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Original Research Article

Evaluation of Fetal Echocardiography As A Routine Antenatal Screening Tool for Detection of Congenital Heart Disease In Unselected and High-Risk Population In Second and Third Trimester

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Abstract:

The aim of this study was to describe the experience of the study with fetal heart screening by fetal echocardiography in non-risk and high-risk population. This was a prospective analytical study, the data was collected prospectively during the time period of November 2018 to December 2019, through a screening of fetal heart. Screening fetal echocardiography was provided to all pregnant women of second and third trimester who came for routine outpatient ultrasound clinic of our hospital. The pregnant females with high risk were provided with extended fetal echocardiography. We categorized the abnormal fetal heart according to severity into "complex", "significant", "minor" and "other". we performed 6634 fetal heart screening. 852 pregnant out of 6634 were identified with conventional risk factors for CHD. The incidence among non-risk population was 4.3 per thousand and among high-risk population was 12.9 per thousand. Based on complexity of anatomical cardiac anomalies, 48.2% cases were complex, 20.6% cases were significant, 17.2% were minor cases and rest 13.7% were other.

Introduction

Congenital heart disease, malformation of the heart or great arteries, is the most common form of major birth defect, being six times more common than chromosomal abnormalities and four times more common than neural tube defects. [1] Environmental, genetic, and chromosomal abnormalities are believed to be causes of congenital cardiac defects, with a higher incidence among infants with affected siblings or mother. Congenital heart disease is a leading cause of infant morbidity and mortality from birth defects with an estimated incidence of 6 per 1000 live births for moderate to severe forms. [2,3]

A detailed evaluation of the fetal heart optimizes the diagnosis of congenital heart disease. This provides an appropriate prenatal and postnatal planning, enabling an improvement in neonatal morbidity and surgical outcome. Also, accurate prenatal diagnosis offers potential clinical benefit with regard to infant outcome, especially in those cases that are likely to require prostaglandin infusion to maintain patency of the ductus arteriosus.[4–6] Detection of anomalies alters the obstetric course and outcome, including reassurance, termination, fetal therapy, mode of delivery, and postnatal referral to a tertiary care center with advanced expertise in management of these patients [7]. Early knowledge of congenital heart disease also allows further monitoring, testing for known associated non-cardiac structural and chromosomal anomalies and parental counselling about pregnancy management options including termination.

Method

This was a prospective analytical study that was carried out on the out -patient door basis along with follow up of 6634 consecutive obstretic patients at the department of Radiodiagnosis and modern imaging, government medical college kota and associated group of teaching hospitals, during the period of November 2018 to December 2019 by a screening protocol (basic fetal echocardiography).

The fetal heart was examined by 2-dimentional, pulsed, wave and colour doppler echocardiographic method. We recorded the indication of fetal heart screening, maternal and gestational age, fetal cardiac screening findings, and extracardiac anomalies (if any). All the 6634 patients (non- selected general population) were provided with 2-dimentional evaluation of fetal cardiac structures with the basic fetal echocardiography (4CH+ 3VV +outlets). 852 patients out of 6634 were identified with high risk (as mentioned in table) and cases with congenital heart disease were from the non-risk population

which were identified with cardiac anomaly during routine scan (i.e. chamber asymmetry, abnormal cardiac axis, abnormal cardiac position, conduction abnormality, proportionate or disproportionate cardiomegaly) during routine obstretic scan were provided with extended fetal echocardiography.

The pregnant patients in which fetal heart screening was normal on screening fetal echocardiography were counselled and advice to report, in case if the treating physician found any clinical abnormality in the newborn child.

According to our protocol and based on fetal echocardiographic findings, we categorised the abnormal fetal heart according to complexity of the heart anatomical abnormalities in the "complex", "significant", "minor" and "others". (table X).

The diagnosis of congenital heart disease was confirmed by the post-natal 2-D echocardiography for the living neonates; however, the foetuses which are aborted or intrauterine death, follow up was not done.

The counselling and decision-making team was consisted of obstreticians/ perinatologist /cardiologist of the institute.

The main statistical parameters of diagnostic precision for fetal echocardiography (i.e. sensitivity, specificity, positive predictive value and negative predictive value) and overall diagnostic accuracy were calculated.

Results

We performed fetal heart screening (basic fetal echocardiography) in 6634 fetuses during the period of November 2018 to December 2019, of which 29 foetuses had congenital heart disease. All patients were similar except for indication of extended fetal echocardiography.

852 patients out of 6634 patients were identified were some risk factors for CHD, maternal or fetal. Maternal indication was advanced maternal gestational age, pre-existing metabolic disorder, teratogenic exposure, maternal infections and history of CHD in previous pregnancy.

Indications for extended fetal echocardiography were maternal (59.8%) and fetal (40.2%), in maternal indications most common was advanced maternal gestational age (29.4%) followed by pre-existing maternal metabolic disorder (12.3%).

Highest incidence of CHD was found in patients with assisted reproductive technology (6.4%) followed by in patients with history of CHD in previous pregnancy (4.6%). In patients with history of teratogenic exposure 2 CHD found out of 65 foetuses (2.98%), In patients with advanced maternal age 4 CHD found out of 251 foetuses (1.6%) and in patients with metabolic disorder where only single CHD found out of 105 foetuses (0.95%). However, no cardiac anomaly found in patients with history of infective disorder i.e. TORCH infection.

In maternal high-risk group 11 foetuses were found with CHD out of total 510 foetuses (2.1%).

Fetal causes were extracardiac anomalies, IUGR, monochorionic twining, and suspicion of cardiac anomaly on routine scan i.e. abnormal cardiac axis, chamber asymmetry, abnormal cardiac position and conduction abnormality.

Most common fetal indication for extended fetal echocardiography was abnormal doppler finding i.e. IUGR (17.4%), followed by foetuses with associated CNS anomalies (10.0%). In fetal high-risk group, highest incidence of CHD was found in association with diaphragmatic hernia (10.5%) followed by foetuses with abnormal doppler finding i.e. IUGR (4.7%). In foetuses with associated CNS anomalies 3 CHD were found out of 86 foetuses (3.4%), in foetuses with associated genitourinary anomalies 3 CHD were found out of 75 foetuses (4.0%). However, no CHD was found in foetuses with monochorionic twin pregnancy.

In fetal high-risk group, 15 foetuses were found with CHD out of total 342 foetuses (4.3%).

Based on complexity of anatomical cardiac anomalies, 14 out of 29 cases were complex (48.2%), 6 out of 29 cases were significant cases (20.6%), 5 out of 29 were minor cases (17.2%) and rest 4 were other (13.7%).

Table 1: Reason for extended fetal echocardiography and frequency of congenital heart disease in that particular risk group group

Reason	Normal heart	Abnormal heart	Total (n=852)	%
1. Maternal				
Advanced maternal age (>=35 year)	247	4	251 (29.4%)	1.6%
H/O congenital heart disease in previous pregnancy	41	2	43 (5.04%)	4.6%
pre-existing maternal metabolic disorder	104	1	105 (12.3%)	0.95%
H/O any maternal infective disease	13	-	13 (1.52%)	-
H/O any teratogenic exposure	65	2	67 (7.82%)	2.98%

Assisted reproductive technique gestation	29	2	31 (3.60%)	6.4%
Total	**499**	**11**	**510**	
2. Fetal				
Associated with CNS abnormality	83	3	86 (10.0%)	3.4%
Associated with genito-urinary abnormality	72	3	75 (8.81%)	4.0%
Associated with congenital diaphragmatic hernia	17	2	19 (2.23%)	10.5%
Associated with IUGR	142	7	149 (17.4%)	4.7%
Monochorionic Twin pregnancy	13	-	13 (1.52%)	
Total	**327**	**15**	**342**	

Table 2: Cardiac abnormality classification

Cardiac abnormality classification	Frequency (n=29)
1. Complex	**14 (48.2%)**
Hypoplastic left heart syndrome	05
Hypoplastic right heart syndrome	04
Complete A-V canal defect	01
Double outlet right ventricle	02
Double outlet left ventricle	01
Complex cardiac anomaly associated with congenital diaphragmatic hernia	02
2. Significant	**06 (20.6%)**
Large ventricular septal defect	04
Tetralogy of fallot	01
Dysplastic tricuspid valve	01
3. Minor	**05 (17.2%)**
Atrial septal defect	02
Tricuspid regurgitation	02
Membranous ventricular septal defect	01
Other	**04 (13.7%)**
High degree A-V conduction block	02
Fetal mesocardia	01
Giant right atrium syndrome	01

Discussion

In our present study, incidence of congenital heart disease among non-risk population is 4.3 per thousand and among high-risk population is 12.9 per thousand, nearly corroborates with literature. The difference in the incidence between non-risk and high-risk group is significant statistically.

In the present study, Indications for extended fetal echocardiography were maternal (59.8%) and fetal (40.2%), in maternal indications most common was advanced maternal gestational age (29.4%) followed by pre-existing maternal metabolic disorder (12.3%).

Highest incidence of CHD was found in patients with assisted reproductive technology (6.4%) followed by in patients with history of CHD in previous pregnancy (4.6%).

Most common fetal indication for extended fetal echocardiography was abnormal doppler finding i.e. IUGR (17.4%), followed by foetuses with associated CNS anomalies (10.0%).

In fetal high-risk group, highest incidence of CHD was found in association with diaphragmatic hernia (10.5%) followed by foetuses with abnormal doppler finding i.e. IUGR (4.7%). In foetuses with associated CNS anomalies 3 CHD were found out of 86 foetuses (3.4%).

In present study, based on complexity of anatomical cardiac anomalies, 14 out of 29 cases were complex (48.2%), 6 out of 29 cases were significant cases (20.6%), 5 out of 29 were minor cases (17.2%) and rest 4 were other (13.7%).

In present study, most common cardiac defect was VSD (isolated and as a part of complex CHD), most common complex cardiac abnormality was hypoplastic left heart syndrome.

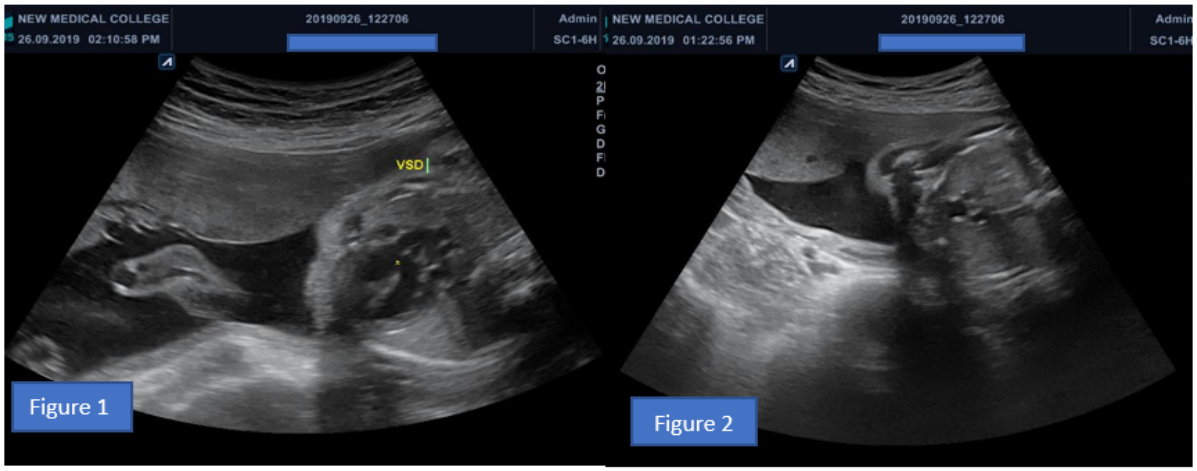
In present study, CHD foetuses (n=29) of non-high risk and high-risk group, four chamber view was abnormal in 26 out of 29 cases, followed by three

vessel view in which 12 out of 29 cases were abnormal. Cardiac axis found abnormal in 5 cases, criss-crossing of great vessels was absent in 3 cases, and 7 cases showed reversal of flow in ductus arteriosus.

In present study, Amniotic fluid abnormality (polyhydramnios/oligohydramnios) were predominantly found in foetuses with CHD which were associated with other system abnormality i.e. urogenital or CNS anomalies. Only single fetus with isolated CHD had moderate oligohydramnios.

Case 1

Double Outlet Right Ventricle with Pulmonary Stenosis



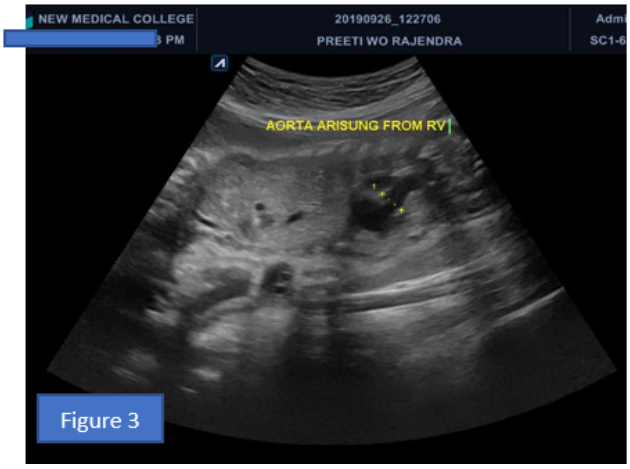


Figure 1 & 3: Aorta arising from right sided ventricle with >50% overriding of aorta over VSD
Figure 2: Anteriorly placed aorta on 3 VV PA diameter less than Aorta

Case 2

Situs Inversus Totalis with Single Ventricle (Right Ventricle Morphology)

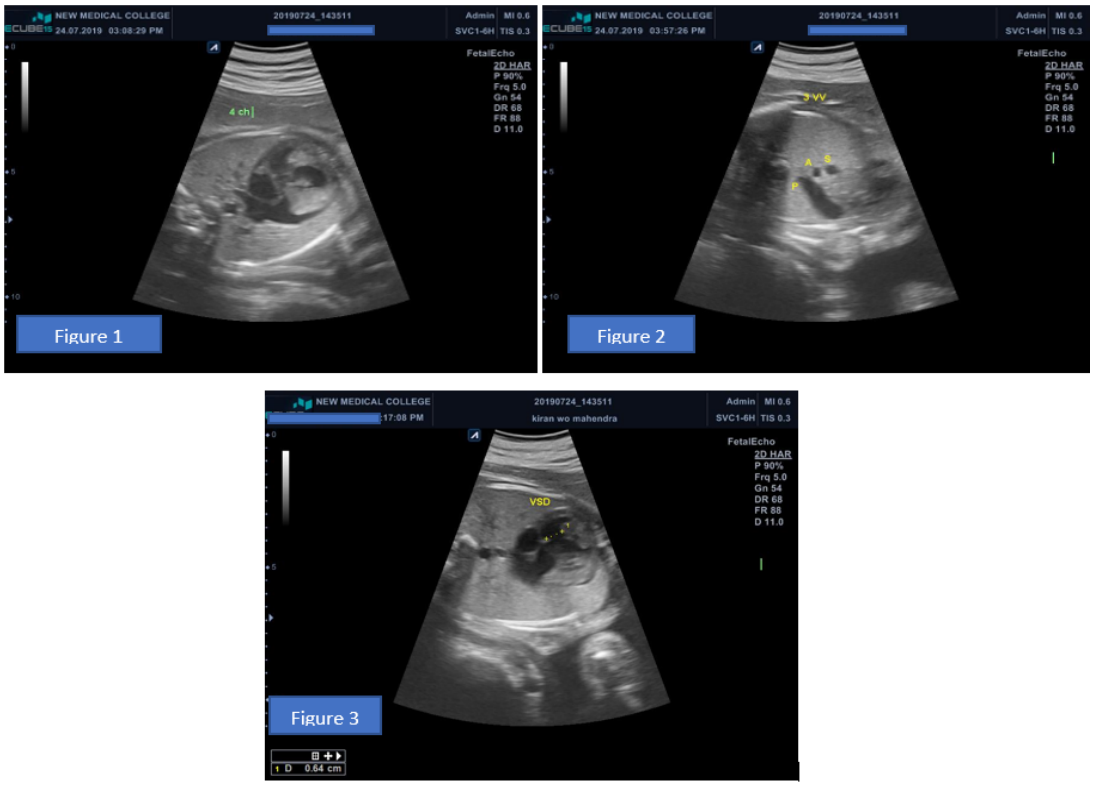


Figure 1: single ventricle (right ventricle morphology).
Figure 2: Hypoplastic aorta
Figure 3: large VSD

Case 3

Tetralogy of fallot with pulmonary hypoplasia

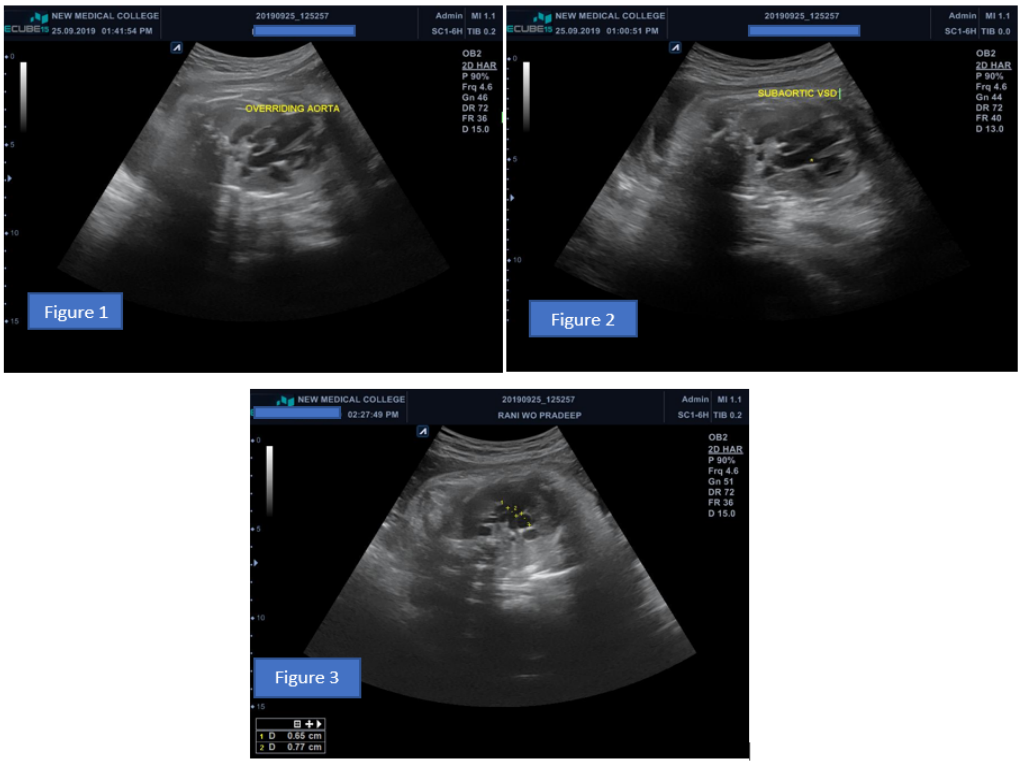
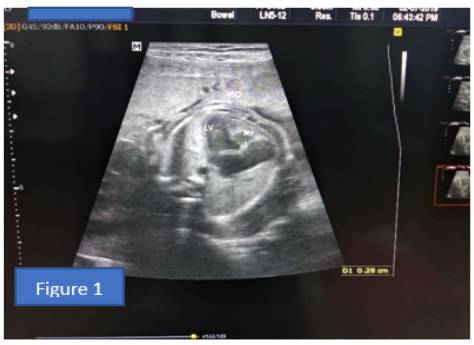
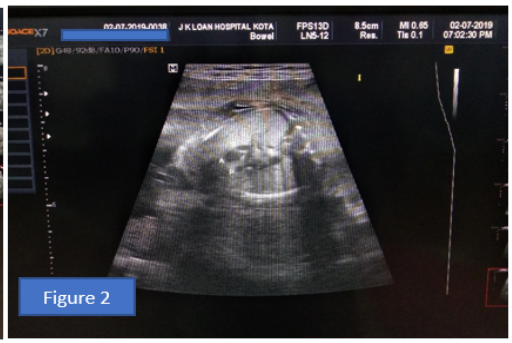


Figure 1&2: subaortic VSD with overriding aorta
Figure 3: Small pulmonary artery diameter than aortic diameter on 3 VV

Case 4

Hypoplastic Right Heart Syndrome





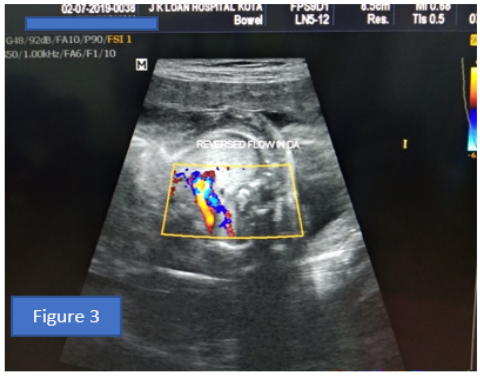
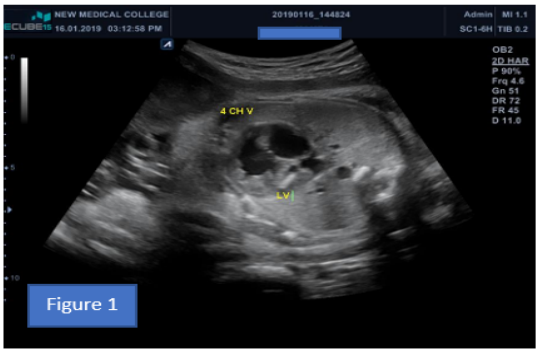
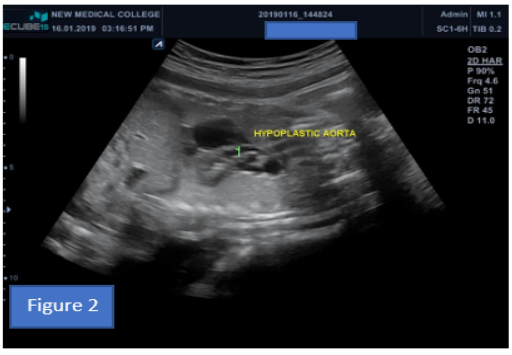


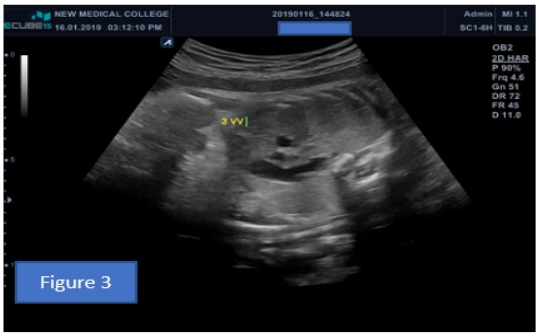
Figure 1 &2: Hypoplastic RV, RA and pulmonary artery
Figure 3: Reversal of flow in ductal arch

Case 5

Hypoplastic Left Heart Syndrome







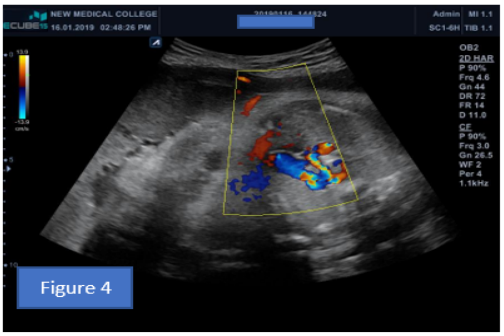


Figure 1,2 & 3: Hypoplastic left atrium, ventricle and ascending aorta on four chamber, LVOT and three vessel view
Figure 4: Anterograde flow in ductal arch (no reversal)

Case 6

Enlarged Right atrium due to tricuspid regurgitation

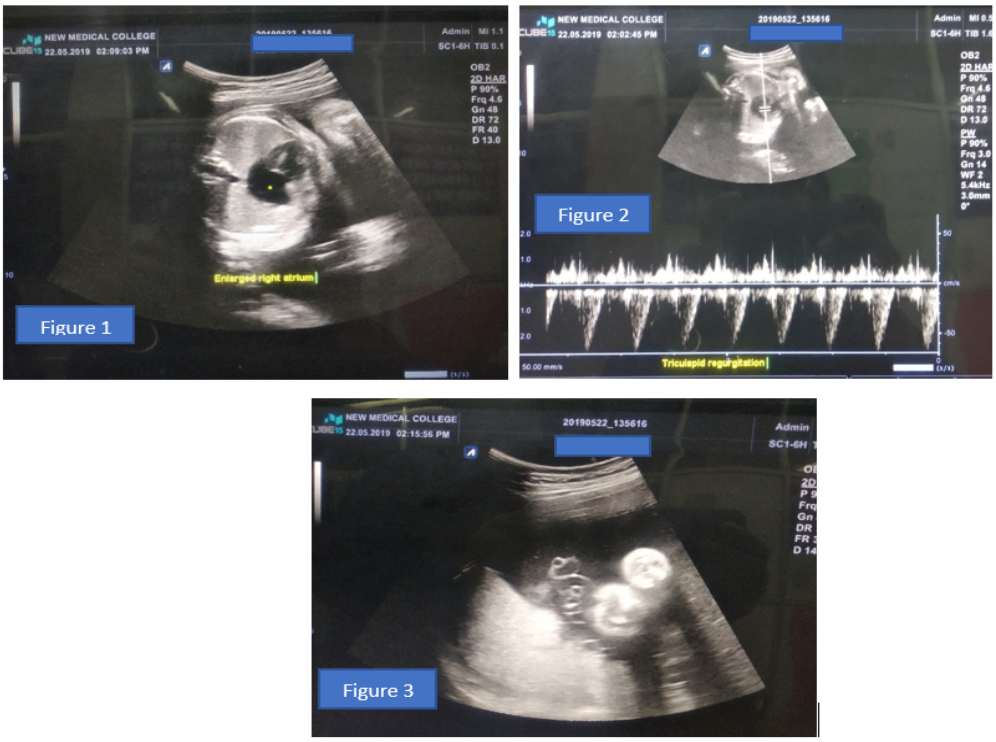


Figure 1: Enlarged Right atrium
Figure 2: Tricuspid valve waveform showing moderate TR
Figure 3: single umbilical artery

Case 7

High degree A-V conduction block associated with hydrops fetalis

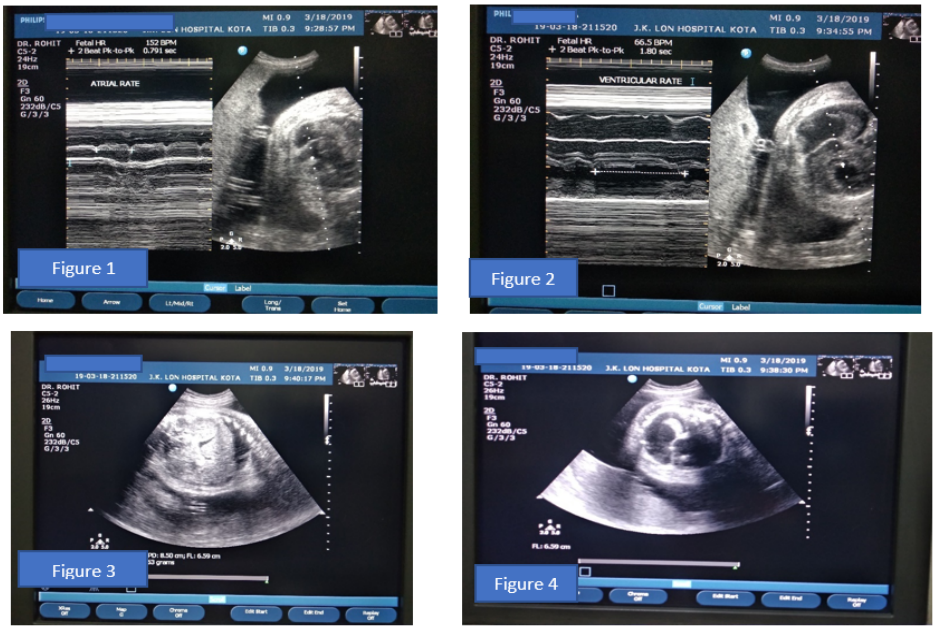


Figure 1 & 2: Atrio-ventricular dissociation with high degree A-V block with 2:1 ratio of A-V Conduction rate
Figure 3 & 4: significant ascites, pericardial and pleural effusion with significant subcutaneous edema i.e. hydrops fetalis

Case 8

High degree A-V conduction block with large ssASD

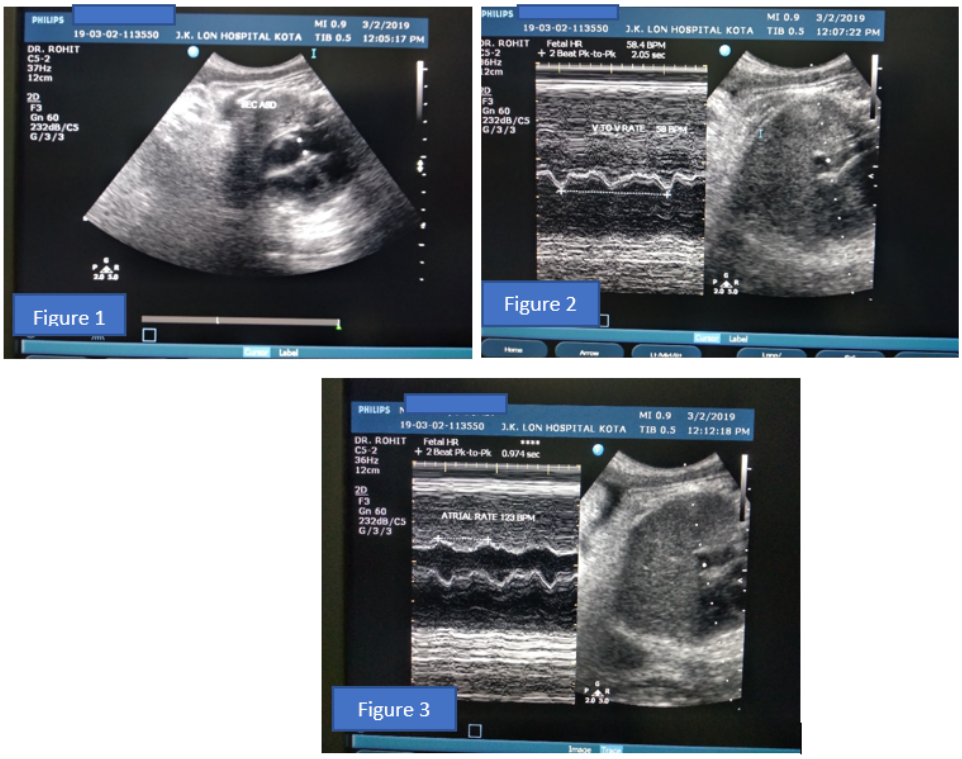


Figure 1: septum secondum ASD
Figure 2 & 3: Atrio-ventricular dissociation with high degree A-V block with 2:1 ratio of A-V Conduction rate

Case 9

Giant Right atrium syndrome

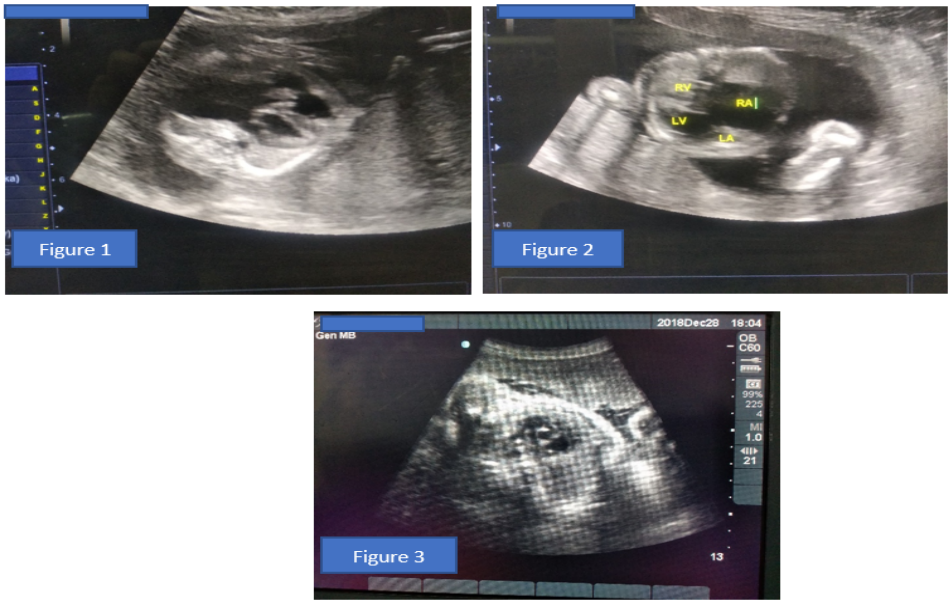
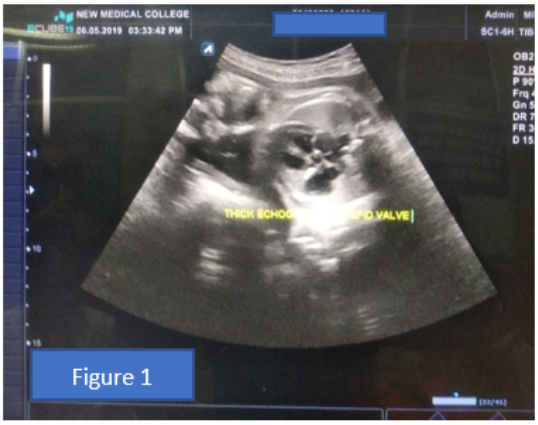


Figure 1 & 2: massively enlarged Right atrium with normal arrangement of septal leaflet of tricuspid valve
Figure 3: dilated SVC on three vessel view

Case 10

Dysplastic tricuspid valve with cardiac crux defect



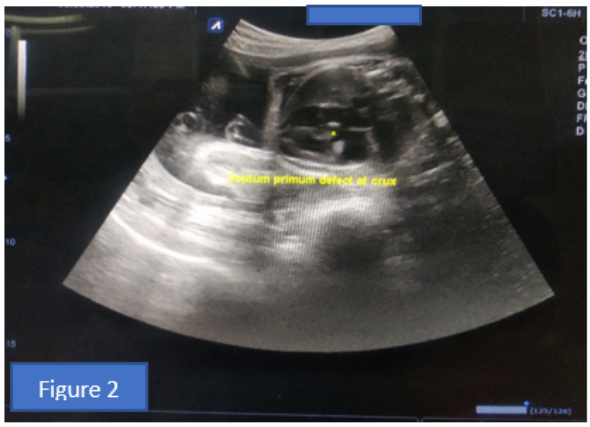


Figure 1: Dysplastic tricuspid valve
Figure 2: Crux defect

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