

An Introduction to **Fetal Echocardiography**

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I. Instructions

Welcome to "An Introduction to Fetal Echocardiography." This written guide is designed to start you on the road to Fetal Echocardiography. Please read the material and then proceed directly to the written test questions on the Acuson Website. Click on your answer to each question and then click on "score quiz." This written guide and questions should take approximately 180 minutes to complete. This booklet is accredited by the SDMS for 3 CME credits.

Objectives:

Upon completion of the instruction booklet the reader should be able to:

- Describe the routine views obtained for a fetal echo exam
- Describe the anatomy demonstrated in each of the required views.
- List and recognize various forms of congenital heart disease.
- List and recognize common types of fetal arrhythmias.

II. The Fetal Echo Exam

The purpose of this guide is to serve as an introduction to fetal echocardiography. It is meant as a beginner's manual to help the ultrasonographer understand the basics of obtaining and interpreting images of the fetal heart. It is not meant to supplant the many excellent textbooks available on this subject.

The guide is set up as a step-by-step approach to performing an adequate evaluation of the fetal heart. An attempt will be made to keep to the basics. As each view is shown, the normal anatomy will be illustrated. The potential pitfalls and misdiagnoses will also be outlined. As with all ultrasonography, the abnormal is easy to differentiate while the many variants of normal can present the greatest difficulty in interpretation. In view of the small size of the fetal heart in the first and early part of the second trimester, an anatomical scan and full fetal echocardiography presents one of the most difficult tasks in obstetrical ultrasound. It is hoped that this guide may assist in the development

of the skills necessary to better understand fetal echocardiography.

Four Chamber View

A fetal echocardiogram begins with a real time image of the four chamber view of the heart and progresses to the incorporation of pulsed-wave Doppler flow, M-mode and color Doppler imaging into the study. A majority of defects are discovered as abnormalities in the apical four chamber view. This view is the basis from which the exam progresses. It is recommended that the basic cardiac survey should include the four chamber view and the outflow tracts of the great vessels. Once these views are mastered the examination can be expanded to include both long axis and short axis views of the heart. Each of these views allows further detailing of cardiac anatomy. The use of pulsed-wave Doppler allows

the examination to include not only cardiac anatomy but also cardiac function. Flow velocities can help differentiate the function of the cardiac valves. M-mode can help analyze arrhythmias. Color Doppler imaging is useful in further differentiation of anatomical structures that are poorly defined in two dimensional imaging and can also be used for the illustration of vascular shunting.



Congenital heart defects occur in 0.8% (8/1000) live births (Hoffman 1990). The spectrum ranges from clinically benign septal defects to life threatening structural malformations. The actual incidence of congenital heart defects in-utero is probably significantly higher secondary to the prevalence of those defects in stillbirths.

Risk Factors

A number of risk factors have been identified as possible contributory factors in the development of congenital heart defects. Congenital heart defects occur in approximately 30% of all chromosomal abnormalities (Vladimiroff 1985). This equates to approximately 6% of all congenital heart defects. (Greenwood 1975) An additional 3% of defects can be attributed to single gene defects. A majority of defects occur from

multifactorial inheritance. Family history is a significant risk factor in the occurrence and reoccurrence of defects. When there is a family history of congenital heart disease there is an increased risk that the infant may also be affected (Vladimiroff 1985).

Teratogens can cause abnormalities in the development of the fetal heart. By the eighth week of fetal development the fetal heart has achieved its basic structure. Exposure to a potential teratogen can disrupt the normal development during this period of organogenesis. For example, antenatal exposure to lithium has been implicated in Ebstein's anomaly. This is a rare malformation of the tricuspid valve that occurs in approximately 2% of infants exposed. Other common substances that have been described as causing cardiac malformations include hydantoin, alcohol and retinoic acid.

Infections in the first trimester have been shown to cause cardiac malformations. The rubella virus can induce a combination of malformations that has been described as Congenital Rubella Syndrome. The cardiac malformations described in this syndrome include both atrial and ventricular septal defects, pulmonary stenosis, persistent ductus arteriosus and Tetralogy of Fallot.

Insulin dependent diabetes is another clinical situation in which there is an increased risk of having a child with a congenital heart defect. This risk has been quoted as high as 5 times greater than that of the general population (Rowland 1973). The types of lesions described are varied from major structural anomalies to cardiomyopathy. Two lesions that have been described in association with diabetes are double outlet right ventricles and truncus arteriosus (Ferencz 1990).

Due to the association of extracardiac defects and cardiac anomalies the fetal echocardiography should be done in conjunction with a detailed anatomical survey and biometric sonogram. This relationship is best understood in that several of the same cells that are important for cardiac development also play a role in the development of other structures. An example of this is the neural crest cells. Neural crest cells are responsible for the septation of the great vessels. They are also responsible for facial development (Sadler 1999).

Anatomical and Biometric Scans

An anatomical and biometric scan consists of measurements of the biparietal diameter (BPD), head circumference (HC), cerebellum (CB), abdominal circumference (AC), femur length (FL), tibia measurement, humerus measurement and ulna measurement. Anatomical

structures identified and imaged are: lateral ventricles of the brain, cavum septum pellucidum, orbits, cisterna magna, lip and nose, four chamber heart (demonstrating apex pointing to the left), sagittal view of the diaphragm, stomach bubble on the left, kidneys, umbilical cord insertion into the fetal abdomen, bladder, spine, both humeri and femurs, placental location, amniotic fluid assessment, trivascular umbilical cord and a systolic to diastolic ratio of the umbilical cord.

Of the measurements taken, the biparietal diameter is crucial, since many of the cardiac nomograms for normal size of chambers are based on the BPD measurement.

III. Normal Views and Structures

Beginning the Fetal Echo Exam

The fetal situs needs to be determined at the start of the fetal echocardiogram. The apex of the heart should be pointing to the left and the stomach bubble should lie under the diaphragm on the left side. One can assess situs by using the following method initially described by Cordes, O'Leary, Seward & Hagler (1994). The sonographer needs to demonstrate the fetal head to the right of the ultrasound monitor (Figure 1).

After demonstrating the fetal head to the right of the monitor, rotate 90 degrees clockwise into a transaxial view of the fetal chest. This always places the fetus as if it was in a breech presentation thus making it easy for the sonographer to identify the fetal right and left sides. After demonstrating that the fetal heart apex is pointing to the left (Figure 2), the sonographer needs to remain in the transaxial plane and move inferior on the fetus to demonstrate that the stomach bubble is on the left side (Figure 3). After ensuring that situs is correct, then begin imaging the fetal heart with the apical four-chamber view.



Figure 1. Fetal head placed at right of screen.



Figure 2. Transaxial view of fetal chest with cardiac apex pointing to fetal left.



Figure 3. Transaxial view of fetal abdomen with stomach bubble to left.

Apical Four Chamber View

Acquisition of Image

After determining situs, a transverse view of the fetal thorax is imaged. The transducer should be aligned so that the intraventricular septum is parallel to the ultrasound beam. This can be accomplished with the spine either up or down in relationship to the beam. A diameter drawn through the spine and anterior chest wall should intersect the left atrium, mitral valve and intraventricular septum (Figure 4).

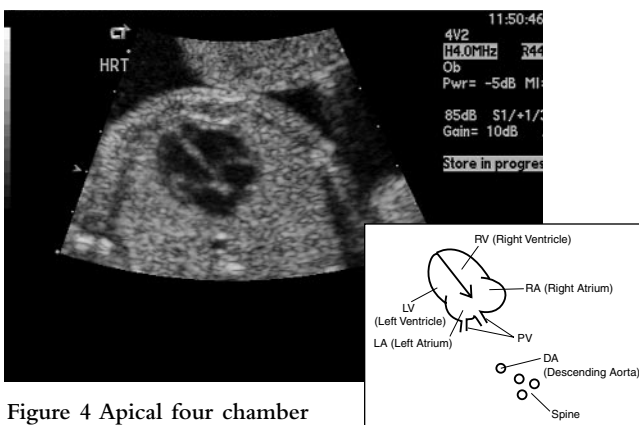


Figure 4 Apical four chamber view demonstrating right atrium (RA), left atrium (LA), right ventricle (RV) and left ventricle (LV). Pulmonary vein (PV) is returning to left atrium.

Structures Identified	Conditions Identified
• Right atrium	• Hypoplastic chambers
• Left atrium return	• Major septal defects
• Pulmonary veins emptying into left atrium	• AV valve misplacement
• Tricuspid valve	• Total Anomalous Pulmonary venous Return
• Mitral valve	
• Atrial septum with Foramen ovale	
• Descending aorta	
• Left ventricle	
• Right ventricle	
• Intraventricular septum	

Limitations of View

The artificial appearance of an intact atrial septum (loss of visualization of the patent foramen ovale) due to insonation of the structure along a parallel plane. Also, artifactual appearance of membranous septal defects for the same reason. Limited outflow tract visualization (until one angles into the five chamber view).

Doppler Applications

Valve function can be determined by measurement of blood velocity across the AV Valves. Doppler flow measurements to be taken are the E and A velocities across the mitral valve, and E and A velocities across the tricuspid valve. Generally, in the fetus, the E peak is lower than the A peak. Also, one should use this view to image a right pulmonary vein and Doppler this vein as it enters the left atrium. This rules out the possibility of total anomalous pulmonary venous return (TAPVR).

Color Doppler Applications

Color Doppler is useful to determine irregular flow across the AV Valves (to include the evaluation of valvular regurgitation jets). In addition, it can be used to identify septal defects by noting color Doppler to cross the septum. Color Doppler also should be used to assess the connection of the pulmonary veins to the left atrium. The sonographer/sonologist may need to decrease the scale to demonstrate color filling in the pulmonary veins. The pulmonary veins will have low flow velocities.

Horizontal Four Chamber View

SUBCOSTAL FOUR CHAMBER VIEW

Acquisition of Image

Fetal situs is determined as described above. A transverse view of the fetal thorax is imaged. The beam is then focused so that it is perpendicular to the intraventricular septum (Figures 5 and 6).

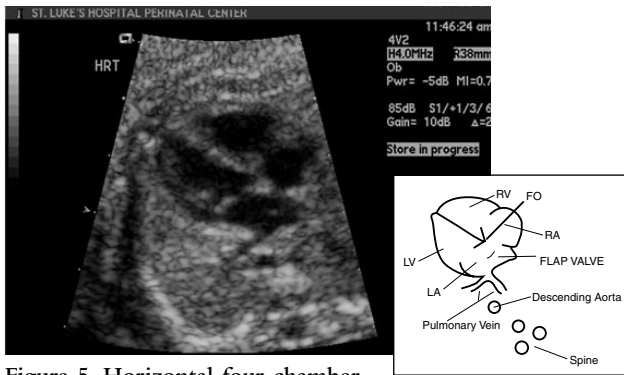


Figure 5. Horizontal four chamber view demonstrating pulmonary vein.

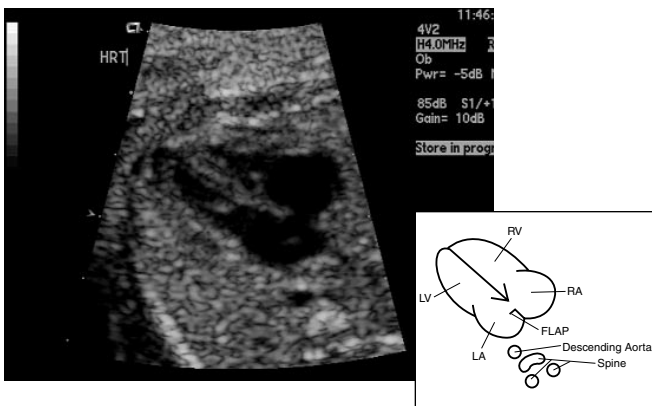


Figure 6. Horizontal four chamber view demonstrating right atrium (RA), left atrium (LA), right ventricle (RV) and left ventricle (LV). Pulmonary vein (PV) is returning to left atrium. The flap valve is demonstrated projecting into left atrium and FO represents foramen ovale.

Structures Identified

- Right atrium
- Left atrium
- Foramen ovale
- Right ventricle
- Left ventricle
- Intraventricular septum
- Pulmonary veins entering into left atrium

Conditions Identified

This view illustrates similar findings to the apical view but with more complete visualization of intraventricular and atrial septal integrity. Due to the ability to better visualize the atrial septum in this view one should

always measure the diameter of the foramen ovale in this view (Figure 7). The foramen ovale should be the same size as the aortic root. If the foramen measures larger than the aortic root, one should question the possibility of a secundum atrial septal defect. There are also nomograms available to evaluate the normal size of the foramen ovale vs. ASD based on gestational age. One should also demonstrate the flap valve flapping into the left atrium in this view.

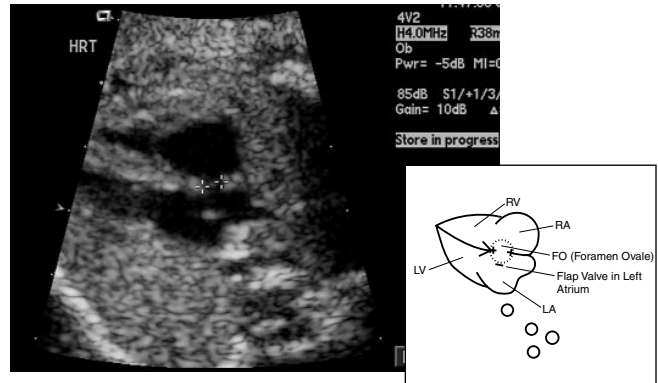


Figure 7. Measurement of foramen ovale.

Limitations of View

Cardiac axis cannot be determined in the horizontal four chamber view. The outflow tracts cannot be determined without angling cephalad and anterior to the fetus.

M-Mode Applications

M-Mode can be used to measure wall thickness as well as wall motion. The simultaneous measurement of atrial and ventricular wall motion can be used to identify and classify cardiac arrhythmias. This view also is the view in which the ventricular diameters should be measured.

Color Doppler Applications

Color Doppler mapping is used in this view to identify shunting across the foramen ovale. It can also be used to image turbulent flow and mixing of blood streams found in septal defects. Color Doppler should also be used to evaluate the blood flow in the left pulmonary veins as they return to the left atrium. By documenting at least one vein returning to the left atrium, one can rule out the possibility of total anomalous pulmonary venous return.

Five Chamber View

Acquisition of Image

The heart is imaged as in the apical four chamber view. The transducer and beam are then angled slightly

towards the fetal head. The aortic root should appear to lie between the two atria producing an image of a five chambered heart. The intraventricular septum appears to run contiguously with the wall of the ascending aorta (Figure 8).

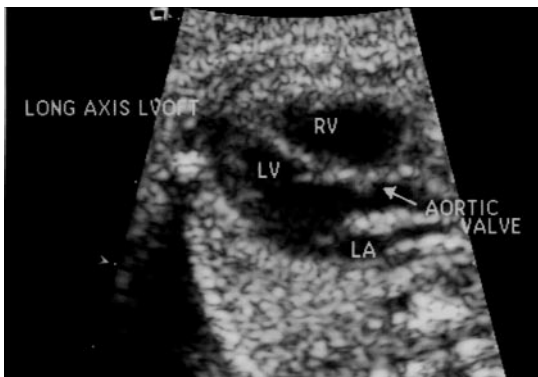


Figure 8. Five chamber view of aortic root.

Structures Identified	Conditions Identified
<ul style="list-style-type: none"> • Right atrium • Left atrium • Left ventricle • Intraventricular septum • Aortic root • Aortic valve • Ascending aorta 	<ul style="list-style-type: none"> • Aortic stenosis • Transposition of the aorta • Overriding aorta • Ventricular septal defect

Doppler Applications

Flow velocities across the aortic valve to diagnose aortic stenosis or aortic regurgitation.

M-Mode Applications

Aortic root measurements.

Color Doppler Measurements

Illustration of direction of flow across aortic valve.

Long Axis View with Left Ventricular Outflow Tract AORTIC ROOT AND ASCENDING AORTA

Acquisition of Image

A transverse view of the thorax is obtained. From the transverse view of the thorax a horizontal view of four chambers is identified. The position of the ultrasound beam is angled slightly towards the right of the fetus. The left ventricular outflow tract is seen as an extension of the left ventricle between the two atria. The aortic valve (AV) appears as a flap in the center of the outflow tract (Figure 9). One can measure the diameter of the aorta in 2D in this plane.

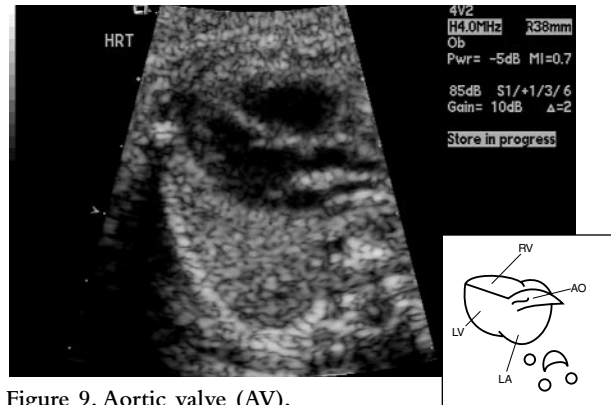


Figure 9. Aortic valve (AV).

Structures Identified	Conditions Identified
<ul style="list-style-type: none"> • Left ventricle • Right ventricle • Left atrium • Aortic valve • Ascending aorta 	<ul style="list-style-type: none"> • Aortic stenosis • Aortic insufficiency • Malposition of aorta or Great Vessels • Detection of abnormal flow patterns

Doppler Applications

Determination of outflow velocities in the diagnosis of aortic valve abnormalities. Velocity should be below 1.0 meters per second.

M-Mode Applications

Measurement of aortic root diameters.

Color Doppler Applications

Demonstration of laminar flow in the ascending aorta. Evaluation for aortic insufficiency through demonstration of a regurgitant jet on color Doppler.

Long Axis View with Right Outflow Tract PULMONARY VALVE AND PULMONARY ARTERY

Acquisition of Image

A transverse view of the thorax is obtained so a horizontal four chamber view is seen. As in left outflow tract visualization; the ultrasound beam is angled slightly towards the right shoulder of the fetus. Once the left outflow tract is identified the beam is further angled to the right until the right outflow tract appears to cross the aorta. The two outflow tracts should form an "X" (Figure 10).

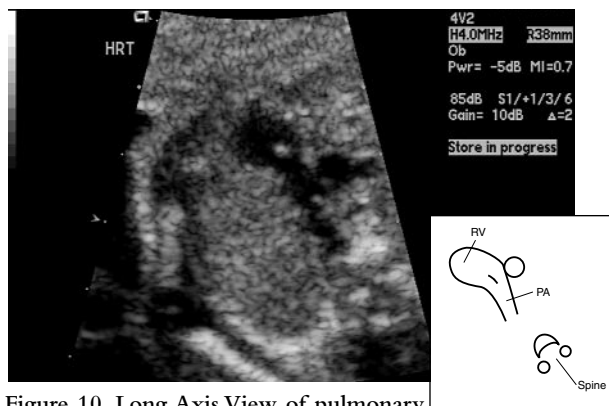


Figure 10. Long Axis View of pulmonary artery (PA) and valve.

Structures Identified Conditions Identified

- | | |
|--------------------|----------------------------------|
| • Right ventricle | • Pulmonary artery stenosis |
| • Pulmonary valve | • Pulmonary artery insufficiency |
| • Pulmonary artery | • Malposition of Great Vessels |

Color Doppler Applications

Determination of outlet flow velocities in the diagnosis of pulmonary artery and valve abnormalities. Doppler in the outflow tract, at the valve level and beyond the valve to evaluate any areas of stenosis.

M-Mode Applications

Measurement of pulmonary artery diameters for the diagnosis of pulmonary artery anomalies, if the length of the vessel is displayed in such a manner the M-mode cursor will cut through it perpendicularly.

Short Axis Right Ventricular Outflow Tract (RVOFT)

Acquisition of Image

Return to the apical four chamber view and angle cephalad to the fetus. This will bring what is commonly referred to as the circle and "sausage" view. The circle represents the aortic root; the sausage represents the right ventricular outflow tract. This view is used to not only evaluate the RVOFT but also the main pulmonary artery and the bifurcation into the right and left pulmonary arteries (Figure 11).

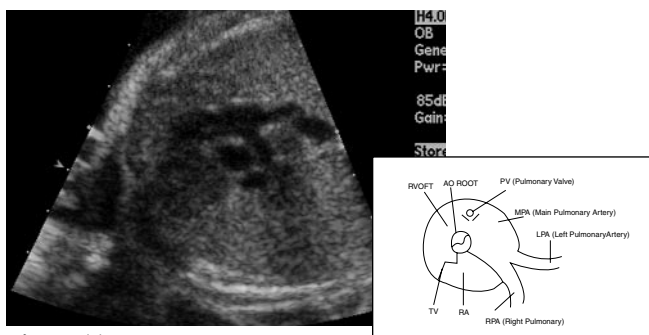


Figure 11

Structures Identified

- Right atrium
- Tricuspid valve
- RVOFT
- Pulmonary valve
- Main pulmonary artery
- Left pulmonary
- Right pulmonary
- Aortic valve in short axis
- Aortic root in short axis

Conditions Identified

- Tricuspid regurgitation
- Infundibular stenosis
- Pulmonary atresia
- Pulmonary artery stenosis
- Aortic root size
- Bicuspid aortic valve
- Transposition of the Great Vessels

Limitations of View

Does not assess LV side at this level in short axis.

Doppler Flow Applications

Tricuspid regurgitation

Main pulmonary artery velocity

Right pulmonary artery velocity

Left pulmonary artery velocity

M-Mode Applications

M-Mode can be used to measure the aortic root and evaluate the placement of the aortic valve. If the valve is eccentrically placed, one should question the possibility of a bicuspid aortic valve.

Color Doppler Applications

Color Doppler is useful to determine irregular flow across the tricuspid valve and pulmonary valve.

Aortic Arch

Acquisition of Image

The fetal thorax is visualized in the sagittal plane. The ascending aorta can be seen originating from the left ventricle. The ascending aorta becomes the transverse aorta as it becomes a rounded arch with head and neck vessels arising from the apex of the arch. After the vessels branch off the transverse arch turns caudal and becomes the descending aorta (Figure 12).

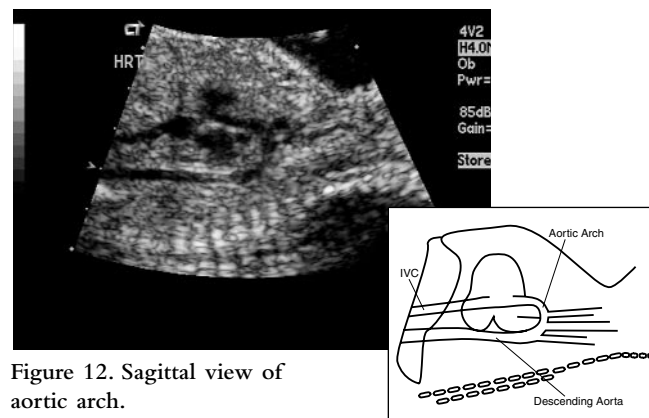


Figure 12. Sagittal view of aortic arch.

Structures Identified	Conditions Identified
<ul style="list-style-type: none"> • Ascending aorta • Transverse aortic arch • Descending aorta • Neck vessels 	<ul style="list-style-type: none"> • Coarction of the aorta • Aortic valve stenosis • Aortic valve atresia

Limitations of View

A patent or normal appearing arch does not rule out coarctation.

Doppler Applications

Pulsed-wave Doppler imaging is used to evaluate flow velocities. Areas of increased velocity may indicate a narrowing of the lumen.

Color Doppler Application

Color Doppler is useful in demonstrating the course and caliber of the aorta.

Ductal Arch

Acquisition of Image

Obtain a sagittal view of the fetus in which one can demonstrate a fetal profile of the face. Staying in the same plane, move caudally on the fetus to the level of the heart. One should fall into the ductal arch view. The ductal arch is shaped like a hockey stick (Figure 13).

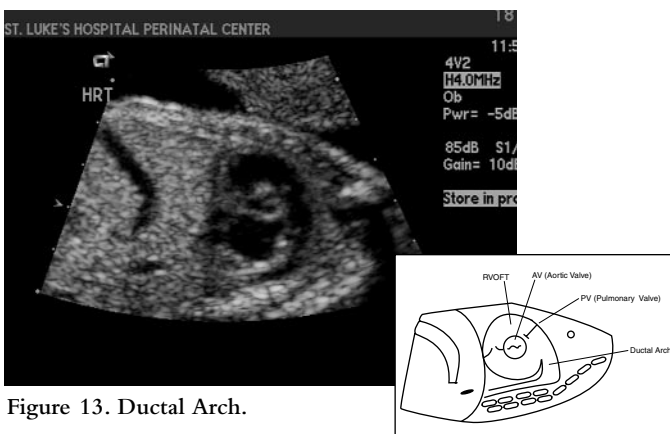


Figure 13. Ductal Arch.

Structures Identified	Conditions Identified
<ul style="list-style-type: none"> • Right ventricular outflow tract • Aortic root • Main pulmonary artery • Patent ductus arteriosus • Right pulmonary artery 	<ul style="list-style-type: none"> • Transposition of the Great Vessels • Ductal constriction

Limitations of View

Cannot evaluate the Left Pulmonary Artery.

Doppler Applications

Valve function can be evaluated by measuring the peak flow velocity across the pulmonary valve.

M-Mode Applications

M-Mode can be used to measure the aortic root and evaluate the placement of the aortic valve. If the valve is eccentrically placed, one should question the possibility of a bicuspid aortic valve.

Color Doppler Applications

Color Doppler is useful to determine irregular flow across the pulmonary valve.

SVC/IVC View

Acquisition of Image

Obtain a sagittal view of the fetus. Demonstrate the IVC and SVC returning to the right atrium.

Structures Identified	Conditions Identified
<ul style="list-style-type: none"> • Right atrium • Inferior vena cava (IVC) • Superior vena cava (SVC) 	<ul style="list-style-type: none"> • Interrupted IVC

Color Doppler Applications

Lower color scale to evaluate blood flow in the IVC and SVC returning to the right atrium.

IV. Pathology and Defects

CONGENITAL HEART DISEASE

Atrial Septal Defect

Definition

A ventricular septal defect (VSD) is a defect in the septum separating the right ventricle and left ventricle. The defect can present as either an enlarged foramen ovale or absence of tissue of the septum usually extending towards the atrioventricular valves.

Types of Defects

Ostium Secundum Defect: An enlarged defect, located centrally, in of the area of the foramen ovale. (Figure 14).

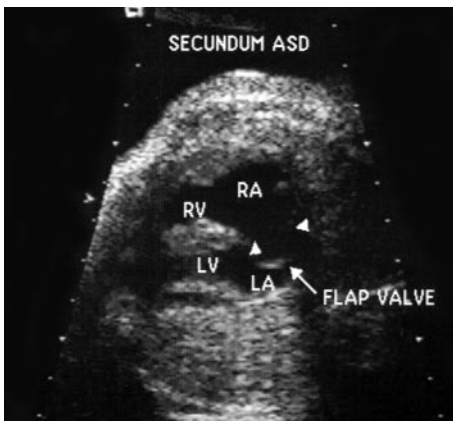


Figure 14 Ostium secundum defect represented by arrows. ASD denotes atrial septal defect.

Ostium Primum Defect: A defect adjacent to the atrioventricular valves in the lower portion of the atrial septum (Figure 15).

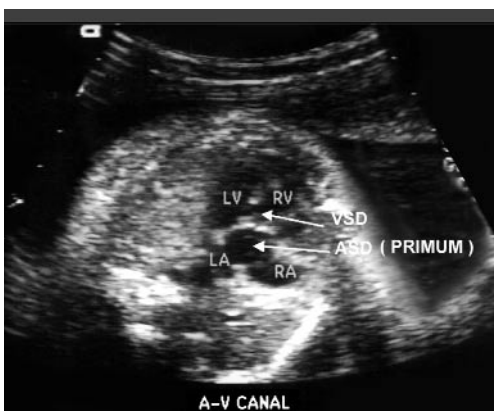


Figure 15. Ostium primum defect in a fetus with trisomy 21 and an atrial ventricular defect.

Acquisition of Image

Apical four chamber view and horizontal four chamber view. Color Doppler should be used

to demonstrate flow across the defect. Flow in the atrial septal defect may be bidirectional.

Points of Interest

The foramen ovale should be smaller than the normal aortic outflow tract. Nomograms may also be used to determine appropriate size of the foramen ovale.

Ventricular Septal Defects

Definition

A ventricular septal defect (VSD) is a defect or absence of tissue separating the right ventricle and left ventricle.

Types of Ventricular Septal Defects (VSD)

Membranous or Perimembranous Defects:

A defect of the membranous portion of the ventricular septum adjacent to the atrioventricular valves (Figure 16).

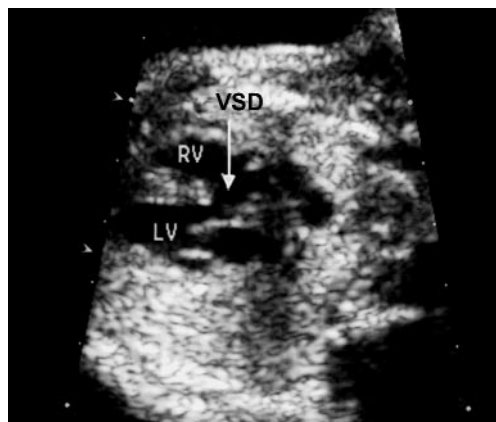


Figure 16. Perimembranous ventricular defect marked by arrow and label VSD.

Muscular Defect: A defect of the muscular portion of the intraventricular septum (Figure 17).



Figure 17. Muscular ventricular defect. Note the color crossing the ventricular septum.

Acquisition of Image

Horizontal four chamber view. Long Axis LVOFT to evaluate for perimembranous defects.

Points of Interest

Frequent false positive diagnosis of drop out areas in the membranous portion of the septum. Defect can spontaneously close in utero.

Tetralogy of Fallot

Definition

A complex cardiac lesion consisting of a ventricular septal defect (perimembranous), overriding aorta, right ventricular hypertrophy and pulmonic stenosis (Figure 18).

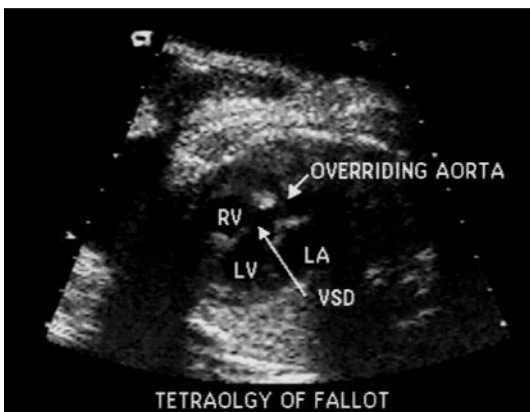


Figure 18. Overriding aorta and perimembranous ventricular defect in a patient with Tetralogy of Fallot.

Acquisition of Image

Obtain five chamber view to identify overriding aorta. The subcostal four chamber view is used to confirm the VSD. Color Doppler in the five chamber view will demonstrate flow from both the right ventricle and left ventricle entering the aorta. It is important to measure the diameter of the aorta and the pulmonary artery to assess the degree of stenosis. It is also important to confirm forward flow through the pulmonary artery and to assess the velocity of the flow.

Points of Interest

Tetralogy of Fallot is the most common form of cyanotic heart disease in live born infants. Right ventricular hypertrophy may not be identified in utero secondary to fetal circulation.

Double Outlet Right Ventricle (DORV)

Definition

The pulmonary artery and at least 50% of the aortic outflow arises from the right ventricle. A VSD is usually but not always present (Figure 19).

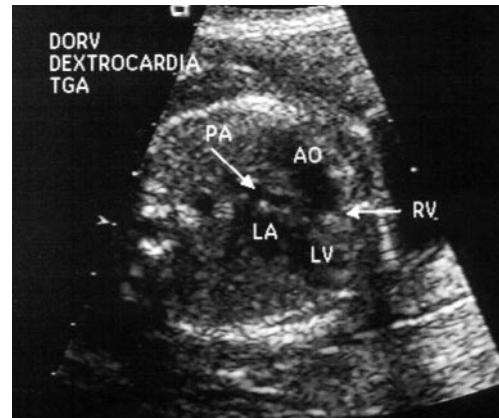


Figure 19. A double outlet right ventricle with pulmonary stenosis and transposition of Great Vessels. (PA denotes pulmonary artery, AO is aorta, RV is right ventricle, LV left ventricle and LA left atrium).

Image Acquisition

Five chamber view and apical four chamber view demonstrating both great arteries arising from the right ventricle.

Points of Interest

DORV may be present with other cardiac lesions such as pulmonary stenosis, or transposition of the great arteries. This lesion also may be associated with chromosomal anomalies.

Hypoplastic Left Heart

Definition

Underdevelopment or absence of visualization of the left ventricle resulting in hypoplasia or atresia of the mitral valve, left ventricle, aortic valve and ascending aorta (Figure 20).



Figure 20. Hypoplastic left heart. Note the very small left ventricle and restrictive foramen ovale.

Variations

Variations of this defect may manifest itself in the size of the mitral annulus, left ventricle chamber, aortic valve and ascending aorta.

Acquisition of Image

An apical four chamber view is obtained that demonstrates a discrepancy in size of the ventricles and annulus of the atrioventricular valve. The foramen ovale may be smaller than normally seen. The flow through the foramen ovale is often reversed. The color Doppler will demonstrate flow moving from the left atrium to the right atrium instead of right to left in the fetus. Color Doppler will also demonstrate reverse flow in the aortic arch. When the diagnosis of a hypoplastic left heart is made, it is necessary to measure the ventricular chamber size on m-mode. In addition, measurements of the annulus of the atrioventricular valves and ascending aorta should be obtained. Nomograms for normal sizes of chambers and aorta are available to assist the clinician in comparing the findings of the ultrasound to what is normal for gestational age.

Points of Interest

Careful attention should be paid to color Doppler patterns. This assures that a dilated right ventricle makes the normal left ventricle appear hypoplastic.

Hypoplastic Right Heart

Definition

A condition characterized by underdevelopment or absence of the right side of the heart resulting from varying degrees of right ventricular development. This is usually accompanied by atresia of the pulmonary or the tricuspid valve (Figure 21).

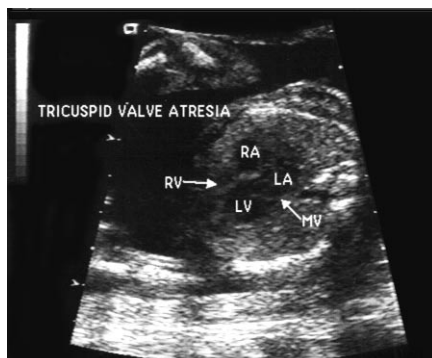


Figure 21. Hypoplastic right ventricle. Note very small right ventricle and tricuspid valve atresia.

Variations

In the cases with tricuspid atresia, the size of the right ventricle may vary according to the degree of atresia. The degree of hypoplasia may vary from only mild to severe. In cases of pulmonary atresia the decrease of blood to the right ventricle prevents normal development (Figure 22).

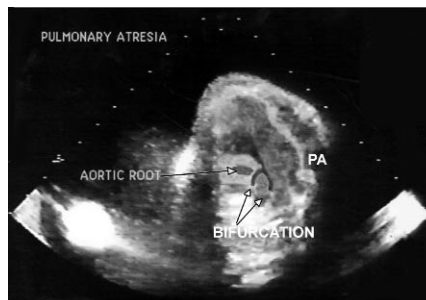


Figure 22. A case of pulmonary atresia.

Acquisition of Image

An apical four chamber view is obtained to demonstrate a size discrepancy between the right and left ventricle. Color Doppler may also show a lack of flow through the tricuspid valve.

Points of Interest

A comparison of the size of the tricuspid valve annulus to mitral valve annulus should be obtained. The integrity of the intraventricular septum needs to be documented on two-dimensional scanning. Pulmonary stenosis can be identified by turbulence on color Doppler and by increased flow velocity of greater than 1.0m/sec on pulsed-wave Doppler.

Atrioventricular Canal Defect

A-V CANAL

Definition

A complex congenital heart defect disease that is characterized by a primum atrial septal defect (ASD) and a membranous ventricular septal defect (VSD) (Figure 23).

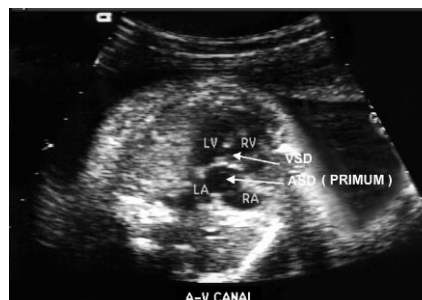


Figure 23. An ostium primum defect in a fetus with trisomy 21 and an atrioventricular defect.

Acquisition of Image

The defect can be identified in the apical four chamber view by demonstrating a dropout in the inferior (primum) portion of the atrial septum and a dropout in the membranous portion of the ventricular septum. On color Doppler, one will notice blood flows to the center of the heart to flow through the atrial ventricular valves. This lesion has several variations dependant upon the presence of both atrial and ventricular defects, symmetry of ventricular size, normal or abnormal relationship of the great vessels. A horizontal four chamber view is important to obtain to thoroughly evaluate the atrial septum. If there is only an atrial septal defect and no ventricular septal defect, this lesion is referred to as a partial A-V canal.

Points of Interest

This defect is frequently associated with chromosomal abnormalities. It is one of the leading heart defects in infants with Down's syndrome.

Transposition of the Great Vessels (d-Transposition).

Definition

The pulmonary artery arises from the left ventricle while the aorta arises from the right ventricle (Figure 24).



Figure 24. Transposition of Great Vessels. Note the anterior placement of aorta and neck vessels coming off arch.

Acquisition of Image

The apical four chamber view appears normal. In the subcostal four chamber view the vessels are parallel. A short axis view (RVOFT) or "sausage view" cannot be visualized. If the Great Vessels cross forming the "X" a d-Transposition is not present.

Points of Interest

There is a 2:1 ratio male to female occurrence. Additional structural defects are frequently found.

Anatomic Corrected Transposition L-TRANSPOSITION

Definition

A complex congenital heart defect in which the pulmonary artery is connected to the morphologic left ventricle located on the right side of the heart and the aorta is connected to morphologic right ventricle located on the left side of the heart (Figure 25).



Figure 25. Transposition of Great Vessels. This patient has the morphologic tricuspid valve and right ventricle located on the left side of fetal heart. Mitral valve and morphologic left ventricle are on right side of fetal heart. There is also an Ebstein's anomaly present with the left atrial ventricular valve.

Acquisition of Image

The lesion is identified from the apical and subcostal views. The ventricles appear reversed with the moderator band and thick trabecular tissue visible on the left side of the heart. The atrioventricular valves are displaced and reversed in their position.

Points of Interest

This defect may be associated with ventricular septal defects (VSD), complete heart block and Ebstein's anomaly of the tricuspid valve on the left side of the fetal heart.

Coarctation of the Aorta

Definition

Narrowing of the aorta lumen. The narrowing can be either proximal (preductal) to the Ductus arteriosus or distal to the Ductus (postductal) (Figure 26).



Figure 26. Coarctation (narrowing) of aorta.

Acquisition of Image

An aortic arch view is obtained. A narrowing of the aortic lumen can be demonstrated on two dimensional and color Doppler. The narrowing restricts blood flow from the left ventricle causing an increase of flow from the right ventricle. The result is an enlargement of the right ventricle compared to the left ventricle. In coarctation, the pulmonary artery appears larger than the left outflow tract. With increased left sided pressure the shunt across the foramen ovale can become bidirectional.

Points of Interest

Coarctation of the aorta is very difficult to diagnose. Prenatally the lumen may appear to have a normal diameter with the discrepant size of the ventricles as the only symptom present. Coarctation of the aorta is frequently associated with other cardiac anomalies.

V. Fetal Arrhythmias

Acquisition of Image

To diagnose fetal arrhythmia the origin of the ectopic or irregular beat must be determined. The horizontal four chamber view is obtained and then the M-mode cursor is positioned so it intersects both the atrial and ventricular wall simultaneously. A normal rhythm should have a 1:1 conduction ratio.

Premature Atrial Contraction (PAC)

Definition

PAC's are extra beats of the atrium usually arising from an ectopic focus. These beats can be conducted or non-conducted to the ventricles. If they are conducted then there is a corresponding ventricular contraction. If they are non-conducted there is usually a compensatory pause for ventricular repolarization, which gives the impression of the heart momentarily stopping (Figure 27).

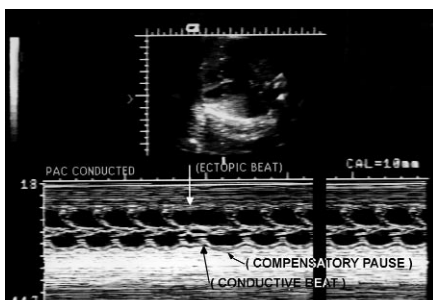


Figure 27. Premature atrial contraction (PAC) on M-mode.

Points of Interest

PAC's are the most frequent diagnosed arrhythmia in the fetus. They are generally considered benign, however they may occur with structural cardiac defects. Their etiology may be secondary to an immature conduction system. PAC's have also been linked to maternal caffeine and alcohol use.

Premature Ventricular Contractions (PVC)

Definition

PVC's are extra beats of the ventricular wall arising from an ectopic ventricular focus. As with PAC's they are usually benign but can be accompanied by structural defects (Figure 28).

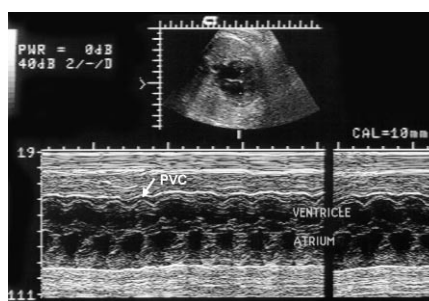


Figure 28. Premature ventricular contraction (PVC) on M-mode.

Fetal Tachyarrhythmias

Type	Atrial Rate	Ventricular Rate	Etiology	Points of Interest
Supraventricular tachycardia	180-280	180-280	1:1 conduction	Ectopic SVT can be continuous Reentrant SVT has sudden onset and cessation. Can lead to fetal hydrops and death
Sinus tachycardia	180-210	189-210	1:1 conduction	Can be caused by medicine, fever, hormones
Atrial flutter	150-300	Varying	1:1 -4-1 conduction	Is associated with congenital heart defects and can lead to congestive failure
Ventricular tachycardia	Varying	150-210	A-V dissociation or varying conduction	Usually benign with no fetal compromise

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