)	1
	ATS mechanical open pivot bi-leaflet(ATS medical Inc. Minneapolis MN, USA)	2

Pre-operative functional status of the patients as per the NYHA classification was comparable. Only one patient was in NYHA class II while most (52/91, 57.14%) were in NYHA class IV. Most patients in the study groups were having persistent or permanent atrial fibrillation before surgery (86/91, 94.51%) while, few (5/91, 5.49%) had paroxysmal atrial fibrillation. Mitral stenosis was the most common lesion overall (46/91, 50.59%) and group 1 had statistically significant number of patients with mitral stenosis, while in group 2 and 3 it was not statistically significant. Pre-operative LA size was highest in group 3 (57.11 ± 5.42mm) and lowest in group 1 (54.43± 8.37 mm) but, the difference was not statistically significant. Total 17 (18.68%) patients

had a clot in LAA. Group 1 had higher percentage of patients having LAA clot 12(21.42%) as compared to Group 2, 4(15.38%) and group 3, 1(11.11%). However, there was no statistically significant difference.

About half of the patients under went mitral valve repair (45/91, 49.45%) while approximately half underwent mitral valve replacement (46/91, 50.55%). The rate of mitral valve repair was higher in group 2 (65.38%) but, it was not statistically significant. Significant tricuspid valve pathology (either stenosis or regurgitation or both) that required repair of the tricuspid valve was significantly higher in Group 3 and group 2. Various techniques used for tricuspid valve repair were: modified devedgas tricuspid annuloplasty 4, MC3 ring annuloplasty 8, papillary muscle approximation 2, commissurotomy 1.^[17] Various techniques used for mitral valve repair are shown in [Table 1].

Mean follow up was significantly longer in group 1 (left atrial cryomaze lesion set) i.e. 54.66±16.78 months as compared to group 2 (bi-atrial cryomaze lesion set) ie. 32.58± 13.85 months and group 3 (modified coxmaze III cut and sew maze) i.e. 25.44± 8.06 months.

Table 3: Shows post-operative rhythm class of all patients in three groups on follow up.

	Group 1 (LA) (n=56)	Group 2 (BA) (n=26)	Group 3 (C \$ S) (n=9)
Sinus rhythm	46(82.14%)	19(73.07%)	9(100%)
SV rhythm	1(1.79%)	0	0
AF rate controlled	9(16.07%)	3(11.54%)	0
AF rate uncontrolled	0	3(11.54%)	0
CHB requiring permanent Pacemaker	0	1(3.85%)	0

Overall rate of conversion to sinus rhythm was 81.32% (74/91). There was no statistically significant difference in rhythm status of the patients across the three groups.

The overall freedom from atrial fibrillation in this study was 82.42%. Highest rate of freedom from atrial fibrillation was noted in the group 3 (modified coxmaze III, cut and sew maze) i.e. 100%, and was lowest in group 2 (BA cryomaze lesion set) i.e. 73.08%. But, the rate of freedom from atrial fibrillation was not statistically significant amongst the three groups.

Table 4: Rates of CVA/stroke among patients

Group	CVA	Total patients
Group 1(LA)	1(1.78%)	56
Group 2(BA)	2(7.69%)	26
Group3(C & S)	1(11.11%)	9
Total	4(4.39%)	91

Total 4 patients suffered stroke during follow up culminating into an incidence of 4.4% (4/91). All but one patient who had stroke in the study had post-operative AF. In group 1 (left atrial cryomaze lesion set) one patient out of 9 having post-operative atrial fibrillation suffered from cerebrovascular accident while 2 patients out of 26 having post-operative atrial fibrillation in group 2 (bi-atrial cryomaze lesion set) suffered cerebrovascular accident. The overall rate of stroke in patients having post-operative atrial fibrillation was 20% (3/15). No patient in group 1 or 2 who was in sinus rhythm suffered from stroke. But, in the cut and sew coxmaze III group one female patient who continued to be in sinus rhythm suffered embolic stroke.

Overall mortality observed in the study till the last follow up was 13.19%. Mortality in patients who continued to be in atrial fibrillation (33.33%) was significantly higher as compared to those who were free from atrial fibrillation (9.2%).

DISCUSSION

Rheumatic fever and rheumatic heart disease still remain a major health problem in India. Sequelae of chronic rheumatic heart disease affecting the mitral valve results either in mitral stenosis or regurgitation or mixed lesion. Patients who suffer from rheumatic mitral valve pathology tend to be commonly affected with atrial fibrillation (AF) which is initially paroxysmal and later becomes persistent and is caused by various pathophysiologic mechanisms including left atrial (LA) dilation, inflammatory and fibrotic processes.^[1,18,19]

AF is associated with palpitations, decreased ventricular filling, formation of thrombus/clots in left atrial appendage (LAA) resulting in peripheral embolization and stroke, poor quality of life, tachycardia induced cardiomyopathy, and decreased overall survival.^[20]

Medical management of AF includes anticoagulation, anti-arrhythmic drugs to control rate or rhythm, which are potentially toxic and dangerous in structural heart disease particularly if associated with congestive heart failure.^[21] Surgical treatment of rheumatic mitral valve disease has advanced rapidly in recent decades. It has evolved from the earlier treatment of replacement with a mechanical prosthesis to the use of bioprosthetic valves with longer durability and even better to repair of the valve. The basic tenet behind the concept of repair has been the avoidance of lifelong anticoagulation and its antecedent complications and preservation of left ventricular function. But, even with a durable valve repair if the patient has AF, the whole purpose of repair stands defeated as anticoagulants and their antecedent complications are not avoided. Concomitant procedure to correct AF with valve

surgery can be the answer to this perplexing situation.

The coxmaze III procedure has remained the gold standard for the treatment of AF with excellent long term results.^[22,23] Prasad et al have shown that the Coxmaze III procedure has equivalent operative risk and long term efficacy in patients undergoing both lone operations and concomitant procedures.^[24] But, due to the complexity of cut and sew lesions, Coxmaze III has still not become a commonly performed procedure.

We performed bi-atrial cryomaze lesion sets when there was a concomitant flutter and also when a trans-septal approach for mitral valve was required. There are studies to support that bi-atrial cryomaze is better than left atrial cryomaze in terms of freedom from AF.^[25,26] We used modified coxmaze III cut and sew lesion sets only when the thickness of left atrial wall was more than 7mm making the transmural of cryolesions questionable hence, the number of patients in this group is significantly less. The predominant mitral valve pathology affecting the patients in the study was mitral stenosis, representing late or burnt out phase of the disease process.^[27]

Associated tricuspid valve disease (either regurgitation or stenosis or mixed) requiring surgical correction was significantly high in group 3 and 2.^[17] Niv Ad et al in their study have shown that concomitant surgery for mitral and tricuspid valve along with cox-maze did not increase morbidity and reduced thromboembolic complications.^[28] Thus, correction of mitral and tricuspid valve pathology along with correction of AF seems feasible.

The long-term benefits of the maze procedure in patients with atrial fibrillation undergoing mechanical valve replacement who already require lifelong anticoagulation has remained controversial but Kim et al in their study showed that compared with valve replacement alone, the addition of the maze procedure results in reduction of thromboembolic complications and improvements in hemodynamic performance.²⁹ All the 3 patients who received mechanical valve are in sinus rhythm and symptom free.

LA/LAA clot incidence is less as compared to earlier studies describing incidence of LA/LAA clot as high as 26 to 33%.

The highest rate of conversion to sinus rhythm was seen in the cut and sew maze group 100% (9/9) at mean follow up of 25.44 months. Study by Cox et al has reported 93% arrhythmia free rate after 8 and ½ years.^[22]

There are conflicting evidences in context of performing correction of AF in patients with rheumatic mitral valve disease. Fukuda et al suggested reconsideration of the indications for the maze procedure for AF associated with rheumatic mitral stenosis. But, the study population in their paper was very small (n=29). On the contrary Baek

et al and Kim et al have shown that maze procedures are safe and effective in treating chronic atrial fibrillation associated with rheumatic mitral valve disease and that atrial fibrillation without a Maze procedure increases the risks of mitral valve dysfunction and adverse outcomes. Therefore, routine performance of a Maze procedure is warranted in the presence of atrial fibrillation whenever possible.^[30-32]

The rate of freedom from atrial fibrillation in our study was not statistically significant amongst the three groups. These results are comparable to numerous other studies as presented in [Table 5].

Table 5: showing results of cryomaze procedure in various published studies.

Study	Freedom from AF & Follow up
Gammie et al	95% 1 yr (Argon based cryomaze)
Doll et al	74% 6 months (Argon based cryomaze)
Manasse et al	81.4 % 3years (Argon based cryomaze)
Lee et al	95% rheumatic / 97% non Rheumatic
Baek et al	6 months
Chitwood et al	84 % Rheumatic 6 months (Argon based cryomaze)
Rahmanian et al	73-87 % 1 year (Argon based cryomaze)
Gammie et al	87 % 304 days (Argon based cryomaze)
Lohchab et al	85% (intermittent AF), 50% (continuous AF) 3 years (Argon based cryomaze)
Alireza Yaghoubi et al	95% Rheumatic 6 months (Argon based cryomaze)
Kyung-Hak Lee et al	76.7% 6 months (N2O based cryomaze)
Hiroyuki Nakajima et al	82.5% 1 year (N2O based cryomaze)
	85.7% 1 year (argon based cryomaze)
	97.7% 3 years (argon based cryomaze)
	90.4% 3 years (cut and sew maze)

One patient in the cut and sew coxmaze III group had suture line bleeding (1/9- 11.11%). Afrasiabi et al reported suture line bleeding in 2 out of 10 (20%) patients in their study.^[33]

One patient in cut and sew coxmaze III group developed changes of pulmonary venous congestion on left side and suspicion of pulmonary vein stenosis was raised but, the congestion cleared gradually. Della Bela et al have reported high incidence of pulmonary vein stenosis with the use of radiofrequency for maze procedure especially with repeated procedures but, Bogot et al have reported no change in pulmonary vein diameter in patients undergoing cryomaze procedure.^[34,35] One patient in the bi-atrial cryomaze group developed upper gastro-intestinal tract bleeding and endoscopy demonstrated an esophageal tear but it could not be determined whether the

injury was caused by cryoprobe or trans esophageal echo (TEE) probe. However, Rodriguez et al have reported that cryotherapy is devoid of this potential complication which can occur with the use of other energy sources.^[36]

Other complications like circumflex coronary artery injury, coronary sinus injury, phrenic nerve injury, atrio-esophageal fistula, **intracavitary** thrombus formation, mitral valve leaflet damage was not seen in our study and have been commonly reported with radiofrequency maze procedures in various studies.^[37-41]

The patient who required pacemaker implantation underwent bi-atrial cryomaze procedure for AF thus supporting Soni et al,^[42] and Cox et al,^[22] in their conclusion that addition of right atrial lesion set may increase morbidity in form of higher incidence of pacemaker implantation.

Of all four patients who had stroke in the study, one had post-operative AF. Studies have reported an incidence of stroke of about 4.5 per 100 patient years in America by 1978 and 5.9 per 100 patient years in China.^[43] The lower observed rate of strokes in this study may be related to the fact that in all patients left atrial appendage was either excised or closed.

So, even if patient remained in AF post operatively, the occurrence of stroke was decreased as the potential source of clot was removed. Of note was one patient of the cut and sew coxmaze group who suffered from stroke even after being in sinus rhythm. Kim et al reported 12 (5% -12/ 240) patients with sustained sinus rhythm who suffered stroke after maze procedure. They identified that having a stroke history was the only preoperative risk factor that could lead to a stroke event after surgery. But, in our patient there was no such history.^[44]

Mortality in patients who continued to be in atrial fibrillation (33.33%) was significantly higher as compared to those who were free from atrial fibrillation (9.2%). Rahmanian and colleagues reported mortality rates of 8.2% but the follow up period in their study was very low (305+/- 195days).^[45]

CONCLUSION

Despite improvements in surgical management of rheumatic mitral valve disease correction of AF still remains largely unaddressed in majority of patients. Very few centers in India are performing concomitant AF correction procedures with rheumatic valve surgery. Surgical treatment of atrial fibrillation concomitant to rheumatic mitral valve surgery appears safe and effective. Cryomaze procedure produces equivalent results in terms of freedom from atrial fibrillation and is devoid of complications pertinent to other energy sources.

Freedom from atrial fibrillation reduces mortality while improving functional class of the patients.

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