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Randomized Study to Compare Continuous and Interrupted Technique of Ventricular Septal Defect Closure

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Abstract

Objective: To compare the outcome of continuous and interrupted surgical technique of Ventricular Septal Defect (VSD) closure with respect to the time taken for VSD closure, incidence of residual VSD and conduction abnormality.

Methods: Randomized case control study was done with Pre-operative TTE and intraoperative TEE before instituting CPB to confirm the type of VSD. Patients were put on Cardio pulmonary bypass using standard technique, all VSDs were approached though Right atrium. VSD closure was done using PTFE patch in all the patient. 5–0 polypropylene double arm sutures were used in a total of 60 patients, 30 in each group with respect to continuous and interrupted technique of VSD closure. Residual VSD and conduction abnormality were assessed intra-operatively after termination of CPB, immediately post operatively in Intensive Care Unit (ICU) and after 1 month.

Results: The study included total 60 patients, 30 in each group as continuous and interrupted. The mean age group was 6.5 years. Most common cardiac abnormality detected in the study group was Tetralogy of Fallot (40%), 25% patient had isolated VSD. Most commonly encountered VSD type was Perimembranous (86.67%). We observed that 3 patients had residual VSD, out of these 2 were of continuous group with residual VSD size of less than 2 mm and 1 was of interrupted group with residual VSD of 3 mm. All residual VSDs were detected immediately after CBP but there were no residual leaks seen in the post operative period. Only 58 patients were followed for 1 month with no residual VSD. Only one patient of continuous group had complete heart block requiring pacemaker.

Conclusion: All types of VSDs can be closed by either of the technique. The residual VSD detected in the post bypass period in both the groups were statistically insignificant. In isolated VSD continuous technique is better in terms of less time required for VSD closure, less number of cardioplegia and lesser cardiopulmonary bypass (CPB) time hence less myocardial damage due to ischemia and reperfusion, where as it does not give added advantage in patients with VSDs as well as associated anomalies as the total CPB time and number of cardioplegia delivered is unpredictable.

Keywords: VSD Closure; TTE; PTFE Patch.

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Introduction

Amongst all the congenital heart diseases, ventricular septal defect (VSD) is the most common type, occur in 0.5 of 1000 live birth and 4.5 to 7 of 1000 premature infants.[1-4] VSD can be isolated or may occur with other complex cardiac anomalies. In 1955, Lillehei and colleagues performed first successful VSD closure under direct vision using cross-circulation at University of Minnesota.[5] In 1956, Dushane and Kirklin et. al. performed the first successful closure of VSD using cardiopulmonary

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bypass at Mayo Clinic.[6] Closure of VSD can be done using PTFE/Dacron, native or bovine pericardium etc, the technique can be continuous, interrupted or in part continuous and rest interrupted, which varies among surgeons but the objectives are secure closure without any residual leak, valvular regurgitation and conduction abnormality. In earlier series residual leak was reported to be 1% to 8%.[7-11] In recent series less than 5% showed residual VSD which is mainly due to suture cut through, patch dehiscence, widely placed buttressing pledgets and missed margin.[11] Suturing technique play a significant role in preventing residual leak. After surgical closure of VSD trivial residual shunting is nowadays easily detected with modern sensitive echocardiographic techniques. Intraoperative transoesophageal echocardiography (IOTEE) during surgical repair of congenital heart diseases allows for immediate identification of the location, size, and severity of the residual lesions. Some of the residual VSD defect, which are not detected on IOTEE, are noted on follow up TEE conducted at the time of discharge. Transiently elevated right ventricular pressure or peri-patch swelling in the operating room may contribute to the masking of the small defect that only becomes apparent during post operative period.[12] Some VSDs detected on follow up course might have been missed during early post operative TTE or might have developed de novo.

This study was undertaken to compare the results of Interrupted versus Continuous suture techniques for VSD closure with regards to residual VSD during immediate post operative period, surgical time and residual VSD on the post operative follow up.

The aim of the study is to compare the incidence of residual leak, time taken for VSD closure and conduction abnormality in continuous and interrupted technique respectively.

Methods

The study was conducted in the department of cardiac surgery and cardiology, PGIMER, Chandigarh. 60 patients with congenital ventricular septal defect were enrolled into the study. An informed consent was taken. 60 Patients were randomized into continuous or interrupted group respectively at the time of admission by using the table of random numbers. The operating surgeon was unaware of the enrollment of the patient included in the study. Patients with non congenital VSDs, previous cardiac surgeries, VSDs with severe PAH and patients with infective endocarditis were not included in the study. Phillips-Matrix pediatric biplane TEE/TTE probe (iE 33, Bothell, 98041 USA) at a frequency of 3.5MHZ or 5.5MHZ was used for the assessment of VSD and other associated congenital anomalies during initial diagnosis and before instituting cardiopulmonary bypass. 5.5MHZ probe was used to assess the integrity of VSD patch, location and size of residual defect, as well as,valvular competency and biventricular function was also assessed. When the residual defect was noted a detail of the defect in the form of transverse and longitudinal diameter and the exact site of the residual defect was recorded in millimeters. If there was a very small jet of flow via Doppler color flow imaging but the residual VSD not visualized by 2D imaging, the defect was considered as <2mm in diameter. Follow up TTE was done in immediate post operative period in ICU and during follow up in OPD.

Surgical Techniques

All patients were subjected to median sternotomy, after dissection and partial excision of thymus gland, pericardium was opened in inverted T manner and hitched up. The cardiac morphology was examined, patients were heparinized and put on cardiopulmonary bypass using aortic and bicavalcannulation, venacavaewere snared. Aortic cross clamp was applied and aortic root antegrade blood cardioplegia was delivered (20ml/kg) soon after aortic cross clamp applied. Right atrium was opened close and parallel to AV grove from base of appendage to IVC cannula, blood sucked out from RA and both ventricle, clearing delivered cardioplegia, stab incision was made in the fossa ovalis and LA vent was placed through it. VSD defined, in case of difficulty in visualizing VSD, detachment of septal leaflet of tricuspid valve was done. PTFE patch slightly larger and conforming to the shape of VSD was cut out a double arm 5–0 polypropylene starting from anterior-inferior border of VSD in anti-clockwise direction till tricuspid annulus was reached PTFE patch pledgets were used intermediately to buttress the VSD margin whenever fragile VSD margin was encountered as shown in Fig. 1.

The other arm of the suture was carried clockwise at the posterior-inferior border; suture bites were taken 3– 5 mm from the margin to avoid conduction bundle. Both arm of the sutures was brought on the atrial aspect of tricuspid valve, tied and cut as shown in Fig. 2. In interrupted technique several

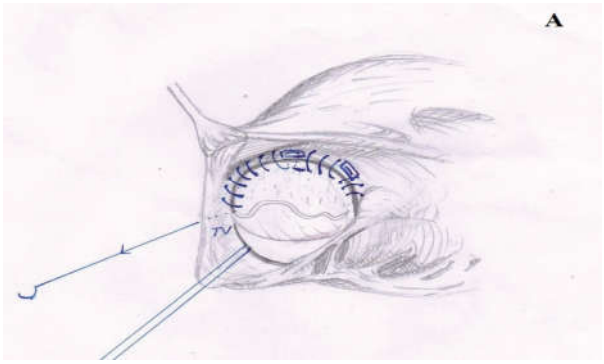

Fig. 1: Continuous suturing using single double arm 5-0 Polypropylene suture ;view through RA- Tricuspid valve. (A) In Progress (B) Complete.

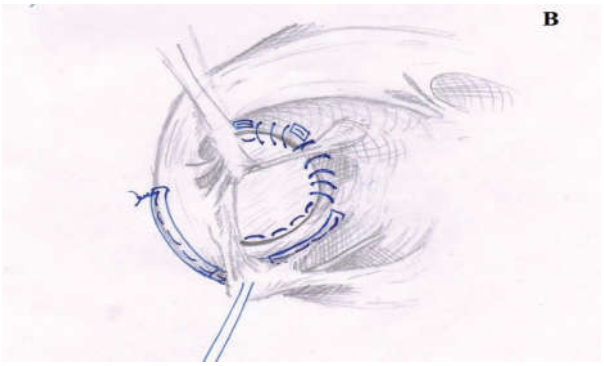

Fig. 2: Continuous suturing using single double arm 5-0 Polypropylene suture ;view through RA- Tricuspid valve. (A) In Progress (B) Complete.

pledget reinforced mattress stitches were placed around perimeter of VSD closely, PTFE patch slightly largerthanVSD was cut and all sutures were passed through the margin of the patch, then the patch was lowered or parachuted and attached securely to ventricular septum by tying all sutures.

The analysis of categorical variables was performed with X2 test. Continuous variables described as the mean +/– standard deviation was analyzed using the independent student's t-test. Logistic regression analysis was used to analyze predictive values for residual shunt at discharge. A significant difference was found when probability values were smaller than 0.05.

Results

A total of 60 patients, 30 in each group who fulfilled the inclusion criteria were included in the study. Results were analyzed with respect to two groups; according to the technique- continuous and interrupted technique of VSD closure.

The mean age in the study group was 6.5 years (range: 0.17 to 36 years), males were predominant with 66.7% (Table 1–2).

The most common cardiac abnormality detected in the study was Tetralogy of Fallot (TOF) 40% and 25% patients had isolated VSD. Mean pre-operative

Table 1: Postoperative conduction abnormalities in the two groups.

Conduction Abnormality Postoperative		Group		Total
		C	I	
Vsd With Associated Anomalies		20	22	42
	NSR	(87%)	(100%)	(93.3%)
	RBBB	3(13%)	0	3(6.7%)
	TOTAL	23	22	45
Isolated Vsd	CHB	1(14.3%)	0	1(6.7%)
	NSR	6(85.7%)	8(100%)	14(93.3%)
	Total	7	8	15

Table 2: Mean parameters in continuous and interrupted group and overall (n=60).

Parameter	Continuous (N=30)	Interrupted (N=30)	Mean (N=60)	P Value
Cross Clamp Time in Min	72.76	86.67	79.71	0.186
CPB Time in Min	122.1	133.56	127.85	0.423
Vsd Closure Time in Min	22.7	37.7	30.23	<0.001
No. of Cardioplegia	2.25	1.87	2.63	<0.001

Table 3: Technique of VSD closure in VSD with associated anomalies and isolated VSD.

Group	Technique	Number
Vsd With Associated Anomaly	Postoperative	23
	Interrupted	22
Isolated Vsd	Continous	7
	Interrupted	8

Table 4: Mean duration in VSDs with associated anomalies and isolated VSDs.

Group	Parameter	Technique	Number	Mean	P Value
VSD With Anomalies	Cross Clamp Time	Continuous	23	81.4783	0.165
		Interrupted	22	98.5000	
	CPB Time	Continuous	23	135.0000	0.485
		Interrupted	22	146.4	
	VSD Closure Time	Continuous	23	24.00	0.001
		Interrupted	22	40.05	
	No of Cardioplegia	Continuous	23	2.04	0.001
		Interrupted	22	2.8	
Isolated VSD	Cross Clamp Time	Continuous	7	44.1	0.325
		Interrupted	8	54.1	
	CPB Time	Continuous	7	79.8	0.358
		Interrupted	8	98.25	
	VSD Closure Time	Continuous	7	18.43	0.004
		Interrupted	8	31.50	
	No Of Cardioplegia	Continuous	7	1.29	0.009
		Interupted	8	2.13	

Table 5: Table showing Post CBP residual VSD in the two groups.

Post CPB Residual Vsd	Continuous	Interrupted	Total
Yes	2	1	3
No	28	29	57
	30	30	60

Table 6: Post CPB residual VSD site.

Residual Vsd	Group	Total
	Continuous	Interrupted
None	28	29	57
Subaortic	0	1	1
Inlet	1	0	1
Muscular	1	0	1
	30	30	60

Table 7: Follow up TTE showing valvular lesion in both continuous and interrupted group (each grouped as isolated VSD and VSD with other anomalies).

Valvular Lesion	Continuous Group (N=30)		Interrupted Group (N=30)	
	Isolated VSD (N=7)	VSD Associated With Other Anomalies (N=23)	Isolated VSD (N=8)	Vsd Associated With Other Anomalies (N=22)
AR	Mild AR In 1	No	Mild AR In 1 Case	No
MR	No	No	No	Mild MR In 1
PR	No	9	No	9
TR	Mild TR In 1	4	Mild TR In 2	5
Follow Up Residual VSD	No	No	No	No
Infective Endocarditis	No	No	No	No

VSD size was 12.53 mm with perimembranous type being the commonest type. Only one patient had pre-operative Right bundle branch block (RBBB), after surgery 4 patients developed conduction abnormalities out of the 3 recovered and one patient required permanent pacemaker insertion (Table 3–5).

VSD closure time, number of cardioplegia used were less in continuous group which were statistically significant whereas mean duration of cross clamp time in continuous was 72.76 minutes and interrupted 86.87 minutes (Table 6) which was statistically insignificant hence further analysis done by splitting the respective group into Isolated VSD and VSD with associated anomalies (Table 7).

Various parameters like total surgical time, cross clamp time, CPB time and VSD closure time with respect to groups were compared and was found that the difference in mean cross clamp time, CPB time was statistically not significant, when the techniques were employed for VSDs with associated anomalies and isolated VSD repair. However, the number of cardioplegia used and the VSD closure time were significantly less in continuous technique in both the groups (Table 8).

Residual VSD was detected in 5%(3/60) patients of these 2 were in the continuous group and 1 from interrupted group. Both residual VSDs in continuous group occurred in patients with TOF and were of 2mm in size, whereas in interrupted group residual VSD occurred in isolated VSD.

Discussion

Surgical closure of VSD is a routinely performed operation, using standardized surgical techniques and postoperative care. Outcomes are excellent with mortality and morbidity rates approaching zero for isolated VSD in almost all centers internationally. When VSD is a part of more complex congenital heart disease such as TOF or Atrio-ventricular canal defect, the surgical mortalities range from 1–5% and 3–11% respectively.[11] In the modern era, elective closure is performed in infancy or early childhood. After successful surgical repair, long standing preoperative pulmonary hypertension or volume overload of the ventricle is relieved there by reducing the potential residual long term morbidity. The focus on the post surgical history of these defects lies in long term quality of life and functional status which will be influenced by eventual residual lesions, one of which is a VSD shunt.

A prospective randomized study was conducted over a period of one year (December 2012 to December 2013). 60 patients were randomly divided into two groups: continuous (30 patients) and intermittent (30 patients) based on the technique of VSD closure. Randomization was done at the time of admission using table of random numbers.

The mean age of the study group was 6.5 years out of these the mean age of patients with isolated VSD was 3.74 years this is higher than that reported by Scully et. al. (mean age was 10 months) in their study.[12] In present era and in this part of world, late presentation reflects lack of awareness and health care facility. Majority of patients were males in both the group, similar results have also been reported by Tanveer et. al.[13] All types of VSDs are amenable to closure by either of the technique, the time taken in VSD closure can be influenced by the site of VSD and its surgical approachability. In both the groups perimembranous group was the most commonly encountered type of VSD and hence there was no statistically significant difference, so the type of VSD did not influence the surgical technique employed.

In this study, mean cross clamp time, mean CPB time, mean VSD closure time and number of cardioplegia were 79.7 min, 127.8 min, 30.23 min and 2.25 respectively these results are higher compared to those of Raapa et. al.,[14] they reported a mean CPB duration of 64±25 min, mean cross

clamp time of 34±13 min. These differences can be explained as they included patients with isolated VSD only whereas we had patients with associated cardiac anomalies and hence the duration of surgery and other parameters were longer. The total CPB time was also not statistically significant in both group because of the same reasons. The cross clamp time and VSD closure time was less in continuous group and statistically significant. The number of cardioplegia used in interrupted group were more than double and statistically significant. The reported incidence of complete heart block after closure of VSD ranges from 0–11%. In our study, it was 10% matching the results by Sigmann et. al.[15] One patient had CHB, the child was pacemaker dependent with his own heart rate of 40–50/min requiring permanent pacemaker but relatives refused further intervention and the child was discharged against medical advice, we followed up the patient after 6 months telephonically and the child was doing well with heart rate of 60–70/min.Batra et. al.,[16] noted that recovery of atrio-ventricular conduction occurred in 9.6% at median of 41 days (range 18 days to 113 days) after the surgery.

A perfect surgical technique to close VSD should not leave any residual VSD. The various possible cause of residual VSDs are, missing margin, too wide suture bites, suture cutting through VSD margin, suture breakage and folding of VSD patch at the margin. In our study, 3 patients (5%) had residual VSDs, 2 in continuous group and 1 in intermittent group. In continuous group, one patient had residual leak near the posterior-inferior margin and the other near the anterior margin of the VSD patch. Both the residual shunts were less then 2mm size and hemodynamically insignificant hence no intervention needed. One patient of interrupted group showed residual leak in sub aortic region which was 4 mm in size and patient had difficulty in coming off CPB hence residual leak was closed with additional pledgeted suture after reinstituting CPB and arresting the heart. Yang and colleagues17 detected a residual VSD in 96 of 294 patients (33%), being slightly higher in patients after closure of an isolated VSD (41%) as compared with that after correction of more complex defects with a VSD component (30%) using intraoperative TEE. From the 96 of 294 residual defects seen by intraoperative TEE, only 33 had a residual VSD detected by TTE at hospital discharge (34%).

Khatami et. al.[18] found a global residual shunt rate ranging between 15% and 25% on intraoperative TEE, compared with a 30% to 46% rate of residual defects detected by postoperative TTE in the ICU, and a rate between 35% and 38% on TTE by hospital discharge. This incidence may seem high but includes a majority of 1 mm defects, which are mostly hemodynamically insignificant.

The groups of VSD closure in our study were not matched for age, hence the differences in the age may be an additional risk factor in the study. The mean surgical time, cross clamp time and CPB time in two groups may not be an actual reflection of the outcome due to surgical technique of VSD closure employed because of concomitant cardiac anomalies. The examiner who performed IOTEE was not necessarily the same one who performed the transthoracic echocardiography later on, which may raise a concern regarding inter-observer variability. No long term follow up to know the state of late occurrence of residual leak. Cardiac catheterization was not done to show residual leak.

Conclusion

All types of VSDs are amenable to closure, either by continuous or interrupted technique, there is no significant difference in the incidence of residual VSD between both the groups. The cross clamp time, VSD closure time and number of cardioplegia used were less in continuous group, albeit, isolated VSD patients showed statistical significance, whereas, in patients with complex congenital heart disease, due to varying amount of time required in repairing associated anomalies, no statistically significant difference was observed.

Conflict of Interest : Nil.

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