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Early Surgical Closure of the Ventricular Septal Defects; to Be Done or Not to Be Done? A Question to Be Answered

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Abstract

Objectives: Ventricular septal defect (VSD) includes 40% of congenital heart diseases. Surgical closure of VSD is the most common procedure in pediatric cardiac surgery. Weight is the most restrictive factor for performing the surgery as it complicates the operation and post-operative care. The aim of this study was to determine the results of the surgery for the patients undergoing this procedure with the weight under 5 kilograms and to catch a good insight into performing surgery at lower age and weight.
Methods: A retrospective study was conducted by operative and postoperative case note review of 54 patients from March 2014 to 2017. We assessed the outcomes of the early surgical closure of the ventricular septal defects.
Results: In our study, the weight was 4.4 + 0.61 kilograms and the age was 5.72 + 2.22 months. Post-surgical result by echocardiography showed reduced immediate pulmonary artery pressure in all patients, other post-surgical evaluations showed 1 (1.9%) mild, 1 (1.9%) moderate to severe pericardial effusion, 1 (1.9%) first degree AV Block, 2 (3.7%) right bundle branch block and 4 (7.4%) complete heart block leading to permanent pace maker implantation. Significant myocardial stunning (ejection fraction < 40%) was noted in 6 (11.11%). The patient mortality in the first 30 days was zero and there was no post-operative immediate endocarditis, seizure, bleeding or cardiac arrest.
Conclusions: Observations can prove increased ability, knowledge and techniques of the surgeons operating VSDs. Based on the outcomes, earlier surgical VSD closure is recommended.

Keywords: Ventricular Septal Defect, Early Surgery, Outcomes

1. Background

Ventricular septal defect (VSD) includes 40% of congenital heart diseases (1) and occurs 0.34 to 2.68 per 1000 live births, as the most common congenial heart anomaly (2-4). Spontaneous closure of the defect can occur in 80% of patients, especially before the age of one month but surgical repair is considered for whom the defect remains (5). Surgical closure of VSD is the most common procedure in pediatric cardiac surgery field (3). Surgery is even preferred for the asymptomatic patients without pulmonary hypertension but with any findings showing increment in left ventricle volume (6) and it is recommended to perform surgery as soon as possible for the defects locating near the great vessels, since the risk of aortic valve regurgitation and also spontaneous closure is less possible (7). Weight is the most restrictive factor for performing the surgery as it complicates the operation and post-operative care. The aim of this study was to determine the results of the surgery for the patients undergoing this procedure with the weight under 5 kilograms and to catch a good insight about performing surgery at lower age and weight.

2. Methods

A retrospective study was conducted by operative and postoperative case note review from March 2014 to 2017, in Children's Medical Center, Tehran, Iran. Echocardiographic reports, clinical inpatient notes and surgical notes were assessed. Of 58 initially identified cases from our database, 4 were excluded due to exclusion criteria. We defined the inclusion criteria as: all VSD patients (diagnosed by echocardiography) undergoing open-heart surgery and patients with operative weight under 5 kilograms. Patients with concomitant atrial septal defect (ASD), patent fromen ovale (PFO), patent ductus arteriosus (PDA), aortic coarctation (coA) and web were also included but other complex cardiac anomalies were excluded. The exclusion criteria were: any patient with VSD undergoing pallia-

tive surgery (such as pulmonary artery banding) or transcatheter VSD closure and operative weight above 5 kilograms. Initial diagnosis and hemodynamic evaluation was done by echocardiography. All echocardiographies were interpreted by staff echocrdiographers and all surgeries were performed with identical techniques. Standard transthoracic M-mode, two-dimensional and Doppler echocardiography was carried out by one physician with GE 9 echocardiography system. The VSDs were categorized by their location as perimembranous, muscular, inlet type and outlet type VSD. All VSDs were closed using right atrial approach with Gore-tex patch. Cardiopulmonary bypass was used for all patients. Concomitant web resection, ASD, PFO closure, PDA ligation and coA repair were done if indicated. The standard 12-lead post-operative electrocardiography was examined for rhythm, rate, any signs of myocardial infarction and PR interval. Indications for VSD closure were considerable left to right shunt with Qp/Qs > 2, progressive or new aortic regurgitation, failure to thrive irresponsive to medical treatment, signs of heart failure irresponsive to medical treatment and refractory systemic pulmonary hypertension . The age and weight at the time of the surgery, gender, concomitant anomalies, type and size of the defects, existence of pericardial effusion, myocardial stunning, cardiac arrest, post-operative arrhythmia, bleeding, seizure, endocarditis, total hospital stay, presence of confirmed genetic disorder, need for re-operation because of residual VSD and 30-day mortality were extracted from the medical records within a 30-day post-surgical follow up. Ethical approval for the study was obtained from the Institutional Review Board.

2.1. Statistical Analysis

The data was analyzed with SPSS software version 22. The descriptive values are expressed with mean ± standard deviation. Linear regression analysis was performed for the determination of the association between weight and length of hospital stay.

3. Results

Our study was carried out by reviewing the case notes of 54 patients undergoing VSD closure surgery between March 2014 and 2017. Our patients were classified as second category in RACHS score (risk adjustment for congenital heart surgery score), first category in STS-EACTS score (Society of Thoracic Surgeons and the European Association for Cardiothoracic Surgery Mortality score) and second category in the ABC score (aristotle basic complexity score). 39 (72.2%) of the patients were female and 15 (27.8%) were male. The weight was 4.4 ± 0.61 kilograms and the age was 5.72 ± 2.22 months. The size and type of VSD was found in pre-operative echocardiography and the mean size of the VSD was 9.85 ± 2.6 mm and 5 (9.3%) were inlet-type VSD, 10 (18.5%) were outlet-type VSD, 13 (24.1%) were muscular and 26 (48.1%) were perimembranous VSD (Table 1). One (1.9%) patient had residual VSD and had undergone reoperation for hemodynamically significant residual VSD. 10 (18.52%) had ASD secundum, 18 (33.33%) had PDA, 1 (1.9%) had coA and 4 (7.4%) had web. The indication for surgery was substantial left to right shunt in 53 (98.1%) patients, progressive aortic regurgitation in 1 (1.9%), refractory systemic pulmonary hypertension in53 (98.1%) and failure to thrive in 53 (94.45%) patients. Post-surgical result by echocardiography showed immediate pulmonary artery pressure reduction in all patients, other post-surgical evaluations showed 1 (1.9%) mild 1 (1.9%) moderate to severe pericardial effusion, 1 (1.9%) first degree AV Block, 2 (3.7%) right bundle branch block and 4 (7.4%) complete heart block leading to permanent pace maker implantation. Significant myocardial stunning (ejection fraction < 40%) was noted in 6 (11.11%). 2 (3.7%) had Down syndrome. Patient mortality in the first 30 days was zero. The hospital stay was 15.6 ± 11.36 days and every excess kilogram of operative weight results in 3.24-days shorter hospital stay. There was no post-operative immediate endocarditis, seizure, bleeding or cardiac arrest.

Table 1. The Size and Type of Ventricular Septal Defects

Type of Ventricular Septal Defects	No. (%)
Inlet-type VSD,	5 (9.3)
Outlet-type VSD,	10 (18.5)
Muscular VSD	13 (24.1)
Perimembranous VSD	26 (48.1)

4. Discussion

Surgery is known to be the definite treatment of the ventricular septal defect. It wipes the left to right shunt, prevents pulmonary vascular disease development, decreases the risk of endocarditis, prevents the occurrence of aortic regurgitation, improves the functional classification and increases long-term survival (8). Lower weight at the time of the surgery and prematurity are the risk factors leading to higher post-operative mortality and this implies the fact that these patients are less tolerable for the surgery (9); however according to the vast advances in the past 25 years, weight has disappeared as a limitation for the operation (10). Recent advances even enabled the surgeons to operate the patients with the weight less than 2.5 kilograms whilst palliative therapy was the only treatment in the past

(11). According to Chang et al. palliation and surgery until the appropriate weight gain results in not only less survival but also higher mortality during the surgery (12). Surgical closure of these defects are safer and more effective (13) and is preferred to the palliative therapies.

According to a retrospective study done by Anderson et al. on a consecutive series of 369 ventricular septal defect closure, they found that every extra kilogram of weight at the time of surgery results in 2.3-day shorter length of hospital stay, they also found an increment of 1.8 fold in composite risk for the surgery with every kilogram decrement in weight before 6 months of age. Finally they concluded that the age and weight are important factors of morbidity and should be highly considered for the patients undergoing surgery, especially under 6 months of age (14). According to our findings, each extra kilogram of operative weight results in 3.24-day shorter length of hospital stay. Clearly shorter length of hospital stay leads to less costs for the health system besides lower risks of nosocomial infections.

Contrariwise, antithetic findings are reported, as well. For the evaluation of early intervention outcomes of surgical VSD closure, Kogon et al. investigated 225 patients and categorized them based on their operative weight. They showed that length of ICU and hospital stay and surgical complications such as residual VSD, did not have any significant association with weight. They recommend early surgical closure of the defect as it can prevent heart failure and growth impairment (15). Another study on 243 patients, found a correlation between hospital stay and weight but none between weight and other major complications and adverse effects (16). Both of them reported no mortality but the second one reported two (0.8%) cases of pacemaker implantation due to permanent complete heart block and 5 (2.1%) cases of re-operation because of hemodynamically important residual VSD. In our study, 7.4% of the patients underwent pacemaker implantation and 1.9% needed re-operation. It is assumed that cannulation of right atrium for cardiopulmonary bypass is associated with sinus node dysfunction (17). The right bundle branch block is rare in normal population (18) so post-operation right bundle branch block is probably as a result of the intervention and it is proximally damaged by the closure of the defect, although it has a little clinical significance (19). European Association for Cardio-Thoracic Surgery (EACTS) congenital databases reported the 30-day mortality of patch repair and primary VSD closure as 1.38% and 1.84% (20). Zero 30-day mortality and 1.9% incidence of residual VSD is lower than other in studies. Existence of the missed residual VSD is improbable since the color Doppler echocardiography is a sensitive modality for identifying the integrity of septum. These observations can prove increased ability, knowledge and techniques of the surgeons operating VSDs and so, based on the outcomes, earlier surgical VSD closure is recommended.

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