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Research Article

Ventricular Septal Defect (VSD) Among Children Attending Three Health Institutions: Clinical Correlates and Patients' Characteristics

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ABSTRACT

Background: Ventricular Septal Defect (VSD) is the commonest acyanotic congenital heart disease which presents with some clinical and post-operative characteristics.

Objectives: This study is aimed at determining clinical and post-operative characteristics of children with VSD.

Methods: An observational study, done in three institutions over a five-year period. Seven hundred and fifty-eight (758) echocardiography reports on children with cardiac defects were ascertained and a total of 151 children had VSD was extracted.

Results: An observational study, done in three institutions over a five-year period. Seven hundred and fifty-eight (758) echocardiography reports on children with cardiac defects were ascertained and a total of 151 children with VSD were extracted, with a mean age of 3.3 ± 4.4 years.The patients' characteristics evaluated in this study include clinical profile, surgical outcome and nutritional status of children with VSD. Fast breathingwas the commonest clinical findings in children with VSD70 (127); 55.1%, followed by cough 11 (68; 16.2%) and poor weight gain 55 (125); 44%.Thirty point nine (30.9%) were both wasted and stunted. 6.9% of the children were overweight (BMI+2SD) and 2.0% obese BMI+3SD). Aortic regurgitation was noted in (5/150) 3.3% of children with VSD, seen commonly in Peri-membranous VSD. Prevalence of pulmonary hypertension in this study was 47 (31.3%).

Complications noted post-operation are aortic regurgitation 3.3%, and residual VSD. Seventeen point nine (17.9%) (27/151) of the patients had surgery for surgical closure of VSD. There were a total of 19 deaths of which 47.4% was before surgery and 52.6% among the females.There were a total of 19 deaths of which 47.4% were before surgery and 52.6% among the females. Majority of the deaths was in the infants (47.4%), the preschool and school age contribute 21.0% each and the adolescents, 10.5%. Among the 27 children that had surgery, 37.0% died post-surgery while 7.4% were lost to follow up. The remaining 56.0% are alive and being followed up with others who are yet to have surgery. Cause of death was documented in 13 of the 14 deaths, (10 post-surgery and 4 before surgery). Other causes of death included rheumatic heart disease (23.1%), heart failure (15.4%), and fall at home (15.4%), infective endocarditis (7.6%) and post-surgery achalasia (7.7%).

Conclusion: The frequent symptom of VSD is fast breathing and Peri-membranous type is the commonest. Aortic regurgitation is the commonest post-surgical complication associated with VSD closure. The children present with various degrees of malnutrition. There was ahigh mortality noted before surgery.

Keywords: Acyanotic heart disease; Nutrition; Mortality rate; Children; VSD closure

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INTRODUCTION

Ventricular Septal Defects (VSDs) are the commonest type of congenital heart disease excluding bicuspid aortic valve. The defect can be seen in any part of the ventricular septum, with clinical symptoms ranging from mild to severe [1,2].

Isolated ventricular septal defect contributes to about 20% of children with congenital heart defect [3]. This heart lesion presents with variable incidence. For instance, among term infants, the incidence is about 1.5 to 3.5 per 1,000, 4.5 to 7 per 1,000 in preterm babies and 5 to 50 per 1,000 in new born [2] Ventricular Septal Defects (VSDs) are the most common lesion associated within many chromosomal syndromes, especially trisomy 21, trisomy 13, and trisomy 18 [2].

In Nigeria, Ventricular septal defect constituted 40.6% of all congenital heart disease.Mohammed, et al. [4] documented a progressive increase in the contribution of VSD to the burden of congenital heart defect with an average of 27.5% from the last sixty years to 55.8% in the last decade.

Children with ventricular septal defects parent with several characteristics. These include clinical correlates,several grades of malnutrition, echocardiographic findings and surgical outcome.

Peri-membranous defect is noted as the commonest type of VSD with about 70%-80% of cases [5,6]. The clinical features of VSD depend on the size of the defect. Small size defects with trivial left to right shunt with normal pulmonary arterial pressure are always asymptomatic and murmurs are picked as accidental findings during routine physical examination. Children with large defect present with increase pulmonary blood flow and pulmonary hypertension. They present with dyspnoea, malnutrition and heart failure especially in early infancy [7].

The impact of nutrition on children with VSD is enormous. For instance, Basheir, et al. [8] and colleaguesnoted an overall prevalence of malnutrition as 84.0% in patients with CHD, especially VSD and 20% in controls. He also noted various degree of stunting, wasting and poor dietary history in his study.Malnutrition is a notableissue among children with ventricular septal defect and this could be caused by low oxygen saturation and pulmonary hypertension [8].

In the last five decades, high peri-operative mortality and sudden death are common in patient with surgical closure of VSD. However, in recent times a giant stride towards early surgical correction to avert pulmonary vascular disease has been achieved [9,10].

Studies on pattern and epidemiology of congenital heart defect in a single institutional centre in Africa and Nigeria abound. However, data onnutritional status, predictors of mortality and surgical outcome of children with VSD done over a long period and in multiple health institution, like ours, is lacking especially in South East Nigeria.

This study is therefore important, as it aims at determining the clinical profile, predictors of mortality, nutritional status and surgical outcome of children with ventricular septal defect presenting in threedifferent hospitals in a snap shot. It also highlights the dare need to improve on the frequency of surgery, as low surgery turnout rate is the very reason for increase mortality.

MATERIALS AND METHODS

Study design

An observational study, done in three institutions over a five-year period, Seven hundred and fifty-eight (758) echocardiography reports on children with cardiac defects were ascertained anda total of 151 children had VSD was extracted.Children with echocardiographic diagnosis of ventricular septal defect and children with pulmonary artery banding for severe pulmonary hypertension were included in the study while children with isolated atrial septal defect, patent ductus arteriosus, coarctation of the aorta or other VSD dependent lesions like transposition of great Artery and teratology of fallout were all excluded.

Study area and study population

All children who presented with congenital heart defect with an echocardiographic diagnosis of Ventricular septal defect between 2016 to 2020 both at the university of Nigeria Teaching Hospital, blessed children hospital and Niger Delta University teaching Hospital were retrospectively reviewed. Ventricular septal defect was defined as either an isolated VSD or those with Patentductus arteriosus, Atria septal defect or VSD with mild mitral or tricuspid regurgitation [8]. Complete closure of ventricular septal defect was the surgical intervention of choice for the subjects.

The clinical profiles of the subjects were also ascertained. The clinical correlates include age, gender, weight, height, associated morbidities or syndromes, age at surgery. The type of VSD and indication for surgery were also documented.Immediate surgical outcome and complications were also documented.

Surgical technique

A median sternotomy was the used surgical approach of choice for those who had surgical intervention. They went through cardiopulmonary bypass. Before the surgery,screening echocardiography was done for all the patients and preoperative investigations with emphasis on International Normalization Rate(INR) were done.Postoperative echocardiography was also done to ascertain any possible post-operative complications.

Consent

This was obtained from the parents and/or caregivers in the course of admission to the ward.

Data analysis

Categorical variables were analysed in the form of proportions and percentages and presented in the form of tables. Discrete variables were analysed in the form of means and standard deviations.

RESULTS

Table 1 illustrates the demographic characteristics of the participants. A total of 151 children had 2-echocariography done over a period of five years. This gives a prevalence of VSD as 19.9% (151/758).The study comprised 53.0% females and 47%. The age ranged from one week to 18 years, with mean age of 3.3 ± 4.4 years and infants constituting the majority (49.7%).

Table 1: Demographic characteristics of the subjects.

Variable	n	%
Sex		
Male	71	47
Female	80	53
Age group		
Infants	75	49.7
Preschool	42	27.8

School age	18	11.9
Adolescents	16	10.6
Total	151	100

Table 2 illustrates the frequency of various clinical features among the patients with VSD. Fast breathing and poor weight gain were the commonest features.Features of Down syndrome were observed in 3.1% of the patients.

Table 2: Frequency of clinical features associated with VSD.

Clinical feature	n (N)	% (n/N) × 100
Cough	11 (68)	16.2
Fast breathing	70 (127)	55.1
Cyanosis	2 (127)	1.6
Poor weight gain	55 (125)	44
Excessive sweating	5 (120)	4.2
Hypertension	47 (134)	35.1
Easy fatigability	28 (123)	22.7
Squarting	0 (126)	0
Incidental murmur	9 (128)	7
Chest pain	1 (129)	0.8
Orthopnea	1 (127)	0.8
Down syndrome	4 (129)	3.1

One hundred and one (101) of the patients had complete data set for assessing nutritional status. Ten of them (9.9%) were wasted (weight-for-age or weight-for-height/length or BMI-2SD), 2.0% severely wasted (-3SD), 2.9% stunted (height/length-for-age-2SD), 8.9% severe stunting (height/length-for-age-3SD) while 30.9% were both wasted and stunted. 6.9% of the children were overweight (BMI+2SD) and 2.0% obese BMI+3SD).

Table 3 illustrates the anatomical locations of VSD among the patients. Majority (54.3%) of the VSDs were peri-membranous in location, 25.2% were sub-aortic while 7.9% were located in the muscular part of the ventricular septum.

Table 3: Anatomical locations of Ventricular Septal Defect (VSD).

VSD location	N	%
PM	82	54.3
Subaortic	38	25.2
Muscular	12	7.9
Inlet	4	2.6
PM with subaortic extension	3	2
PM with muscular extension	3	2
Pulmonic	1	0.7
Unspecified	8	5.3
Total	151	100

Among the 59 patients with associated cardiac defects, 23.7% of the associated defects were Atrial Septal Defect (ASD) alone, 13.5% were ASD and Patent Ductus Arteriosus (PDA) and 18.6% were aortic regurgitation. Other associated defects or comorbidities included: PDA alone (11.8%), Pulmonary Stenosis (8.5%), Mitral Regurgitation (6.8%), PDA and Mitral Regurgitation (5.1%), ASD and Pulmonary Stenosis (3.4%) while Patent Foramen Ovale (PFO), aortic aneurysm and Infective Endocarditis (IE) constituted 0.7% each. Aortic regurgitation was noted in (5/150) 3.3% of children with VSD,seen commonly in Peri-membranous VSD.

Prevalence of pulmonary hypertension in this study is 47 (31.3%). Fast breathing, poor weight gain and peri-membranous VSD are seen as common presentations of VSD.

Only 17.9% (27/151) of the patients had surgery for cardiac defects with patient to surgery ratio of 1:6; while 4.6% of the total patients have had spontaneous closure of their VSD. Seventy-four (74.1%) had simple VSD closure, 11.1% had combined VSD and ASD closure while the remaining 14.8% had total intra-cardiac repair of their defects.

There were a total of 19 deaths of which 47.4% were before surgery and 52.6% among the females. Majority of the deaths was in the infants (47.4%), the preschool and school age contribute 21.0% each and the adolescents, 10.5%. Among the 27 children that had surgery, 37.0% died post-surgery while 7.4% were lost to follow up. The remaining 56.0% are alive and being followed up with others who are yet to have surgery. Cause of death was documented in 13 of the 14 deaths, (10 post-surgery and 4 before surgery). Other causes of death included rheumatic heart disease (23.1%), heart failure (15.4%), fall at home (15.4%), infective endocarditis (7.6%) and post-surgery achalasia (7.7%).

DISCUSSION

This study is aimed to identify the clinical profile and post-operative characteristics of children with VSD. We noted no gender preference among children with Ventricular Septal Defect (VSD). The commonest type of VSD noted in our study is the peri-membranous type with fast breathing being the commonest clinical presentation.Other studies have also noted gender ambivalence [11-14]. Chinawa, et al. [12],in their study, also noted no gender difference. They also documented peri-membranous VSD as the commonest type of VSD. Other studies also documented fast breathing as the commonest symptom [7,13-15].

There is a late presentation of children with VSD as shown in our study, as age of presentation is 3.3 ± 4.4 years with infants constituting the majority.It is expedient to point out that early diagnosis and surgical closure of VSD have been shown as the only way of reducing mortality and morbidity. However, in a setting like ours, surgical closure is at its lowest ebb as depicted in our study, where only 17.9% had surgical intervention.Surgery is done only by the visiting foreign mission, and does not occur frequently. At times, it could beunaffordable and out of reach for the poor. More so, many children diet an early age before even diagnosis is made [12].

Post-operative complications noted in our subjects were aortic regurgitation, mitral regurgitation, rheumatic heart disease, infective endocarditis, residual VSDs, Pulmonary hypertension, rhythm abnormalities and death.

Aortic regurgitation is seen in 3.3% of our patient, occurring commonly in children with peri-membranous VSD. Aortic Regurgitation (AR) with Ventricular Septal Defects (VSD) is an anatomic anomaly which arises from prolapsed of Right Coronary Cusp (RCC), Non-Coronary Cusp (NCC) or both. It occurs in 4.5%-11% of cases. Aortic valve regurgitation occurs mostly with doubly committed sub-arterial VSDs [16,17]. Sub-arterial VSDs is about five times more often than Peri-membranous VSDs to be affected [18]. Kulyabin, et al. [19], noted aortic valve prolapse and subsequent regurgitation as two serious complications of Ventricular Septal Defects (VSD) with prevalence rates ranging from 5% to 10%.

We noted mitral regurgitation in five of our cases after surgical

closure of ventricular septal defect. We could not decipher the cause of the mitral regurgitation.However [20], assess mitral valve function after repair of Ventricular Septal Defect (VSD),over a nine-year period on 46 patients that had VSD closure and concluded that the presence of mild residual MR in the early postoperative period may trigger severe MR in future.However, they did not hazard any reason for the cause of the mitral regurgitation in their study.

Our study revealed that two of our patientswith post-operative ventricular septal defect presented with Rheumatic Heart Disease (RHD).This was proven by the mitral regurgitation and positive ASO titre seen in the serum of affected subjects.

Though echocardiography is a valuable tool in early diagnosis of RHD, however, echo detection of pathological valves or valvar regurgitation does not guaranteedisease progression or even diagnosis [21]. A single most important technique in making diagnosis of RHD is criteria adopted by the World Heart Federation [21]. Possible reasons for RHD in our series could be due to poor and substandard socioeconomic conditions [22].

Infective Endocarditis (IE) is a very common postoperative complication seen in our cases.This was seen in 7.6% of our cases. Boussir,et al. [22] pointed out that infective endocarditis is very common in children with VSD even before surgery. Infective endocarditis abounds in the tropics where common bacterial infections and malnutrition are the norm [22]. Furthermore, Phong, et al. [23], in Singapore,compared the incidence of infective endocarditis among children that had VSD preoperatively and those with VSD closure. They noted eight episodes of IE from six patients with VSD who had no closure compared with none from those with VSD closure.They concluded that subjects with VSDs, especially if unrepaired, could carry a reasonable risk of IE compared to the general population [24].

It is pertinent to note that only one of our cases had a residual VSD post operation. This index patient had no clinical symptoms or pulmonary hypertension.Scully, et al. [24] noted avery high prevalence of 51% in children who had residual VSD's after surgical closure. Nonetheless,they opined that spontaneous closure occurred in 7 out of 10 children withresidual VSD after a 3 year follow up. Indeed [25] noted a prevalence of 2.1% of reoperation rate in their studynoted that routine trans-oesophageal echocardiography in all their patients that undergo cardiac surgery regardless of age, could account for this very high prevalence. We did not use trans-oesophageal echo in any of our cases, this might also explain this very low prevalence in our study.In the contrary, Anderson, et al. [25] documented a prevalence rate of 16% in their series while Kogon, et al. [26] found residual VSD's in 8% of the patients after a follow-up duration of 12 years. In general, it can be said that spontaneous closure of residual VSD's occurs relatively early after surgery.A study has related spontaneous closure of VSD to size of the residual VSD. For instance Ali, et al. [27] noted,in his study,that, residual VSDs less than 2 mm normally closespontaneously in the majority of his subjects within one year but those more than 2 mm are unlikely to close spontaneously [28]. Though our case with residual VSD is more than 2mm in size, regrettably we lost our only case to follow up, as such we could not ascertain if there is spontaneous closure [28].

Pulmonary hypertension after closure of VSD is uncommon.We recorded two cases with pulmonary hypertension post operation. Presence of residual VSD has been adduced as a cause of this sequel. Bambul,et al. [28] noted in his study that PAH is very rare among children who had VSD closure especially in the first year of follow-up.

Arrhythmias such as complete heart block and junctional tachycardia are notable complications seen in our subjects. Fortunately,the patient recovered spontaneously. It is well known that most children, who develop completeheart blockpost-operatively, had about 42%-93% chance of spontaneous recovery within 7–14days [29,30]. This is also akin to our case who recovered with a sinus rhythm within 2 weeks.

Possible reason for complete heart block seen in our patient could be due to thepoor weight gain seen in our patient. Stephanie, et al. [30,31] noted that the incidence of surgical complete heart block is higher among children with weight less than 4 kg and where VSD is of inlet variety.

One of our series had a pulmonary arterial banding.The child was grossly underweight,had pulmonary over-circulation froma very large VSD.Our aim for performing pulmonary arterial banding was to reduce pulmonary overload and thus protect the pulmonary architecture fromintimal proliferation and thickening, thus averting a possible attendant irreversible pulmonary hypertension. Muhammad,et al. [31] and colleagues opined that, in ventricular septal defect associated with severe pulmonary hypertension, a two-stage repair (Pulmonary banding and VSD closure at a later date) is a safe and effective technique with reduced mortality.

This study revealed a total of 19 deaths, of which 47.4% was before surgery and 52.6% among the females. Majority of the deaths was in the infants. Among the 27 children that had surgery, 37.0% died post-surgery while 7.4% were lost to follow up. This high mortality rate is at variance from that documented in various studies.For instance, Nancy, et al. [32] noted operative mortality of less than 5% in VSD closure. Predictors of morbidity and mortality as seen in this study vary from poor weight gain, prolonged pulmonary hypertension to low frequency rate of surgery. Indeed, low surgery turnout rate, is the very reason for increase mortality.

We noted a prevalence of 19.9% of VSD among children with congenital heart disease.This in keeping with [15] who noted a prevalence of 21.5% among children with congenital heart disease. The reason we had similar prevalence with could be the large sample size used by both studies.

The prevalence of malnutrition in our study, using Z score varies from stunting to wasting or both. A minute percentage were either wasted, severely wasted or stunted. However, about 39 percent of them were both wasted and stunted. This is low when compared [33] who noted a prevalence of 40% which decrease to 16% after surgery.

CONCLUSION

The frequent symptom of VSD is fast breathing and Peri-membranous type is the commonest. Aortic regurgitation is the commonest post-surgical complication associated with VSD closure. The children present with various degrees of malnutrition. There was a high mortality noted before surgery.

RECOMMENDATIONS

High index of suspicion, nutritional rehabilitation, early referral, and capacity building which include state of the art facility, with training and retraining of cardiothoracic surgeons and paediatric cardiologist will help reduce the heavy mortality seen in this study.

STRENGTH OF THE STUDY

The study is made robust with a very good sample size of 758 children with congenital heart disease managed over a five-year period. In addition, this study was executed in 3 different health

institutions, this makes it exceptional. Again, this is the very first time were embarking on this study in the south East. It therefore provides a data base for future studies.

LIMITATIONS

A nation-wide survey of children with VSD would have made the paper better

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This complies with national guidelines. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standard. Ethical approval was obtained from the Ethics and Research committee of the University of Nigeria Teaching hospital Enugu (IRB number of 00002323).

COMPETING INTEREST

We declare that have no competing interests.

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AUTHOR CONTRIBUTIONS

JMC conceived and designed this study while CFC,CD and ATC helped in critical revision of the article. BFC also did the Data analysis/interpretation. All authors have read and approved the manuscript.

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