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Original Article

Conduction system disorders after surgical patch closure of ventricular septal defects; a comparison between two suturing techniques

Abdallah Nosair[1], Mohamed Elkahely[2], Rezk Abu-Gamila[2]

[1] Cardiothoracic Surgery Department, Faculty of Medicine, Cairo University, Giza, Egypt

[2] Department of Cardiothoracic Surgery, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt

Abstract

Background: Ventricular septal defect (VSD) is the most common congenital heart disease, and conduction disorder is one of the frequent complications after VSD closure. Suturing technique used for VSD closure may affect the occurrence of this complication. The aim of this study was to compare the outcome of VSD surgical patch closure using continuous versus interrupted suture techniques.

Methods: The study included 150 VSD patients who had surgical patch closure between December 2014 and March 2017. They were subclassified into two groups according to the suture technique; continuous suture technique (n= 75) and interrupted suture technique (n= 75). Preoperative, operative, and postoperative variables were reviewed and analyzed. The postoperative rhythm was recorded using continuous electrocardiogram during intensive care unit stay. 12-leads electrocardiogram and echocardiography were performed immediately after surgery and repeated before discharge and after 3, 6, 12 months then yearly. The follow-up period ranged from 1 to 3.25 years (2.04 ± 0.84 years).

Results: Aortic cross-clamp time was longer in the interrupted technique group (51.40±15.21 vs. 42.32±13.86 minutes; p <0.01). 7 (9.3%) patients in the continuous technique group had an atrioventricular block during ICU stay, and 2 (2.7 %) had complete heart block. However, one patient (1.3%) in the interrupted technique group had an atrioventricular block, and no patient had complete heart block (p=0.006). Incidence of conduction defects during follow-up was insignificantly different between the groups. There was no significant difference in the postoperative complications between the groups.

Conclusion: Complete heart block is an infrequent complication after VSD patch closure. The interrupted suture technique was associated with a lower incidence of conduction defects during the early postoperative period.

KEYWORDS

Conduction disorders; Cardiac arrhythmia; Ventricular septal defect; Complete heart block

Article History

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Introduction

Ventricular septal defect (VSD) is the most common congenital cardiac disease (CHD), and it occurs in 20% of patients with CHD either as an isolated defect or in association with other lesions [1]. Injuries to the conduction system can occur during surgical repair of VSD because of the proximity of VSD to the conduction system [2].

Corresponding author: Abdallah Nosair abdallah_nosair@live.com

The same degree of traction and tension while anchoring the patch is essential during both continuous or inter¬rupted suture techniques, and this maneuver is used to achieve good surgical exposure [3]. Postoperative complete heart block (CHB) can occur due to direct injury of the conduction system by the stitches or the edema complicating the repair [4]. The incidence of CHB following surgical closure of VSD varied in the literature, and it can occur in up to 3.5% in some studies [5]. Postoperative CHB negatively affects morbidity and mortality after VSD repair [3, 6-9].

The optimal suturing technique to repair the VSD is still debatable, and the technique used for patch closure of VSD may affect postoperative conduction disturbance. Our study aimed to compare the early and midterm outcomes of VSD surgical patch closure using continuous versus interrupted suture techniques and evaluate their effect on postoperative conduction system defects.

Patients and Methods:

We performed a retrospective cohort study on 150 patients who had surgical patch closure of the VSD between December 2014 and March 2017. The surgical intervention was performed by one surgeon in multiple cardiac centers in Cairo with both interrupted and continuous suturing techniques. The choice of the technique was done according to the surgeon's preference, experience, and familiarity in closing VSDs according to the anatomical factors.

We included patients less than 16 years at the time of surgery who presented with congenital VSD or VSD associated with simple concomitant CHD, eg: atrial septal defects (ASD), double-chambered right ventricle (DCRV), patent ductus arteriosus (PDA), pulmonary stenosis (PS) or tetralogy of Fallot (TOF). While patients who had VSD associated with more complex cardiac anomalies such as hypoplastic left heart syndrome (HLHS), left ventricular outflow tract obstruction (LVOTO), atrioventricular canal (AVC) defects, partial or total anomalies of pulmonary or systemic venous connection, coarctation, cortriatriatum, and patients with previous surgery or congenital valvular lesions were excluded. Additionally, we excluded patients with multiple VSDs and patients who had direct VSD closure without a patch.

The first 75 patients with complete data who had repair using either the continuous or interrupted suture technique were included in the study to create two equal groups.

Data collection

Preoperative data:

We reviewed the patients' medical record, preoperative imaging, and surgical notes. Data collected included age, sex, body weight, history of arrhythmia, VSD type, size, the pressure gradient across the defect, pulmonary artery systolic pressure (PASP), and the associated CHD. Electrocardiogram (ECG) and Echocardiography (ECHO) were analyzed, and their data were recorded.

Operative data:

Operative variables that were recorded included: method of defect closure (continuous or interrupted suture), type of patch material used, the need for tricuspid valve detachment and aortic cross-clamp (ACC) time.

Postoperative data:

Continuous monitoring of ECG was done during intensive care unit (ICU) stay. Regular follow-up with ECG and Echocardiography was performed immediately after surgery and repeated before discharge then, after 3, 6, 12 months then yearly. The follow-up period ranged from 1 to 3.25 years (mean± SD: 2.04 ± 0.84 years). Holter monitoring was used for patients who had major conduction defects on the routine postoperative ECG if sinus rhythm was not regained within 10 to 14 days. For patient on a temporary pacemaker, we performed daily ECG to check the intrinsic rhythm and guide the decision for pacemaker discontinuation. Duration of ICU and hospital stay, operative complications and mortality were recorded.

Surgical Technique

We standardized our technique for VSD closure in all patients. We performed the patch closure using cardiopulmonary bypass with aorto-

Table 1: Comparison of the preoperative and operative patients' characteristics between the continuous and interrupted suture technique. (Continuous variables are presented as mean± standard deviation and range. Categorical variables are presented as number and percent)

Variables		Continuous (n= 75)	Interrupted (n= 75)	P-value
Age (years)		3.00±2.78 (0.4 – 16)	2.55±2.14 (0.4 – 14)	0.268
Males		45 (60%)	43 (57.3%)	0.774
Weight (Kg)		12.82±8.43	10.62±8.19	0.107
Associated congenital anomalies	Isolated VSD	20 (26.7%)	18 (24%)	0.779
	TOF	26 (34.7%)	17 (22.7%)	0.148
	ASD	14 (18.6%)	17 (22.7%)	0.532
	PDA	6 (8%)	10 (13.3%)	0.382
	PS	5 (6.7%)	10 (13.3%)	0.263
	DCRV	4 (5.3%)	3 (4%)	0.500
Type of defects	Perimembranous	48 (64%)	59 (78.7%)	0.086
	Muscular	13 (17.4%)	11 (14.7%)	
	Inlet	7 (9.3%)	3 (4%)	
	Subarterial	7 (9.3%)	2 (2.6%)	
VSD size (mm)		6.76±2.30	6.09±2.79	0.110
Pressure gradient across VSD		45.87±24.85	40.84±21.96	0.194
VSD patch material	PTFE (Gortex)	50 (66.7%)	51 (68.0)	0.068
	Dacron	5 (6.7%)	13 (17.4%)	
	Bovine pericardium	14 (18.6%)	4 (5.3%)	
	Native pericardium	6 (8.0%)	7 (9.3%)	
Tricuspid valve detachment		12 (16%)	8 (10.7%)	0.407
Aortic cross clamp time (min)		42.32±13.86	51.40±15.21	0.0002

ASD: Atrial septal defects; DCRV: Double-chambered right ventricle; PDA: Patent ductus arteriosus; PS: Pulmonary stenosis; PTFE: Polytetrafluoroethylene; TOF: Tetralogy of Fallot; VSD: Ventricular septal defects

bicaval cannulation, and mixed blood and crystalloid cardioplegia in a ratio of 1:4 was used in all surger¬ies. Oblique right atriotomy was used in all cases, and tricuspid detachment was used if the defect exposure was not optimum or excess TV tissue or chordae jeopardized the closure of VSD (n= 20). VSD closure started first before the repair of other associated lesions if present

We used patch closure technique in all cases. Approach to the ventricular septum and type of sutures were noted (For the interrupted group we used Ethibond 4/0 Teflon felt stitches (Ethicon Inc. Cornelia, Georgia, USA) and polypropylene 5/0 in the continuous group). Defect size was defined by the largest VSD diameter at surgical inspection and the preoperative¬ VSD diameter measured with Echo was considered if it was matched with the operative finding.

Statistical Analysis

Continuous data were described as mean and standard deviation and categorical data as number and percentage. The student t-test was used to compare numerical variables between the two groups. Chi-square ($\chi 2$) or Fisher Exact test was used to compare qualitative data. A p-values < 0.05 was considered statistically significant. Our statistical analyses were done using Statistical Package for the Social Science (SPSS version 23) (IBM Inc., Chicago, IL, USA).

Results

The total number of patients was 150; 88 (58.7%) of them were males. The mean age was

3.00 ± 2.56 years, and mean weight was 11.72 ± 8.36 kg. In the continuous suture technique; the concomitant congenital anomalies were TOF (34.7%), ASD (18.6%) and PDA (8%), and 26.7% of cases had isolated VSD. In the interrupted group, 22.7% had TOF, 22.7% had ASD, and PDA was present in 13.3%, and 24.0% of cases had isolated VSD. Aortic cross-clamp was longer in the interrupted technique group (51.40±15.21 vs. 42.32±13.86 minutes, p <0.01). (Table 1)

Sixty-six (88%) patients in the continuous group had sinus rhythm which occurred during the ICU stay, 7 (9.3%) had atrioventricular block (AVB), and 2 (2.7 %) had complete heart block (CHB). In the interrupted technique group, 74 (98.7%) patients had sinus rhythm, and 1 (1.3%) patient had AVB. No patient in this group had CHB.

At the time of the last follow-up, 52 (71.2%), 17 (23.3%), and four patients (5.5%) in the continuous technique group had sinus, right bundle branch block (RBBB) and RBBB with right anterior hemi-block, respectively. On the other hand, 56 (75.7%), 17 (22.9%), and one patient (1.4%) in the interrupted technique group had sinus, right bundle branch block (RBBB) and RBBB with right anterior hemi-block (HB), respectively (P=0.006). The incidence of cardiac conduction defects at the midterm follow up was not statistically significant between the two groups (P = 0.242).

The mean ICU and hospital stays were comparable between the two groups (P = 0.220 and 0.425, respectively) (Table 2). Two (2.7%) patients in the continuous technique group had hospital mortality. Causes of death were heart failure and bleeding. One patient (1.3%) in the interrupted technique group had hospital mortality due to heart failure (Table 2). No other major events or reoperations for residual defects or valve lesion were reported during the follow-up. No major neurological insult occurred in the studied groups.

Discussion

VSD is the most common congenital heart defects requiring surgical repair [3]. Conduction system defects, especially CHB are serious complications of VSD closure and the leading cause of cardiac morbidity during the long-term follow-up, especially when performing surgical repairs in younger patients [7].

Table 2: Comparison of the outcomes between continuous and interrupted suture technique. (Continuous variables are presented as mean± standard deviation and categorical variables as number and percent)

Variables		Continuous (n=75)	Interrupted (n=75)	P-value
ICU rhythm	Sinus	66 (88%)	74 (98.7)	0.006
	AVB	7 (9.3%)	1 (1.3%)	
	CHB	2 (2.7%)	0 (0)	
Follow up rhythm	Sinus	52 (71.2%)	56 (75.7%)	0.242
	RBBB	17 (23.3%)	17 (22.9%)	
	RBBB with RT anterior HB	4 (5.5%)	1 (1.4%)	
ICU stay (days)		2.57±1.57	2.32±0.79	0.220
Hospital stay (days)		5.32±1.38	5.18±0.63	0.425
Complications	Bleeding	1 (1.3%)	0 (0%)	0.529
	Superficial wound infection	2 (2.7%)	1 (1.3%)	
	PH crisis	1 (1.3%)	1 (1.3%)	
	Chest infections	0 (0%)	1 (1.3%)	
Mortality		2 (2.7%)	1 (1.3%)	0.617

AVB: Atrial ventricular block; CHB: Complete heart block; RBBB: Right bundle branch block; ICU: Intensive care unit; PH: pulmonary hypertension; HB: hemi-block

The incidence of conduction defect was higher in the continuous technique group during ICU stay (p=0.006). In agreement with our findings, multiple studies reported a low incidence of CHB after VSD closure [7, 10-12]. Based on their results, they suggested that the risk of postoperative CHB after VSD closure should be < 1% and the expected mortality for those patients should be near 0%. In the interrupted technique group, CHB and overall mortality were 0 and 1 (1.3%) respectively, and the overall complication rate was 3 (4.0%). Recently Gholampour-Dehaki and colleagues exhibited a nearly similar rate of CHB. In their interrupted technique group, the incidence of CHB and the operative mortality were 2.2% and 0.4%, respectively. Furthermore, 3.9% of their patients needed reoperation for residual VSD with no valve-related complications and good left ventricular (LV) function postoperatively [3]. Our findings suggest that the incidence of conduction defects was very low with both methods of closure, and conduction defects were similar in the two groups during the follow-up.

Right bundle branch block (RBBB) was common in our series, and in the last follow up, RBBB was detected in 17 (23.3%) patients who had continuous suture and 17 (22.9%) patients with interrupted suture repair. RBBB with right anterior heart block was detected in 5.5% and 1.4% in the continuous and interrupted suturing groups; respectively. This is similar to what was observed by Gholampour-Dehaki and associates, where 18.2% of their cases had complete RBBB, and 12.6% had RBBB with right anterior hemi-block [3]. The clinical implication of long-standing RBBB has been fully reported by Pederson and colleagues who studied the long-term effects of RBBB on LV function after surgical closure of VSD. They concluded that RBBB had a very high incidence after surgical repair, but did not affect systolic LV function; however, it may affect diastolic function during the long-term follow-up [9].

Previous studies suggested an association between heart block after surgical VSD closure and small patients' weight as a risk factor [13, 14]. Siehr and coworkers revealed that patients with body weight < 4 kg have significantly higher risk for AV block postoperatively [15]. Our results could not confirm such a difference. Moreover, Anderson and colleagues concluded that the anatomical location of VSD and the type of repair for associated defects significantly predicted the risk of surgical heart block. They concluded that patients post-AV canal repair were likely to develop postoperative heart block compared to patients with TOF and isolated VSD repair. In our study, we excluded VSD associated with AV canal and more complex association to study the effect of suturing methods on our outcome without involving different approaches or complex surgeries that may affect our results. Additionally, the majority of patients in their study with postoperative heart block had inlet VSDs, this can be explained by the proximity of the conduction pathway to the inlet VSD [16]. In our study, 71.33% of our patients had perimembranous VSD, and the minority was inlet defects; this may explain the lower incidence of conduction defects when compared with their results. Tanveer and colleagues study showed that residual VSD is more common with the continuous suture compared to the interrupted technique of surgical VSD closure, but they did not find any cases with postoperative heart blocks in their patients [17].

In summary, conduction defects occurred more frequently in the early postoperative period, and they were more frequent with continuous suture technique. During follow-up, the prevalence of conduction defects was not different between the two techniques.

Study limitations

The retrospective nature of the study and the small patient numbers are the major limitations, and the findings need to be verified by other prospective larger studies. Additionally, long-term follow-up may be required for better evaluation of the late incidence of conduction defects.

Conclusion

Complete heart block is an infrequent complication after VSD patch closure. The interrupted suture technique was associated with a lower incidence of conduction defects during the early postoperative period when compared with the continuous technique. However, no difference

was found between both techniques during follow-up.

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Conflict of interest: Authors declare no conflict of interest.

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