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A Study Of Fetal Congenital Cardiovascular Anomalies By Ultrasonography In Rural Tertiary Health Care Hospital In Southern India

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Abstract

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Introduction

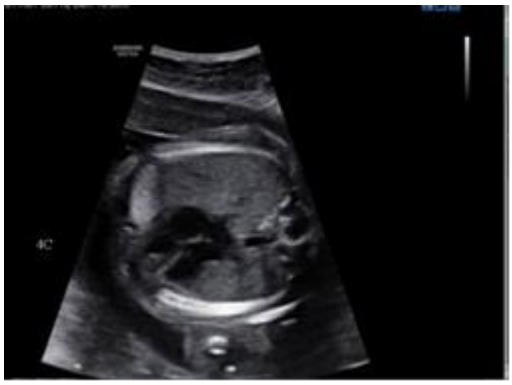
Fetal anomaly scan or Targeted imaging for fetal anomalies is commonly done ultrasound examination to study the anatomy of various fetal structures and identify any malformations. It is done between 18-22 weeks of gestational age. Before 18 weeks of gestational age, the size of the heart will be too small and after 22 weeks of gestational age, there will be less amniotic fluid and uncompromising fetal position, so 18-22 weeks is preferred(1).

Cardiovascular anomalies are common causes of perinatal mortality among all fetal anomalies. They are classified clinically into acyanotic and cyanotic congenital cardiovascular anomalies. Fetal echocardiography is suggested to pregnant women with diabetes, infections (TORCH), family history of congenital heart diseases. It is done routinely in our institution for pregnant women undergoing fetal anomaly scans. Extra cardiac anomalies are seen in 25% of these cases (1,2).

Fetal Cardiac Imaging: Initially, we have to assess laterality i.e orientation of the fetus in the maternal abdomen (Presentation and lie)then situs. Situs means organ position to bilateral body symmetry. The basic view is 4 chamber view and extended views like the right ventricular outflow tract and left ventricular outflow tract, three-vessel view help in the detection of cardiac anomalies.

4 Chamber View: The most basic view performed (3) where both atria and ventricles along with AV valves are visualised. Cardiac axis and position can be determined with this view. Position of cardia can be Dextrocardia (Apex pointing to the right), levocardia (Apex pointing to left) or myocardial(Centrally located). A sequential segmental approach includes morphologic identification of the atria, ventricles, and great arteries, not on their spatial relationship(4).

Fig 1: Basic 4-chambered view showing both atria and ventricles



Ventricular Outflow tract views: Assessing the normality of the two vessels(aorta and main pulmonary artery), which includes their connection to the appropriate ventricles, their relative size and position and adequate opening of the arterial valves. Including these views helps us to identify conotruncal anomalies such as TOF, TGA, double outlet right ventricle and truncus arteriosus

Fig 2: Showing LVOT view.

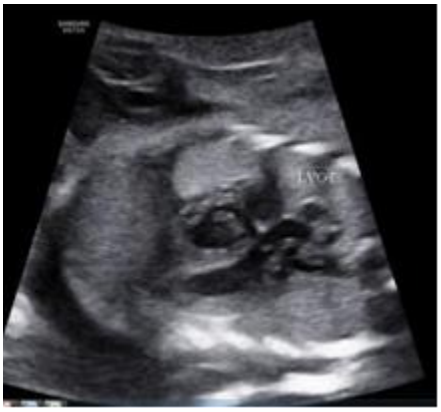
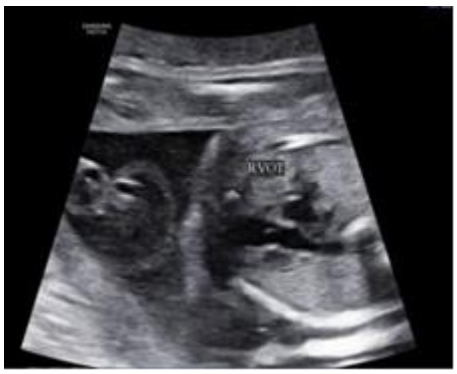


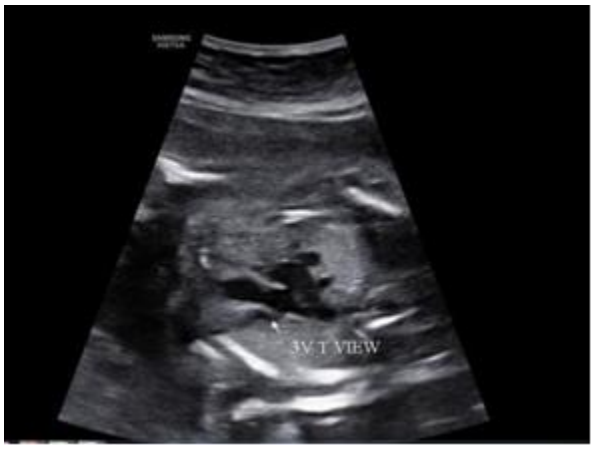
Fig 3: Showing RVOT view.



3 Vessel view and 3Vessel trachea view: Evaluating the pulmonary artery, ascending aorta and superior vena cava, and their relative sizes and relationships. This view helps in the detection of lesions such as coarctation of the aorta, right aortic arch, double aortic arch and vascular rings.

Volume 5, Issue 6; November-December 2022; Page No 69-77

Fig 4: Showing 3VT view.



Color-Flow, Pulsed Doppler, Color Doppler: It helps in detecting flow through cardiac chambers, vascular structures, and septal defects. The direction of the flow helps in the detection and quantification of valvular lesions like regurgitation and stenosis. Reversal of the flow through a valve indicates regurgitation. Aliasing in colour Doppler indicates high velocities suggestive of stenosis Color Doppler is also used in the evaluation of pulmonary and systemic venous connections and small septal defects.

Materials And Methods: A study was done in the department of Radio diagnosis, PESIMSR, Kuppam. This study includes all antenatal women referred for TIFFA scan between 2019 July to 2021 July. The study documented fetal cardiac anomalies including structural and functional defects.

Study location: This study was done in the department of Radio diagnosis, PESIMSR, Kuppam.

Study Duration: July 2019 to July 2021.

Sample size: 36 patients

Inclusion criteria: All antenatal women with the gestational age of 18- 22 weeks and who underwent TIFFA scan were included in the study.

Exclusion criteria: Antenatal women with gestational age less than 18 weeks or more than 22 weeks were exempted from the study.

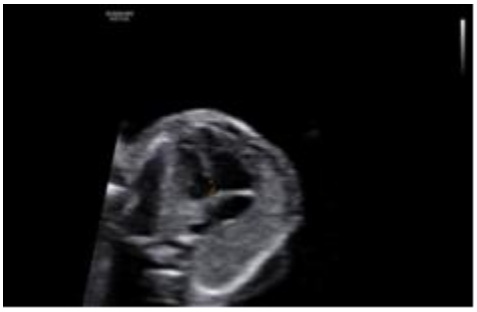
Results: Among 3756 anomaly scans done per month in dept of radio diagnosis, PES college, Kuppam, only 36 cases were diagnosed with cardiac anomalies between July 2019 to July 2021.

The distribution types of cardiovascular anomalies were VSD is the commonest among fetal cardiac anomalies, 11 out of 36 cases, followed by TOF, AVSD, TR and left axis deviation seen in 3 out of 36 cases and MR, persistent left SVC, right aortic arch and dysplastic MV seen in 2 out of 36 cases and AS, PS, HLHS, TGA, POF, coarctation of the aorta and AV block seen in 1 out of 36cases.

1)Ventricular Septal Defect: Among congenital heart diseases, Ventricular septal defect (VSD) is the most common type, accounting for 30% of all cardiac anomalies (4). In our study, it is seen in 11 out of 36 cardiac anomaly cases (32%). It can be isolated or associated with other anomalies (cardiac/extracardiac).VSD is discontinuity in the interventricular septum -membranous or muscular portion. In Muscular portion is again subdivided either into the inlet, outlet or trabecular portion(6). The size of the defect may vary. Four chamber view gives optimal details about the defect in the interventricular septum. Small VSD can be missed on a greyscale, color doppler imaging may be used to show flow across the defect. Spontaneous closure occurs in small defects but large defects need surgical repair.

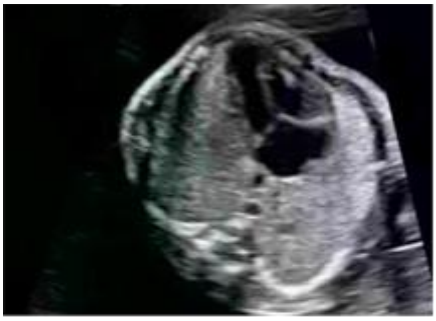
Volume 5, Issue 6; November-December 2022; Page No 69-77

Fig 5: 4 chambered view showing defect in Interventricular septum-VSD



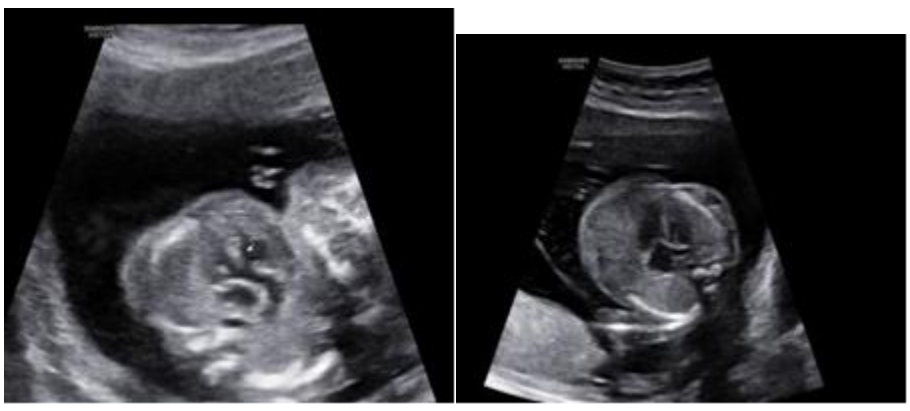
2)ATRIOVENTRICULAR SEPTAL DEFECT: Previously known as A-V canal defects or Endocardial cushion defects. AV septal defect accounts for 2–7% of congenital heart defects(5). It occurs due to deficiency of interatrial as well as interventricular septum along with mitral and tricuspid valves due to failure of fusion of endocardial cushions. Other associated cardiac anomalies are HLHS, TOF, septum secundum ASD, left atrial isomerism. Most of the cases with ASVD showed complete heart block. It can be Complete or incomplete(7). Complete ASVD shows a single valve with multiple leaflets(usually 5). Incomplete ASVD shows two leaflets with a narrow strip of tissue connecting them, It appears like two-valve orifices.5 cases were diagnosed with AVSD in our study.

Fig 6: 4 chambered view showing a defect in both Interatrial septum and Interventricular septum-AVSD



3)**Tetralogy Of Fallot:** It accounts for 5–10% of congenital cardiac defects(5). The four components of TOF are 1)VSD 2)Overriding of the aorta 3)Right ventricular outflow tract stenosis 4)Hypertrophy of the right ventricle.VSD is mostly of perimembranous type. TOF occurs when the conus septum is placed too anteriorly, causing unequal division into small anterior right ventricular portion and larger posterior part. When the interventricular septum closes incompletely, it results in overriding of the aorta(8). RV hypertrophy occurs rarely. The survival rate is more for cases operated earlier at the age of 4-6 months. Seen in 3 out of 36 cases in our study. Pentalogy of Fallot is characterised by tetralogy of Fallot along with Atrial septal defect. Only 1 case was diagnosed with POF in our study.

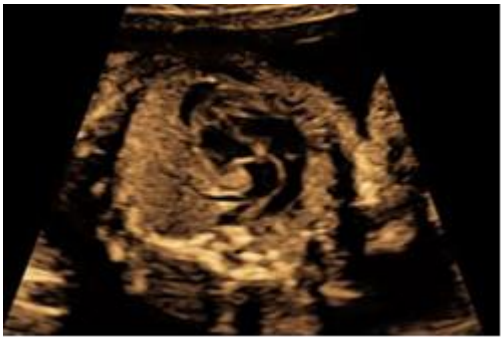
Fig 7a and 7b : USG Showing VSD and overriding of the aorta and associated Left axis deviation.



Volume 5, Issue 6; November-December 2022; Page No 69-77

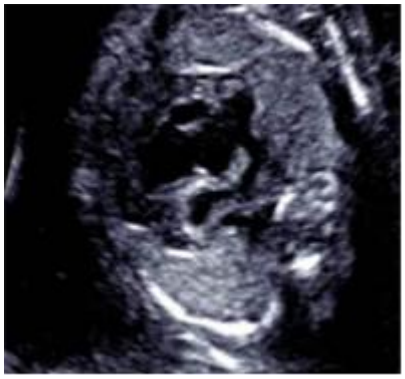
4) TRANSPOSITION OF GREAT VESSELS: Characterised by aorta arising from the right ventricle and Pulmonary artery arising from the left ventricle(ventriculoarterial discordance). Seen in 1 out of 36 cases in our study. It may be complete (D-TGA) or Congenitally corrected (L-TGA). In D-TGA, atria and ventricles are correctly placed but the aorta arises from the right ventricle and the Pulmonary artery arises from the left ventricle. Incompatible with life after birth because foramen ovale and ductus arteriosus close after birth. Arterial switch operation in the first few days of life increases the survival rate in any case. In L-TGA, A-V discordance is present which is not seen in D-TGA. Here, the aorta arises from the left-sided, morphologic right ventricle, pulmonary artery arises from the right-sided, morphologic left ventricle.

Fig 8 : USG Showing Aorta arising from Right ventricle, Pulmonary artery arising from Left ventricle- TGA



5)HYPOPLASTIC LEFT HEART SYNDROME: Pathological reduction in the size of the left ventricle. It occurs when less amount of blood flows into and out of the left ventricle. It is associated with Aortic atresia, aortic stenosis and MV atresia(9). Coarctation of the aorta is commonly seen in HLHS.On colour doppler study, there will be no flow through mitral and aortic valves. 1 case diagnosed with HLHS in our study.

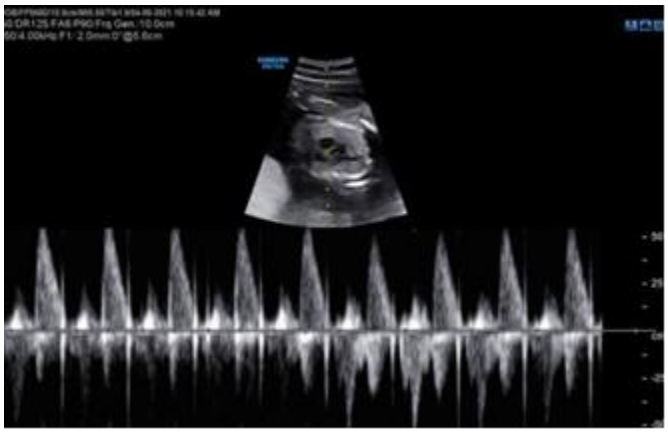
Fig 9: USG images showing hypoplastic left ventricle



6) AORTIC STENOSIS: Obliteration of left ventricular outflow tract. Subdivided into Supravalvular , valvular and subvalvular type. Other associated cardiac anomalies are bicuspid aortic valve (10), Hypertrophic obstructive cardiomyopathy, asymmetrical septal hypertrophy. On USG, there will be -Thickened leaflets of the aortic valve, post stenotic dilatation and enlargement of the left ventricle .2 out of 36 cases are diagnosed with AS.

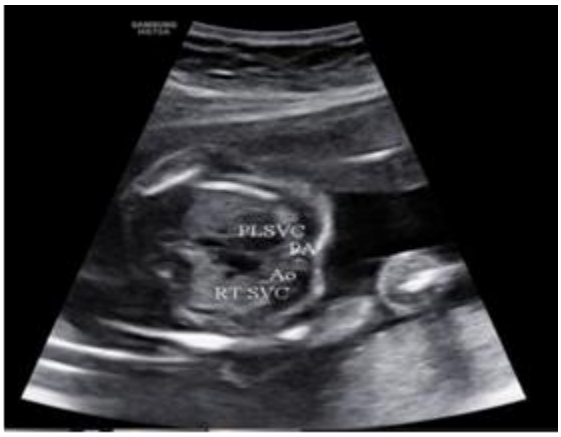
Volume 5, Issue 6; November-December 2022; Page No 69-77

Fig 10: LVOT showing stenosis of the aorta with post stenotic dilatation and the Peak systolic Velocity is recorded as 60 cm/sec.



7)PERSISTENT LEFT SVC: Among congenital venous anomalies in the chest, Persistent left SVC has the highest incidence rates. It is seen in 3 out of 36 cases. During normal embryonic development, the left common cardinal vein and caudal portion of the superior cardinal vein will regress and disappear. If it persists, it forms the persistent left svc. It can drain into either the right atrium (coronary sinus) which is most common or the left atrium. Most of the cases does not show any symptoms. It drains about 20 % of blood from the left half of the head and neck and left arm. Usually, no hemodynamic change occurs. Other associated cardiac anomalies are ASD (most common), VAD, TOF etc.

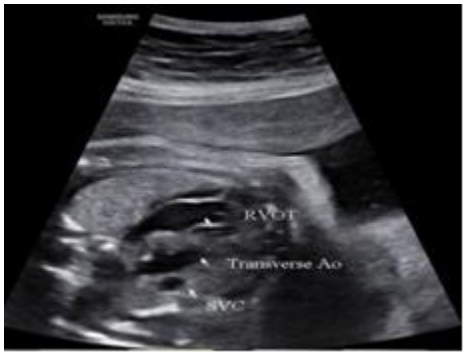
Fig 12: 3VT view showing Persistent Left SVC above the main pulmonary artery



8)RIGHT AORTIC ARCH: In the normal fetal situs, the aortic arch passes to the left of the trachea together with the ductus arteriosus. In some cases, it will pass to the right of the trachea. The laterality of the aortic arch and the relationship of the arch to the trachea is determined using both two-dimensional (2D) grey-scale and colour Doppler imaging at the 18–20-weeks of gestation, with the inclusion of the three vessels and trachea (3VT) view.2 cases were diagnosed with Right aortic arch.

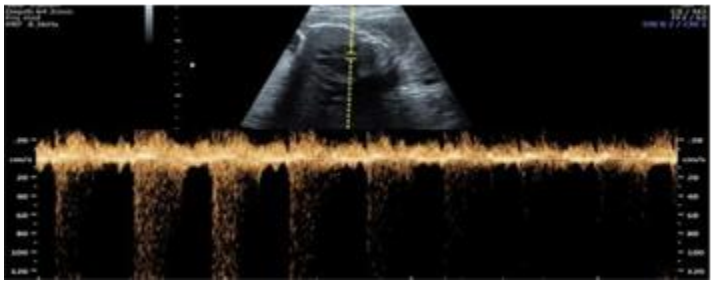
Volume 5, Issue 6; November-December 2022; Page No 69-77

Fig 13: 3VT view showing Right aortic arch.



9)MITRAL REGURGITATION: MR is seen in 2 out of 36 cases. Characterised by abnormal reversed flow from the left ventricle to the left atrium. Clinically significant mitral regurgitation (MR) in fetal life is rare. It can occur in isolation or conjunction with other structural and functional abnormalities, such as AS with global left ventricular (LV) dysfunction and dilatation. It can also occur in conditions with high fetal cardiac output, such as anaemia or extracardiac arteriovenous malformations, or with arrhythmias. Mild to moderate MR is most commonly observed in evolving or established hypoplastic left heart syndrome (HLHS).

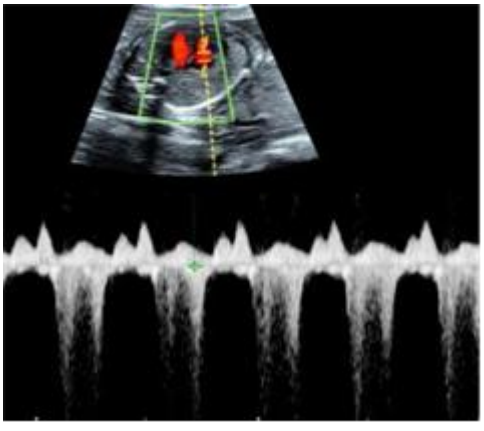
Fig 14: USG with Spectral Doppler of the regurgitant jet in mitral valve showing increased peak systolic velocity (~75 cm/sec).



10)TRICUSPID REGURGITATION :3 cases were diagnosed with TR among 36.A common finding in imaging of fetuses. It is characterised by abnormal backward flow of blood from the right ventricle to the right atrium. Also referred to as tricuspid insufficiency/tricuspid valvular incompetence.

It can be isolated findings or associated with cardiac/extracardiac abnormalities. On USG, the regurgitation jet velocity is at least 80 cm/sec and its interval extends to more than half of the systole. On the Color Doppler study, flow in the opposite direction is seen with a different colour compared to mitral valve flow with aliasing, denoting high-velocity flow in opposite direction.

Fig 15: USG with Spectral Doppler of the regurgitant jet in tricuspid valve showing increased peak systolic velocity(~70 cm/sec).



Volume 5, Issue 6; November-December 2022; Page No 69-77

NAME OF CARDIOVASCULAR ANOMALY	NO. OF CASES	PERCENTAGE
VSD	11	30%
TOF	6	16%
AVSD	5	13%
TR	3	8%
PERSISTENT LEFT SVC	3	8%
MR	2	5%
TGA	1	2%
AS	2	5%
HLHS	2	5%
RIGHT AORTIC ARCH	2	5%

Discussion

Our study gives us information about the incidence, distribution and associated anomalies in fetuses with congenital cardiovascular anomalies in tertiary care hospital in the tri-state area of kuppam.In our study,the incidence of CVS anomalies in antenatal women is approximately 1%.

Antenatal USG is the most commonly performed noninvasive modality of choice for the detection of congenital cardiovascular anomalies. Cardiovascular anomalies are common causes of perinatal mortality among all fetal anomalies

Ventricular septa defect (VSD) is the most common cardiovascular anomaly, can be associated with cardiac/extracardiac anomalies. In our study, it was seen in 11 cases (30%), it was associated with absent ductus venosus in 2 cases,1 VSD was seen associated with TOF, one VSD associated with TGA and another case VSD associated with HLHS and dysplastic mitral valve.

Tetrology of FALLOT (TOF) was seen in 6 cases accounting for 16% among total cases in our study.TOF associated with ASD (POF) was found in one case. It can be associated with chromosomal/ extracardiac anomalies.

Atrioventricular septal defect (AVSD) can be associated with valvular defects, other cardiac and extracardiac anomalies. It was seen in 5 cases (13 %).In our study, it was found to be associated with left axis deviation, MR and TR in one case, another case associated with hypertrophy of right and left ventricles.

Hypoplastic left heart syndrome (HLHS) was seen in 2 cases with an incidence rate of 5%. It is seen associated with the hypoplastic aortic valve, ascending and transverse aorta, reversal of flow noted in the transverse aorta.

Tricuspid regurgitation (TR), seen in 3 cases with an incidence rate of 8 %.Mitral regurgitation (MR), right aortic arch seen in 2 cases with an incidence rate of 5%.

Aortic stenosis (AS) seen in 2 cases, with an incidence rate of 2-3%.

Transposition of great arteries (TGA) was seen in 1 case with an incidence rate of 2%.

Conclusion

Antenatal routinely TIFFA performed helps in the early detection and characterization of most of the cardiac anomalies. Detailed evaluation of defects can be done with fetal echocardiography. Doppler imaging is useful in the evaluation of valvular lesions like TR, MR and AS.

Finally, this study gave us information regarding the incidence, distribution of cardiovascular anomalies and other associated anomalies, the ability of USG in diagnosing these conditions which influences prognosis and prenatal counselling of parents.

Volume 5, Issue 6; November-December 2022; Page No 69-77

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Volume 5, Issue 6; November-December 2022; Page No 69-77