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Original Article

Anatomy Section

Echocardiographic Profile of Ventricular Septal Defect among Children Attending Tertiary Care Teaching Institutions: A Descriptive Study

ARPAN KUMAR GOSWAMI[1], ANUPAM BASKE[2], NITA RAY[3], SHRUTI GOSWAMI[4], BISWAJIT MAJUMDAR[5]

ABSTRACT

Introduction: One of the developmental defects, the Ventricular Septal Defect (VSD) needs to be studied to reduce morbidity and mortality among the children.

Aim: To describe the VSD cases on the basis of site, size along with few aspects of functional derangement and pathology produced therewith.

Materials and Methods: A cross-sectional survey was carried out among 200 clinically diagnosed and suspected consecutive VSD cases between age group of 1-12 years attending the Cardiology Outpatient Departments (OPD) of two teaching institutions. After collecting baseline information for each participant, Electrocardiograph (ECG) was taken along with 2-D Colour Doppler Echocardiography. Data were summarised by proportion and Fisher-exact test was used for drawing inference.

Results: The cases were classified into perimembranous type (83%), muscular (15.5%) and multiple (1.5%). Small variety of VSD with diameter of <5 mm was more common with left to right (L-R) shunting predominant. The severity of defects were found to be complicated by Pulmonary Arterial Hypertension (PAH), Infective Endocarditis (IE) and Isolated Valvular Diseases (IVD) summing up to 15% of the participants.

Conclusion: More than 3/4th (78.0%) of VSD belonged to the smaller variety which needs early detection for prompt medical management to prevent pathologies like obstinate Pulmonary Vascular Obstructive Disease (PVOD).

Keywords: Congenital heart disease, Functional derangement, Pulmonary arterial hypertension

INTRODUCTION

The structure and evolution of the heart to its recent most shape is a field of research for anatomist. Its biatrial and biventricular evolution has been studied thoroughly [1].Congenital Heart Disease (CHD) is a cause of morbidity and mortality among children and contributes 10% infant deaths in India [2]. Various studies across the world reported its incidence to be ranging from 1.01 to 17.5 per 1000 live births [3]. Its incidence was reported be about 12 in 10,000 live births [4,5]. A prevalence of 2.25-5.2 per 1000 children has been found in India [6] with an incidence of 3.9/1000 live births [7]. Being the most common form, isolated VSD contributes 20 to 25% of CHDs [8,9]. Based on their location on ventricular septum, VSDs are commonly categorised into perimembranous (situated in the membranous ventricular septum in subaortic region), supracristal (found in the conal septum in subpulmonary region), Atrioventricular (AV) septal (defect located in the posterior septum), and muscular (located in the muscular and apical areas of ventricular septum) [10]. Unusual channelling of blood across the ventricles is the main haemodynamic pathology among VSD cases. Many VSDs close spontaneously but large defects leads to detrimental complications such as IE, PAH, ventricular dysfunction and an increased risk of arrhythmias [11-13].

The important pathophysiology of VSD is creation of shunt between the right and left ventricles. Amount of blood and the direction of flow through shunt determine the haemodynamic significance of the VSD which in turn is governed by size and location of VSD as well as Pulmonary Vascular Resistance (PVR) [14]. L-R shunt across the VSD induces Left Atrium (LA) and Left Ventricular (LV) hypertrophy. High PVR prevents this shunt to manifest in the neonates and during the first weeks of life. As the PVR falls the L-R manifests leading gradually to PVOD as early as 18 months to 2 years of age if a large VSD is left unrepaired [8].

Clinicians are encouraged to take challenges of handling CHD cases, prompted by the success of treatment in developed countries. As an important determinant of infant mortality, the extent and type of CHD requires to be studied to bring appropriate changes in health care policies [15]. A revolutionary improvement in diagnosis of CHD was made by the introduction of echocardiography [16]. After being validated Doppler echo has proved it to be a sensitive method for diagnosing VSD with portrait of its haemodynamics [17].

Studies reported that types of VSD as revealed in autopsy findings of heart are similar to that of Echocardiography observations of suspected VSD [18-21]. This study aimed at describing echocardiography findings among suspected VSD cases.

MATERIALS AND METHODS

A cross-sectional survey was conducted, from March 2011 to January 2012, involving clinically diagnosed VSD cases between the ages of 1-12 years attending Cardiology OPD of Nilratan Sircar Medical College and Hospital (NRSMCH) and R. G. KAR Medical College and Hospital (RGKMCH), Kolkata, West Bengal, India. The study was carried out after obtaining approval from the Institutional Ethics Committee of NRSMCH, Kolkata (No. NMC/Ethi/Gen-25/86 dated: 03.01.2011) as well as the informed consent of the parents/guardians and ascent of the children aged ≥7 years. Total enumeration of VSD cases diagnosed clinically and confirmed by echocardiography was considered for the present study. Patients with multiple congenital heart defects, cyanotic CHD and parents/guardians unwilling to participate were excluded.

Sample size was calculated based on formula for descriptive cross-sectional study: $n=Z^2pq/l^2$, where, Z=2 (two sided) at 95.4% confidence interval, p=prevalence of a particular type of VSD, q is complement of p and l is acceptable error around the reported prevalence. Assuming p=20% (muscular variety of

VSD) as per existing literature [8] and l=6 (absolute) the sample for the present study was estimated to be 178 and considering 10% non-response the sample size was revised and rounded to 200.

Consecutive cases of isolated VSDs were included in the study. Information pertaining to age, sex, clinical features at the time of diagnosis were collected via interview, clinical examination and scrutinising of relevant medical records. A predesigned pretested semi-structured questionnaire was developed and used for this purpose. Then each of the participants was subjected to echocardiography to determine the size of VSD and the direction of shunt. Echo machine having 2D mode facility was utilised to determine the three components of Inter-Ventricular Septum (IVS) responsible for the various sizes of defect and the direction of shunt was ascertained by the help of colour Doppler. VSDs are categorised into three types according to diameter of the defect: a small VSD has diameter <5 mm; a medium VSD has diameter ≥5 and <10 mm; and a large VSD has diameter ≥10 mm [22].

STATISTICAL ANALYSIS

Data were compiled in microsoft excel sheet and described by estimated proportion. Displaying of data was done by charts and tables. Fisher-exact test and Odds ratio (OR) with its 95% Confidence Interval (CI) were used to draw statistical inference. The p-value of <0.05 (two tailed) was considered as statistically significant. Epi. Info 3.4.3, CDC Atlanta version was used for the purpose of data analysis.

RESULTS

In this study, the cases comprised of equal number of male and female with age between 1-12 years. More than half {114 (57.0%)} of the participants belonged to age group up to 4 years, 33.0% (66) were in the age range of 4-8 years and 10.0% (20) were aged ≥8 years. Echo Doppler findings showed that majority of the VSD was of Perimembranous type 166 (83%) followed by muscular 31 (15.5%) and mixed 3 (1.5%).

Analysis revealed that most of the participants had Left-to-Right (L-R) shunt (96.0%), more than 3/4th (78.0%) of VSD were of small in size. [Table/Fig-1]. The pair wise analysis revealed that bidirectional shunting wasn't significantly higher in small and large VSDs compared to that of the moderate VSDs [Table/Fig-1] However, comparison between small and large VSDs reflected that significantly higher proportion of participants with larger VSDs was having bidirectional flow of blood {p=0.017, OR=6.61(1.27-34.51)}.

Size of VSD	Direction of shunt		p-value (pair wise Fisher-exact test)
	Left-to-Right No. (%)	Bidirectional No. (%)	
Small {n1=156 (78%)}	152 (97.44)	4 (2.56)	1.00
Moderate {n2=17 (8.5%)}	17 (100.0)	-	*
Large {n3=27 (13.5%)}	23 (85.19)	4 (14.81)	0.146
Total (N=200)	192 (96.0)	08 (4.0)	-

[Table/Fig-1]: Distribution of participants according to size of VSD and direction of shunt (N=200).
*Reference group having lowest proportion of bidirectional shunt

Most (56.67%) of the complications were found in small type of VSD [Table/Fig-2]. Further analysis explored that 15.0% of the participants having an equal male and female already developed complications which were of three varieties namely PAH, IE, IVD [Table/Fig-3].

Analysis revealed that significantly higher proportion of study subjects with large VSD was found to sustain any form of complications {p=0.0004 (Fisher-exact test)} [Table/Fig-2].

Complications*	Category of VSD according to size (mm)			
	Small (n=156) No. (%)	Moderate (n=17) No. (%)	Large (n=27) No. (%)	Total (N=200) No. (%)
PAH	7 (4.49)	-	7 (25.93)	14 (7.0)
IE	1 (0.5)	-	-	1 (0.5)
IVD	9 (5.77)	2 (11.76)	4 (14.81)	15 (7.5)
Total	17 (10.89)	2 (11.76)	11 (40.74)	30 (15.0)

[Table/Fig-2]: Distribution of participants according to size of VSD and complications (n=30).
*PAH: Pulmonary arterial hypertension; IE: Infective endocarditis, IVD: Isolated valvular diseases

Gender	Complications			
	PAH No. (%)	IE No. (%)	IVD No. (%)	Total No. (%)
Male (n1=100)	8 (8.0)	-	7 (7.0)	15 (15.0)
Female (n2=100)	6 (6.0)	1 (1.0)	8 (8.0)	15 (15.0)
Total (N=200)	14 (7.0)	1 (0.5)	15 (7.5)	30 (15.0)

[Table/Fig-3]: Distribution of participants according to complications and gender (n=30).

DISCUSSION

This study involved VSD cases with age between 1-12 years as spontaneous closure occurs maximum by 12 years of age. In the present study, echo Doppler findings confirmed 83% VSD as perimembraneous type, 78.0% of smaller in size and most of them (96.0%) were found to have L-R shunt. Significantly, higher proportion of participants with larger shunt was found to have bidirectional flow of blood. Majority (56.67%) of the complications were found in small type of VSD however, higher proportion of larger VSD cases revealed to sustain any complication.

L-R shunt is an expected sequel of VSD which may result in even Congestive Cardiac Failure (CCF) in earlier part of life in case of larger one and may be silent and incidentally detected in later stage of life in case of smaller one, if not closed spontaneously till then [14].

In the present study, male and female participants were found to be equal in number. Dakkak W and Oliver TI and Manuel V et al., also reported that VSDs have no gender predilection [14,23]. However, exact age group and method of selecting study subject wasn't mentioned by Dakkak W and Oliver TI and in case later study it was 0-18 years. Studies also reported male predominance in VSD cases [24,25]. This dissimilarity may partly be explained by difference in the age range of the study subjects. Other factors like sampling method, gender sensitivity in hospital attendance and consent of the parents of girls to participate in the study might have some roles. Rao PS and Harris AD, described that the membranous type of VSDs are the most common (80% prevalence), and supracristal (5 to 7%), AV septal (8%), and muscular (5 to 20%) defects are being less common varieties. Most of the VSDs are single; however, multiple defects may be present, the muscular variety, described as the "Swiss cheese" type of VSDs [8]. Predominance of perimembraneous variety was also reported other studies [9,21].

Most of the studies found a maximum number of patients in the age group of less than one year [9,16,26] whereas it was at 24 months as reported by Manuel V et al., [23]. It might be due to early manifestation of symptoms in case of moderate to large size VSDs, availability of screening programme and good care seeking practice among people for the formers and reverse for the later. However, in the present study 57.0% subjects belonged to 0-4 year age group as compared to the findings of Yasmeen M et al., who reported 70% children with CHD were below the age of 1 year, 20% over 1 year to 6 year and 10% were over 6 to 12 year [27].

Comparison between these hospital based studies may be futile as the sample size, sampling method, age range of the participants.

Though the VSDs may get closed spontaneously in the postnatal life, but before that the affected babies suffer from growth retardation, recurrent infection, heart failure and even death [28]. Size of VSD is a major factor affecting prognosis [29] and is usually assessed by measuring the diameter of the defect [22]. It is noteworthy that the majority (78.0%) of the VSD in the present study belonged to the small category as per the aforementioned criteria [Table/Fig-1]. Another welcome finding of the present study is that overall 96.0% of the participants were still having L-R shunt, even around 85.0% of those with large shunt among whom the proportion of bidirectional shunt was found to be sustained significantly [Table/Fig-1]. Smaller VSD requires medical management along with assurance of the parents and perhaps subacute bacterial endocarditis prophylaxis and occasional clinical follow-up [8].

In the present study, one participant with small VSD was found to be affected by IE. Overall, 7.0% had PAH. Significantly higher proportion of study subjects with large VSD was found to sustain any form of complications {p=0.0004 (Fisher-exact test)}[Table/Fig-2].Shahid N et al., reported no participant to be suffered from IE. However, they observed that 48.2% of study subjects were affected with PAH [25]. Preventing development of PVOD by taking every possible measure is of prime importance. Failure to thrive, markedly engorged LA and LV with or without pulmonary artery pressure indicate surgical closure of moderate size VSDs. Pulmonary-to-systemic flow ratio (Qp:Qs) greater than 2:1 may be an additional hint [8].

Subjects having large VSDs with systolic pressures in Right Ventricle (RV) and pulmonary artery close to LV and aortic systolic pressures, closure should be considered, preferably before 6-12 months of age and latest by 18 months ignoring whether weight gain and heart failure are controlled or not [8].

Limitation(s)

The characteristics of VSDs in its early stage i.e., at asymptomatic stage couldn't be grasped which would have given a hint regarding earliest scope of intervention. Moreover, this small scale study has constraint in its external validity. A large scale community based screening of the neonate, postneonate or toddler is a better choice to resolve all these issues.

CONCLUSION(S)

This study results provided a happy note that majority of the VSD belonged to the smaller variety with favourable L-R shunt. However, majority (83%) of the VSDs were of perimembranous type which isn't prone to spontaneous closure. Therefore, prompt detection is required for medical management of pathologies like IE, already evident among a portion of VSD cases, and prevention of obstinate PVOD.

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PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Anatomy, Bankura Sammilani Medical College, Bankura, West Bengal, India.
2. Assistant Professor, Department of Anatomy, Bankura Sammilani Medical College, Bankura, West Bengal, India.
3. Tutor, Department of Obstetrics and Gynaecology, Diamond Harbour Government Medical College, Diamond Harbour, West Bengal, India.
4. MBBS Student, Tripura Medical College, Agartala, India.
5. Associate Professor, Department of Cardiology, R G Kar Medical College, Kolkata, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Anupam Baske,
QR No.2/1/4 (Near Ladies Hostel), BS Medical College Campus, PO: Kenduadihi,
Bankura-722102, West Bengal, India.
E-mail: dranupambaske@gmail.com

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