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Original Article

Persistent Left Superior Vena Cava: A Benign Ultrasound Finding or a Marker for Other Fetal Anomalies? Analysis of 27 cases from a single fetal cardiology referral center

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Abstract

Persistent Left Superior Vena Cava: A Benign Ultrasound Finding or a Marker for Other Fetal Anomalies? Analysis of 27 cases from a single fetal cardiology referral center

Objective: We aimed to evaluate the prevalence of associated cardiac and extracardiac conditions with a persistent left superior vena cava detected in fetal echocardiography.

Method: The study included 27 cases with a prenatal diagnosis of persistent left superior vena cava with the presence of bridging left brachiocephalic vein and bilateral superior vena cava and the absence of the right superior vena cava.

Results: Seven fetuses had an isolated persistent left superior vena cava (7/27; 26%) of which four had extracardiac malformations. In twenty cases (20/27; 74%), a persistent left superior vena cava was accompanied by cardiac anomalies, of which twelve had different extracardiac malformations. There were 27 fetuses with 62 cardiac diagnoses; aortic valve and aortic arch anomalies accounted for 12 diagnoses (12/62; 19.4%). Abdominal anomalies were the most common extracardiac conditions (10/22; 45.5%), followed by polyhydramnios in seven fetuses, intrauterine growth restriction in six and a single umbilical artery in five cases.

Conclusion: Persistent left superior vena cava is not always a benign finding, but it may coexist with significant cardiac and extracardiac anomalies.

Keywords: persistent left superior vena cava, cardiac defect, extracardiac anomalies, fetal echocardiogram, prenatal diagnosis

Introduction

A persistent left superior vena cava is the most common variant of the venous system and occurs in about 0.3–0.5% of otherwise healthy individuals [1].

According to the data from the Polish National Prenatal Cardiac Pathology Registry, a persistent left superior vena cava represented 3.5% of the total number of registered heart defects in fetuses in 2014, and 2.6% in 2015 [2].

The development of venae cava is complex. Consequently, it may undergo a vast number of congenital anomalies [3].

There may be a few anatomical combinations of persistent left superior vena cava [4]. Figure 1 illustrates the anatomical variations of superior vena cava (Figure 1).

Usually, the right and left superior vena cava are present with or without the bridging vein between them [5]. An absent right superior vena cava is an extremely rare cardiac anomaly and less commonly detected in utero [6-8]. In these circumstances, the blood continues to return to the right atrium directly or via the dilated coronary sinus. Therefore, if isolated, this condition has no clinical significance after birth and as such is asymptomatic [9]. However, it may constitute a technical difficulty later in life in the event of the need for central venous access or transvenous implantation of a pacemaker from the left subclavian vein [10,11].

A persistent left superior vena cava is easily diagnosed in fetal echocardiography, especially in the second trimester of pregnancy [12]. However, this requires an accurate and detailed differentiation with other anomalies to avoid a diagnostic error.

A mistake could occur if the anomaly of systemic veins is not considered [13].

Detailed fetal ultrasound should be performed to search for not only cardiac de-fects but also for extracardiac anomalies to provide the best prenatal counseling and management after birth [14].

We reviewed the current publications in which a persistent left superior vena cava was described in the context of an isolated systemic vein malformation or combined with other cardiac and extracardiac anomalies.

Mehmet at al. reported that the defects of the heart, which are commonly associated with the presence of persistent left superior vena cava, include heterotaxy syndrome, a ventricular septal defect, an atrial septal defect, an aortic coarctation, and a tetralogy of Fallot [15].

Materials and Methods

It is a retrospective observational study done based on data collected between 2015 and 2018. We performed the data analysis on the premise of the database of the Prenatal Cardiology Department of Polish Mother's Memorial Hospital, Research Institute in Poland.

We included 27 cases with a prenatal diagnosis of a persistent left superior vena cava, a bilateral superior vena cava, which was defined as the presence of right and left superior vena cava without a bridging

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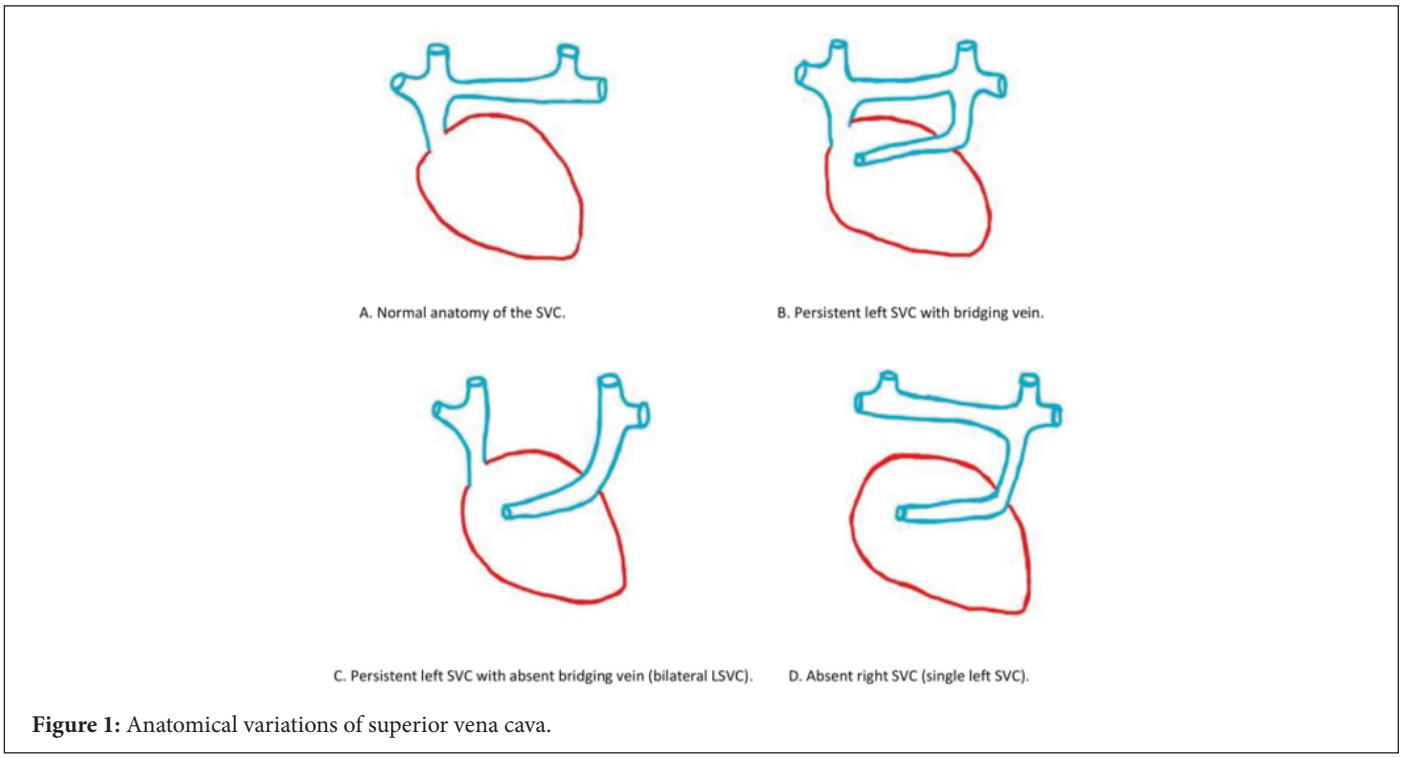

Figure 1: Anatomical variations of superior vena cava.

vein, and an absent right superior vena cava between 2015 and 2018 in the study. We included only fetuses in which antenatal diagno-sis was confirmed by postnatal echocardiography.

We performed echocardiography in all patients in a tertiary referral center using high-resolution equipment. We used a mean, a standard deviation, and a median for the statistical analysis.

Patient and Public Involvement

Patients and the public were not involved in any way in the study.

Clinical demographics

A total of 27 fetuses were found to fit the criteria.

The most common cause of a referral to a tertiary fetal center was the abnormal anatomy of the heart in an obstetric ultrasound, which represented 14 cases (14/27; 51% of total). The second most common indication, with nine cases (9/27; 33%), was an abnormal three vessels view. In two cases, PAPPA test results were abnormal. In one of them, there was an increased nuchal translucency. One fetus was noticed to have bradycardia. An abnormal heart axis and an extracardiac abnormality, that was an omphalocele was an indication for referral in one case.

Table 1 summarizes the indications for detailed fetal echocardiography.

Seven pregnant women had maternal disease (7/27; 26%). Hypothyroidism treated with thyroxine supplementation was diagnosed in two cases. One woman had Hashimoto's disease in the euthyroid state. Three women had been diagnosed with ges-tational diabetes, and one of them had type I diabetes.

In 26 cases, this was a single pregnancy; in one case, it was a twin pregnancy. There were 11 male fetuses (11/27; 41% of the total) and 16 female fetuses (16/27; 59%).

The gestational age at the time of detection of a persistent left superior vena cava in our tertiary fetal cardiology center varied between 21- and 38-weeks' gestation, with a mean of 28.3±0.8, and a median of 27.4.

Table 1: The indications for detailed fetal echocardiography.

The indications for detailed fetal echocardiography	Number of cases	%
Abnormal heart anatomy in the obstetric scan	14	51
Abnormal three vessels view in the obstetric scan	9	33
Abnormal PAPPA test result in the 1st trimester	2	8
Fetal bradycardia	1	4
Abnormal heart axis and extracardiac abnormality	1	4

At the time of the last scan, the minimum gestation age was 26 weeks, a maxi-mal 39, a mean 34.4±0.6, and a median 35.

There were seven premature births in less than 37 weeks gestation (7/27; 26% of the total), minimum gestational age at birth were 33 weeks, maximal 39 weeks, a mean 36.8±0.4, and a median 37.5.

The Apgar score in newborns varied between 3 to 10 in the first minute of life, a mean 7.8±0.5, and a median 9.

The minimum Apgar score after 10 minutes was 3 and a maximal 10, a mean 8.4±0.5, and a median 9.

The minimum birth weight was the 1950 grams, the maximal 3660 grams, the mean 2646±115 grams. We present our demographic data in Table 2.

Results

We compiled a descriptive-analytical statistic.

The most common anomaly of the systemic veins was a persistent

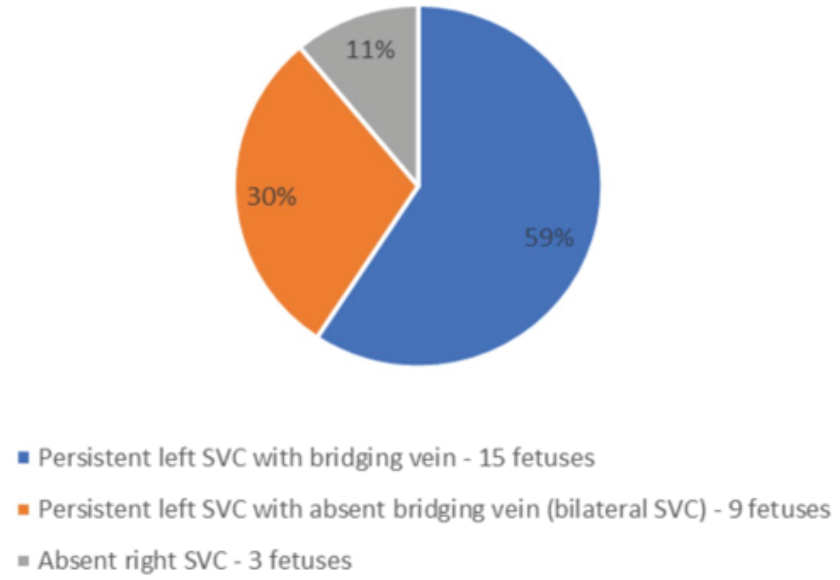

Figure 2: Anatomical variations of superior vena cava in our study.

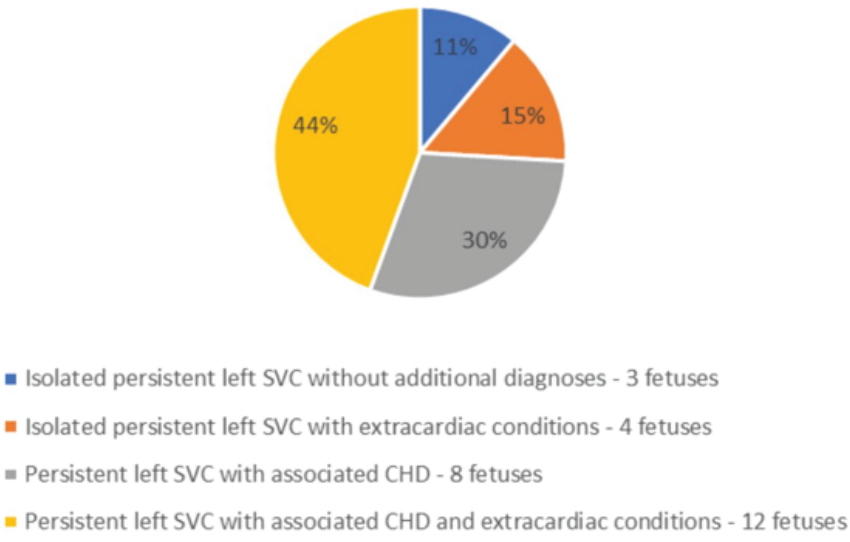

Figure 3: Prevalence of cardiac and extracardiac conditions with persistent left superior vena cava in our study.

left superior vena cava with a bridging vein, which present in 15 fetuses (15/27; 59 % of the total). A bilateral superior vena cava (without a bridging vein) was present in nine cases (9/27; 30 %), and an absent right superior vena cava was noted in three fetuses (3/27; 11%). Figure 1 presents anatomical variations of superior vena cava in our study population.

A persistent left superior vena cava without additional diagnoses occurred in 3 fetuses (3/27; 11%). A persistent left superior vena cava was associated with congenital heart anomalies in 8 fetuses (8/27; 30%). Extracardiac conditions were diagnosed in 4 fetuses with a persistent left superior vena cava (4/27; 15%). Finally, a persistent left superior vena cava with associated cardiac and extracardiac anomalies occurred in 12 fetuses (12/27; 44%). Figure 3 demonstrates our results.

There were three post-birth deaths (3/27; 11%). Twenty-four fetuses survived (24/27; 89%). Two deaths were related to severe congenital cardiac anomalies: one fetus had aortic valve stenosis, aortic arch hypoplasia, as well as coarctation of the aorta and the second fetus had heterotaxy syndrome with left isomerism; abdominal situs inversus with levocardia, a complete atrioventricular septal defect, and a heart block. A third death was related to extracardiac malformations—duodenal atresia and polycystic kidneys.

In two fetuses, a chromosomal abnormality was confirmed by a genetic test. One fetus had a karyotype 47XY+22 and the other one 46XY, del 2 (q3q33). The fetuses with genetic conditions were in the group of survivors.

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Table 2: Clinical demographic data.

Gestational age at the time of detection of PLSVC (weeks)	Mean 28.3 ± 0.8 Median 27.4
Gestational age of the last scan in the fetal tertiary unit (weeks)	Mean 34.4 ± 0.6 Median 35
Premature birth <37 weeks gestation	7 (26%)
Gestation age at birth (weeks)	Mean 36.8 ± 0.4 Median 37.5
Single pregnancy	26 (96%)
Twin pregnancy	1 (4%)
Male fetus gender	11 (41%)
Female fetus gender	16 (59%)
Prenatal diagnosis with the genetic disorder	2 (7.4%)
Neonatal Apgar score	1 min: Mean 7.8 ± 0.5 Median 9 10 min: Mean 8.4 ± 0.5 Median 9
Neonatal birth weight (g)	Mean 2646 ± 115 Median 2675

Table 3: Cardiac diagnoses associated with persistent left superior vena cava.

Cardiac diagnoses (62 total)	Number of cases	%
Aortic valve and aortic arch anomalies in total	12	19.4
Pericardial effusion	6	9.6
Hypoplastic aortic arch	5	8.1
Complete atrioventricular septal defect	5	8.1
Ventricular septal defect	5	8.1
Cardiomegaly	5	8.1
Aortic valve stenosis	4	6.5
Ventricle hypertrophy	4	6.5
Ventricle disproportion	4	6.5
Tetralogy of Fallot	3	4.6
Right aortic arch	3	4.6
Coarctation of the aorta	2	3.2
Heterotaxy	2	3.2
Single ventricle anatomy	2	3.2
Interrupted aortic arch	1	1.6
Abnormal mitral valve	1	1.6
Total anomalous pulmonary veins drainage	1	1.6
Pulmonary atresia	1	1.6
Pulmonary stenosis	1	1.6
Main pulmonary artery enlargement	1	1.6
Complete heart block	1	1.6
Foramen ovale premature closure	1	1.6
Foramen ovale abnormal flow	1	1.6
Abnormal cardiac axis	1	1.6
Absent ductus venosus	1	1.6
Echogenic intracardiac focus	1	1.6

Table 4: Extracardiac conditions accompanying persistent left superior vena cava.

Extracardiac malformations (22 total diagnoses)	Number of cases	%
Total abdominal malformations	10	45.5
Polyhydramnios	7	31.8
Facial dysmorphia	3	13.6
Confirmed genetic disorder	2	9.1
Situs visceral inversus	2	9.1
Hyperechogenic bowels	2	9.1
Omphalocele	2	9.1
Oligohydramnios	2	9.1
Increased nuchal translucency	2	9.1
Hypertelorism	2	9.1
Cleft palate and lip	2	9.1
Long bones shortening	2	9.1
Congenital diaphragmatic hernia	1	4.5
Esophageal atresia with tracheoesophageal fistula	1	4.5
Duodenal atresia	1	4.5
Jejunal distension	1	4.5
Autosomal recessive polycystic kidney disease	1	4.5
Radius hypoplasia	1	4.5
Ambiguous genitalia	1	4.5
Hydrops testes	1	4.5
Agenesis corpus callosum	1	4.5
Increased abdomen circumference	1	4.5
Spina bifida	1	4.5

Table 5: Other extracardiac anomalies associated with persistent left superior vena cava.

Other extracardiac anomalies (24 total)	Number of cases	%
IUGR	6	25.0
Single umbilical artery	5	20.8
Thick placenta	1	4.2
Infection	4	16.6
Umbilical cord around the fetus	3	12.5
Hepatitis	2	8.3
Pyelectasis	1	4.2
Choroid plexus cyst	1	4.2
Maternal diabetes	1	4.2

We made sixty-two cardiac diagnoses. Twelve cases had an aortic valve and an aortic arch anomaly (12/62; 19.4% of the total cardiac diagnoses). A ventricular septal defect was a diagnosis in five fetuses (5/62; 8%). Similarly, five cases had a diagnosis of a complete atrioventricular septal defect (5/62; 8%). A tetralogy of Fallot was a diagnosis in three cases (3/62; 5%). Heterotaxy syndrome of the left isomerism occurred in two cases (2/62; 3%). Two fetuses had single ventricle anatomy (2/62; 3%). A right-sided aortic arch was a diagnosis in three cases (3/62; 5%). Six fetuses had pericardial effusion (6/62; 10%), five had cardiomegaly (5/62; 8%), four had ventricular hypertrophy (4/62; 6%), and four had ventricle disproportion in the privilege of the right ventricle (4/62; 6%). Table 3 shows the prevalence of the associated cardiac defects.

Table 6: List of cardiac and extracardiac abnormalities associated with each type of left superior vena cava.

Cardiac diagnoses (62 total diagnoses) Extracardiac malformations (22 total diagnoses) Other extracardiac anomalies (24 total diagnoses)	Persistent left SVC with bridging vein - 15 fetuses	Persistent left SVC without bridging vein (bilateral SVC) - 9 fetuses	Absent right SVC - 3 fetuses
Pericardial effusion	3	2	1
Hypoplastic aortic arch	3	2	
Complete atrioventricular septal defect	3	2	
Ventricular septal defect	3	2	
Cardiomegaly	3	2	
Aortic valve stenosis	4		
Ventricle hypertrophy	3	1	
Ventricle disproportion	3	1	
Tetralogy of Fallot	2	1	
Right aortic arch	3		
Coarctation of the aorta	2		
Heterotaxy		2	
Single ventricle anatomy	1	1	
Interrupted aortic arch		1	
Abnormal mitral valve	1		
Total anomalous pulmonary veins drainage	1		
Pulmonary atresia		1	
Pulmonary stenosis		1	
Main pulmonary artery enlargement	1		
Complete heart block		1	
Foramen ovale premature closure	1		
Foramen ovale abnormal flow	1		
Abnormal cardiac axis		1	
Absent ductus venosus	1		
Echogenic intracardiac focus	1		
Polyhydramnios	3	4	
Facial dysmorphia	3		
Confirmed genetic disorder	2		
Situs visceral inversus		2	
Hyperechogenic bowels	1	1	
Omphalocele		2	
Oligohydramnios	2		
Increased nuchal translucency	1		
Hypertelorism	1		
Cleft palate and lip	1	1	
Long bones shortening	1	1	
Congenital diaphragmatic hernia	1		
Esophageal atresia with tracheoesophageal fistula		1	
Duodenal atresia	1		
Jejunal distention	1		
Autosomal recessive polycystic kidney	1		
Radius hypoplasia	1		
Ambiguous genitalia	1		
Hydrops testes	1		
Agenesis corpus callosum	1		
Increased abdomen circumference			1
Spina bifida	1		
IUGR	5	1	
Single umbilical artery	3	2	
Thick placenta		1	
Infection	2	1	
Umbilical cord around the fetus	2	1	
Hepatitis	1		
Pyelectasis		1	
Choroid plexus cyst		1	
Maternal diabetes	1		

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Four from a total of seven fetuses with an isolated persistent left superior vena cava (4/7; 47%) and twelve from twenty fetuses with a persistent left superior vena cava accompanied by cardiac anomalies (12/20; 60%) had a variety of extracardiac malformations.

Various types of abdomen anomalies were the most common extracardiac malformations, accompanied by polyhydramnios in seven fetuses.

We described extracardiac anomalies as extracardiac malformations and other extracardiac abnormalities, which we present in Table 4 and Table 5.

Table 6 presents the list of abnormalities associated with each type of left superior vena cava.

Discussion

A persistent left superior vena cava, when isolated, is considered a benign finding for a pediatric cardiologist. Does it mean the same for a fetal cardiologist? In the current published literature, there are not many answers.

Our study showed that 74% of fetuses with the diagnosis of a persistent left superior vena cava had other cardiac anomalies. We demonstrated that the most common associated cardiac anomalies were aortic valve and aortic arch defects, which represented 19.4% of the total cardiac diagnoses.

Other studies describe that an increased nuchal translucency occurs in 29% fetuses diagnosed with a persistent left superior vena cava, regardless of whether it is an isolated anomaly or is associated with other cardiac malformations or heterotaxy [16]. However, in only one case, it was a reason for referral to our center.

Chromosomal abnormalities such as trisomy 21, trisomy 18, and others are de-scribed in some studies and occur in about 9% of fetuses diagnosed with a persistent left superior vena cava [17,18]. We confirmed a genetic disorder in two fetuses, which represents 7.4% of the total.

Extracardiac malformations such as spleen and bowel abnormalities were common in cases with a persistent left superior vena cava and heterotaxy syndrome [14]. We found similar results. The total number of abdomen anomalies was the most common and represented 45.5% of total extracardiac malformations.

Other authors also describe a single umbilical artery, abnormalities of the umbilical venous system, and intrauterine growth restriction [19].

Interestingly, we also noticed a high prevalence of intrauterine growth restriction and a single umbilical artery in our study population.

Making a diagnosis of a persistent left superior vena cava is difficult before 20 weeks of pregnancy. We should emphasize that we can easily create a diagnostic error if not considering the occurrence of this anomaly. A dilated coronary sinus, for example, can be confused with abnormal pulmonary venous drainage to the coronary sinus.

Clinical problems in the fetus and then after birth depends on whether it is an isolated anomaly, therefore without clinical significance, or this is related to a cardiac anomaly. Later, the clinical presentation depends on the gravity of heart defect [20,21]. It is recommended to perform postnatal echocardiography to rule out an atrial septal defect, prenatally undiagnosed coarctation of the aorta, or anomalous pulmonary venous drainage to the coronary sinus. Also, the persistent left superior vena cava may drain to the left and not right atrium when the coronary sinus is partially or entirely unroofed [22].

A diagnosis of a persistent left superior vena cava is clinically relevant in adult-hood. First, this situation may cause technical difficulties during the insertion of a central venous access catheter or implantation of a pacing electrode through a left subclavian vein into the heart [23]. Therefore, a prenatal diagnosis of a persistent left superior vena cava may prevent unexpected problems during the procedure.

Conclusion

Our study showed that diagnosis with a persistent left superior vena cava is not always a benign finding as it may coexist with significant cardiac and extracardiac conditions. Some of the cardiac lesions, such as a coarctation of the aorta, may develop in fetal life and can be missed in the scan during the second trimester. In our study, the aortic valve and aortic arch anomalies represent 19.4%% of all cardiac diagnoses. Various types of abdomen anomalies, polyhydramnios, intrauterine growth restriction and a single umbilical artery were the most common extracardiac conditions.

Therefore, an accurate fetal ultrasound should be performed in cases with a persistent left superior vena cava to search for cardiac and extracardiac anomalies and further follow up is necessary to provide the best prenatal counseling and management after birth.

Limitations

It was a retrospective study from one tertiary center. The small sample size was the main limitation of our research.

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