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Atrioventricular Block In Patients Undergoing Elective Isolated Aortic Valve Surgery

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Abstract
A descriptive and intuitive study was conducted to determine the frequency of atrioventricular block and degree of block in patients undergoing elective isolated aortic valve surgery. There were 80.6% male and 19.4% female patients. Atrial fibrillation was 23.3%, ejection fraction was 42.7%, prolonged CPB time was 12.6% and prolonged aortic clamp time was 17.5%. Atrioventricular block was 18.4% out of which 21.1% was first degree, 42.1% were second and 36.8% were third degree. There was significant association of atrioventricular block with gender, age, diabetes mellitus, and prolonged CPB time.

Background
Cardiac conduction system disorders are potential complications of the procedures for heart valve surgery. Atrioventricular conduction disturbances are commonly seen following cardiac surgery, in particular in patients after aortic valve replacement and tricuspid valve repair.

Introduction
A significant increase in the number of patients referred for surgical treatment of aortic valve disease has been seen in the recent years. A study in past reported actuarial survival of 90% at 10 years and 78% at 15 years after isolated aortic valve replacement. Atrioventricular (AV) conduction disturbances are commonly seen following cardiac surgery, in particular in patients after aortic valve replacement and tricuspid valve repair and its incidence in the post-aortic valve surgery. Disorders may be of temporary nature and will require temporary cardiac pacing, but 1% to 3% of patients, have permanent block for which the will be subjected to permanent pacemaker

Klapkowski A et al. reported of all the analyzed clinical, anatomical and surgical factors, prolonged cardiopulmonary bypass time, prolonged aortic cross-clamp time, larger size of the implanted valve prosthesis, endocarditis as the indication for surgery, and electrolyte disturbances were found to be statistically significant predictors of permanent pacemaker implantation.

A study conducted by Wahlers T Cet al. concluded that isolated rapid deployment aortic valve replacement through an upper hemisternotomy can lead to shorter cross clamp times than has been reported historically in the literature. This may facilitate minimal access aortic valve replacement by eliminating the issue of prolonged cross clamp times. Further, low in-hospital mortality and new permanent pacemaker implant rates were observed regardless of surgical approach. A systematic review by Matthews IG et al.reported current best available evidence suggests that baseline evidence of conducting system disease first degree atrioventricular block (AVB), left anterior hemiblock, right bundle branch block (RBBB) or left bundle branch block (LBBB) is the most powerful independent predictor of PPM requirement following AVR.

Steyers III CM et al. conducted systematic review of the literature addressing rates and predictors of pacemaker dependency in patients requiring permanent pacemaker implantation after cardiac surgery and reported pacemaker dependency rates ranged from 32%-91% and recovery of AV conduction ranged from 16%-42%.
Baraki H et al. conducted a study and observed 138 patients (6.6%) out of total of 2,106 consecutive patients underwent isolated AVR developed significant conduction disorders leading to permanent pacemaker (PPM)

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implantation postoperatively and among these in 103 (75%) patients indications for pacemakers was atrioventricular block III.

Ferrari AD et al. reported clinical and electrocardiographic atrioventricular block during the postoperative period in 15.5% of patients underwent aortic valve surgery.

Atrioventricular block after Aortic Valve Surgery is severe complication, this disorder may be of temporary nature and will require temporary cardiac pacing, but in about 1% to 3% of patients are subjected to permanent Pacemaker. Therefore, this study is designed with aim to assess the quantum of atrioventricular block after aortic valve surgery in our setting.

Materials and Methods

Sample size was calculated using WHO sample size calculator version 2.0 considering 15.5% atrioventricular block during the postoperative period among the patients underwent aortic valve surgery, with 95% confidence interval, and 7% of margin of error, sample size of n=103 patients was calculated. Non-probability consecutive sampling was used for the study. Total 103 patients underwent Isolated Aortic Valve Surgery were included. ECG and echocardiography were performed and atrial fibrillation and ejection fraction were labelled. CPB time and aortic clamp time were recorded. Atrioventricular block, and degree of atrioventricular block were recorded. Descriptive statistics were calculated. Stratification was done. Poststratification chi-square test was applied. P-value ≤0.05 was considered as significant.

Original study

Atrioventricular Block (AVB): It was labeled as "Yes" if any degree of AVB (first degree, 2nd degree, or 3rd degree) was detected on ECG during first 24 hours after the surgery, otherwise, was labeled as "No".
Degree of Atrioventricular Block: It was classified based on the examination of ECG as under;
First Degree: PR interval of greater than 0.20sec on ECG was classified as first degree AVB.
Second Degree: QRS waves don't follow the next P wave or the QRS wave was missing
Third Degree: The P waves occurred at a faster rate, and it wasn't coordinated with the QRS waves.
Effect modifiers include:

- Diabetes Mellitus
- Hypertension
- Smoking
- Chronic kidney disease
- Atrial fibrillation
- Ejection fraction
- Prolong CBP time
- Prolonged Aortic clamp time

NYHAClass:

NYHA classification of the patients was determined as per the ACCF/AHA guideline, listed below.
NYHA I = No limitation of physical activity: defined as ordinary physical activity does not cause undue fatigue, palpitation, dyspnea (describe difficulty breathing when engaged in a simple activity like walking up stairs).
NYHA II = Slight limitation of physical activity: defined as comfortable at rest and ordinary physical activity (such as walking up stairs) results in fatigue, palpitation, dyspnea.
NYHA III = Marked limitation of physical activity: defined as comfortable at rest but less than ordinary activity (such as walking short distances 20-100 yards) causes fatigue, palpitation, or dyspnea.
NYHA IV = Unable to carry on any physical activity without discomfort. Symptoms of heart failure (such as fatigue, palpitation, or dyspnea) at rest and symptoms aggravate on involving in any less than ordinary activity (such as walking short distances 20-100 yard)

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Results

Total 103 patients of either gender with age 20 years to 80 years meeting inclusion criteria of study were evaluated to determine the frequency of atrioventricular block and degree of block in patients undergoing elective isolated aortic valve surgery. Descriptive statistics were calculated using SPSS version 21. Normality was assessed by shapiro wilk test. Stratification was done and post stratification chi square test and fisher exact test was applied to observe the effect of modifiers on outcome. P value ≤0.05 was considered as significant. Out of 103 patients, 80.6% were male and 19.4% were females. The overall mean age of patients was 55.10±10.64 years. The overall CPB time and Aortic clamp time was 204.88±40.32 minutes and 134.18±27.31 minutes respectively. Among 103 patients, 40.8% were found with diabetes mellitus, 66% with hypertension, 48.5% with smoking and 6.8% with chronic kidney disease. It was observed that, 16.5% were classified with NYHA class-I, 34% with class-II, 32% with class III and 17.54% with class-IV. Total 23.3% patients were found with atrial fibrillation, 42.7% with ejection fraction, 12.6% with prolonged CPB time and 17.5% with aortic clamp time. In our study, 18.4% patients were found with atrioventricular block out of which 21.1% were first degree, 42.1% were second and 36.8% were third degree. Stratification with respect to gender, age group, diabetic mellitus, hypertension, smoking status, chronic kidney disease, NYHA Class, atrial fibrillation, ejection fraction, prolonged CPB time, and prolonged aortic clamp time was done to observe effect of these modifiers on outcome (atrioventricular block). P-value ≤0.05 was considered as significant. The results showed that there was significant association of atrioventricular block with gender (p=0.021), age group (p=0.035), diabetes mellitus (p=0.028) and prolonged CPB time (p=0.002). While no significant association was found with hypertension (p=0.807), smoking status (p=0.101), chronic kidney disease (p=1.000), NYHA class (p=0.475), atrial fibrillation (p=0.229), ejection fraction (p=1.000), and prolonged aortic clamp time (p=0.515).

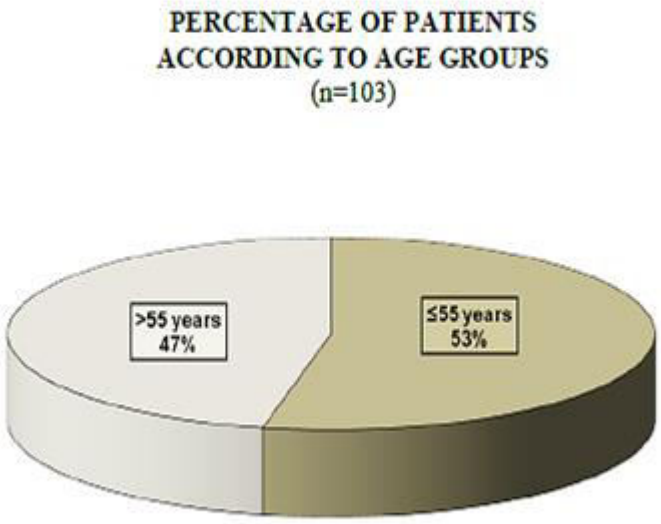

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Table 1: Frequency of Artrioventricular block according to the following factors (n=103)

	Gender	Age	Diabetes Mellitus	Hyper-tension	Smoking	Kidney Disease	Artrial Fibrillation	Ejection Fraction	Prolong CBP Time	Prolong Aortic clamp time	Total
	Yes + No	Yes + No	Yes + No	Yes + No	Yes + No	Yes + No	Yes + No	Yes + No	Yes + No	Yes + No	
Male	19 +64 = 83 (22.9) (77.1)		-	-	-	-	-	-	-	-	
Female	0 + 20= 20 (0) (100)		-	-	-	-	-	-	-	-	
≤55 years		6 + 49 = 55 (10.9) (89.1)	-	-	-	-	-	-	-	-	
≥55 years		13 + 35= 48 (27.1) (72.9)	-	-	-	-	-	-	-	-	
Yes			12+30= 42 (28.6)(71.4)	13+55=68 (19.1) (80.9)	6+44=50 (12) (88)	1+6=7 (14.3)(85.7)	2+22=24 (8.3)(91.7)	8+36=44 (18.2)(81.8)	7+6=13 (53.8)(46.2)	2+16=18 (11.1)(88.9)	103
No			7+54= 61 (11.5)(88.5)	6+29=35 (17.1) (82.9)	13+40=53 (24.5)(75.5)	18+78=96 (18.8)(81.3)	17+62=79 (21.5)(78.5)	11+48=59 (18.6)(81.4)	12+78=90 (13.3)(86.7)	17+68=85 (20)(80)	
Total	19+0+19 64+20=84	6+13= 19 49+35=84	12+7= 19 30+54= 84	13+6=19 55+29=84	6+13=19 44+40=84	1+18=19 6+78=84	2+17=19 22+62=84	8+11=19 36+48=84	7+12=19 6+78=84	2+17=19 16+68=84	
P-value	**0.021****	**0.035****	**0.028****	**0.807****	**0.101****	**1.000****	**0.229****	**1.000****	**0.002****	**0.515****	

Fisher Exact Test was applied.
P-value ≤0.05 considered as Significant.
**Not Significant at 0.05 levels

Table 2: Frequency of atrioventricular block according to NYHA class

	Class-I	Class-II	Class-III	Class-IV	Total
Yes	4 23.5	7 20	7 21.2	1 5.6	**19**
No	13 76.5	28 80	26 78.8	17 94.4	**84**
Total	**17**	**35**	**33**	**18**	**103**

P-Value: 0.475**

Discussions

Aortic valvular stenosis and regurgitation are associated with abnormalities of conduction, including higher degrees of atrioventricular (AV) block. Aortic valve replacement (AVR) can result in the development of further conduction abnormalities, which may be associated with an increased risk of sudden death, Higher degrees of AV block, although often reversible, may also necessitate permanent pacemaker implantation (PPM). In this study we determined the frequency of atrioventricular block and degree of block in patients undergoing elective isolated aortic valve surgery. Bileaflet aortic valve is a common congenital heart anomaly, present in 1–2% of the general population. Patients with this defect are prone to the development of aortic stenosis or regurgitation. Despite reports on the association between the presence of bileaflet aortic valve and the rate of postoperative complete AV block. In another study by Dawkins S et al. aortic regurgitation was the indication for surgery in 7.5% patients. They did not

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find significant differences between the two groups in regard to the type of aortic valve disease which was the indication for the surgery. Other studies suggesting that aortic regurgitation is a factor predisposing to permanent AV conduction disturbances.The presence of preoperative conduction disturbances including 1st degree AV block, and right or left bundle branch block, was not found to be associated with the need for permanent pacemaker implantation in a study despite suggested, obvious association with the occurrence of postoperative complete AV block. The presence of such conditions as hypertension, diabetes, previous myocardial infarction, mitral valve disease, and heart failure was also not associated with an increased risk of postoperative complete AV block in literature. Long duration of the surgery, as electrolyte disturbances are more frequently seen in those patients in whom duration of myocardial ischaemia and cardiopulmonary bypass are longer. Transient postoperative AV conduction disturbances may develop following cardiac surgery, requiring temporary pacing. Various degree AV blocks, bundle branch blocks, and sinus node dysfunction may resolve, possibly with return of sinus rhythm.82 Time after which perioperative AV block should be considered permanent, and thus permanent pacemaker implantation is indicated, is a controversial issue. Sinus rhythm return has been observed even several days after the surgery. In some studies, they considered 10 days as the period after which a permanent pacemaker should be implanted for complete AV block. A factor accelerating this decision is often rapidly increasing pacing threshold of the epicardial lead that was placed intraoperatively. As shown by the follow-up evaluation of patients with a pacemaker implanted, this decision turned out to be too hasty in many of them. Perhaps the waiting period in patients with complete AV block should be extended by another several days, obviously on condition that the effectiveness of epicardial pacing in a patient without adequate escape rhythm is not decreasing. Conduction disturbances following cardiac surgery may be explained by various mechanisms, including manipulation close to the cardiac conduction system resulting in its mechanical damage, and extensive coronary lesions preventing proper cardioprotection during cardiac arrest, resulting in ischaemia. Both these mechanisms may operate during aortic valve replacement. Few previous studies have evaluated the incidence of PPM after valvular surgery. Keefe and coworkers evaluated 102 consecutive patients undergoing isolated AVR at a single institution during 1977 to 1978. Postoperative complete heart block was common, occurring in 18 patients (18%). In the majority of cases this was a transient phenomenon. Six patients (6%) required PPM before discharge, and a further 3 patients (3%) required late PPM (median follow-up, 4.2 years; time of late PPM not specified). The investigators were unable to demonstrate any predictive clinical or operative variables for the early development of postoperative complete AV block. Atrioventricular block after aortic valve replacement is usually a consequence of His bundle dramatization following annular decalcification in the area of membranous septum and the right fibrous triangle below the right-noncoronary commissure. While mechanical damage mostly results in a permanent block, haematoma or oedema of the surrounding tissues usually leads to a transient block resolving within a few days. Careful decalcification and cautious suturing in this area may decrease the rate of conduction disturbances.92 On the other hand, too shallow suturing may result in a perivalvular leak. This most surgeons prefer operative techniques that allow firm attachment of the valve prosthesis to the aortic annulus, as reoperation that might be need due to a perivalvular leak is associated with much higher risk than pacemaker insertion. Despite better understanding of the potential causes of complete AV block following surgical treatment of aortic valve disease, this is no universal approach to avoid this complication. More recent transcatheter aortic valve implantation techniques are associated with even higher risk of postoperative conduction disturbances, most commonly complete AV block (rate 9–49%, mean 20.8%). The reason for this is even higher dramatization of the aortic annulus, associated with that fact that calcified tissues and a metal stent are pushed under high pressure into susceptible structures of the cardiac conduction system.

Conclusions

By the study results it can be concluded that, Atrio ventricular block after aortic valve replacement is a common occurrence in patients who undergone aortic valve replacement. Atrioventricular block should be discussed as part of the preoperative consent process.

Study limitations:

The main limitation of our study was the small sample size. Other limitations of the present study include a single-center experience. It was conducted with urban environment therefore, the results might not be generalizable to larger populations.

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