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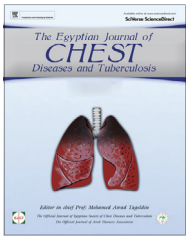

ORIGINAL ARTICLE

Permanent complete heart block following surgical closure of isolated ventricular septal defect

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KEYWORDS

Congenital heart defect;
Complete heart block;
Pacemaker;
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Morbidity

Abstract A serious complication after surgical closure of ventricular septal defect (VSD) is complete heart block (CHB). It continues to be a leading cause of long-term postoperative cardiac morbidity despite all surgical technical improvements, especially with performance of more surgical procedures in increasingly younger patients.

Objective: This study was undertaken to determine the incidence of early postoperative CHB requiring pacemaker implantation following surgical repair of isolated ventricular septal defect, and try to identify possible procedural risk factors.

Design: Prospective study design.

Setting: Multicenter study: Ain-Shams University Hospital, Aboul Reesh Student Hospital and The National Heart Institute.

Method: We reviewed four hundred patients who had a surgical repair of isolated VSD from 2009 to 2011.

Results: 14 out of 400 patients (3.5%) developed permanent post-operative CHB. All; but one; underwent closure of large perimembranous VSD. CHB patients had a significant lower body weight (8.36 vs. 12.68 kg, $p < 0.01$), longer ACC time (42.6 vs. 36.4 min, $p < 0.01$), longer CPB time (75.4 vs. 67.4 min, $p < 0.01$) and longer hospital stay (19 vs. 8.3 days, $p < 0.01$). Tricuspid valve detachment was performed in 28 patients (7%) and was associated with a higher incidence of CHB (7% vs. 3.75%, $p = 0.6$).

Conclusion: Large perimembranous VSD and lower body weight appear to be independent risk factors for permanent CHB following the surgical closure of isolated VSD.

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Introduction

Permanent complete heart block (CHB) is a significant complication of intracardiac repair for congenital heart disease. It refers to post-operative heart block that does not spontaneously revert to the pre-operative rhythm (usually

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within 10 days of the operation). Treatment entails lifelong dependence on an artificial pacing system requiring replacement at least once every decade. The relevant part of the cardiac conduction system in this setting is the atrioventricular (AV) node and the bundle of His. The AV node is located in the triangle of Koch within the floor of the right atrium and continues as the His bundle which penetrates the right fibrous trigone to emerge at the base of the non-coronary aortic cusp in the upper interventricular septum. The bundle of His (and its divisions) is located within the ventricular septum and is thus vulnerable to injury during surgical procedures on the ventricular septum. CHB has been reported after repair of lesions such as isolated ventricular septal defect (VSD), atrioventricular septal defects (AVSD), VSD in the setting of conotruncal anomalies {tetralogy of Fallot (TOF), double outlet right ventricle (DORV), and others} and subaortic stenosis (SAS).

The risk of post-operative permanent CHB has decreased since Lev and others [1–3] delineated the course of the conduction tissue in various types of congenital cardiac malformations of the ventricular and adjacent atrial septa. In earlier reports [4] of 1971, the risk of surgical CHB was as high as 25%. Improved surgical techniques and better understanding of the anatomy of the conduction tissue in various congenital cardiac anomalies have reduced this risk to 1–4% in the current era [5]. Anderson et al. reported a risk of 0.7% for closure of isolated VSD [6]. It is however a real risk that both the surgeon and his potential patient must confront.

Unlike other centers worldwide, the incidence of early postoperative heart block for congenital heart disease in Egypt has not been reported in a large study. This study was undertaken to determine the incidence of early postoperative CHB requiring pacemaker implantation following surgical repair of isolated ventricular septal defect, and try to identify the possible procedural risk factors.

Patients and methods

The is a multicenter prospective observational study of 400 consecutive patients who underwent elective open heart operations for isolated ventricular septal defect between December 2009 and December 2011 at 3 centers: Ain-Shams University Hospital, Aboul Reesh Student Hospital and The National Heart Institute. Patients with associated complex cardiac anomalies, previous VSD surgery, and those with chronic arrhythmias were excluded. Data collection included preoperative age and body weight, history of arrhythmia, preoperative 12 lead electrocardiogram and echocardiogram, operative details including surgical details, ischemic time and cardiopulmonary bypass time and postoperative invasive arterial blood pressure continuous monitoring, central venous pressure measurement, and peripheral and core temperature continuous monitoring. Continuous ECG monitoring was performed during the entire ICU stay with Drager Infinity Vista XL monitors. When arrhythmias were detected on the ECG monitor, this was also documented with the standard 12 lead ECG. In case temporary pacing was required, the patient's own rhythm was checked at 12-h intervals by shortly turning off the pacemaker and recording the patient's ECG for decision regarding the continuation of pacing therapy. Before hospital discharge, a 12-lead ECG was routinely done. In the case of arrhythmia in the postoperative course, the patient also had a 24-h Holter recording before discharge.

Results

During the period under review, 400 patients underwent a surgical closure of isolated VSD. There were 236 (59%) males and 164 (41%) females. Their age ranged from 0.2 to 14 years (mean of 3 ± 3.29 years). The body weight ranged from 3 to 53 kg (mean of 12.14 ± 8.46 kg). According to echocardiogram, VSD type distribution was 328 (82%) perimembranous (PM), 36 (9%) muscular (MS), 4 (1%) PM + MS and 32 (8%) subarterial. VSD closure was done through trans-atrial approach in 390 (97.5%) cases, trans-pulmonary in 6 cases, combined trans-atrial trans-pulmonary in 2 cases and trans-aortic in 2 cases.

Tricuspid valve detachment (TVD) was done in 28 (7%) patients according to surgeon's preference. All VSDs were closed with patch (pericardial or synthetic). Patch stitching was continuous, interrupted, or combined (continuous and interrupted). Mean aortic cross clamp (ACC) time was 37 ± 5 min (range 27–55 min) and mean cardiopulmonary bypass (CPB) time was 68 ± 6 min (range 58–90 min). Mean ICU stay was 3 ± 2 days (range 1–22 days) and mean hospital stay 9 ± 3 days (range 6–30 days). 10 (2.5%) patients died, the most common cause of mortality was LCOS.

14 patients (3.5%) developed postoperative CHB for more than 14 days ending in insertion of PPM. None of them showed clinical or electrocardiographic (ECG) evidence of complete heart block before surgery. All were in sinus rhythm pre-operatively. Intra-operative rhythm was sinus as shown by continuous ECG monitoring until the institution of cardiopulmonary bypass. The clinical data and the intracardiac anatomy of their defects confirmed at operation are shown in Table 1. All but one of the VSDs of patients developing post-operative permanent CHB were perimembranous in location (only one was muscular type) and all were large defects (> 50% of the patient's aortic root).

Temporary epicardial pacing was routinely employed in all patients after separation from cardiopulmonary bypass before the heart fully regained normal rhythm and chronotropy from the effects of cardioplegia and hypothermia. For most patients this was necessary for less than 24 h. For patients with post-operative CHB, attempted cessation of this temporary pacing revealed bradycardia and hypotension. Continuous ECG monitoring in the Intensive Care Unit post-operatively showed CHB. Temporary pacing was then continued with the expectation of spontaneous resolution within 7–10 days.

CHB patients had a significant lower body weight (8.36 vs. 12.68 kg, $p < 0.01$), longer ACC time (42.6 vs. 36.4 min, $p < 0.01$), longer CPB time (75.4 vs. 67.4 min, $p < 0.01$) and longer hospital stay (19 vs. 8.3 days, $p < 0.01$). None of the CHB patients with PPM regained AV conduction during the hospital stay of a mean of 19 days (range 16–23 days). We also noticed a higher incidence of CHB with TVD vs. non-TVD group (7% vs. 3.75%, $p = 0.6$) Table 2.