PREPLADDER

NEET-SS

PEDIA

VOLUME -1

INDAEX

1 BASICS OF FETAL CIRCULATION

Major Differences in Fetal Versus Adult Circulation 00:01:03

Site of Oxygenation

- In a fetus, the oxygenation occurs at the placenta, whereas in adults or post-neonatal children, the oxygenation occurs in the lungs.

Systemic and Pulmonary Pressures

- In the case of a fetus, there is a high Pulmonary vascular resistance and low systemic resistance.
- Whereas in the case of adults, there is low pulmonary pressure, and systemic pressure is high.

Parallel Circuit Versus Series Circuit

- In a fetus, the circulation is arranged in parallel, whereas in the case of adults, the circulation is arranged in series.

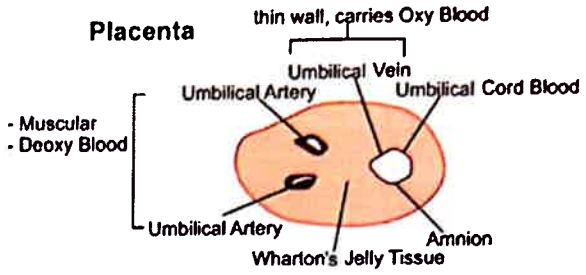
Shunts

- According to the Park's pediatric cardiology 6th edition, there are four shunts to ensure the optimum growth of the fetus.
  - Placenta is where the oxygenation of the fetus happens.
  - The Ductus venosus is a structure that connects the umbilical vein to inferior vena cava.
  - Foramen ovale is communication between the left atrium and right atrium.
  - Ductus arteriosus is an arterial vessel that connects the aorta with Pulmonary artery.

- These are the four differences found in fetal versus adult circulation.

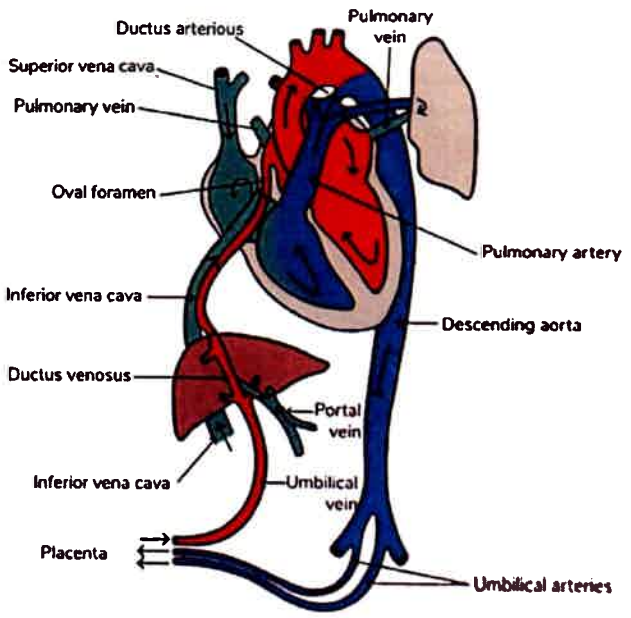
Placenta 00:04:26

- Placenta is the site of oxygenation in a fetus.
- The oxygen efficiency of placenta, is also known as exchange efficiency, is less than that of postnatal lungs. Thus, the partial pressure of oxygen in the umbilical vein is only around 30-35 ml of mercury, as per Nelson 21st edition.
- Placenta is the site of lowest vascular resistance in the fetus as per the Park's 6th edition.
- The organ received the largest combined right and left ventricular output.
- From the placenta, a vessel arises, which is called an umbilical cord. It carries the umbilical vein and umbilical artery.



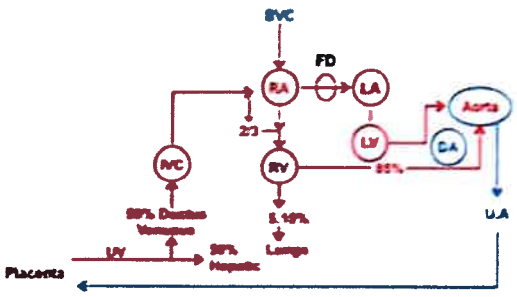
- As per the structure of an umbilical cord, there are two umbilical arteries (UA) in all normal children and one umbilical vein (UV).
- Umbilical arteries are abnormal as they have a muscular wall which usually carries deoxygenated blood. In contrast, the umbilical vein is a single vessel with a thin wall that usually carries oxygenated blood in the fetus.
- The holding substance between them is called Wharton's jelly tissue, and the umbilical cord is covered by a layer called the amnion.
- Both the umbilical arteries are branches of the anterior division of the internal iliac artery.
- Whereas umbilical veins arise from placenta they merge into ductus venosus, and some part is carried on as a part of the hepatic circulation.

Fetal Circulation 00:07:46



- This is what fetal circulation looks like and is where the fetal placenta is present.
- Oxygenation occurs at the placenta: the umbilical vein carries this oxygenated blood. Thus, the saturation of oxygenation will be highest in the umbilical vein.
- Once it reaches the near liver, it divides into two zones.
  - One zone provides hepatic blood flow. Therefore 50% is diverted into the hepatic system.
  - 50% of blood is carried by a ductus venosus which merges into the inferior vena cava.
- Oxygenated blood from the umbilical vein will mix with inferior vena cava deoxygenated blood: thus, saturation will fall slightly.
- This mixed blood reaches the right atrium, and once it opens into the right atrium, it will get divided into two parts.
  - One-third of this blood directly passes from the right to the left atrium through the foramen ovale due to the involvement of two structures: the eustachian valve and crista dividends.
  - The remaining two-thirds will cross from the right atrium into the right ventricle. At the same time, the superior vena cava will also open into the right atrium, and this entire blood will get mixed.
  - The right ventricle saturation is always lesser as compared to IVC.
- Now systole will happen in the fetus so that both ventricles will contract.
- The right ventricle will send the blood into the pulmonary artery, but blood will not move from the pulmonary artery to the lungs due to high pulmonary vascular resistance.
- This will turn back through the ductus arteriosus into descending aorta.
- When the left ventricle is contracting, the blood will move into the ascending aorta, and from the ascending aorta through subclavian vessels, the blood will pass into the head, neck, and upper limbs.
- Some blood will merge with the blood from the ductus arteriosus and move via descending aorta.
- Once the blood reaches the descending aorta, the tissues will utilize 35% of the blood, and 65% will go back into the placenta.
- Two umbilical arteries from the internal iliac artery will go to the placenta, and the circuit will be completed.

Course of Fetal Circulation 00:14:41



- From the placenta, an umbilical vein carrying the oxygenated blood will divide, and 50% will go into the hepatic circulation, and the remaining 50% will enter into ductus venosus.
- This ductus venosus opens into the inferior vena cava, further into the right atrium.
- Once it opens into the right atrium, ⅔ of this blood goes to the right ventricle, and ⅓ moves directly across the foramen ovale into the left atrium.
- This blood will further reach the left ventricle.
- When the left ventricle contracts, it will send blood into the aorta.
- Simultaneously, the blood reaches the right ventricle after contraction. 5-15% of this blood reaches the lungs, whereas 85% of blood comes back into the aorta through a structure called ductus arteriosus.
- The superior vena cava also brings blood into the right atrium, directly into the right ventricle.
- Once it reaches the aorta, there are umbilical arteries that arise, which will carry the blood back to the placenta.

Rapid Fire MCQ Points and Facts

Q. What is the saturation content of various fetal structures?
Ans. Umbilical vein (80% saturation content) > IVC (70% saturation content) > LV (65% saturation content) > RV (60% saturation content) > UA (below 50% saturation content).

Q. What is the PO2 content in major fetal structures?
Ans. In the umbilical vein, the PO2 content is 30 to 35 mm Hg. IVC has 26 to 28 mm Hg. SVC has 12 to 14 mm Hg. LV, and ascending aorta has 26 to 28 mm Hg, and finally, the descending aorta has 24 mm Hg.

Q. Which structure diverts IVC blood from reaching RA into LA via foramen ovale?
Ans. Eustachian Valve and Crista dividends.

Q. What is the fate of UV blood?
Ans. 50% goes into the liver, and 50% goes into IVC via ductus venosus.

Q. What is the fate of descending Aorta blood?
Ans. 65% returns to the placenta, and 35% [illegible] refuses the fetal organs and tissues and is return [illegible] the inferior vena cava.

Q. What are the ventricular dimensions in fetus?
Ans. Since RV output is 1.3 times LV output in a fetus and handles more blood, the RV wall is thicker than LV in the fetal and first few days of post-natal life.

Q. What percentage of the total ventricular output is handled in fetus by the two ventricles individually?

Ans. RV handles 55%, whereas the left ventricle handles 45%.

MCQ Concept

Q. Why does fetal distress produce a fall in cardiac output?

Ans.

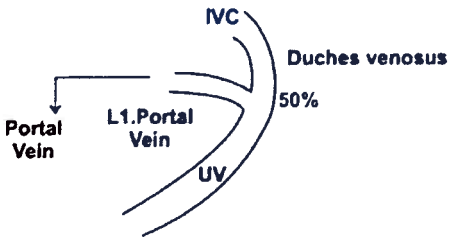
- The following formula gives cardiac output:
  - **CO = Heart Rate × Stroke Volume**
- In the case of adults, whenever there is bradycardia, the stroke volume increases proportionately, so the cardiac output is maintained.
- In the case of the fetus and the early neonatal period, distress in the fetus or hypoxia will produce bradycardia. Still, in these patients, the stroke volume fails to rise due to low compliance of the fetal heart, and thus the cardiac output tends to fall, leading to the appearance of a shock-like state in the patient.

Changes In Circulation After Birth 00:26:11

- Lungs Expand and Become the Site of Gaseous Exchange
  - It results in a reduction in pulmonary vascular resistance.
  - It leads to improvement in pulmonary blood flow.
- Removal Of the Placenta Results In
  - Increase in systemic vascular resistance.
  - There is a cessation of blood flow in the umbilical vein.

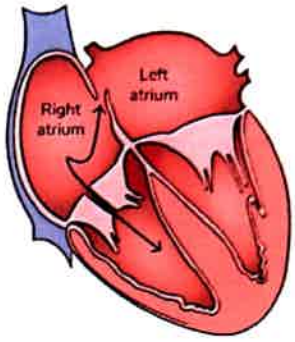
Closure of Shunt Vessels 00:27:09

Ductus Venosus



- It is a structure that connects the umbilical vein to the inferior vena cava.
- Usually, the umbilical vein gets split into two parts:
  - Left portal vein.
  - Ductus venosus, which is the continuation of the umbilical vein.
- The ductus venosus merges into the larger vessel called the inferior vena cava.
- 50% of oxygenated blood goes via ductus venous into the inferior vena cava, and 50% moves into the liver, that is, the left portal vein.
- This portal vein is attached to the main portal vein.
- Cessation of umbilical vein blood flow causes closure of venous.
- The closure is of two types
  - **Functional closure:** occurs within a few hours of birth.
  - **True or anatomic closure:** occurs on day 7 of life.

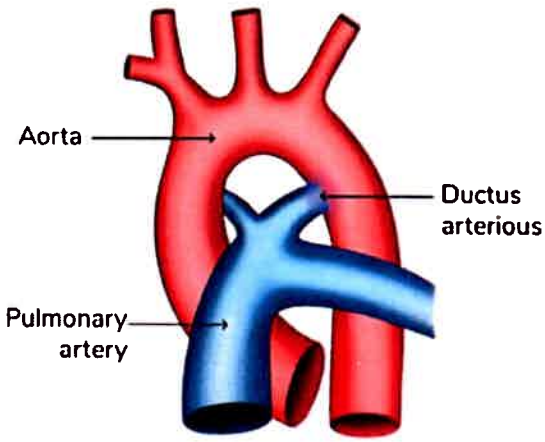
Foramen Ovale



↓RAP → Septum Primum
↑LAP → Septum Secundum
(Compressed)

- It is present between the left atrium and the right atrium.
- Closure of the foramen ovale is stimulated by a change in the pressure gradient across the right and left atrium.
- In post-birth, right atrium pressure fails due to ductus venosus closure, and left atrium pressure increases due to more blood coming in via pulmonary veins.
- Whenever there is a fall in right atrium pressure and an increase in the left atrium pressure, it pushes septum primum and septum secundum, which get compressed against each other. This compression closes the opening called foramen ovale.
- The time of functional closure is controversial.
- True or anatomic closure occurs three months after the postnatal age.

Closure of shunt Vessels



- It is a proper vessel that connects the aorta with pulmonary artery.
- The location of the ductus arteriosus is fixed, which is distal to the origin of the left subclavian artery.
- In utero, it is kept open by two things:
  - Low oxygen tension.
  - High maternal prostaglandin levels.

Clinical Question

Q. Which is the most important prostaglandin in keeping the ductus arteriosus open in utero?

Ans. PGE2.

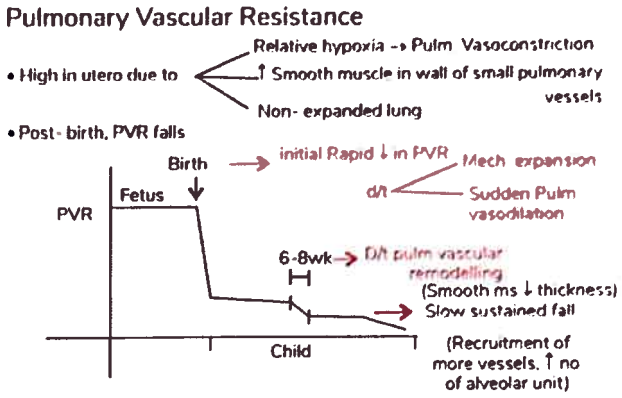
- In post-birth, its closure happens, stimulated by four factors or stimuli:
  - Rise in the oxygen tension, which is the most important factor.
  - Rapid fall in the prostaglandin levels.
  - Increase in the acetylcholine levels.
  - Increase in the bradykinin levels.
- Physiological closure will occur due to the spasm of smooth muscle in the tunica media, usually within few hours of birth.
- According to Nelson 21st edition, it occurs within 10-15 hours of birth.
- Anatomical or definite closure occurs due to changes in endothelium and proliferation with fibrosis of the intimal cells.
- Anatomical closure happens between day 10 and day 21 of postnatal life.

Facts To Know About Ductus Arteriosus - Park's 6th Edition

- Whenever there is a maternal intake of aspirin in pregnancy, it can constrict the ductus arteriosus in utero, leading to the newborn's persistent pulmonary hypertension of Newborn (PPHN).
- Before anatomic closure happens, the ductus arteriosus can re-open only if there is hypoxia and acidosis. For example, Asphyxia, High altitude, or by giving Prostaglandin E1 infusion, also known as Alprostadil.
- The ductus arteriosus smooth muscle responsiveness to oxygen is less in preterm newborns.
- Oxygen dilates pulmonary arterioles but it constricts the ductus arteriosus.

Pulmonary Vascular Resistance (PVR) 00.43:06

- PVR is high in utero due to three main reasons:
  - In utero, there is relative hypoxia due to pulmonary vasoconstriction.
  - There is increased smooth muscle in the wall of small pulmonary vessels, keeping them closed.
  - Non-expanded lung.
- At post-birth, the PVR falls.



- Suppose there is high pressure in utero. If a birth happens suddenly, there will be a rapid fall in the pulmonary vascular resistance, which will fall within few minutes after birth.
- Then it will become static.
- Another fall will happen during 6-8 weeks of postnatal age, and then it will cause a slow, sustained fall.
- At birth, there is an initial rapid fall in PVR which occurs due to two reasons:
  - Mechanical expansion of the lungs.
  - Sudden pulmonary vasodilatation.

- The second fall, which occurs between 6-8 weeks, occurs due to pulmonary vascular remodeling.
- In pulmonary vascular remodeling, the smooth muscle tends to decrease in thickness.
- The slow, sustained fall will occur throughout childhood up to 2 years. It occurs because of the recruitment of more vessels and an increase in the number of alveolar units.

What are the Implications

- Infants with a large amount of VSD develop CCF only after 6-8 weeks of age due to delayed fall in PVR.
  - In large VSD, the left atrial pressure is directly transmitted to the pulmonary artery via a large septal defect.
  - This does not allow the rapid fall in pulmonary vascular resistance, so the left-to-right shunt is insignificant.
  - However, there will be vascular remodeling once the 6–8-week age is attained. The pulmonary vascular resistance falls when the left to right shunt begins leading to congestive cardiac failure.

- Infants with large amounts of VSD do not develop CCF when living at high altitudes, but as they move to sea level, CCF appears.
  - In a large VSD, there will be hypoxia if the patient lives at a high altitude.

- This will result in sustained constriction of the pulmonary arterioles. So, the pulmonary vascular resistance does not fall much; thus, there is less left to right shunt, so there is no CCF.
- When the patient moves to sea level, hypoxia decreases, followed by a fall in pulmonary vascular resistance so that the left-to-right shunt will improve.

- Preterm babies with left to right shunt and severe HMD do not develop CCF, but paradoxically CCF may appear as HMD improves.
  - If there is severe HMD, there will be hypoxia, resulting in a sustained increase in PVR, so the left to right shunt is less; thus, no CCF has been found.
  - As the patient improves or HMD improves, oxygen concentration becomes followed by a fall in pulmonary vascular resistance, and CCF will be precipitated.

Table - Park's 6th Edition

- Neonatal conditions that interfere with the normal maturation of pulmonary arterioles
  - Hypoxia or High altitude.
  - Acidemia or Acidosis.
  - Increased pulmonary artery pressure secondary to a large VSD or PDA.
  - Increased pressure in the left atrium or pulmonary vein.

Clinical Question

Q. Preterm babies have a higher risk of PDA. Why?

Ans. There are majorly two reasons:

- The ductal smooth muscle in preterm babies does not show a constrictor response to oxygen.
- These babies have relatively higher PGE2 levels due to decreased lung degradation.

Q. Why do preterm babies have early onset CCF in PDA?

Ans. The pulmonary vascular smooth muscle is not as well developed as in full-term infants. So PVR falls very rapidly, and the L-R shunt starts early.

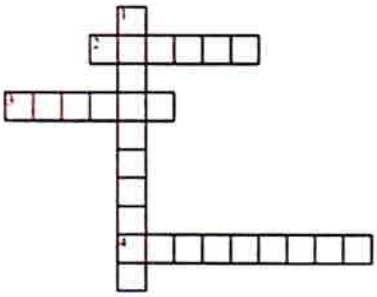
- Preterm babies with HMD will develop hypoxia and have late CCF in PDA.
- However, Preterm babies with no respiratory illness rapidly fall in pulmonary vascular resistance, leading to early CCF in PDA.

Nelson's 21st Edition Says

- The newborn cardiac output of 350 mL/kg/min falls in the first 2 months of life to approximately 150 mL/kg/min and then more gradually to the normal adult cardiac output of 75 mL/kg/min.
- Cardiac output in mL/kg/min falls as age advances.

CROSS WORD PUZZLES

Crossword Puzzle 1



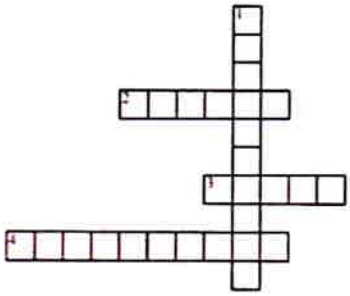
Across

2. Umbilical ____ carries deoxygenated blood from the fetus to the placenta.
3. ____ is responsible for closing the ductus arteriosus.
4. _____ vein carries oxygenated blood from the placenta to the fetus.

Down

1. Ductus ____ shunts blood away from the lungs in fetal circulation.

Crossword Puzzle 2



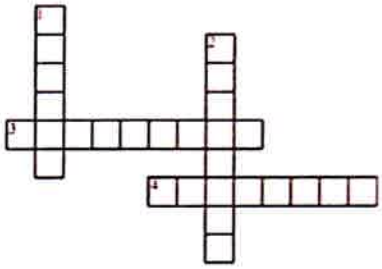
Across

2. An increase in _____ tension causes the closure of the ductus arteriosus at birth.
3. ____ carries oxygenated blood to the body in neonatal circulation.
4. The umbilical vein becomes the _____ venosum in neonatal circulation.

Down

1. Closure of the ductus ____ is the first step in transitioning from fetal to neonatal circulation.

Crossword Puzzle 3



Across

3. The ductus arteriosus in fetal circulation shunts blood from the ____ artery to the aorta.
4. Umbilical vein carries oxygenated blood from the ____ to the fetus during fetal circulation.

Down

1. The foramen ovale in fetal circulation allows blood to flow from the right ____ to the left ____.
2. ____ in oxygen levels triggers the closure of the ductus arteriosus after birth.

2 CHEST-X RAY IN PEDIATRIC CARDIOLOGY

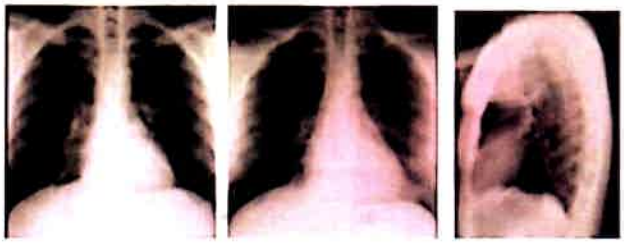
Importance and Information Obtained 00:01:31

- Through chest X-ray, we can find the cardiac size, cardiac shadow abnormalities, pulmonary blood flow, individual chamber abnormalities, the status of pulmonary parenchyma, the status of the spine, the status of ribs, and the overall diaphragmatic status of the patient.
- It helps you diagnose the underlying disease.

Views Taken 00:03:40

- The ideal view taken is the PA view. It gives the best view for assessing the cardiac status of the child.
- However, this is impossible in children younger than three years without resorting to complex manoeuvres.
- It should be done by erecting the film over the front of the body, giving you the X-ray result.
- The AP view is found to be inferior to the PA view as the scapula will overlap the lung field. There is some degree of increase in the cardio-thoracic ratio, which can produce a false sense of cardiomegaly in the patient, and this may not be true.
- But AP view is better suited for children below two years of age as it can also be done in a supine position.
- The lateral view is a bit trickier but is used in situations like right ventricular enlargement.

Parameter	PA VIEW	AP VIEW
Patient posture	It is done in an erect position.	It is done in the supine position.
Scapula	It is away from the lung fields.	It overlies the lung fields.
Clavicle	It is present over the lung zones.	They project over the lung apices.
Distinct ribs end	The posterior end is seen.	The anterior end is seen.
Patients' hands	It is placed on the hips.	It is placed on the sides of the thorax.
Heart magnification	There is minimal or negligible cardiomegaly.	There is moderate or significant cardiomegaly.
Cardiothoracic ratio	It is a normal 1:2 ratio.	It is spuriously increased.
Diaphragm	It is at the lowest level.	It is at the highest level.
Gastric fluid	It is seen.	It is not seen. No gas is seen.
Respiratory phase	It is done with deep inspiration.	It is done during mild inspiration or expiration.
Lung expansion	There is maximal lung expansion.	There is restricted lung expansion.
Lung markings	It is normal and prominent in lower zone vessels due to gravity.	It is crowded, and it is unduly prominent in upper zone vessels.
Lung Volume	It is normal.	It is reduced.



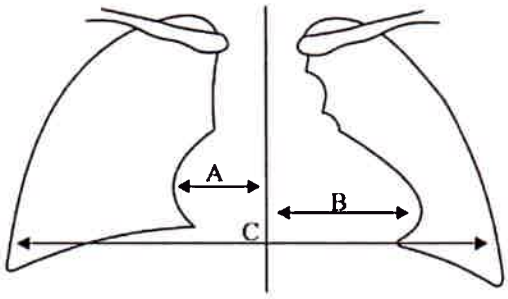
- The images given are the PA view, AP view and Lateral view in order.
- In image A, the scapulae are not coming into the field, but in B, it is coming into the field.
- The clavicle is present above the apices in image B.
- In image B, the diaphragm is more acutely placed than in A.
- The posterior ribs are visualized in image A than in image B.
- Image A shows the PA view of the X-ray, and image B shows the AP view of the X-ray.
- The third image shows the X-ray's lateral view, which is not popularly done. It is only done when disorders like RV enlargement, isolated LV enlargement, and echocardiography growing popular lateral view are almost altogether avoided.

Cardiac Size 00:09:32

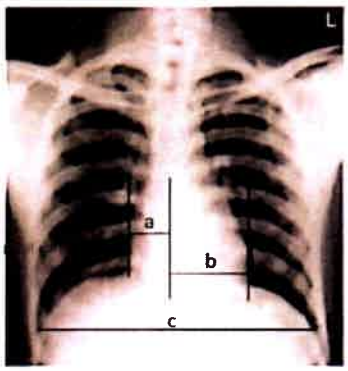
- The most important information we get when an X-ray is done is cardiac size.
- The cardiothoracic ratio is the ratio of the maximum

transverse diameter of the heart to the maximum internal thoracic diameter.

- We say the patient has cardiomegaly if the value exceeds 50%.
- It may not be accurate on AP view as it may be slightly increased.
- Some studies say the cut-off value should be around 55% when the AP view is taken, but it is not a standard reference.



- A vertical line is drawn from the centre of the X-ray or the sternal shadow.
- We calculate the maximum diameter from this on the right side, labelled as A.
- Then the maximum diameter on the left side is taken and labelled as B.
- A+B is the maximum possible diameter of the heart.
- C is taken to be maximum in the thoracic cage.
- Hence, CT ratio is given by (A+B)/C.

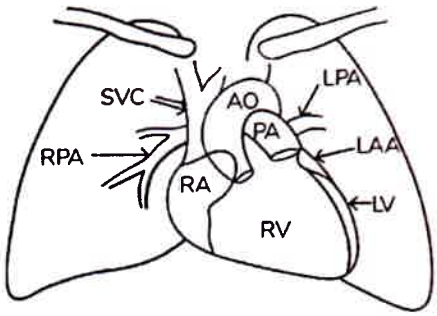


MCQ Points

- In addition to the CT ratio, for cardiomegaly, one also gets a lateral X-ray, which detects the isolated RV enlargement.
- CXR better detects volume overload, and ECG better detects pressure overload.
- In pressure overload, when there is an increase in pressure, concentric hypertrophy occurs. The cardiac muscle thickens on the inside, and it will not move outwards.
- This remodelling will not be easily measured on a CXR. Still, when you perform an ECG due to increased cardiac muscle mass, you will find right-sided or left-sided excess division features. So, pressure overload is better demonstrated by ECG.
- A PA film may erroneously show cardiomegaly in a flat chest or narrow AP diameter patient.
- A CXR below three years of age is more likely to be an AP view than a PA one unless specific manoeuvres are used.

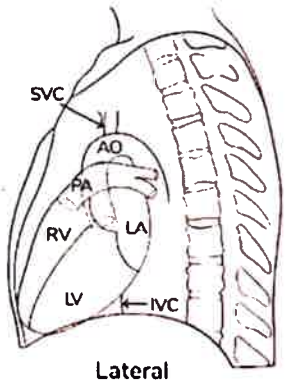
Normal Cardiac Silhouette

00:15:50



Posteroanterior

- This is the image of a normal cardiac silhouette in PA view.
- Structures like the superior vena cava and right atrium form the right heart border.
- The left heart border is formed by structures like the aortic knuckle or aortic knob, pulmonary artery and left ventricle, and sometimes the left atrial appendage can also be found.



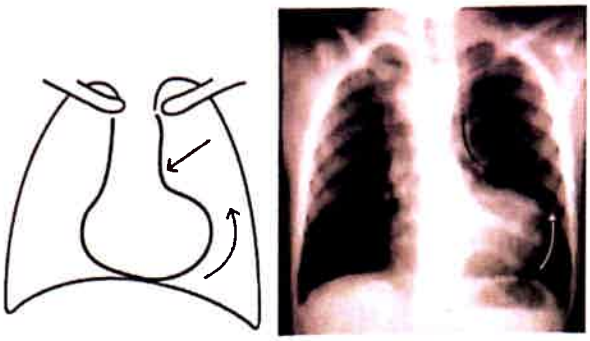
Lateral

- In the lateral view, the anterior segment is majorly formed by the right ventricle and some pulmonary artery segments.
- The left ventricle and auricle form the posterior segment.
- In a normal cardiac silhouette, the left ventricle meets or overlaps the inferior vena cava above the dome of the diaphragm.

Abnormal Cardiac Silhouette

00:20:36

Boot-Shaped Heart



- The factors that produce a boot-shaped heart include upturning the apex due to right ventricular hypertrophy, RV outro obstruction due to decreased pulmonary blood flow, and hypoplastic pulmonary artery segment, producing a concavity.
- It is also called coeur-en-sabot.
- It is most commonly seen in the tetralogy of Fallot.
- The overturning of the apex is not that prominent in tricuspid atresia.

Clinical Question

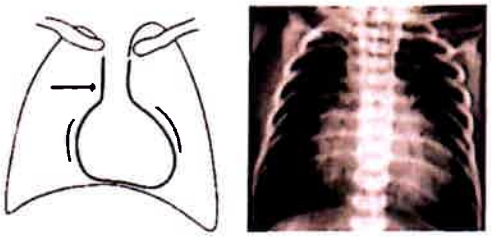
Q. A CXR done in a cyanotic infant showed the typical boot-shaped heart. The next investigation will be helpful to see if it's TOF or Tricuspid Atresia if echocardiography is not available immediately.

A.

- When a CXR showing a boot-shaped heart is obtained, echocardiography is immediately performed.
- Since it is not available, an ECG is performed.
- If the ECG shows features of RVH, then tetralogy of Fallot is the most likely diagnosis, and if features of LVH are seen, then it is tricuspid atresia.

Egg-on String Appearance 00:24:44

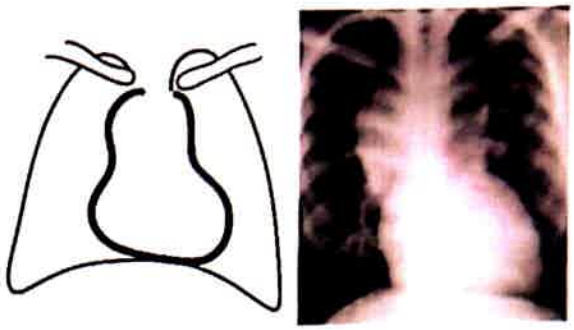
Egg on String Appearance



Also K/A - Egg on side appearance

- It is also called the egg-on-side appearance or egg-shaped heart.
- It is most commonly seen in dextroposed TGA.
- Cause: There is a narrow upper pedicle with convexity due to abnormal relation of the great arteries and reduced or absent thymic shadow, and these findings are associated with increased PBF.

Snowman Appearance 00:27:11

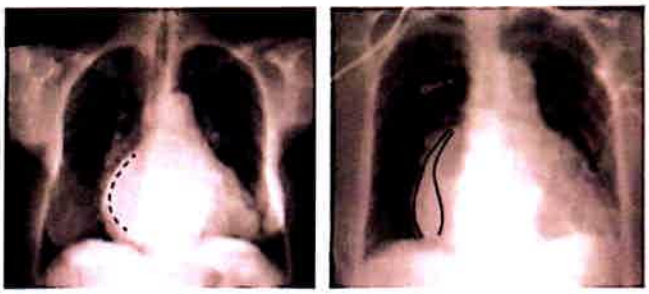


- It is also called the figure of eight appearance and cottage loaf appearance.
- It is seen in the supra-cardiac form of TAPVC.
- There is dilatation of the superior vena cava and prominent left innominate or the left vertical vein.

Individual Cardiac Chambers 00:30:50

Left Atrial Enlargement

- The mild LA enlargement is best seen on the lateral view, producing a posterior protrusion of the LA border.
- On PA view, the signs of LA enlargement include:
  - Double density sign is when the left atrium is significantly enlarged. It forms a partial shadow finishing just before the right heart border. So, two cardiac shadows are seen on the right side.
  - There will be a prominent left atrial appendage on the left heart border.
  - There will be elevation on the left mainstem bronchus, which is not always seen in young children.

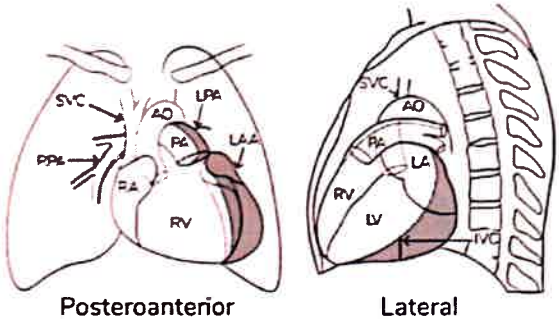


Right Atrial Enlargement

- It is best seen on PA view as an increased prominence of the lower heart border.
- It is not very useful as false positives and negatives can sometimes be seen.

Left Ventricular Enlargement

- On the PA view, the apex is displaced downwards and laterally.
- On the lateral view, the lower posterior cardiac border is displaced farther posteriorly and meets the IVC line below the diaphragm level.



Posteroanterior Lateral

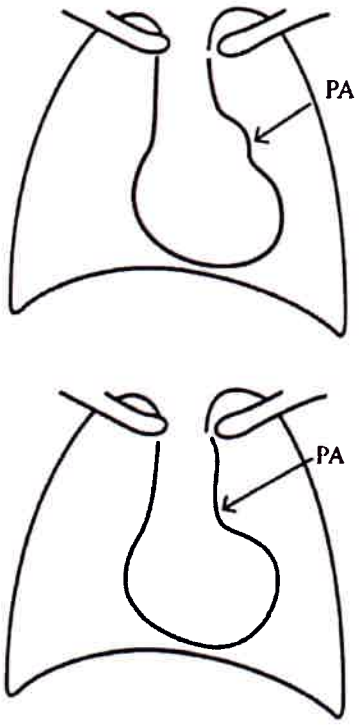
Right Ventricular Enlargement

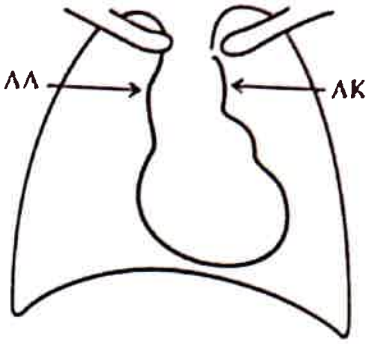
- It is best recognized in the lateral view in which it manifests by filling of the retrosternal space.

Sternal Normal Lateral View

Sternal RV Enlargement

Size and Abnormalities in the Great Vessels 00:35:50





Prominent Main Pulmonary Artery

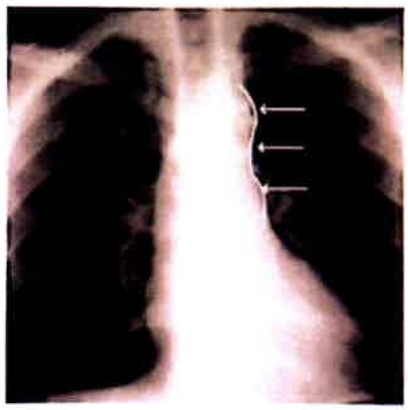
- There is a convexity formed due to the main pulmonary artery.
- It is seen in increased PBF conditions like ASD and VSD.
- It can be due to post-stenotic dilatation like pulmonary valvular stenosis.

Hypoplastic Pulmonary Artery

- It is seen in patients with decreased PBF, like tetralogy of Fallot.
- There is concavity in the main pulmonary artery.

Aortic Dilatation

- If the arch of the aorta is dilating, it will form a convexity on the right side of the heart. If the aortic knuckle is formed, it will be a convexity in the upper left corner.
- It is seen in conditions like post-stenotic dilatation in aortic valvular stenosis.
- It is also seen in Marfan's syndrome, PDA, and coarctation of aorta.

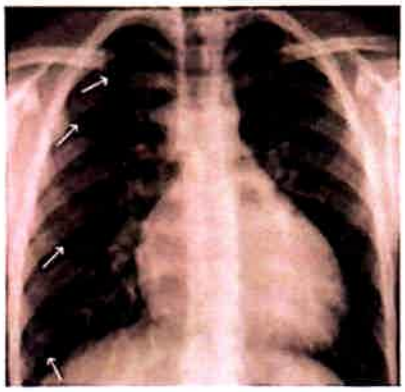


- In this figure, a 3 shaped figure is observed.
- There is stenosis (concavity) and pre and post dilatation (convexities), which is happening.
- This is seen in the coarctation of the aorta (COA)

Pulmonary Blood Flow 00:40:30

- There can be increased or decreased pulmonary blood flow.
- The increased PBF is also called pulmonary plethora, and decreased PBF is called pulmonary oligemia.

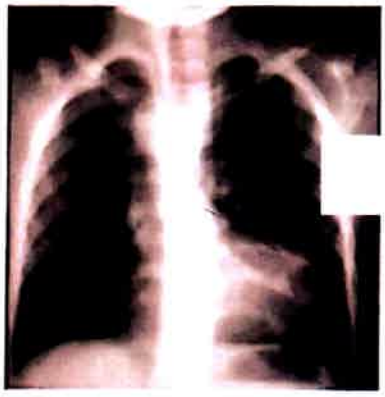
Pulmonary Plethora

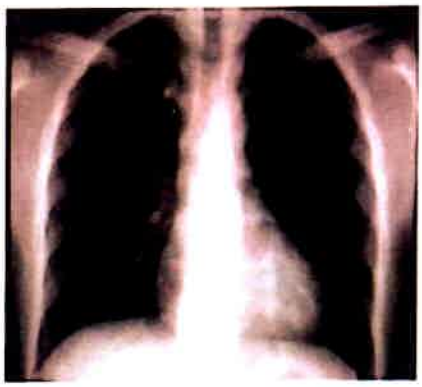


- The radiological clues include the enlargement of the right or left pulmonary artery
- Prominent vascular markings
- Vascular markings extending beyond 2/3rd of the lung fields, i.e., reaching the peripheral 1/3rd lung fields.
- Starting from the hilum, the lung is divided into three parts. The vascular markings can be present in the hilar 1/3rd and the middle region. If these vessels can reach beyond the middle region, then it is a sign of increased pulmonary blood flow.
- The external diameter of the right PA visible in the right hilum is wider than the internal diameter of the trachea.

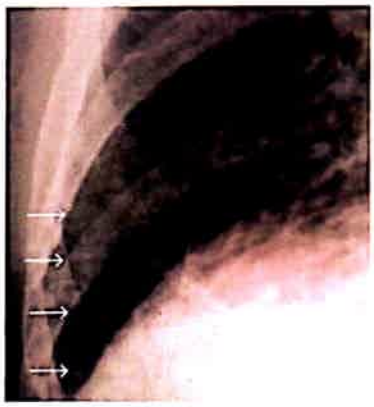
Pulmonary Oligemia

- The radiological markings include small hilum, inconspicuous pulmonary vascular markings, dark or black lung fields, vascular markings will be covering less than 1/3rd of the lung fields, and small and thin pulmonary vessels.





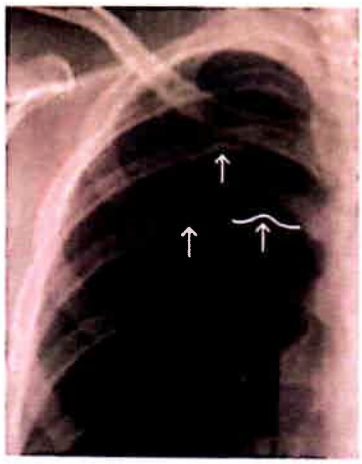
Kerley B Lines



- They are short transverse strips of increased density best seen in the costophrenic sulci.
- Engorged lymphatics and interstitial edema of the interlobular septa secondary to pulmonary venous congestion cause them.
- It is a sign of pulmonary venous congestion.
- Examples of such diseases are acute LV failure and mitral stenosis.

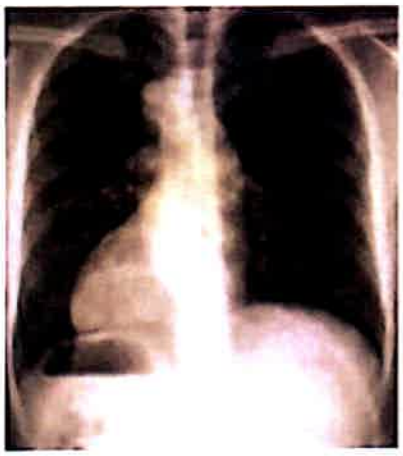
Other Information Obtained 00:47:18

Inferior Rib Notching



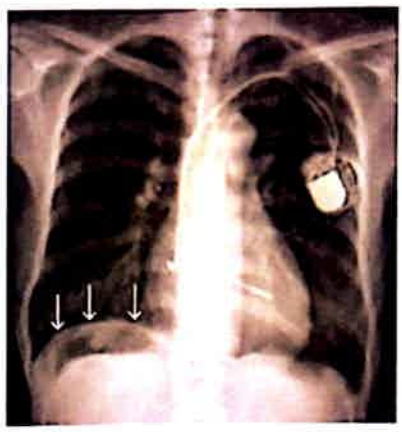
- It is a feature of coarctation of the aorta. It involves the third to eighth ribs.
- There are erosions on the inferior surface of the ribs.
- It happens due to collateral development between the anterior and posterior intercostal vessels.
- Inferior rib notching occurs due to the development of collaterals between branches of anterior intercostal arteries (supplied by ascending aorta) and branches of posterior intercostal arteries (supplied by descending aorta).
- The first two ribs are not involved because the anterior and posterior intercostal arteries arise from ascending aorta in the first two intercostal spaces, so no collaterals are needed.
- . Inferior rib notching in coA is also called
  Roesler sign
  Dock's sign

Dextrocardia With Situs Inversus 00:50:20



- In a normal person's CXR, the cardiac shadow occupies one-third of the right side, two-thirds occupies the left side of the thoracic cavity, and the apex points towards the left side, and if it points to the right, then it is called dextrocardia.
- The two diaphragm domes are not at the same level in a normal person. The right-sided dome is slightly higher than the left. The cardiac apex rests on the left dome and does not allow the dome to rise. The apex on that side is slightly on the lower side.
- A normal person has a hepatic shadow on the right side and a stomach bubble on the left side.
- In situs inversus, the situation is reversed. The apex of the heart points towards the right side. The stomach bubble also moves to the right, and the position of the diaphragmatic domes will change.
- The dome of the diaphragm is lower on the right side due to the cardiac shadow.

Heterotaxia Syndrome 00:53:23



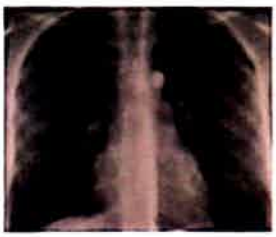
- There is an incomplete rotation of the axis of the body.
- It is suspected on CXR if, with a right-sided cardiac apex, there is a left-sided stomach bubble or with a normal left-sided cardiac apex, there is a right-sided stomach bubble.
- Many may have a mid-line liver associated with the absence of the spleen and Polysplenia abnormality.

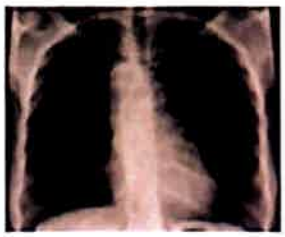
Important Information

False Sign of Cardiomegaly

- If the thorax's flattening in AP diameter causes a compensatory increase in the transverse diameter of the chest. It can falsely give the impression of cardiomegaly.
- It is seen in patients with pectus excavatum.

Right-Sided Aortic Arch



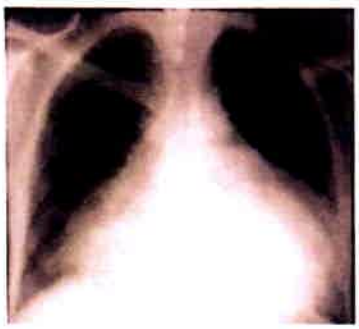


- It is seen in conditions like truncus arteriosus and tetralogy of Fallot.
- In a normal person, a normal left-sided aortic knob is present.
- Right-sided aortic arch is suspected when the aortic knuckle is on the opposite side of the side where the air-filled airway is present (shown in the second image above).

Water-Bottle Sign

- It is also called the flask-shaped heart (money bag appearance).

- It is seen in patients with massive pericardial effusions.

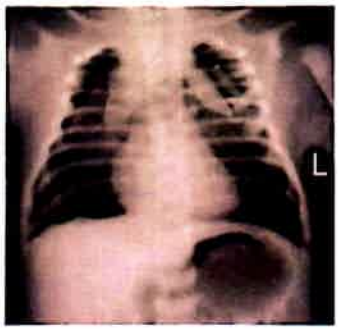


Thymic Shadow 01:00:15

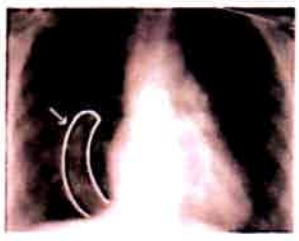
- It produces a classic sign called the sail sign with a wavy border.
- The wavy border is due to the indentation by ribs called the wave sign of Mulvey.
- The enlarged thymic shadow is seen in normal variants, thymic hyperplasia, tumors, leukaemia, lymphoma, and LCH.
- It is absent in DiGeorge syndrome.
- It shrinks or is narrow in patients with cyanotic CHD in infants like d-TGA, and severe CCF.

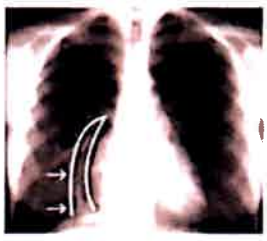
Spinnaker Sail Sign 01:01:27

- It is also called the angel wing sign.
- It is an abnormal finding.
- It refers to the thymus being outlined by air with each lobe displaced laterally and appearing like spinnaker sails.
- It is a sign of pneumomediastinum in young children and infants.



Scimitar Syndrome 01:02:33



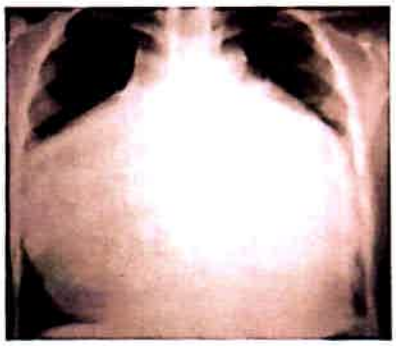


- It is a vertical shadow along the lower right cardiac border shaped like a scimitar.
- It is seen in PAPVR of the right middle or lower lung lobes.
- The pulmonary venous blood drains into the inferior vena cava.
- It is associated with right lung hypoplasia, hypoplastic right PA, sequestration of the right lung, and ASD.

Rare Signs 01:04:54

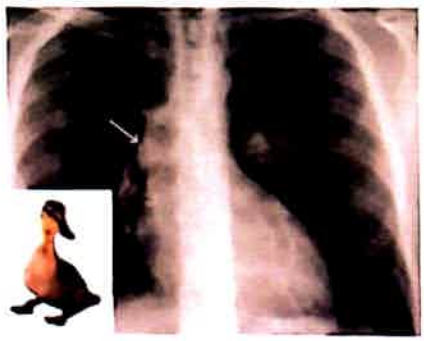
Box-Shaped Heart

- It is a condition where the heart is highly enlarged due to right atrium involvement.
- It is seen in patients with Ebstein's anomaly.



Other Named Signs

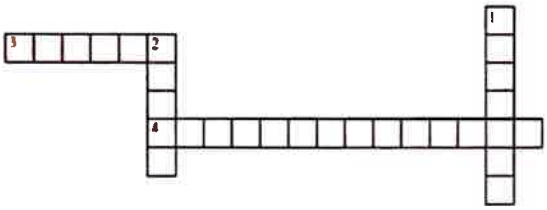
- The jug-handle appearance is seen in patients with the atrial septal defect.
- The globular heart is seen in patients with dilated cardiomyopathy.
- The peripheral pruning of pulmonary vessels is seen in patients with pulmonary hypertension.



- The sitting duck sign is a variant of the boot-shaped sign and is sometimes seen in patients with tricuspid atresia (shown in the image above).

CROSS WORD PUZZLES

Crossword Puzzle 1



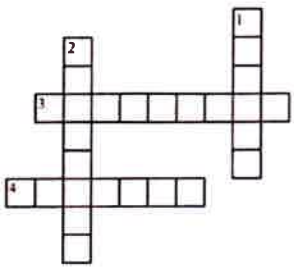
Across

2. AP view is done in an _____ position.
4. The _____ ratio is the ratio of the maximum transverse diameter of the heart to the maximum internal thoracic diameter.

Down

1. The most important information we get when an X-ray is done is _____ size.
3. PA view is done in an _____ position.

Crossword Puzzle 2



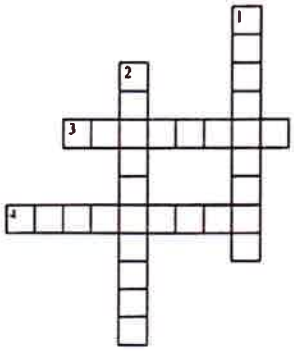
Across

3. In the lateral view, the anterior segment is formed by the right _____ and some pulmonary artery segments.
4. _____ appearance is seen in supra-cardiac form of TGA

Down

1. Boot-shaped heart is seen in tetralogy of _____.
2. The increased PBF is also called pulmonary _____

Crossword Puzzle 3



Across

3. The _____ heart is seen in patients with dilated cardiomyopathy.
4. The _____ pruning of pulmonary vessels is seen in patients with pulmonary hypertension.

Down

1. The _____ appearance is seen in patients with the atrial septal defect.
2. The sitting duck sign is a variant of the _____ sign and is sometimes seen in patients with tricuspid atresia.

3 CLASSIFICATION & APPROACH TO CHD

A. Classification 00:00:38

- Classification of CHD is based on whether it is Cyanotic or Acyanotic CHD.
- It can further be subdivided based on Pulmonary blood flow or Left/Right/Biventricular Hypertrophy. However, classification based on hypertrophy is not preferred.

Refer Flow Chart 3.1

- Examples of L→R shunts: ASD, VSD, PDA, Endocardial Cushion defect/AV Canal defect.
- Examples of Obstructive lesions: Coarctation of Aorta, Interrupted Aortic arch syndrome, Congenital Stenotic lesions (AS, MS).
- Examples of rare congenital regurgitant lesions: AR, MR.
- Examples of Cyanotic CHD with Increased Pulmonary blood flow: TGA, TAPVC, Persistent Truncus Arteriosus, Single atrial physiology, Single ventricular physiology.
- Examples of Cyanotic CHD with Decreased pulmonary blood flow: TOF, Ebstein's anomaly, Tricuspid atresia, Single ventricle with pulmonary stenosis, Pulmonary atresia, Hypoplastic right heart syndrome.

Important Information

- Most common CHD in Down's syndrome is Endocardial Cushion Defects.

B. Ductus Dependent Congenital Heart Diseases 00:09:10

- This is an artificial classification.
- It is based on the approach to therapy, thus is a retrospective classification.
- They are anatomically not linked to each other and are usually complex diseases (multiple problems).
- Normally, Ductus arteriosus (DA) connects Aorta to Pulmonary artery which is kept open in-utero by Hypoxia and maternal Prostaglandins (PGs). After birth ductus closes due to increased Oxygen tension and reduced maternal PGs.
- If the ductus closure does not happen, it leads to Patent Ductus Arteriosus (PDA) which further leads to Left --> Right shunting causing Increased pulmonary blood flow and Congestive cardiac failure (CCF).
- However, certain cardiac diseases need an open ductus for survival. These diseases are "Those complex congenital heart diseases where survival of child is relatively improved by keeping DA open in early post-natal life"
- Classification of ductus dependent CHD:

Circulation-1	Circulation-2
• Left ventricle → Pulmonary Artery → Lungs → Pulmonary veins → Left atrium → Back to left ventricle	• Right ventricle → Aorta → Organs → SVC and IVC → Right atrium → Back to right ventricle.

- **Ductus Dependent Oxygenation:** eg- TGA with Intact Ventricular Septum/Pure TGA.

- **In TGA:** There exist 2 circulations which are usually joined by a DA or patent foramen ovale.
  - → Before birth, Oxygenation occurs in circulation-2 and organs receive Oxygen.
  - → However, after birth, DA closes and oxygenation are restricted to circulation-1
  - → leading to failure of oxygen supply to organs causing intense cyanosis.
  - → Thus, a lifesaving intervention done in this case is administration of PGE1 (Alprostadil)
  - → Which keeps the DA open.

- **Ductus Dependent Pulmonary Circulation:** eg- Tricuspid atresia, Pulmonary atresia, Hypoplastic right heart syndrome, Ebstein's anomaly.
  - → In Pulmonary atresia, Pulmonary valve is replaced by a fibrous band.
  - → Thus, when RV contracts, blood cannot move into pulmonary artery.
  - → The patients usually have a VSD or Patent foramen ovale which allows deoxygenated blood to enter from RV into LV and get oxygenated via DA.

- **Ductus Dependent Systemic Circulation:** e.g.- Hypoplastic left heart syndrome (HLHS), Severe neonatal Coarctation of Aorta, Severe neonatal congenital aortic stenosis, Interrupted aortic arch syndrome.
  - → In HLHS, there is hypoplasia of mitral valve, LV and proximal Aorta. This reduces LV ejection fraction.
  - → This leads to low cardiac output manifesting as Shock, absent pulses, Progressive acidosis and anuria.
  - → The lifesaving intervention done is PG infusion to keep DA open. Since the aortic pressure is low, blood will flow from pulmonary artery to Aorta via Patent DA and enter into the descending aorta.

C. MCQ Discussion 00:21:38

Q. Which of the following is a ductus dependent lesion?

A. TGA

B. TAPVC

C. ECD

D. Supracristal VSD

Q. Which of the following is a ductus dependent lesion?

A. TGA

B. Tricuspid atresia

C. ECD

D. Supracristal VSD

Q. A neonate developed shock, absent pulses and poor perfusion on day 2 of life. Sepsis markers were negative and there was poor response to Dopamine & Epinephrine. On doing echocardiography, a specific abnormality in heart was detected for which Alprostadil infusion was started and there was a dramatic improvement in his clinical status. What could not have been the likely CHD?

A. Hypoplastic left heart syndrome

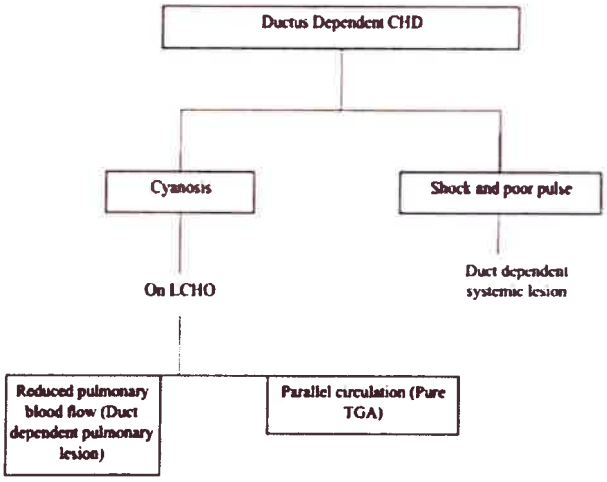
B. Hypoplastic right heart syndrome

C. Severe critical coarctation of aorta

D Interrupted aortic arch syndrome

D. Summary 00:27:10

- Any neonate who worsens in the 1st 2 weeks of life and improves with PGE1/Alprostadil is likely a case of Ductus dependent CHD.



E. Nadas Criteria 00:28:45

- Major criteria

1. Systolic murmur grade 3 and above.
2. Any grade diastolic murmur.
3. Central cyanosis.
4. CCF.

- Minor criteria

1. Systolic murmur < grade 3.
2. Abnormal second heart sound.
3. Abnormal Blood pressure.
4. Abnormal Chest X-ray.
5. Abnormal ECG.

Important Information

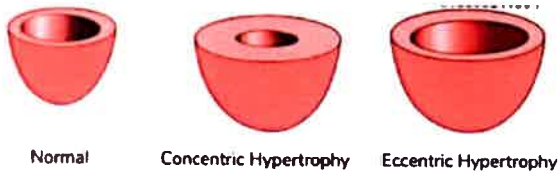
- Presence of 1 major or 2 minor criteria is suggestive of heart disease in child.

F. Clues, Hacks and Tricks for CHD 00:30:59

1. History of Growth Retardation

- Any child with significant growth retardation having decreased height and weight would probably be suffering from Cyanotic CHD.
- Any child with significant growth retardation having reduced weight with relative preservation of linear growth is probably suffering from Acyanotic CHD (L-->R shunt).
- Absence of significant growth retardation indicates a mild-moderate acyanotic CHD of obstructive variety.

2. Volume V/S Pressure Overload



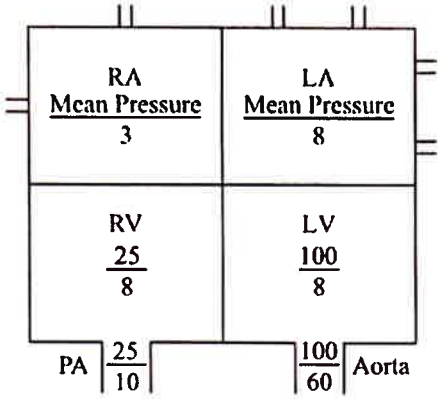
- There can be two types of pressure loads in the cardiac chamber.
- Volume overload (e.g.- Large ASD) can be due to L-->R shunt or R-->L shunt or regurgitant lesions. It is characterized by extra blood in the ventricles leading to Eccentric hypertrophy/dilatation of ventricles.
  - On Chest X-ray- Increased Cardiothoracic ratio.
  - On ECHO- Chamber cavity size increased.
  - On ECG- Axis deviation on side of ventricle enlargement.
- Pressure Overload (Coarctation of Aorta) is characterized by Concentric hypertrophy (Increased thickness inside).
  - On Chest X-ray- Normal sized heart.
  - On ECHO- Chamber cavity size Normal or reduced.
  - On ECG- Axis deviation on side of ventricle enlargement.

3. Pulmonary Blood Flow

- Increased pulmonary blood flow will present clinically as increased chances of CCF, Dyspnea, Respiratory distress and increased chest infections like pneumonia.
- Radiologically, it will show pulmonary plethora.

- Decreased pulmonary blood flow will present clinically as Cyanosis, Shortness of breath transiently improved by squatting. Radiologically, it will show pulmonary oligemia.

4. Cardiac Chamber Pressures in a Child



- If pressure gradient (ΔP) between 2 chambers is >= 12 mm of Hg, it is usually significant.
- In ASD, ΔP = 5 mm of Hg, thus it presents as silent murmur.
- In VSD, ΔP during systole is high and during diastole is low, thus it presents as Pansystolic murmur (Roger's murmur).
- In PDA, ΔP is raised in both systole and diastole, thus it presents with continuous machinery like murmur (systole + diastole).

5. Murmurs and Infective Endocarditis (IE):

- Murmur requires 2 things- Adequate blood flow and Turbulence.
- Turbulence is produced by stenosis or regurgitation or if there is a jet of blood moving from high pressure area to low pressure area through a small opening.
- Significant turbulence causes micro-erosions on endocardium which act as nidus for bacteria to grow as vegetations.
- Risk of IE α Degree of turbulence.
- VSD, MR, AR have high ΔP. Therefore, have increased turbulence and increased risk of IE.
- ASD has low ΔP. Therefore, it has decreased turbulence and decreased risk of IE.

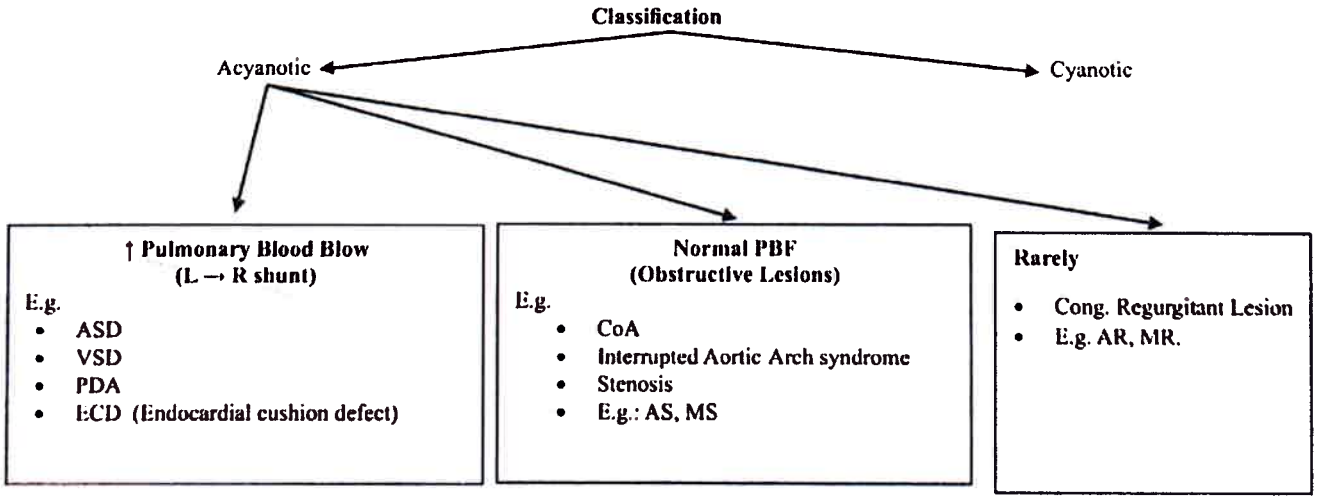
6. QP: QS Ratio

- Qp = Pulmonary blood flow.
- Qs = Systemic blood flow.
- In L-->R shunts, Qp: Qs > 1.
- Qp:Qs up to 1.5:1 is clinically silent (ASD).
- Qp: Qs >=2 is hemodynamically significant- Requires medical or surgical management or both.
- In R-->L shunts, Qp: Qs is 0.7-0.8 (e.g., TOF).

G. Things to Focus on in a Child with CHD 00:48:07

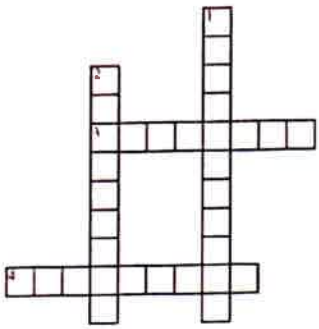
- Time of onset?
- Acyanotic v/s Cyanotic?
- CCF or not?
- Pulmonary blood flow?
- Murmur and specific findings.
- Chest X-ray and ECHO findings.

Flow Chart 3.1



CROSS WORD PUZZLES

Crossword Puzzle 1



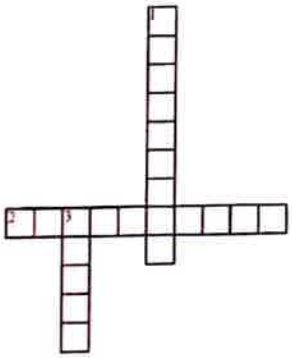
Across

3. _____TAPVC is which type of CHD
4. _____Type of hypertrophy in volume overload

Down

1. _____PG analogue to keep ductus open
2. _____Pulmonary blood flow in VSD

Crossword Puzzle 2



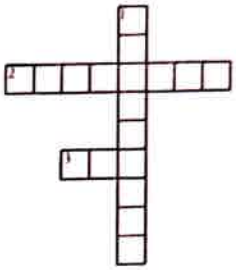
Across

2 _____Type of hypertrophy in pressure overload

Down

1. _____Type of flow predisposing to IE
3. _____Criteria for CHD in children

Crossword Puzzle 3



Across

2. DA closes due to____ in oxygen tension
3. Number of minor criteria required for CHD diagnosis

Down

1. _____Radiological finding in increased pulmonary blood flow