The incidence and follow-up of isolated ventricular septal defect in newborns by echocardiographic screening

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The aim of this study was to evaluate the incidence and spontaneous closure rate of ventricular septal defects in a randomly selected newborn population, using color flow Doppler echocardiographic screening.

Color flow Doppler echocardiographic screening was performed in 1075 neonates within the first 72 hours of life. We also followed-up patients with ventricular septal defect for a year to detect spontaneous closure rate and its timing.

The incidences of ventricular septal defect in all neonates, preterm neonates and term neonates were found as 47.4/1,000, 56/1,000 and 46.3/1,000 live births, respectively. All patients with ventricular septal defect except one were asymptomatic. Forty-six cases had a trabecular and five cases had perimembranous ventricular septal defect. With the exception of one case, all had a small ventricular septal defect (≤3 mm). Spontaneous closure was observed in 88.6% of ventricular septal defects within the first year. Closure rate was found as 100% for preterm infants and 87.8% for term infants (p>0.05).

The incidence of ventricular septal defect was considerably high in neonates when routine color flow Doppler echocardiographic examination was performed. Despite increased incidence of ventricular septal defect, spontaneous closure rate was remarkably high within the first year of life. These defects may result from delayed physiologic development and have fairly good prognosis.

Key words: echocardiography, newborn, ventricular septal defect, incidence.

After discovery of color flow Doppler echocardiography, the incidence of ventricular septal defects (VSDs) have been reported between 3.9 and 7.1/1,000 live births[1-4]. Some authors, however, have recently reported higher incidences of VSD when they carried out neonatal screening by echocardiography[5-8]. In some of these studies, the incidence of muscular VSD was examined in full-term[5,6] or preterm neonates[7] and in neonates having low risk for the development of VSD[8]. They concluded that the incidence of VSD might have been underestimated in the past. The increasing preterm delivery, environmental factors or better echocardiographic imaging due to evolving technology may be responsible for the increase in the reported incidence of VSD. Data regarding the epidemiology of VSD is very limited and depends on a few epidemiological studies[9-11]. Thus, we designed this study to evaluate the incidence of VSD in a randomly selected preterm and full-term newborn population, using color flow Doppler echocardiographic screening. We also planned to follow-up patients with VSD for a year to detect spontaneous closure rate and its timing.

Material and Methods

All live born consecutive neonates delivered in the Obstetrics Department of a university hospital from May 2002 to May 2003 were included in the study group. Parental consents were obtained from the parents of each neonate. The ethics committee of our institution approved the study (Approval No: 22-2002/402). Detailed history of the neonates,

parents and family members were taken by interviewing the parents. Demographic and clinical characteristics of cases with VSD were compared with neonates without congenital heart defect (CHD). One thousand seventy-five neonates (567 M, 508 F) were included in the study. There were 950 (88.3%) full-term and 125 (11.6%) preterm (gestational age <37 weeks) infants. Their gestational ages ranged from 27 to 42 weeks (38.2±1.9 weeks) and birth weights from 720 to 4780 g (3170±567 g). Echocardiographic studies were performed in all neonates by two of the authors (FE or NÖ) and reviewed by two experienced authors (ET or SA) within the first 72 hours in the Department of Pediatric Cardiology of the same university hospital. Complete transthoracic two-dimensional, M-mode, continuous wave and pulsed wave Doppler and color Doppler echocardiographic examinations were performed in all cases followed by a thorough physical examination. Echocardiographic examination was performed using Hewlett Packard Model Sonos 5500 cardiac imager (Andover, Massachusetts, USA) with 3.5-8 MHz multiband transducer.

The diagnosis of a VSD was established based on the presence of a mosaic image passing anywhere through the ventricular septum from the left ventricle to right ventricle, and a turbulent systolic flow jet recorded on the right surface of the VSD by pulsed or continuous wave Doppler. The diameter of VSD in two-dimensional and/or color flow mapping was measured in all planes and the largest diameter of VSD was recorded. Apical four-chamber, apical five-chamber, parasternal long- and short-axis and subcostal positions were used to image the defect. The defects were classified according to previously defined criteria[12]. Infants who had associated complex structural cardiovascular defects were excluded from the isolated VSD group.

In neonates with VSD, echocardiography was repeated at the 1st, 3rd, 6th, 9th and 12th months of age or until the spontaneous or surgical closure of the VSD was confirmed. The chi-square test or Fisher's exact test and the Student's t-test were used to compare the differences where appropriate. A p value less than 0.05 was considered statistically significant.

Results

Incidence of VSD

Ventricular septal defect was found in 51 of 1,075 neonates, at an incidence of 47.4 in 1,000 live births. Forty-four of them were full-term and 7 were preterm infants. The incidences of VSD in full-term and preterm neonates were 46.3 in 1,000 live births (44/950 cases) and 56 in 1,000 live births (7/125 cases), respectively. There was no statistical difference in the incidence of VSD between full-term and preterm infants (p=0.52).

By echocardiographic screening, other CHDs were identified in 20 neonates. Atrial septal defect, bicuspid aortic valve and patent ductus arteriosus were detected in 11, 5, and 2 cases, respectively. Tetralogy of Fallot (1 case), anomalous origin of left coronary artery from the pulmonary artery (1 case), and transposition of great arteries (1 case) were also identified. In our study, the first echocardiographic examination of babies was performed within the first 72 hours after birth and we detected the interatrial septal opening in 843 babies; most of them had left to right shunts. At the end of the first year of life, 464 babies were reevaluated by echocardiography and we observed that interatrial communication persisted in only 18 of them. We detected atrial septal defect ≥7 mm in babies at the end of the first year of life[13]. We also detected patent ductus arteriosus in 374 babies within the first 72 hours after birth. At the end of the first year of life, we observed that patent ductus arteriosus persisted in only 2 of them.

Demographic and clinical characteristics of neonates with VSD

Gestational age, birth weight and sex distribution of cases with VSD were not different from neonates without CHD (Table I). Chromosomal abnormality was present in only 1 baby with VSD (trisomy 21), and in only 1 baby (0.02%) (trisomy 13:7) from among neonates without CHD.

Clinical findings

Except for 1 patient who had a large perimembranous VSD, all newborns with VSD were asymptomatic. Fourteen cases (27%) had a systolic murmur at the first examination. A systolic murmur was heard in another 5 infants

Table I. Demographic and Clinical Characteristics of Neonates with Ventricular Septal Defect

	Neonates with ventricular septal defect (n=51) No. of cases (%)	Neonates without congenital heart defect (n=1004) No. of cases (%)	p value
Gestational age (weeks)	*38.2 ± 1.8	*38.2 ± 1.9	0.52
Birth weight (gram)	*3125 ± 520	*3166 ± 570	0.66
Sex (female/male)	1.31	0.80	0.11
Preterm delivery No. of cases (%)	7 (13.7)	118 (11.7)	0.72
Maternal age (year)	*28.80 ± 4.2	*28.2 ± 5.2	0.82
Consanguinity [number of cases (%)]	1 (1.96)	79 (7.86)	0.17

*expressed as mean±SD.

with VSD, during their 1st month visit. Thus, 19 infants (37%) had a systolic murmur at 1 month of age.

Echocardiography

By echocardiography, 46 cases (90.2%) had a muscular VSD (25 located at the apical region, 20 located at the mid-muscular region and 1 at the outlet region) and 5 cases (9.8%) had perimembranous VSD. Forty-six cases had single and 5 cases (9.8 %) had 2 VSDs. Thus, 56 VSDs were detected in 51 neonates. Defect size ranged from 0.8 to 6.8 mm in diameter and except for in 1 baby, all were small-sized (≤3 mm) VSDs. VSDs detected in preterm neonates were all small-sized and located in the muscular region. We detected only 27 of 56 VSDs by using two-dimensional imaging solely. However, all defects were easily recognized after the contribution of color flow Doppler echocardiographic imaging.

Follow-up

Three cases did not present for follow-up examinations after the first visit. The remaining 48 cases with VSD were followed up during the first year. Five of them had a perimembranous and 43 of them had a muscular VSD. Five of them had 2 VSDs. Except for 1, all had small-sized VSD. Spontaneous closure was recorded in 47 of 53 (88.6%) of VSDs (Fig. 1). Spontaneous closure most commonly occurred within the first 6 months. Closure was seen in 43 of 48 muscular VSDs and in 4 of 5 perimembranous VSDs. Spontaneous closure rate was found to be 100% for preterm infants and 87.8% for full-term infants (p>0.05). Only 1 patient with a large perimembranous VSD and a small apical VSD underwent an operation at the sixth month of age, but the baby died on the 15th postoperative day due to sepsis and multi-organ failure.

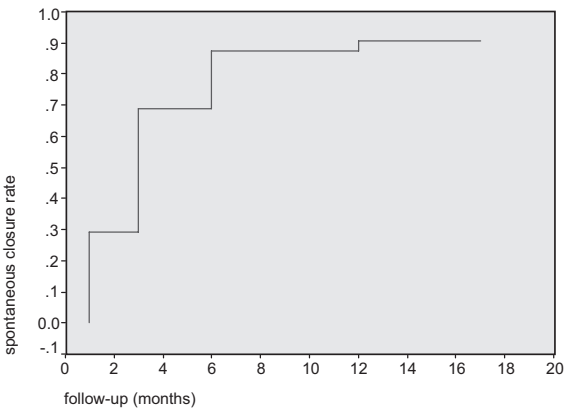

Fig. 1. An exponential curve (Kaplan-Meier) of spontaneous closure rate in children with ventricular septal defect.

Discussion

The incidence of VSD in term newborn infants varies from 20.4 to 53.2/1,000 live births[5,6,8]. Like these studies, we observed that the incidence of VSD was considerably high in full-term infants when routine color flow Doppler echocardiographic examination was performed. There are few studies that have evaluated the prevalence of VSD in preterm infants[7,11]. The prevalence of VSD in preterm infants was evaluated by color flow Doppler echocardiographic screening in only one study[7]. Du et al.[7] reported that the prevalence of muscular VSD in preterm infants was 56.6/1,000 live births.

In this work, the incidence of VSD in all neonates and full-term neonates were similar to rates in Sands'[8] and Roguin's[6] studies. The incidence of VSD in preterm infants in our study was also very similar to the rate reported by Du et al.[7]. In our study, the incidence of VSD in full-term and preterm newborns was not found to be statistically different. Therefore, in contrast to previous thought, we could not demonstrate that increasing preterm delivery was responsible for the increasing incidence of VSD. Color flow Doppler echocardiographic screening is the most reliable method for assessing true incidence of VSD and detects neonates with VSD even in cases without murmur. We could have easily missed about half of the determined VSDs if we had used only two-dimensional imaging. We also conclude that since only 27% of cases with VSD had murmur and most of the VSDs closed spontaneously within the first six months of life in our study, if we preselected newborns by physical examination for echocardiographic examination, the incidence of VSD would have been lower than what we determined, and some of the VSDs would never have been detected.

Major factors influencing the spontaneous closure rate of VSDs are the patient's age at the first examination, localization and size of the defects, and length of the follow-up period[14]. By color flow Doppler echocardiography, the reported spontaneous closure rate of muscular VSD varied from 24 to 68%[1,14-17]. Turner et al.[17] followed 285 patients with VSD and observed that the major factor influencing the spontaneous closure rate of VSDs was the patient's age at the first examination. Since these reports included patients with VSD in all age groups, closure rates might be underestimated. In studies including infants diagnosed with VSD within the first three months of age and followed up during the first year of life by color flow Doppler echocardiography, investigators reported that the spontaneous closure rate of muscular VSDs in the first year of life was higher than that of previous studies, varying from 71.2 to 88.9%[4-7,18,19]. In our study, spontaneous closure was seen in 88.6% of cases during the first year of life and most commonly observed within the first six months. Closure was seen in 89.5% of muscular VSDs. These results were similar to those of Roguin[6], Du[19] and Miyake[18] et al.'s studies. We also could not show a difference in spontaneous closure rate of VSD between full-term and preterm neonates, as in Du et al.'s study[7].

Our study showed that the incidence of VSD was considerably high in full-term and preterm neonates when routine color flow Doppler echocardiographic examination was performed. Despite increased incidence of VSD, most patients' VSD was clinically insignificant and spontaneous closure rate was remarkably high within the first year of life. Thus, we conclude that these defects may be the consequence of delayed physiological development and have fairly good prognosis. Indeed, since the majority of tiny VSDs may either close spontaneously or never cause medical problems, patients with small VSD do not need specialized cardiologic care (20). We also conclude that the routine echocardiographic screening in all neonates without clinical finding is not necessary, except in neonates with a familial history of CHD or having well-defined risk factors.

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