Normal Fetal Circulation and Cardiovascular Adaptations at Birth

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Objectives

• Discuss fetal anatomy
• Discuss the fetal circulation
  – Course of the circulation
  – Admixture of oxygenated and systemic venous blood
  – Fetal vascular pressures
  – Blood gases and oxygen saturation
  – Cardiac output and its distribution
• Birth associated changes in circulation
Objectives

• Discuss specific fetal circulation and transitional circulation in different congenital heart disease states
  – Coarctation of the aorta
  – Hypoplastic left heart syndrome
  – Tricuspid atresia
  – Tetralogy of Fallot
  – Transposition of Great Arteries
  – Total anomalous pulmonary venous return
  – Truncus arteriosus
Fetal Circulation
Fetal Circulation

before birth
3 Unique fetal cardiovascular structures

- Ductus venosus
- Ductus arteriosus
- Foramen Ovale
The uterine artery from the mother supplies the blood to the uterus...
before birth

IVC
before birth
The fetal heart pumps the oxygenated blood to provide oxygen to the vital organs.
Percentages of combined ventricular output

450 ml/kg/min
Transitional Circulation
Transitional circulation

• Mechanical expansion of the lungs
  • Increase arterial PO2
  • Rapid decrease in PVR
• Removal of placenta
  • Removal of low-resistance circulation
• Increase in SVR
Transitional Circulation

• Entire RV output flows to pulmonary circulation
  • PVR < SVR

• Shunt through PDA reverses and becomes left to right.
  • In the course of a few days the PDA constricts (>PO2)
  • Remnant of PDA = *Ligamentum arteriosus*

• Increase of Pulmonary vein flow to LA increases pressure
  • Pressure sufficiently closes the PFO functionally.
Transitional Circulation

• Removal of placenta = closure of the ductus venosus.
  – Remnant of ductus venosus = Ligamentum venosum

• LV now high resistance systemic circulation
  – Wall thickness and mass increases

• RV now low resistance pulmonary circulation
  – Wall thickness and mass decrease.
Neonatal Circulation
Neonatal Circulation

- Heart rate slows as a result of baroreceptor response to increase SVR.
- Blood pressure progressively rises with increasing age
- PVR markedly decreased
  - Major decline achieved to low adult levels from 2-3 days up to 7 days or a few months
Neonatal Circulation

• Foramen ovale functionally closed by 3 mos.
  – Some close by 2 years
  – 25% of population has it patent in adulthood

• PDA functionally closed within 10-15 hours
  – Longer in CHD and preemies
  – Average time 3-5 days
Fetal and Transitional Circulation in Different Congenital Heart Disease States
Coarctation of the aorta
Hypoplastic Left Heart Syndrome

Diagram showing the anatomy of the heart with labels for:
- Very Small Aorta
- Vessel Connecting Aorta and Pulmonary Artery
- Opening Between Atria
- Underdeveloped Left Ventricle
- AO = Aorta
- PA = Pulmonary Artery
- LA = Left Atrium
- RA = Right Atrium
- LV = Left Ventricle
- RV = Right Ventricle
- Oxygen-rich Blood
- Oxygen-poor Blood
- Mixed Blood
Tricuspid Atresia
Tetralogy of Fallot
The boot shaped heart?
Transposition of Great Arteries
The egg on a string?
Total Anomalous Pulmonary Venous Return
TAPVR Types
Snowman Sign?
Truncus arteriosus

Common ‘trunk’ gives rise to pulmonary artery

Large VSD
Types of Truncus Arteriosus
Thank You!