Kocatepe Tıp Dergisi
Kocatepe Medical Journal
24:96-104 / Ocak 2023 Sayısı

ARAŞTIRMA YAZISI / RESEARCH ARTICLE

FARKLI YAŞLARDAKİ OPERE EDİLEN VSD'Lİ HASTALARIN DEĞERLENDİRİLMESİ

EVALUATION OF THE PATIENTS OPERATED WITH VSDs OF DIFFERENT AGES

Abdurrahim ÇOLAK[1], Necip BECİT[2], Uğur KAYA[1], Münacettin CEVİZ[1]

[1]Atatürk Üniversitesi Tıp Fakültesi, Kalp ve Damar Cerrahisi Ana Bilim Dalı
[2]Afyonkarahisar Sağlık Bilimleri Üniversitesi Tıp Fakültesi, Kalp ve Damar Cerrahisi Ana Bilim Dalı

ÖZET

AMAÇ: Ventriküler septum defekt (VSD), sol ve sağ ventrikülü ayıran septuma yerleşen, bir ya da daha fazla sayıda olabilen açıklık olarak tanımlanabilir. Ventriküler septal defektler konjenital veya akkiz olabilir. En sık görülen doğuştan kalp anomalisidir. Bu yazımızda Kliniğimizde cerrahi olarak tedavi ettiğimiz VSD leri literatürler eşliğinde değerlendirdik.

GEREÇ VE YÖNTEM: Kliniğimizde 68 VSD hastasına girişim yapıldı. 39 olgu erkek (%57.3), 29 olgu kadın (%42.7) idi ve yaş ortalaması 9,10±9,13(1-48) yaş/yıl, kilo ortalaması 25±16,5(7-75) kg olarak bulundu. Preoperatif NYHA fonksiyonel kapasite(FK) karşılaştırıldığında FK-I 31 olgu(%45,5), FK-II 30 olgu(%44,1), FK-III 7 olgu(%10,2) olarak belirlendi. Preoperatif anomali olarak en sık 15 olgu(%22,05) aort yetmezliği(AY) ve aort valf prolapsusu (AVP); 18 olgu(%26,4) ASD; 8 olgu(%11,7) PDA mevcuttu.

BULGULAR: VSD tiplerine göre girişim yöntemlerine bakıldığında perimembranöz tipte en sık 53 olgu (%77,9) ile sağ atriotomi, 1 olgu(%1,4) sağ atriotomi ve triküspit septal annulus radial kesisi; müsküler tipte 8 olgu (%11,7) ile sağ atriotomi ve Swiss-Chess tip olan 2 olguda (%2,9) sol ventrikülotomi; DCJA(Doubly Committed Jukstaarteryel) tipte 4 olgu (%5,8) ile sağ ventrikülotomi tercih edilmiştir. Postoperatif komplikasyonlar arasında en sık görülen 9 olgu(%15,3) ile rezidü VSD dir. Fatal seyreden 3 hastanın(%5,09) PAB 67±7,5mmHg; LV-RV şant 49±9,6mmHg; Qp/Qs 4,7±3,87; PVR 7,5±4,6 değerlerinin yüksek oldukları görülmüştür. Pre/postoperatif NYHA ve RVP karşılaştırıldığında istatistiki olarak anlamlı($p<0,05$) olduğu görülmüş olup reoperasyonsuz yaşam olasılığı %93,2 olarak hesaplanmıştır.

SONUÇ: Ventriküler septal defekt en sık görülen konjenital kalp hastalığıdır. Tanı ve sınıflandırılmasında EKO ve kardiak anjiografinin gelişiminin payı büyüktür. Defektleri çok iyi değerlendirip 3 aydan sonra kapatılması tercih edilmelidir.

ANAHTAR KELİMELER: Sol ventrikül, İnterventriküler septum, Defekt

ABSTRACT

OBJECTIVE: Ventricular septum defect (VSD) can be defined as one or more openings located in the septum separating the left and right ventricle. Ventricular septal defects can be congenital or acquired. It is the most common congenital heart anomaly. In this article, we evaluated the VSDs that we treated surgically in our clinic in the light of the literature.

MATERIAL AND METHODS: 68 VSD patients were intervened in our clinic. 39 cases were male (57.3%) and 29 cases were female (42.7%). The mean age was 9.10 ± 9.13 (1-48), and the mean weight was 25 ± 16.5 (7-75). When the preoperative New York Heart Association (NYHA) functional capacity (FC) was compared, FC-I was determined as 31 cases (45.5%), FC-II as 30 cases (44.1%), and FC-III as 7 cases (10.2%). The most common preoperative existing anomalies were 15 cases (22.05%) with aortic insufficiency (AR) and aortic valve prolapse (AVP); 18 cases (26.4%) ASD and 8 cases (11.7%) with PDA.

RESULTS: When looking at the intervention methods according to VSD types, the most common cases of perimembranous type were right atriotomy in 53 cases (77.9%), right atriotomy in 1 case (1.4%) and tricuspid septal annulus radial incision; 8 cases of muscular type (11.7%) and right atriotomy and left ventriculotomy in 2 cases (2.9%) of Swiss-Chess type; Right ventriculotomy was preferred in 4 cases (5.8%) of DCJA (Doubly Committed Jukstaarterial) type. Between postoperative complications the most frequent one was residual VSD in 9 patients (15.3 %). Mortality was seen in 3 patients (5.09 %) with preoperative PAB 67±7.5 mmHg, LV- RV shunt 49±9.6 mmHg, Qp/Qs 4.7±3.87, PVR 7.5±4.6 values in follow-up. According to the comparison of the pre/postoperative NYHA and RVP statistics ($p<0.05$), the survival rate without reoperation was estimated as 93.2 %.

CONCLUSIONS: Ventricular septal defect is the most common congenital heart disease. The development of ECHO and cardiac angiography has a great share in the diagnosis and classification. It should be preferred to evaluate the defects very well and close them after 3 months.

KEYWORDS: Left Ventricle, Interventricular septum, Defect

Geliş Tarihi / Received: 05.01.2022
Kabul Tarihi / Accepted: 28.05.2022
Yazışma Adresi / Correspondence: Doç. Dr. Abdurrahim ÇOLAK
Atatürk Üniversitesi Tıp Fakültesi, Kalp ve Damar Cerrahisi Ana Bilim Dalı
E-mail: abdurrahimcolak@hotmail.com
Orcid No (Sırasıyla): 0000-0002-1380-9779, 0000-0002-9086-515X, 0000-0003-2000-6090, 0000-0003-0166-2893
Etik Kurul / Ethical Committee: Atatürk Üniversitesi Tıp Fakültesi Etik Kurulu (24.05.2021 /40).

INTRODUCTION

Ventricular septum defect (VSD) can be defined as one or more openings located in the septum separating the left and right ventricle. Ventricular septal defects can be congenital or acquired. It is the most common congenital heart anomaly. It constitutes 50% of congenital heart diseases and its prevalence is 41.8 per 10000 live births (1). Although the rate of isolated VSD known in the society is about 20% of congenital heart diseases, the etiopathogenesis of VSD has not been elucidated yet. Along with the genetic predisposition, some environmental factors such as the mother's use of alcohol, smoking and amphetamines, the presence of diabetes in the mother, the mother's work in the paint industry, and pesticides are blamed in the aetiology (2).

VSD is more common in premature and low birth weight children. In colour Doppler ECHO scans performed in recent years, the frequency of VSD at birth has been reported to be between 1-5%. The reason for this increased frequency is the detection of small muscular VSDs, which usually close in the first months of life (3). Although the aetiology of congenital anomalies of the heart is not known exactly, it is thought that both genetic factors and environmental factors play a role in the aetiology. The fact that hereditary or non-hereditary anomalies are sometimes found together with congenital cardiovascular anomalies suggests a genetic feature in some patients (4).

Echocardiography is the most ideal diagnostic method in VSDs. Echocardiographic evaluation should cover all standard precordial leads. Since the ventricular septum is not a simple structure located in a single plane, it must be evaluated in various sections. All except pulmonary vascular resistance (PVR) are evaluated by ECHO. In addition, a good correlation was found between ECHO and cardiac catheterization findings for hemodynamic parameters such as right ventricular pressure and pulmonary-systemic flows ratio (Qp / Qs) measured as an indirect indicator of pulmonary artery pressure on ECHO (5). Transesophageal echocardiography (TEE), such as transthoracic echocardiography, is an important technique in the investigation of VSD morphology and cardiac functions, especially when precordial ECHO images are not sufficient. Catheterization is performed to determine the number of defects, evaluate the size of the shunt, pulmonary vascular resistance, workload of both ventricles, determine other accompanying lesions, inform the surgeon about the anatomical structure and localization of the defect, and transcatheter closure (6). In this article, we evaluated the VSDs that we treated surgically in our clinic in the light of the literature.

MATERIALS AND METHODS

The patients who were operated for ventricular septal defect between 2005 and 2017 by the department were examined. Surgical treatment and follow-up of clinical results of 68 patients who underwent surgical treatment for ventricular septal defects by the Department of Cardiovascular Surgery were retrospectively reviewed. 39 cases were male (57.3%) and 29 cases were female (42.6%). The mean age was 9.19 ± 9.13 (1-48), and the mean weight was 24.1 ± 16.5 (7-75). When the patients were compared according to NYHA functional capacity (FC), FC-I was determined as 31 cases (45.5%), FC-II as 30 cases (44.1%), and FC-III as 7 cases (10.2%). The highest group is the one with a heart murmur in routine health screenings and without symptoms who are referred to the pediatric cardiology clinic. In the physical examination of the patients, there was a murmur in the mesocardiac focus and stiffening at S2. 47 cases (69.1%) of our patients were found to have normal sinus rhythm **(Table 1)**.

Table 1: Preoperative characteristics of the patients

Total Number of Patients	68
Male female	39/29
Age range	1-48 y
Average Weight	25±16,5 (7-75)
NYHA Functional Capacity	
Functional Capacity I	31 (%52,5)
Functional Capacity II	30 (%42,4)
Functional Capacity III	7 (%5,1)
ECG	
Normal Sinus Rhythm	44 (%59,3)
Right bundle branch block (RBBB)	21 (%35,6)
LV Hypertrophy	2 (%3,4)
LV + RV Hypertrophy	1 (%1,7)
Telecardiography: Cardiothoracic Ratio Increased	
Normal	48 (%66,1)
Diagnosis	20 (%33,9)
Echo	
Angiography	3 (%5,1)
Eco + Angiography	1 (%1,7)
VSD Size	64 (%93,2)
Small	
Middle	17 (%25)
Big	28 (%41,1)
VSD amount	23 (%33,8)
Single	
Multiple	64 (%94,1)
	4 (%5,9)

Defects larger than 1 cm were considered large, defects between 0.5-1 cm were considered medium, and defects smaller than 0.5 were considered small. In our study, 23 patients (33.8%) diagnosed with large VSD according to their size were the most common, 28 patients (41.1%) diagnosed with medium-sized VSD and 17 patients (28.8%) diagnosed with small-sized VSD. The definitive diagnosis of the patients was made by echocardiography and cardiac catheterization-angiography **(Figure 1, 2)**.

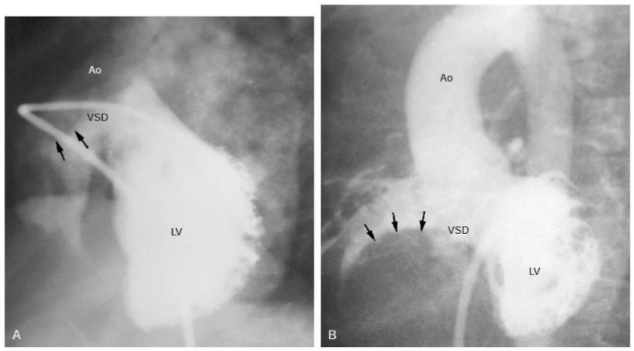

Figure 1: Angiographic view of the VSD

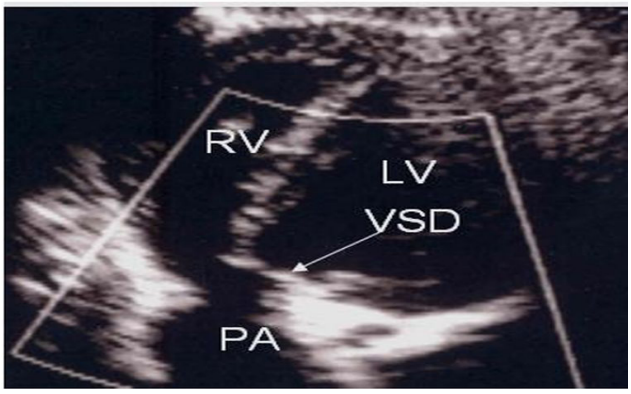

Figure 2: Echocardiographic appearance of the VSD

The mean left ventricular ejection fraction of the patients was measured as 65% (56-80). Mean pulmonary / systemic flow rate (Qp / Qs) was calculated as 2.53 (1.1-8.5), mean shunt between LV and RV as 59.7 mmHg (12-100), RVP as 50.2mmHg (20-100), PAP as 48.8 mmHg (17105) and pulmonary vascular resistance (PVR) as 4.6 (1.8-11.8). Right-left heart pressures and shunt rate were measured in all VSD cases **(Table 2)**.

Table 2: Some preoperative hemodynamic findings of the patients

Echocardiography Mean ejection fraction (EF): 68.86 ± 5.5% (56-87%)
Average LV-RV Shunt (mmHg): 57.7 ± 20.7 (12-100)
Right Ventricular Pressure (mmHg): 50.2 ± 20.4 (20-100)
Cardiac catheterization Pulmonary / systemic shunt ratio (Qp / Qs): 2.51 ± 1.56 (1.1-9.5)
PA pressure / systolic (mmHg): 48.86 ± 22.33 (17-105)
Pulmonary vascular resistance (PVR): 4.44 ± 2.15 (1.8-11.8)

Ethical Committee

At the meeting numbered B.30.2.ATA.0.01.00 / 40, dated 24.05.2012 and numbered B.30.2.ATA.0.01.00 / 40 of the Department of Cardiovascular Surgery of Atatürk University Faculty of Medicine.

Statistical Analysis

SPSS 21 computer program was used to analyse the data. The data are presented as number, percentage, median, mean and standard deviation. The compliance of the groups to the normal distribution was analysed with the Kolmogorov Smirnow Test. Kruskal Wallis Test for comparing weight status according to exitus status; Wilcoxon Signed Ranks Test for the comparison of preoperative right ventricular pressure and postoperative right ventricular pressures; Marginal Homogeneity Test for the comparison of preoperative NYHA FC and postoperative NYHA FC; Chi-Square Test in comparison of postoperative complications according to VSD type, patient symptoms according to VSD diameter, surgical intervention method according to VSD type, exitus rate according to VSD intervention route, postoperative complication rate according to VSD intervention route, postoperative complications according to repair material (patch) If the P value was less than 0.05, the results were considered statistically significant.

RESULTS

In our clinic, all patients having open heart surgery conditions were subjected to cardiopulmonary bypass under general anaesthesia (induction 5 mg/kg pentothal, 1 mcg/kg fentanyl, 0.6 mg/kg rocuronium bromide; maintenance sevoflurane MAC1), after standard bicaval venous and ascending aortic cannulation following median sternotomy. We generally apply 28-30 C° hypothermia for the operation. In moderate hypothermia, cold crystalloid (Plegisol®) at a dose of 20cc/kg initially, followed by intermittent blood cardioplegia (10 cc/kg) to cardiac arrest was achieved by topical cooling with cold saline. The vent cannula placed in the right superior pulmonary vein or through the patent foramen ovale was placed during surgery to draw blood from the left ventricle and left atrium to provide a bloodless environment

during the surgical procedure. In our study, 32 cases (47%) with intracardiac polytetrafluoroethylene (PTFE); 35 cases (51.4) pericardium fixed in glutaraldehyde and 1 case (1.4%) of multiple muscular trabecular type were repaired together with pericardial patch and primary **(Table 3)**. The most frequent 53 cases (77.9%) were reached by right atriotomy as the access route to VSD; 10 cases (14.7%) right ventriculotomy; 1 case (1.7%) right ventriculotomy and aortotomy; 1 case (1.7%) with pulmonary stenosis, right atriotomy and pulmonary arteriotomy; 2 (3.4%) left ventriculotomy with apically located Swiss-Chess type VSD; Right atriotomy + tricuspid septal annulus radial incision after covering with tricuspid leaflet tissue in 1 case (1.7%) with large perimembranous inlet type VSD, and one case (1.7%) with muscular trabecular swiss-chess type VSD accompanied by pulmonary stenosis was reached by performing left ventriculotomy + pulmonary arteriotomy.

Table 3: Intraoperative outcomes

Characteristics	***n* = 68**
Clamp time (min)	45,8±12,2(24-84)
Pump time (min)	79,13±21,11(56-192)
Cardioplegic solution infusion route	
Antegrade	68 (100%)
VSD diameter (mm)	5±2 (2–7)
Patch material used	
Pericardium[a]	33 (48,5%)
Gore-Tex	30 (44,1%)
Primary	5(7,3%)
Combined procedure	
ASD closure	18 (26,4%)
PDA ligation	8 (11,7%)
Subaortic Membrane Excision	1 (1,4%)
TV repair	7 (10,3%)
RVOT muscle resection	1 (1,4%)

Considering the intervention methods according to the VSD types, 54 cases (79.4%) of the perimembranous type were most frequently diagnosed with right atriotomy, 1 case (1.4%) right atriotomy and tricuspid septal annulus radial incision; Right atriotomy with the most common 7 cases (10.2%) of the muscular type and left ventriculotomy in 2 cases (2.9%) of the SwissChess type; Right ventriculotomy was preferred with the most common 5 cases (7.3%) of the DCJA type. In all VSD types, the most common preference of right atriotomy with 46 cases (77.9%) seems significant, but it was not statistically significant (p>0.05) **(Figure 3)**.

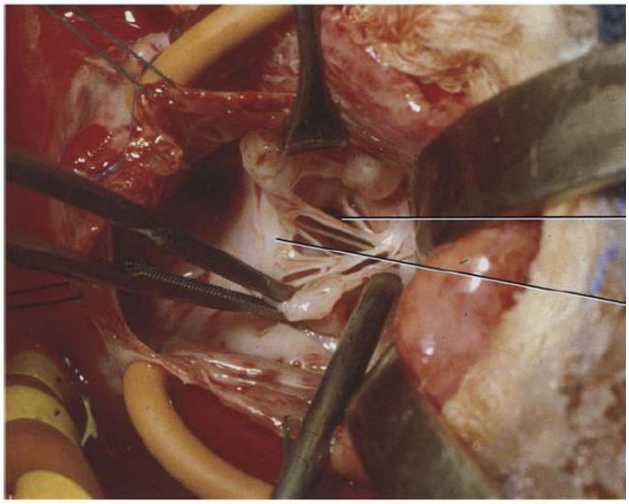

Figure 3: The appearance of the VSD during operation

In preoperative angiography, pulmonary artery pressure (PAP) was measured as 48.86 ± 22.33 (17-105) mmHg. Preoperative and postoperative inhaler iloprost treatment was administered to patients with high PAP (3-5mcg / kg / day). When we close the defect with pericardium or graft (polytetrafluoroethylene (PTFE)), we use 3/0 polyester suture with plegite as the suture material.

In order not to damage the A-V node and the conduction system, we prefer to place a 3/0 polyester pleulitic-free suture on the inferio-posterior edge of the defect, where the defect is close to the conduction paths. In addition, we use 4/0 polypropylene sutures in patients whose atrial septal defect is closed. Ventricular temporary pacemaker wire was placed in all patients. The mean cross-clamp time was 49.9 ± 11.2 (24-84) minutes, and the mean perfusion time was 82.03 ± 20.08 (56-192) minutes. The characteristic of patients with an average intubation period was 3.64 ± 1.29 (2-9) hours in the intensive care unit and prolonged intubation period are patients with preoperative pulmonary hypertension.

There was no perioperative mortality in our patients. Two patients (3.4%) died in the early postoperative period (first 2 months), one due to low cardiac output and the other due to postoperative pericardial tamponade. One patient (1.7%) died in the late postoperative period due to sepsis and bronchopneumonia. In

total, 3 patients (5.09%) had mortality. The preoperative NYHA Functional Capacity of these patients was 2 and above. The mean weight of 2 patients who died in the early postoperative period was found to be 18 ± 11.3 (10-26) kilograms (kg), and one patient who was fatal in the late period was 21 kilograms. The relationship between weight and exitus was not statistically significant (p>0.05). Among the postoperative complications, the most common 8 cases (11.7%) was residual VSD. Since the shunt and Qp/Qs ratio between the LV-RV was low in all residual VSDs, reoperation was not considered and clinical follow-up was performed. It was seen that 66.7% of the residual shunt patients with no hemodynamic significance were perimembranous outlet type. Postoperative temporary A-V block and pericardial tamponade developed in 4 patients (5.8%) with pericardial effusion, and in 1 patient (1.4%), temporary A-V block and pericardial tamponade developed on the 24th.day. Temporary A-V block returned to sinus rhythm on postoperative 12th day. When the effect of the repair material on postoperative complications, especially on residual VSDs (8 cases) was taken into account, it is seen that 5 cases (7.3%) were closed with grafts, and 3 cases (4.4%) were closed with pericardium. When **Table 4** was examined, although complications were seen less in pericardium use, it was not found statistically significant (p>0.05).

Table 4: Postoperative complications seen in VSDs by repair materials

		POSTOPERATIVE COMPLICATION							
Repair Material		Pericardial Effusion	Installing a Permanent Battery	Residue VSD	Tricuspid Insufficiency	Low Flow	Temporary A-V Block	Tamponad+ Temporarym A-V Block	PermanentBattery Installation + Low Flow
Graft	30	2	1	5	0	1	6	1	1
		%2,9	%1,4	%7,3	%0,0	%1,4	%8,8	%1,4	%1,4
Pericard	33	1	0	3	0	0	2	0	0
		%1,4	%0,0	%4,4	%0,0	%0,0	%2,9	%0,0	%0,0
Primary	5	0	0	0	1	0	0	0	0
		%0,0	%0,0	%0,0	%1,4	%0,0	%0,0	%0,0	%0,0

When preoperative NYHA with the data of 31 cases (45.5%) of FK-I, 30 cases of FC-II (44.1%), 7 cases of FC-III (10.2%) were compared with postoperative NHYA with the data of the data of 59 cases (86.7%) of FC-I, 7 cases of FC-II (10.2%), and data of FC-III 2 cases (2.9%), they were found to be statistically significant (p<0.05) **(Table 5)**.

Table 5: Comparison of preoperative and postoperative NYHA

			Postoperative NYHA			
			FK I	FK II	FK III	Total
Preoperative NYHA	FC I	Count	31	0	0	31
		% Pre NYHA	%100,0	%0,0	%0,0	%100,0
		% Post NYHA	%62,0	%0,0	%0,0	%52,5
	FC II	Count	23	6	1	30
		% Pre NYHA	%72,0	%24,0	%4,0	%100,0
		% Post NYHA	%36,0	%85,7	%50,0	%42,4
	FC III	Count	5	1	1	7
		% Pre NYHA	%33,3	%33,3	%33,3	%100,0
		% Post NYHA	%2,0	%14,3	%50,0	%5,1
Totally		Count	59	7	2	68
		% pre NYHA	%84,7	%11,9	%3,4	%100,0
		% post NYHA	%100,0	%100,0	%100,0	%100,0

It was found statistically significant that the preoperative right ventricular pressure value was 50.2 ± 20.4 (20-100) mmHg and the mean RVP was found to be 34.4 ± 12.4 (15-76) mmHg in the postoperative follow-up by ECHO (p<0.05) **(Table 6)**.

Table 6: Comparison of preoperative and postoperative pressures

	Preoperative Echo RVP	Preoperative Angiography PAP	Postoperative Angiography PVR	Postoperative Echo RVP
Valid	68	68	68	68
Missing	0	0	0	0
Mean-	50,22	48,86	4,444	34,47
Median-	47,00	45,00	4,100	34,00
Std. Deviation	20,478	22,339	2,1546	12,459
Minimum	20	17	1,8	15
Maximum	100	105	11,8	76

DISCUSSION

Ventricular septum defect (VSD) can be defined as one or more openings located in the septum separating the left and right ventricle. Ventricular septal defects can be congenital or acquired. It is the most common congenital heart anomaly. Complaints and physical examination findings of patients with ventricular septal defects are closely related to the size of the shunt and thus the defect (1). In our study, 27 cases (45.8%) without symptoms were found to be small and medium-sized VSDs Table 5. However, it was not found statistically significant due to the small number of data (p>0.05). New-borns with large defects are followed closely. If patients have heart failure and lung infection,

medical treatment is given. Patients who do not improve with medical treatment may be surgical candidates in the early period. In our study, 1 patient was operated due to frequent lung infection and 1 patient (1.4%) due to progression of aortic insufficiency after medical treatment. Pulmonary artery pressure and right ventricular pressures must be known in order to evaluate ventricular defects accurately and to determine the surgical time. Studies on this subject have emphasized that Doppler echocardiography is a non-invasive diagnostic tool as an alternative to hemodynamic testing (6). If the necessary information is not available, catheterization is performed to determine the number of defects, evaluate the size of the shunt, pulmonary vascular resistance, workload of both ventricles, determine other accompanying lesions, inform the surgeon about the anatomical structure and localization of the defect, and transcatheter closure (7). Catheterization should be performed especially in cases where there is data on excessive shunt findings, congestive heart failure and pulmonary hypertension. In addition, the role of catheterization is important in understanding additional pathologies. In our clinic, 3 patients (4.4%) scheduled for VSD closure were operated by echocardiography, 1 patient (1.4%) angiography, 64 patients (94.1%) echocardiography and angiography.

Especially patients with large or multiple VSDs are at risk for the development of pulmonary vascular obstructive disease after the age of 2 (8). In patients with PVR more than 10/m^2 and generally Qp/Qs<1.5, whose systolic murmur decreased or disappeared, pulmonary vascularity decreased on thorax radiogram, left ventricle was in normal size, and ECG had moderate right ventricular hypertrophy, it should be considered that Eisenmenger's picture is present and surgical intervention should not be planned. It can be operated if the PVR is between 5-10/m^2. Qp, Qs and PVR measurements will help us after moderate exercise in the patient scheduled for operation. If the Qp/Qs is 1.5-1.8 u/m^2 at rest, the operation should not be performed if this value decreases to 1 u/m^2 or less after exercise. Vasoreactivity test should be applied to make a definite decision. The most commonly used agents in vasoreactivity testing are oxygen, inhaled nitric oxide, epoprostenol, inhaled ilioprost and adenosine (9). The average value of PVR in our clinic was measured as 4.4 ± 2.15 (1.8-11.8). Vasoreactivity test is performed especially with oxygen for patients with high PVR values.

Patients who respond to medical treatment can be waited without catheterization until they are at least six months old. The aim of effective medical treatment in babies with symptomatic VSD is to prevent heart failure and insufficient weight gain. After 6 months, the risk of spontaneous closure and operation is significantly reduced (10). In addition to the medical treatment given to the patients, pre/postoperative inhaler iloprost (platelet aggregation inhibition, artery and vein dilatation; 3-5 mcg/kg/day 6-9 times according to PAP every two hours) treatment is given to patients with preoperative high PAP in our clinic. In patients with multiple defects in the septum (Swiss Cheese Septum), pulmonary banding within the first 3 months and debanding and septum repair within 3-5 years are recommended, as the risk of defect closure is high and left ventriculotomy is required (11).

In our study, we did not have a patient undergoing VSD operation after pulmonary banding. Debanding was performed while closing the vsd of a patient who had banding before **(Figure 4)**.

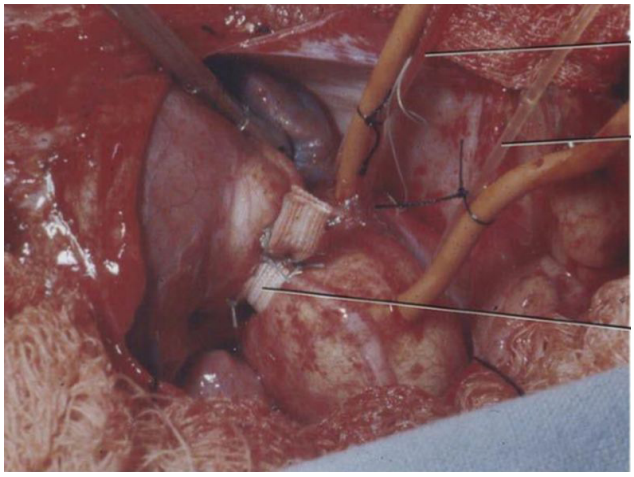

Figure 4: Operational view of pulmonary banding

All VSDs should be closed with a patch (12). In our study, 30 cases (44,1%) were repaired with intracardiac polytetrafluoroethylene (PTFE) and 33 cases (48.5%) were repaired with a pericardium fixed in glutaraldehyde. When closing perimembranous defects, care should be taken not to damage the A-V node and conduc-

tion system. In the area from the Lancisi muscle (medial papillary muscle of the subject) to the tricuspid valve annulus at the top of the Koch triangle, the conduction system proceeds close to the VSD. Clinically, we prefer to place individual sutures without 3/0 polyester on the inferio-posterior edge where the defect lies close to the conduction paths, especially in order not to damage the A-V node and conduction system. The probability of survival without reoperation in the long term was calculated as 93.2%. When pre / postoperative NYHA functional capacities were compared, it was found to be statistically significant ($p<0.05$). Hardin et al. indicated only 1 death in 48 infant cases (13). Mc Groth gave hospital mortality in 1 case in a series of 115 patients (14). In our study, 3 patients died and our mortality was 5.8%. Surgical closure of the VSD may lead to conduction defects, which are the most common complications after the operation. If the atrial route is used for VSD repair, the frequency and severity of postoperative intraventricular conduction disturbances are minimized (14). In our study, transient A-V block was observed in 8 patients (11.7%). Temporary A-V block development after right atriotomy was 37.5% and 62.5% after right ventriculotomy. Permanent pacing was applied to 1 patient followed by temporary pacing, others returned to sinus rhythm during their follow-up.

In our study, although the location of approach to VSD was a significant correlation with the development of A-V block, it was not found statistically significant ($p>0.05$). Small, hemodynamically insignificant residual defects, of which only 1% requires reoperation, have been reported with a frequency of 8% in the area where the patch was placed (15,16). In our patients, 8 patients (11.7%) had residual shunts that did not have any postoperative hemodynamic significance. 5 patients (66.7%) were of the perimembranous outlet type, 1 patient (11.1%) of the perimembranous trabecular type, 1 patient (11.1%) of the muscular inlet type, and 1 patient (11.1%) of the muscular trabecular type VSD. Residual shunts were observed in 6 patients (17.4%) who were treated with right atriotomy. It was not statistically significant ($p>0.05$). All patients were followed hemodynamically and no reoperation was required.

Complications of the aortic valve are mostly related to subarterial VSD due to natural history and anatomical morphology. Lack of anatomical muscle support just below the aortic valve leads to herniation of the leaflet and the additional 'Venturi effect' created by shunt flow during systole pulls the leaflet from the defect (17, 18). Moreover, the defect tendency in subarterial VSD usually does not close on its own. Occasionally, the defect may be seen as a 'functionally' restrictive defect, but in fact it is a major defect covered by the prolapse aortic valve leaflet that can mislead or delay the treatment strategy (19). Prolapse of aortic valves from VSD secondary to aortic insufficiency with VSD creates a significant problem in surgical approach and timing. Backer et al. demonstrated that early closure of doubly commited juxtaarterial VSD prevents progression of aortic regurgitation (18). Nygren et al. have reported that surgical indications are clearer in terms of approach to patients with asymptomatic VSD with a small diameter (restrictive) shunt ratio between 1.5 and 1.99 (19). Clinically, we believe that traditional indications as well as VSDs with aortic valve insufficiency regardless of the shunt rates and also the defects with a shunt ratio of 1.5-1.99 should be placed among the indications for VSD closure. Therefore, subarterial VSD requires close monitoring from the moment of diagnosis, and early surgical closure of subarterial VSD is highly recommended when aortic valve deformity is present and even before the onset of aortic valve deformity since preoperative AR or aortic valve prolapse are risk factors (18 - 20). In our study, there were 13 patients (22%) with preoperative isolated aortic insufficiency and aortic valve prolapse. We think that the reason why none of them had advanced aortic regurgitation in the aortic valve was our working in harmony with the pediatric cardiology clinic and our putting the cases with aortic insufficiency into elective emergency operation.

Various materials and suture techniques can be used while closing the VSD. All VSDs should be patch closed. However, if the defect is very small, the defect can be closed primarily. Synthetic materials such as Dacron, polytetrafluoroethylene (PTFE) can be used for VSD closure, as well as autologous materials such as fresh

pericardium, glutaraldehyde-fixed pericardium, and xenografts such as bovine pericardium (12). Synthetic patch was used in 30 patients (50.8%) and pericardial patch was used in 23 patients (39%) for closing the VSD. When the relationship between postoperative residual VSD (9 cases) and the repair material used in VSDs is considered, it is seen that 5 cases (55.5%) were closed with grafts and 4 cases (44.5%) were closed with pericardium. It was not found statistically significant ($p>0.05$) Table 5. VSD accompanies 31% of congenital cardiac defects (7).

After the surgical closure of the VSD, the risk of bacterial endocarditis is not completely eliminated, but it is significantly reduced (18, 19). In our study, a patient (1.4%) was diagnosed with a perimembranous trabecular type VSD in the angiography performed due to a heart murmur on physical examination and brucella growth in blood culture due to high fever. Most patients are asymptomatic in long-term follow-up and have a normal life span (8, 9). In our study, the probability of survival without reoperation was calculated as 93.2% in the long term. Especially, pre/postoperative NYHA and RVP comparisons were found to be statistically significant ($p<0.05$).

Pulmonary artery taping (PAP) is recommended as a palliative procedure for children in cases such as large ventricular septal defect (VSD), intracardiac anomalies such as single ventricle, a large left-to-right (LV-RV) shunt and large artery transposition (20). It has since been a palliative operation used to prevent congestive heart failure or pulmonary vascular obstructive disease (18). Regardless of the location of the great vessels, taping can be done by left or right thoracotomy or median sternotomy. Ideally, the main pulmonary artery can be accessed through left lateral 3rd-4th intrathoracic space by means of thoracotomy. If the tape is placed more proximally, it may cause dysplastic pulmonary valve development as a result of thickening in the valve and valve leaflet on the pulmonary commissure. If the band is placed too distal on the main pulmonary artery, it may cause kinks or kinking on the pulmonary artery branches. After the aortic and main pulmonary artery pressures are monitored, ideally, after banding, the mean pressure of the main pulmonary artery should decrease by 25-30 mmHg or the mean systemic pressure should decrease up to the ratio of 30% to 50%. Peripheral arterial oxygen saturation does not change with banding. A 5% drop is acceptable in normal patients. A 10% reduction in the presence of large artery transposition is acceptable, but peripheral arterial oxygen saturation should not fall below 65-70% (18).

Pulmonary artery reconstruction (debanding) is required during VSD closure in patients undergoing pulmonary banding. If debanding is done, 3 techniques can be applied; removal of the band and primary angioplasty, vertical removal of the band and narrow segment and patchplasty with pericardial or dacron graft, and resection of the band and narrow pulmonary artery segment and end-to-end anastomosis.

In addition, at present, transcatheter device closure for perimembranous ventricular septal defect has become a widely accepted alternative to open heart surgery (20). Since the development of occluders and intervention techniques, the range of indications has been expanded. Recently, several studies have been reported on the transcatheter device of the ventricular septal defect using the Amplatzer occluder. However, most of the reports are based on small samples with no long-term follow-up (17, 18, 20). As a result; Ventricular septal defect is the most common congenital heart disease. The development of Echo and cardiac angiography has a great share in the diagnosis and classification. It should be preferred to close the defects after 3 months. Small and medium VSDs should be followed up with medical treatment, but patients whose symptoms do not improve with medical treatment, whose pulmonary artery pressure increased and who developed $Qp/Qs>1.5$ and additional complications should be operated early. Surgical intervention should be applied without delay in the repair of large VSDs as early as possible, and in VSD cases with aortic valve insufficiency. Pre/postoperative iloprost treatment should be administered as an inhaler, especially in patients with high preoperative pulmonary artery pressure. In general, right atriotomy should be preferred as a means of access to the VSD and the VSDs should always be closed using a patch and one by one Teflon pledget suture technique. Pre/

postoperative prophylaxis should be applied to the patient from the point of endocarditis.

Closing the ventricular septal defect is one of the basic surgical procedures that a congenital heart surgeon must first specialize. In order to achieve a perfect patch closure of the defect without causing complications such as residual interventricular shunt, tricuspid valve insufficiency or atrioventricular block, the surgeon must have the anatomical features of the defect, effective intraoperative exposure, accurate preoperative and intraoperative assessment and understanding.

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