

Incidence and predictors of AV conduction abnormalities and requirement of permanent pacemaker implantation after valve replacement surgery. A 10 year single centre experience.

Vidhyakar Balasubramanian Rangasamy^{1*}, Murugan Sukumar², Joshua Samuel², Aashiq Ahamed Shukkoor¹, Monisha Ramesh¹

¹Department of Cardiology, PSG Institute of Medical Sciences and Research, Coimbatore, Tamilnadu

²Department of CTVS, PSG Institute of Medical Sciences and Research, Coimbatore, Tamilnadu

ABSTRACT:

Background: Temporary AV conduction abnormalities are a common occurrence after cardiac surgery especially those undergoing valve replacement surgery. Permanent AV conduction disease is a rare occurrence. However, 3-6% of patients undergoing valve replacement surgery develop permanent AV conduction disease requiring permanent pacemaker implantation.

Aim: To evaluate clinical, anatomical, operative factors that cause complete AV block resulting in need for permanent pacemaker implantation.

Method: In our retrospective study, 718 patients underwent valve replacement surgery between 1, January 2011 to 31, December 2020. 331 patients underwent mitral valve replacement, 152 patients underwent aortic valve replacement, 118 patients underwent both aortic and mitral valve replacement, 44 patients underwent mitral valve replacement with coronary artery bypass surgery (CABG), 66 patients underwent aortic valve replacement with CABG, 6 patients underwent both aortic and mitral valve replacement with CABG. Mean age of the patients was 65 years. 425 of those patients were male and 293 were female. 114 patients underwent bioprosthetic valve replacement. Overall 656 had sinus rhythm preoperatively. All patients underwent median sternotomy with cardiopulmonary bypass.

Results: 12 patients developed complete AV block which was persistent even at 7 days postoperatively and were 100% dependant on temporary pacing who finally underwent permanent pacemaker implantation. Univariate analysis showed longer cross clamp time, larger prosthesis, use of antiarrhythmics like intravenous amiodarone, infective endocarditis of native valve and electrolyte imbalances perioperatively were reasons for worsening AV conduction disease requiring permanent pacemaker implantation.

Conclusion: Permanent AV conduction disease post valve replacement surgery is a rare occurrence. Prolonged cross clamp time, larger prosthesis, pre-operative infective endocarditis, electrolyte imbalance, intravenous amiodarone infusion are major factors causing complete AV block.

Keywords: AVR, MVR, DVR

1.INTRODUCTION:

Temporary AV conduction abnormalities are a common occurrence after cardiac surgery especially those undergoing valve replacement surgery. Permanent AV conduction disease is a rare occurrence. However, 3-6% of patients undergoing aortic valve replacement surgery develop permanent AV conduction disease requiring permanent pacemaker¹. The clinical factors responsible for occurrence of complete AV block in valve replacement surgeries have not been studied in detail. Most of the studies are with aortic valve replacement only^{2,3}. The aim of our retrospective study is to evaluate clinical, anatomical and perioperative factors responsible for causing permanent AV conduction disease requiring permanent pacemaker implantation. In our study we evaluated

requirement of permanent pacemaker implantation for aortic and mitral valve alone or double valve replacement also.

2.METHODS:

We retrospectively analysed 718 patients admitted to the Cardiothoracic Surgery unit at PSG Hospitals from 1st January 2011 to 31st December 2020 for valve replacement surgery. 331 patients underwent mitral valve replacement, 152 patients underwent aortic valve replacement, 118 patients underwent both aortic and mitral valve replacement, 44 patients underwent mitral valve replacement with CABG, 66 patient underwent aortic valve replacement with CABG, 6 patients underwent both aortic and mitral valve replacement with CABG. Characteristics of patients who underwent valve replacement surgery is shown in table 1. All patients prior to surgery had an echocardiogram either transthoracic or transesophageal. 128 patients underwent transesophageal echocardiogram for evaluation of infective endocarditis of the native valve. Patents above 40 years of age and those with risk factors for coronary artery disease underwent coronary angiogram procedure.

Patients who required permanent pacemaker due to complete AV block were included in group 1 and the rest of the patients were included in group 2.

All patients were evaluated preoperatively and data collected were analysed with perioperative and postoperative followup data and analysed.

3.STATISTICS:

Numerical variables were presented as arithmetic meanvalues with standard deviation when normally distributed oras median with interquartile range for non-normal distributions.Comparison of them was performed using chi-square test.P-Values from two-sided tests of < 0.05 were consideredstatisticallysignificant. Statistical analysis was performed with SPSS v16.

Preoperative Evaluation

All patients underwent routine 12 lead ECG and 2D transthoracic echocardiogram. 128 patients underwent transesophageal echocardiogram along with other pre operative laboratory investigations. The clinical features and preoperative factors of all patients included in the study is given in table 1. Patients more than 40 years and those with risk factors for coronary artery disease underwent coronary angiography. Patients with preexisting complete AV block, AF with complete AV block, AF with slow rhythm were excluded from study.

Table 1. Baseline characteristics of the over-all study group

Parameter	Study group (n= 718)	Permanent pacing (n=12)	No permanent pacing (n=706)	P
Gender				
Male	425	6	419	<0.05
Female	293	6	287	<0.05

Table 1. Baseline characteristics of the over-all study group

Parameter	Study group (n= 718)	Permanent pacing (n=12)	No permanent pacing (n=706)	P
Age at time of surgery, mean	65	66	65	0.65
Diagnosis				
AS	165	2	159	<0.05
AR	79	4	79	<0.05
AS+AR	96	0	96	<0.05
MS	157	2	155	<0.05
MR	182	2	180	<0.05
MS+MR	149	2	147	<0.05
MVP	9	0	9	<0.05
Cardiac rhythm and conduction disturbances before surgery				
Sinus rhythm	656(91.36%)	4(33.3%)	652(92.35%)	<0.05
AF	22(3.06%)	2(16.6%)	20(2.83%)	<0.05
LBBB	24(3.34%)	2(16.6%)	22(3.11%)	<0.05
RBBB	1(0.13%)	0	1(0.14%)	<0.05
1st degree heart block	15(2.08%)	4(33.3%)	11(1.55%)	<0.05
Other				
Ischaemic Heart disease	180	4	176	<0.05
Diabetes	293	5	288	<0.05
Hypertension	189	2	187	<0.05
Heart Failure (EF ≤40%)	32	0	32	<0.05
Previous cardiac surgery	4	2	2	0.85
Infective endocarditis	7	5	2	0.45

Inter-operative and postoperative features

Table 2. Intraoperative and postoperative characteristics of the overall study group

Parameter	Study group (n=718)	Permanent pacing (n=12)	No permanent pacing (n=706)	P
Aortic valve				
Tricuspid	138	4	134	<0.05
Bileaflet	73	2	71	<0.05
Mitral Valve				
Valve prolapse	9	0	9	<0.05
Annular Calcifications				
Aortic Valve	189	6	183	<0.05
Mitral Valve	292	6	286	<0.05
Implanted valve				
Mechanical	603	10	593	<0.05
Biological	114	2	112	<0.05
Size of implanted aortic valve, mean (SD)	20.44 (1.7006)	22.0 (1.09)	20.41 (1.6653)	0.68
Size of implanted mitral valve, mean (SD)	32.69	26.2(1.09)	24.2(1.02)	0.72
Operation performed by a specialist	718	12	706	<0.05
Duration of cardiopulmonary bypass (min), mean				
DVR	130	130	130	0.95

Table 2. Intraoperative and postoperative characteristics of the overall study group

Parameter	Study group (n=718)	Permanent pacing (n=12)	No permanent pacing (n=706)	P
MVR	80	91	79	0.86
AVR	75	83	74	0.81
Duration of aortic cross-clamp time (min), mean				
DVR	90	90	90	2.35
MVR	52	56	50	1.92
AVR	45	50	45	1.55
Body temperature during CPB (Celsius), mean	30	30	30	>0.05
Cardiac rhythm at the end of surgery				
Sinus	590	12	578	<0.05
Paced (slow intrinsic rhythm)	109	12	97	<0.05
Paced (complete AV block)	32	12	20	<0.05
AF	216	2	214	<0.05
Technique of valve prosthesis insertion				
Single sutures	718	12	706	<0.05
Semicontinuous sutures	0	0	0	>0.05
Electrolyte disturbances				

Table 2. Intraoperative and postoperative characteristics of the overall study group

Parameter	Study group (n=718)	Permanent pacing (n=12)	No permanent pacing (n=706)	P
S. Magnesium, mean	1.6	1.1	1.59	<0.05
S. Potassium, mean	3.9	3.3	3.9	>0.05
S. Calcium, mean	4.7	4.9	4.7	>0.05
Amiodarone Infusion	9	5	4	>0.05
Need for reoperation	7	0	7	<0.05
Postoperative arrhythmias and conduction disturbances				
AF	216	2	14	<0.05
AV Block	79	12	67	<0.05
LBBB	32	2	30	<0.05
RBBB	116	0	116	<0.05
Other				<0.05
Pacing in the postoperative period	79	12	67	<0.05
Need for permanent pacemaker implantation	12	12	706	<0.05

All procedures were performed under cardiopulmonary bypass and with median sternotomy and standard cardioplegia solution via anterograde route according to surgeon's preference. 603 underwent replacement with mechanical prosthesis and 114 underwent replacement with bioprosthesis. Valvular sizing was done perioperatively by valve sizers provided by the prosthetic valve manufactures. The Intraoperative and postoperative features are mentioned in table 2.

Postoperative followup

After surgery, patients were shifted to the Cardiothoracic ICU where they were monitored continuously with ECG recordings, oxygen saturation, central venous pressure, arterial blood

pressure, electrolytes and acid base parameters along with renal and liver function tests. Electrolyte disturbances were mentioned when serum potassium was below 3.5 mEq/L and above 5.5 mEq/L, when serum magnesium was below 1.0 mEq/L and above 1.5 mEq/L, and when serum calcium was below 1.0 mEq/L and above 1.4 mEq/L. All patients were connected to epicardial pacing wire and external pacemaker. Indication for permanent pacemaker implantation was persistence of complete AV block even after 7 days even after correcting all reversible factors.

4.RESULTS:

In our study, permanent pacemaker implantation was done in 12 patients who had permanent AV conduction disease postoperatively where there were 100% pacing dependent after valve replacement. Based on our analysis preoperative factors were more or less same in both group 1 and group 2. Pre existing conduction disease were similar in both groups. Eventhough aortic valve calcification and mitral valve calcification were more in permanent pacing group they were not significant. The size of valve in aortic position was 22.0mm and in mitral position was 26.0mm which was larger than the group which were not requiring permanent pacing. The aortic cross clamp time was 56 mins in permanent pacing group which was longer than the group not requiring permanent pacing. The intraoperative electrolyte disturbances were more prolonged and severe in group requiring permanent pacing than the one not requiring permanent pacing. Prolonged infusion of intravenous amiodarone was seen in 5 patients who developed persistent AV block requiring permanent pacing.

5.DISCUSSION:

Persistent complete AV block after valve replacement surgery is rare but reported in 3-6% of patients undergoing aortic valve replacement surgery. Plausible causes regarding mechanism of complete AV block in aortic valve disease include mechanical stress like severe hypertrophy of the interventricular septum, mechanical compression of the conducting system by severe calcification and ischaemic causes due to hypertrophy and dilatation of aortic valve and hypertrophy of the septal tissue impinging on the conduction tissue along with degeneration of the conduction tissue leading to persistent AV block^{2,4}. Follath and Drinks et al had described that persistent conduction defects during aortic valve surgery were either due to direct injury to the conduction tissue or due to decalcification during surgery³. Also, techniques like continuous suturing of prosthesis leading to damage of the conduction tissue can also lead to injury. Most of the studies are involving aortic valve surgery alone. We have evaluated the occurrence of persistent AV block in patients undergoing aortic valve and mitral valve along with double valve replacement surgery. Nair et. al, have shown increase of permanent pacemaker implantation for patients with calcifications involving aortic valve with mitral annular calcification also⁵. Persistence of complete AV block valve surgery leads to increase in intensive care stay and increase in mortality.⁶

In our study, mean age was similar in both groups. Also pre existing conduction abnormalities were found in 62 patients out of which Atrial Fibrillation was present in 22 patients, LBBB in 24 patients, RBBB in 1 patient and first degree AV block in 15 patients. Aortic valve calcification was encountered in majority of patients with aortic valve disease. But there was no difference in severity of calcifications in patients who developed complete AV block who required permanent pacemaker when compared to patients who did not require permanent pacemaker implantation. Hence, annular calcifications were not considered to be a cause for AV block in our study. Infective endocarditis was the indication for valve replacement in 7 patients where during surgery, extensive tissue resection was done. Of these patients all of them developed complete AV block for which epicardial pacing wires were implanted and were shifted to the intensive care unit of which 2 patients reverted back to sinus rhythm once electrolyte and acid base imbalances were corrected.

Among patients who underwent permanent pacemaker for complete AV block, aortic cross clamp time was longer when compared to those who did not develop CHB. Longer interoperate time lead to electrolyte disturbances especially lower serum potassium and serum magnesium which increased the time taken for correction and hence, increased the persistence of permanent AV block. Longer aortic cross clamp time also produced more coronary ischaemia and permanent conduction tissue damage^{7,8}. Careful decalcification and adequate cross clamp timing would have reduced the incidence of permanent CHB but these are not the only factors responsible for higher incidence of CHB and also not under surgeons control. Preoperative conduction disturbances like first degree AV block, bundle branch block, chronic amiodarone usage were also not significantly higher in patients who developed permanent AV block. Despite understanding the potential causes of development of permanent complete AV block, there is no universal approach to prevent this. Careful monitoring is required in patients undergoing double valve replacement and those requiring extensive decalcification involving both mitral as well as aortic valve⁹. Also patients with mixed aortic valve disease especially those with aortic regurgitation due to enlarged aortic root may require larger prosthesis which may exert more pressure on the conduction tissue leading to permanent AV conduction disease requiring permanent pacemaker implantation¹⁰. In our study the aortic cross clamp time was longer in patients who developed persistent AV block eventhough the cross clamp time was longer in double valve replacement the difference was not statistically significant between the two groups. In the group requiring permanent pacing the electrolyte imbalances were found to be sttistically significant and was for longer duration and resistant to correction when compared to those whose AV conduction recovered. Also it was found that intravenous infusion in presence of electrolyte imbalances were significant factors worsening the AV conduction increasing the need for permanent pacing.

6.CONCLUSION:

Irreversible complete AV block is a rare occurrence after valve replacement. Various factors are responsible for permanent AV conduction disease. We analysed the clinical, preoperative and postoperative features and found that persistent electrolyte disturbances and longer aortic cross clamp time during cardiopulmonary bypass were associated with postoperative permanent AV conduction disease requiring permanent pacemaker. Mixed aortic valve and mitral valve disease and preoperative infective endocarditis were significant causative factors for postoperative complete AV block requiring permanent pacing.

7.REFERENCES:

1. Alblaza SG, Blanco G, Maranhao V, et al. Calcific aortic valvular disease associated with complete heart block. Case reports of successful correction. *Dis Chest* 1968;54:457– 60.
2. Jensen B, Sigurd B. Atrioventricular block in aortic insufficiency. Mechanism, ECG features and clinical consequences. *Acta Med Scand* 1972;192:391– 4.
3. Onalan O, Crystal A, Lashevsky I, Khalameizer V, Lau C, Goldman B, et al. Determinants of pacemaker dependency after coronary and/or mitral or aortic valve surgery with long-term follow-up. *Am J Cardiol* 2008; 101:203–208
4. Follath F, Ginks WR. Changes in the QRS complex after aortic valve replacement. *B Heart J* 1972;34:553– 60.
5. Keefe DL, Griffin JC, Harrison DC, Stinson EB. Atrioventricular conduction abnormalities in patients undergoing isolated aortic or mitral valve replacement. *Pacing Clin Electrophysiol* 1985;8:393– 8
6. Nair CK, Sketch MH, Ahmed I, et al. Calcific valvular aortic stenosis with and without mitral annular calcium. *Am J Cardiol* 1987;60:865–70.

7. Del Rizzo DF, Nishimura S, Lau C, Sever J, Goldman BS. Cardiac pacing following surgery for acquired heart disease. *J Card Surg* 1996;11:332– 40.
8. Totaro P, Calamai G, Montesi G, Barzaghi C, Vaccari M. Continuous suture technique and impairment of the atrioventricular conduction after aortic valve replacement. *J Card Surg* 2000; 15:418–423.
9. Elahi MM, Osman KA, Bhandari M, Dhannapuneni RR. Does the type of prosthesis influence the incidence of permanent pacemaker implantation following isolated aortic valve replacement? *Heart Surg Forum* 2005; 8:396–400.
- 10 .Flack JE 3rd, Hafer J, Engelman RM, Rousou JA, Deaton DW, Pekow P. Effect of normothermic blood cardioplegia on postoperative conduction abnormalities and supraventricular arrhythmias. *Circulation* 1992; 86:II- 385–II-392.