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Evaluation of Early Complete Heart Block and the Use of TPM and PPM After Open Heart Surgery in Children

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Abstract

Objectives: Congenital cardiac disorders are the most prevalent congenital disorders which require interventional or surgical treatments. The most common causes of complete heart block (CHB) are the degeneration of the cardiac conduction system, acute myocardial infarction, and congenital cardiac disorders. CHB after congenital heart surgery is very important and a major cause of post-operation death and heart failure. In addition, the application of a pacemaker is a standard treatment for CHB. Thus, the aim of this paper was to study the frequency of early postoperative CHB in patients with congenital cardiac diseases and the need for temporary (TPM) and permanent (PPM) pacemakers.

Materials and Methods: This descriptive-analytical and cross-sectional study was conducted on children with congenital heart defects who underwent open heart surgery in Shahid Madani hospital of Tabriz from 2011 to 2016. Patients with early postoperative CHB were included in the study. Further, those who improved on their own and those who needed TPM and PPM were identified, followed by assessing the frequency of CHB and the need for TPM and PPM.

Results: In general, 109 out of 2100 operated patients developed early postoperative heart block and the frequency of early CHB after open heart surgery was 5.19%. Furthermore, 69 (63.3%) out of 109 patients with early postoperative CHB needed TPM and 9 patients needed PPM while 22 patients improved without pacemakers. This rate is acceptable from the occurrence of CHB and the use of PPM and TPM in comparison with other centers and studies. It can reduce mortality and morbidity in patients with timely diagnosis and interventions.

Conclusions: To conclude, the prevalence of early CHB in patients operated for congenital cardiac diseases was 5.19. Finally, the need for TPM was high and most of the patients improved cardiac rhythm with no need for PPM or TPM.

Keywords: Congenital cardiac diseases, Complete heart block, Temporary pacemaker, Permanent pacemaker

Introduction

Permanent complete heart block (CHB) is an important complication associated with the intracardiac repair for congenital heart diseases. It is a type of post-operative heart block that does not change back spontaneously to the pre-operative rhythm (usually within 10 days after the operation). One treatment is to utilize an artificial pacing system that should be replaced at least once every ten years. The parts of the cardiac conduction system involved in such a scenario are the atrioventricular (AV) node and the bundle of His. Improvement in surgical techniques and deeper knowledge of the anatomy of the conduction tissue in different congenital cardiac anomalies have now lowered this risk to 1-4% (1,2).

Cardiac conduction disorders, especially AV conduction are among the important complications following congenital open heart surgery (1-3). No conduction passes through the AV node and AV dissociation will occur in CHB with the cardiac conduction system defect (3-5). In CHB, escape rhythm may arise from the AV node resulting in a narrow QRS in the ECG, but wide QRS is observed in the ECG if the scape rhythm occurs below this node and the Purkinje system occurs in the cardiac conduction system (3). The most common causes of CHB are the degeneration of the cardiac conduction system, acute myocardial infarction, and congenital cardiac disorders (6,7).

Over the last two decades, some institutions have published some reports regarding describing the incidence of postoperative heart block. However, the true incidence of this complication in a large cohort of patients is unknown (8).

These disorders sometimes require embedding a TPM or PPM. Moreover, the incidence of CHB affects the length of hospital stay, morbidity, and even in-hospital mortality (7,9,10). Transient CHB can be a risk factor for late CHB as well (4,11). The risk factors for postoperative CHB include age, sex, weight, endocarditis, and aortic valve replacement (12). The use of a pacemaker is a standard treatment for postoperative CHB (13). If no pacemaker is embedded, the mortality rate from postoperative permanent CHB varies from 28 to 100% (14). Additionally, transient CHB will usually disappear in seven days in most cases and the 7th day of block persistence is a good time for embedding a PPM (12).

Considering the advances in state-of-the-art surgical

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techniques, differences in the types of surgery, as well as the amount and types of hospital facilities, this study was conducted in Shahid Madani hospital of Tabriz to investigate the frequency of early CHB after open heart surgery in children and the need for TPM and PPM (14, 15). The importance of this study is to evaluate its incidence in our hospital and timely intervention to reduce mortality and morbidity.

Materials and Methods

This descriptive-analytical and cross-sectional study was conducted on 1-month to 15-year-old patients with congenital cardiac diseases who underwent open heart surgery from 2011 to 2016. The medical histories of the patients were reviewed completely.

Patients were excluded from the study if they were older than 15 years and had an incomplete medical history or a history of preoperative heart block.

Additionally, the sample size was calculated at 90 patients based on a 95% confidence interval, an 80% test power, and a 5% acceptable error rate. Considering the existing resources, 109 patients with early CHB were included in the study.

The study further reviewed the medical histories of 2100 patients with open heart surgery during 2011-2016, who developed CHB. The pieces of obtained information were demographic information, the type of congenital disease, the block type, the need for pacemaker, the lack of a need for TPM and/or PPM, the time interval between surgery and CHB onset and termination, the duration of the need for TPM and, the need for PPM, and the length of hospital stay. In addition, the detection of CHB was based on ECG.

The rate of postoperative CHB and the number of cases who improved on their own and those who needed TPM and PPM were identified and the collected data were analyzed in SPSS, version 22.

Finally, frequency calculation and frequency tables and related charts were plotted and the chi-square test was used to compare the frequency of the variables.

Results

Overall, 109 out of 2100 patients with congenital cardiac diseases undergoing open heart surgery developed early CHB, whose demographic information is presented in Table 1.

The patients' age varied from 2 months to 15 years. Similarly, the age range of the patients who developed early CHB differed from 4 months to 13 years and the mean age of the patients was 3.33±3.14 years. Further, most patients with early CHB aged 1-5 years. The frequency of this age group was 76 patients or 69.72% (Figures 1 and 2).

Of the 109 CHB patients, 62 (56.6%) and 47 (43.1%) cases were males and females, respectively. Furthermore, the patients weighed from 3.5 kg to 36 kg and the mean weight was 13.93±7.49 kg. The weight distribution of the patients is shown in Figure 3.

Table 1. Demographic Information of Patients With Postoperative Complete Heart Block

Total number of operated patients	2100
Number of CHB patients, No (%)	109 (519)
Number (%) of male CHB patients	62 (56.9)
Number of female CHB patients	47 (43.1)
Mean weight (kg)	13.93±7.49
Mean age (year)	3.33±3.14
Patients who did not need a pacemaker, No (%)	31 (37.7)
Patients who needed TPM, No (%)	69 (63.3)
Patients who needed PPM, No (%)	9 (8.3)

Note. CHB: complete heart block; TPM: temporary pacemaker.

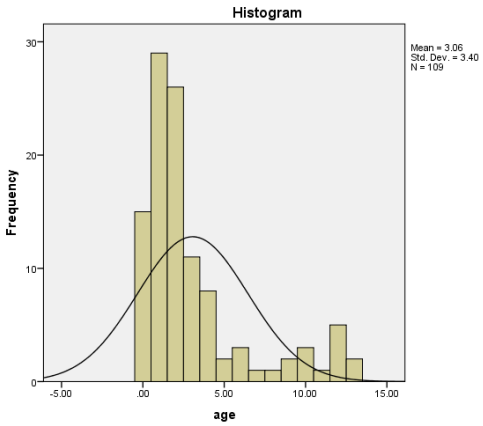

Figure 1. The Frequency of Each Age Group in Patients With Early Postoperative Complete Heart Block.

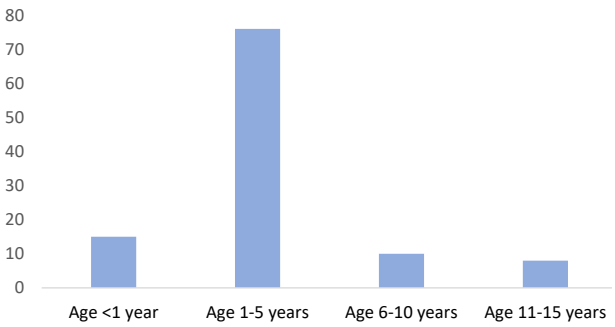

Figure 2. Age Distribution of Patients With Early Postoperative Complete Heart Block.

Of the 109 operated patients with early CHB patients, 69 (63.3%) patients or 3.28% of all cases needed TPM and only 9 (8.3%) patients (those with postoperative CHB) or 0.42% of all cases ultimately needed PPM.

Heart block occurrence varied from the day of operation to 4 days after it. The average number of days after the operation and the appearance of CHB was 0.61+/-0.69 day with a frequency of 52 patients after the operation (Figure 4). Moreover, the time beats would return to normal

sinus rhythm after CHB varied from 1 to 19 days and the average time of normal sinus rhythm appearance was 3.63 days (Figure 5).

Likewise, the time when the patients required PPM varied from 14 to 28 days after the operation with an average of 17.11±4.34 days (Table 2).

The frequency of the type of preoperative congenital diseases and the counterpart need for TPM and PPM are summarized in Table 3.

Discussion

Tremendous advances in the surgical management of congenital heart disease have been made.

Despite the significant advances in pediatric open heart surgery over the past decades, damage to the cardiac conduction system is still one of the important complications that affect children's morbidity and mortality. However, transient or permanent CHB is not a common complication and its prevalence is approximately 0.5 to 3% (16,17).

Postoperative CHB may be either permanent or transient. Transient CHB changes back to sinus rhythm within seven to ten days after the surgery while permanent CHB is less likely to return to sinus rhythm (18,19)

Additionally, the occurrence of CHB after open heart surgeries, especially when patients have conotruncal lesions, has long been a concern for doctors and researchers.

Considering the importance of accurate diagnosis and inspecting the prevalence of CHB after open heart surgeries, in addition to having roots in epidemiological considerations and the effects of CHB anatomical factors, has been more related to the advancement of surgical techniques for cardiac congenital diseases. This identifies the need for TPM, PPM, and the best time to embed a PPM, along with the outcomes of CHB. This is because it has been shown that the incidence of CHB affects the length of hospital stay and the rates of morbidity and mortality.

In the study by Lieberman et al, the prevalence of advanced and advanced cardiac arrhythmias in post-operative cardiac open heart surgery was reported 1.4%. A permanent pacemaker was inserted in these patients who included 1% of the total patient population (8).

In addition, in the studies of Lin et al, the prevalence of CHB was 3.2% (4).

That is why pediatric surgeons and cardiologists should be completely informed about the prevalence of CHB in their centers and how to face this complication so that they would be prepared to handle it and take the necessary

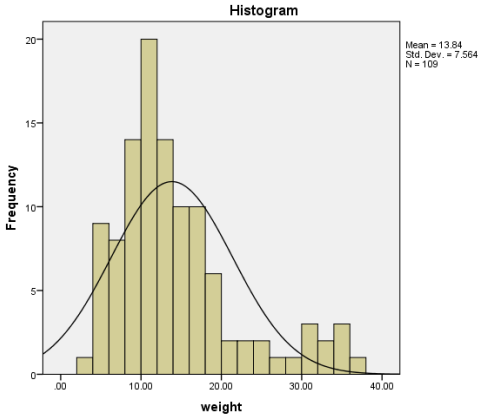

Figure 3. Weight Distribution of Patients With Early Postoperative Complete Heart Block.

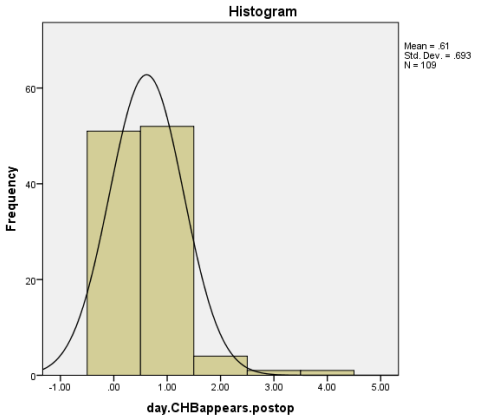

Figure 4. The Frequency of the Days After the Operation Following the appearance of Complete Heart Block.

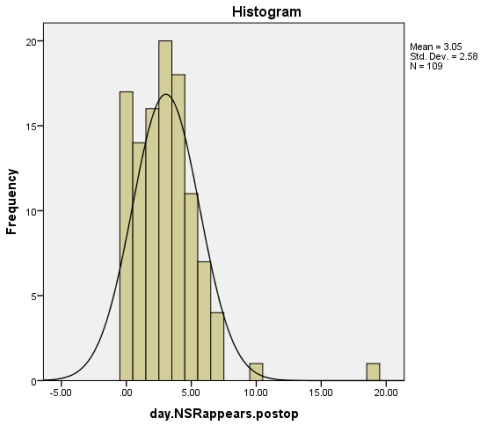

Figure 5. The Frequency of Postoperative Days Following the appurtenance of Sinus Rhythms After Complete Heart Block.

Table 2. The Frequency of Postoperative Days When Embedding a PPM

Number of Postoperative Days	Number of the Patients
14	1
15	4
16	1
17	1
19	1
28	1

Table 3. The Frequency of Preoperative Diagnoses and the Counterpart Need for the Pacemaker

	Operated Patients	CHB, No (%)	TPM, No (%)	PPM, No (%)
VSD	779	49 (6.4)	23 (5.7)	3 (0.7)
ASD secundum, ASD sinus venosus	160	1 (0.6)	1 (0.6)	0 (0)
ASD primum partial AV canal	180	9 (5)	7 (3.3)	2 (1.1)
ASD+VSD (complete AVSD)	476	36 (7.5)	22 (4.6)	1 (0.2)
TOF	385	33 (8.6)	17 (4.2)	3 (0.7)
TGA	84	3 (3.5)	0 (0)	0 (0)
Truncus arteriosus	36	1 (2.8)	0 (0)	0 (0)

Note. VSD: Ventricular septal defect; ASD: Autism spectrum disorders; TOF: Tetralogy of Fallot; TGA: Therapeutic goods Administration.

measures to minimize subsequent complications. They should also seek solutions to reduce the incidence of CHB through using state-of-the-art techniques and appropriate instruments during the surgery.

In another study, Murray et al evaluated patients from 2007 to 2015 and reported a prevalence of 4.7% for a full-bladder heart block after the surgery (20).

In this study, 91.7% of the early postoperative CHB patients improved with or without a TPM and required no PPM whereas 8.3% of them needed a PPM.

In our study, the development of CHB and the need for PPM and TPM were more comparable to those of other studies and centers.

Further, 63% of CHB patients required a TPM while 37% improved without a pacemaker, which seems to be higher compared to other centers and studies and the CHB prevalence, but the need for PPM was less compared to the reports by other centers and studies (8,16,20). This finding may indicate that the likelihood of recovery form CHB is greater in these patients, and therefore, they should be under surveillance for a longer period before embedding a PPM (14).

The highest rate of the CHB prevalence was in patients with tetralogy of Fallot (TOF) (8.6%), complete Atrioventricular septal defect (AVSD) (7.5%), ventricular septal defect (VSD) (4.6%), and partial AVSD (5%) respectively, but the need for PPM was the highest in partial AVSD (1.1%), VSD (0.7%), TOF (0.7%), and complete AVSD (0.2%), respectively. This may suggest that in congenital cardiac complications, further involvement of the upper parts in the conotruncal zone or central fibrosis zone leads to more development of CHB in the patients during the surgery and thus the requirement of PPM.

Clinical Benefits

This study was designed to determine the incidence of the cardiac block in our center and hospital, as well as its timely diagnosis and the use of PPM and TPM in order to reduce the morbidity and mortality of these patients (19).

Limitations

This study had some limitations. The low number of patients was incomplete in a number of cases requiring the accurate insertion of information in patient's files and subsequent studies with more patients.

Conclusions

In general, the prevalence of CHB was not high in the patients operated for congenital cardiac diseases and was around 5.19%. Given its clinical importance, this rather small amount was significant and slightly higher compared to the other centers. The need for TPM pacemakers was high and most patients ultimately improved with or without a TPM. The need for PPM was found to be 8.3% which was higher than that in some studies and lower than that in several other studies (16-18).

In addition, the average time when using PPM after the surgery was 17.11 ± 4.34 days, which was higher compared to previous studies. Given the clinical significance of CBH and other influential factors, complementary research studies are required for better and efficient decision-makings (17).

Conflict of Interests

The authors declare that they have no conflict of interests.

Ethical Issues

This study was approved by the Ethics Committee of Tabriz University of Medical Sciences (ethical code of IR.TBZMED.REC.1397.55).

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