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Comparative study, using transthoracic echocardiography versus left ventriculography to assesses ventricular septal defect eligibility for device closure

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Abstract

Accurate evaluation of ventricular septal defect types (locations) and measurement of the size of ventricular septal defects and distance from ventricular septal defects to aortic valve are essential for successful trans catheter device closure. The aim of study to assess in patient with ventricular septal defects the accuracy of transthoracic echocardiography in determining the size, position (type), and the distance from ventricular septal defects to the aortic valve as compared to trans- catheter approaches. Cross sectional study included patients with a diagnosis of ventricular septal defects with specific criteria suitable for treatment with transcatheter device closure. Eligibility was confirmed during this study and subject demographic (age, sex), growth parameters (height, weight, body surface, and body mass index) were extracted. During study period, patients underwent catheterization for device closure. Prior to catheterization two- dimensional echocardiography evaluation of VSD was done then left ventriculography was performed by interventional pediatric cardiologist to accurately determine the ventricular septal defect's location (type), size and the distance from ventricular septal defects to the aortic valve. Sixty-three patients with in ventricular septal defects. The sensitivity of transthoracic echocardiography in detection the types of ventricular septal defects of compared to catheter- based assessment (left ventriculography) was (100%) for all types of ventricular septal defects. The correlation coefficient sensitivity of assessment of ventricular septal defects size by transthoracic echocardiography compared to catheter-based assessment was (97%) p-value (0.001*). The correlation coefficient sensitivity of distance of ventricular septal defects to the aortic valve measured by transthoracic echocardiography compared to catheter-based measurement was (91%) p-value (0.001*). Conclusion: Transthoracic echocardiography is useful to evaluate VSDs location and useful to assess measurements of ventricular septal defects prior to transcatheter occlusion. Irregularity of ventricular septal defects shape and its changes during cardiac cycles are suboptimally estimated by trasthoracic echocardiography.

Keywords: Comparative study, Transthoracic Echocardiography, Left ventriculography, Ventricular Septal Defect, Device Closure

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Introduction

Historically, Ventricular septal defects constituted 20% to 30% of congenital heart defects represent the most common congenital heart disease. They occur in 1.35 to 3.5/1,000 live births [1, 2]. The incidence of spontaneous closure of isolated VSDs approximated 45% during the first 12 months of life and 22% during childhood. A study of neonates followed for 15 years showed a spontaneous closure rate of 31% uniformly over the first 10 years of follow-up [3]. This explains why the diagnosis of VSDs in adulthood is distinctly rare [4]. With the advent of echocardiography, the recognition of VSDs has increased to 5 to 50/1,000 live births [5, 6].

Multiple classification systems have been proposed for the description of VSDs. The classification system described in the subsequent sections utilizes the description of the ventricular anatomy as per Soto et al. and Anderson et al. The ventricular septum is separated into three separate portions an apical septum, an inlet trabecular septum, and an outlet or infundibular septum [7, 8]. The perimembranous defect also may accompany abnormalities of the tricuspid valve, most often the septal leaflet. The abnormality of the tricuspid valve leaflet may be secondary to damage from the left-to- right shunt [9,10]. Using surgical and autopsy case series, investigators have estimated that outlet type VSDs constitute 5% to 7% of VSDs. Which have been labeled supracristal, infundibular, conal, subpulmonary, or doubly committed subarterial defects. patients from Japan and other Far East nations have a much higher incidence of this type of VSD than Occidental populations. In Japan, outlet septal defects comprise 30% of all VSDs [7,9,11].

The incidence of muscular VSDs ranges from 5% to 20% in surgical and autopsy case series. These defects effectively can be described as either apical or central. The apical defects, as seen from the RV, can have multiple orifices and therefore present with multiple jets. Often, when evaluated from the left ventricular aspect, these have a single point of origin from the LV [12].

Identification of the nature of the defect also will allow an understanding of the course of the conduction system. In perimembranous defects, the bundle of His travels along the posterior and inferior rim of the defect as opposed to the inlet type of defect in which it will be anterior and superior to the defect [8]. Surgically induced atrioventricular block is less likely with an isolated muscular trabecular defect or an outlet type defect because they are distant from the atrioventricular node and the bundle of His [13]. The catheterization procedure is begun by obtaining vascular access through the right femoral vein and right femoral artery. Profiling of the VSD should be done through angiographic evaluation of the left ventricle at a 55°/20° left anterior oblique projection/cranial.

The location, size, and its relationship of the VSD with the aortic valve should be carefully assessed. The diameter of the VSD should be measured at the peak of the diastolic phase. The occlude should be selected based on VSD type and measurements. If the VSD type and sizes are consistent with intervention, then an arteriovenous (AV) circuit is created via a femoral vein approach at the access site. Once the appropriate occlude is selected, a 5 Fr catheter should be advanced from the LV across the defect. After the intervention, patients should be monitored inpatient for 24 hours with continuous ECG monitoring as this period has the highest arrhythmia risk. All patients should receive Aspirin (5 mg/kg daily) for at least to decrease the risk of thromboembolism [14].

The aim of study to assess in patient with ventricular septal defects the accuracy of transthoracic echocardiography in determining the size, position (type), and the distance from ventricular septal defects to the aortic valve as compared to trans- catheter approaches.

Method

Cross sectional study included patients with a diagnosis of VSDs with specific criteria suitable for treatment with transcatheter device closure. Patients were recruited from Ibn Al Nafees teaching hospital during period from May of 2019 to December of 2019. Inclusion criteria: patients with adequate indication for device closure who’s VSDs have the following feature: Location (site or type): Membranous, muscular and sub aortic. Adequate rims no neighboring structures (device dependent).

Diameter: suitable for device closure (not large). No contraindication for VSDs device closure (malalignment) Exclusion criteria: not suitable for device closure. Location (site): inlet, sub pulmonic. Absent rims to neighboring structures (device independent). Diameter: too large for device closure. Contraindication for VSDs closure devices (e.g. AV prolapsed +/-AR, malalignment VSDs).

Eligibility was confirmed during this study and subject demographic parameters (age, sex), growth parameters (height, weight, body surface, and body mass index) were extracted. During study period, patients underwent catheterization for device closure prior to catheterization 2D TTE evaluation of VSD was done to all patients including evaluation of: Size of VSD. Position (type) of VSD.

The distance from VSD to aortic valve. TTE was done by well-trained Echocardiographer and interventional pediatric cardiology consultant with GE Vivid 9 machine including 2D and Doppler examination with following views: Parasternal long axis view. Parasternal short axis view (base, mid, apex).

Apical four chamber view. Subcostal long axis view. Written informed consent was signed by the parents of patient after they were provided with a comprehensive explanation about procedural details ,the advantage and possible complication .All procedures were done by interventional pediatric cardiologist in the catheterization laboratory under general anesthesia, TTE and Fluoroscopic control, special attention was given to minimize hypothermia, intravenous heparin was administered to all patients and was regularly monitored to maintain clotting time, left ventriculography was performed by interventional pediatric cardiologist to accurately determine the VSDs location (type), size (the defect entry diameter was measured on angiography at the largest diastolic phase on LV side)and its relation to adjacent aortic valve (distance).

Data of all cases were entered, managed and analysis by using statistical package for social science (SPSS) version 24, IBM, USA, 2014. Descriptive statistics were presented as frequencies (numbers) percent (%) for categorical variables (gender, types of VSDs, sensitivity) and as a means and standard deviation for continuous variables (age, weight, height, BSA, BMI).

Correlation coefficient sensitivity with considering p-value < 0.01 was statistically significant for differences in frequency of categorical variables (size of VSDs and distance of VSDs to Aortic valve).

Results

Sixty-three patients with VSDs included in study, twenty- five patients (39.7%) were female and thirty- eight patients (60.3%) were male see figure (1).

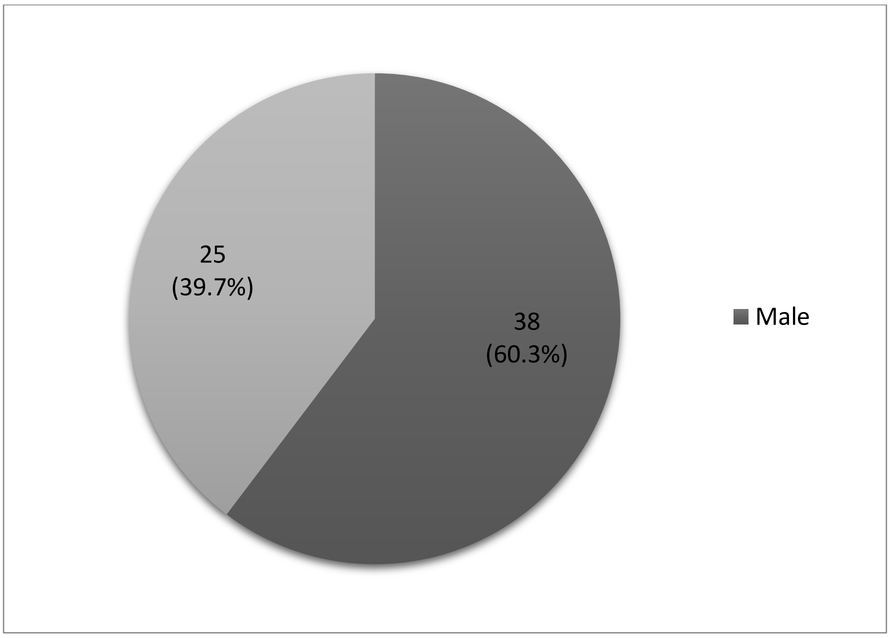

Figure 1.

Numbers and percentages of study patients are according to gender.

Fourteen patients (22.2%) had membranous type of VSDs, 39 patients (61.9%) sub aortic type, 7 patients (11.1%) had midmuscular and high muscular in 3 patients (4.8 %). Sensitivity of TTE in evaluation VSDs was 100% compared to catheter-based assessment for all types of VSDs included in study table (1).

Table 1.

Types and sensitivity of TTE in evaluation of VSDs locations compared to catheter-based assessment.

Type of VSD	*Number of cases*	*Percentage*	*Sensitivity*
Subaortic VSD	39	61.9%	100%
Membranous VSD	14	22.2%	100%
Midmuscular VSD	7	11.1%	100%
High muscular VSD	3	4.8 %	100%

The mean standard ± deviation age of patients (year) was (10.5317 ± 9.17389). The mean standard ± deviation weights (kg) of patient was (31.6817 ± 23.97681). The mean standard ± deviation heights (cm) of patients was (112.3333 ± 34.25038). The mean standard ± deviation body surface area (m^2) of patients was (0.9525 ± 0.40554). The mean standard ± deviation of body mass index (kg/m^2) was (17.7121 ± 3.99364) (table 2).

Table 2.

Means and standard deviations of age, weight, height, surface area and BMI

	Mean ± Standard Deviation
Age (years)	10.5317 ± 9.17389
Weight (Kg)	31.6817 ± 23.97681
Height (cm)	112.3333 ± 34.25038
Surface Area(m^2)	0.9525 ± 0.40554
BMI (Kg/m^2)	17.7121 ± 3.99364

The mean VSDs diameters by TTE and left ventricular angiography were (3.7873 ± 1.56386), (3.4133±1.80897) respectively, the bias of difference between two measurements regarding mean ± standard deviation was (0.374 ±0.24511). The correlation coefficient sensitivity of assessment of VSDs size by TTE comparing to catheter-based assessment was (97%) p- value (0.001*) (table 3).

Table 3.

Comparison between size of VSDs by TEE and by left ventricular angiography.

Size of VSD	Sample Size	Mean ± Standard Deviation	P. value	Correlation Coefficient Sensitivity
By TTE	63	3.7873 ± 1.56386	0.001*	97%
By LV Angiography	63	3.4133 ± 1.80897		

**** P-value < 0.01 is significant.***

Comparison of assessment of distance (mm) of VSDs to aortic valve between TTE and left ventricular angiography assessment show that the distance measured by TTE was (6.7873 ± 5.29060), and by left ventricular angiography was (4.5508 ± 4.11895) respectively, the bias differences between two measurements regarding mean ±standard deviation was (2.2365 ±1,17165). The correlation coefficient sensitivity of distance of VSDs to the aortic valve measured by TTE compared to catheter-based measurement was (91 %) p-value (0.001*) (table 4).

Table 4.

Comparison between measurements of distance from VSDs to aortic valve by TEE and by left ventricular angiography.

AV distance from VSD	Sample Size	Mean ± Standard Deviation	P. value	Correlation Coefficient Sensitivity
By TTE	63	6.7873 ± 5.29060	0.001*	91%
By LV Angiography	63	4.5508 ± 4.11895		

**** P-value < 0.01 is significant.***

Discussion

The percentage of male with VSDs included in study was (60.3%), and the percentage of female with VSDs included in study (39.7%), and these findings not consistent with current study of P. Engelfried et al, [15], neither with study by Zeze Thabet et al, Egypt [16]. And this difference attributed to small sample study and exclusion criteria of patients involved in study. The percentage of patients with membranous VSDs included in study was (83.1%) while percentage of patient with muscular VSDs included in study was (15.9%), and these findings consistent with current study of Dakkak W et al, treasure Island [17], and also with Psyamasundar Rao et al, USA [18].

Accurate evaluation of VSDs types (locations) and measurement of the size of VSDs and distance of VSDs to aortic valve is essential for successful transcatheter device closure. Use of catheter base assessment sizing and appropriate device selection versus conventional method (transthoracic echocardiography) have been well published but have not been enough compared.

The sensitivity of TTE in detection of types of VSDs compared to catheter base assessment was (100%), which is considered high with excellent concordance rate. These findings consistent with study of CF Wppermann et al, Germany [19] and also consistent with study of Besse Sarmila et al, Makassar, south Sulawesi [20]. The sensitivity of TTE measurement of distance between VSDs and aortic valve was (97%); this finding is highly consistent with current study by Gui- Can Zhang et al, Chinese medical centres [21]. Regarding the sensitivity of assessment of the size of VSDs by TTE compared to catheter base assessment it was (91%) with lesser consistency to the current study of, Gui-Can Zhang et al, Chinese medical centers [21].

This bias of differences in measurements attributed to three causes: Related to examiner: Experience, viewing, interviewer difference, test and retest, and ability of using different echocardiographic modalities in diagnosis. Related to equipment: new equipment have an excellent quality in diagnosis and measurement of VSDs in comparison to the old one, so modalities, setting of anew equipment enable the examiners to reach proper diagnosis and more closed measurement to the standard one. Related to the patient: Cooperation of patient, age, chest or cardiac surgery, deformity of chest, and minimal measurements differences during cardiac cycle.

Conclusion

Transthoracic echocardiography is useful to evaluate VSDs location and useful to assess measurements of ventricular septal defects prior to transcathetered occlusion. Irregularity of ventricular septal defects shape and its changes during cardiac cycles are suboptimally estimated by trasthoracic echocardiography.

Ethical Approval

The study was approved by the Ethical Committee.

Conflicts of Interest

The authors declare that they have no competing interests.

Authors' Contributions

All authors shared in conception, design of the study, acquisition of data, and manuscript writing, the critical revising and final approval of the version to be published.

Reference

1. Hoffman JI, Rudolph AM. The natural history of ventricular septal defects in infancy. Am J Cardiol 1965;16:634–653?
2. Graham TP, Bender HW, Spach MS. Ventricular septal defect. In: Adams FH, Emmanouiledes GC, eds. Moss; Heart Disease in Infants, Children and Adolescents. 3rd ed. Baltimore, MD: Williams & Wilkins, 1983:134.
3. Dickinson D, Arnold R, Wilkinson J. Ventricular septal defect in children born in Liverpool: 1960•1969. Br Heart J 1981;46:47– 54.
4. Hoffman JI, Kaplan S, Liberthson RR. Prevalence of congenital heart disease. Am Heart J 2004;147:425–439.
5. Tikanoja T. Effect of technical development on the apparent incidence of congenital heart disease. Pediatr Cardiol 1995;16:100–101.
6. Roguin N, Du Z•D, Barak M, et al. High prevalence of muscular ventricular septal defects in neonates. J Am Coll Cardiol 1995;26:1545–1548.
7. Soto B, Becker AE, Moulaert AJ, et al. Classification of ventricular septal defects. Br Heart J 1980; 43:332–343.
8. Anderson RH, Wilcox BR. The surgical anatomy of the ventricular septal defect. J Cardiac Surgery 1992;7:17–34.
9. Lincoln C, Jamieson S, Joseph M, et al. Transatrial repair of ventricular septal defects with reference to their anatomic classification. J Thoracic Cardiovasc Surg 1977; 74:183–190.
10. Scully BB, Morales DLS, Zafar F, et al. Current expectations of surgical repair of isolated ventricular septal defects. Ann Thoracic Surg 2010; 89:544–551.

11. Tatsuno K, Ando M, Takan A, et al. Diagnostic importance of aortography in conal ventricular septal defect. Am Heart J 1975:89:171–177.
12. Wennik ACG, Oppenheimer Dekker A, Moulaert AJ. Muscular ventricular septal defects: a reappraisal of the anatomy. Am J Cardiol 1979;43: 259–264.
13. Anderson RH, Leval MR. The morphology of ventricular septal defects as related to the mechanics associated with aortic regurgitation. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 2006:140–146.
14. Jortveit J, Leirgul E, Eskedal L, et al. Mortality and complications in 3495 children with isolated VSDs Arch. Dis. Child.2016; 01(9):808-13.
15. Engelfriet P, Mulder BJM. Gender differences in adult congenital heart disease, 2009.
16. Zeze Thabet, Hebatallah Hsan Safar. Outcome of congenital heart disease in Egyptian children: Is there gender disparity? Egypt, 2014.
17. Dakkak W, Oliver Ti. Ventricular septal defect, treasure Island,2019.
18. Psyamasundar Rao, Anderea D Harris. Recent advance in managing septal defects and atrioventricular septal defects. USA, 2018.
19. Wipperman CF et al. Detection and localization of VSD using color Doppler echocardiography specificity limitation,1989.
20. Besse sarmila, Burhanuddin,Iskandar, Dasril Daud ,diagnostic value of ECG for VSDs, 2019. Makassar, south Sulawesi.
21. Gui-Can zhang, Qiangchen, Liang-Wan, et al, transthoracic echocardiographic guidance of minimally invasive perventricular device closure of perimembrance VSDs without cardiopulmonary bypass: initial experience 2012 P74 .