Q6 Define venous admixture and list its causes. (50% of marks) How is it diagnosed and how is it quantified? (50% of marks) (Sept 2009)

Venous admixture – the amount of mixed venous blood that would need to be added to pulmonary end-capillary blood to produce the given drop in PO2 seen between end capillary blood and arterial blood.

Causes

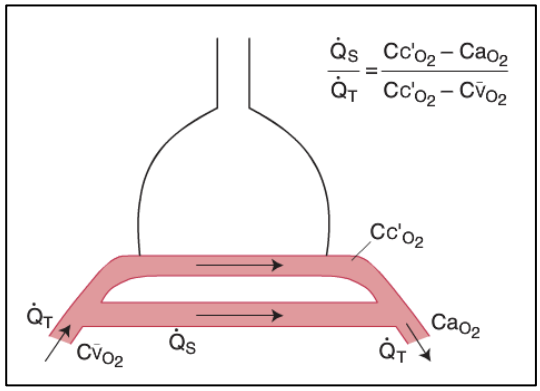
- Shunt (blood which passes through the pulmonary vasculature without coming into contact with ventilated alveoli)
  - True shunt – anatomical (bronchial venous blood, thebesian circulation draining directly into left atrium)
  - Pathological shunt – pneumonia, pulmonary oedema, congenital defects (eg, VSD)

- V/Q mismatch (describes the situation where ventilation and perfusion are not perfectly matched)
  - Normal V/Q mismatch – blood which has perfused alveoli with a V/Q ratio of <1 (as occurs at the lung bases), resulting in blood that is not fully oxygenated
  - Pathological – COPD, pulmonary fibrosis, pneumonia

Diagnosis

- Requires calculation of the A-a gradient using the alveolar gas equation $P_AO_2 = P_IO_2 – (PCO_2/R) + F$, where P_IO_2= inspired O_2, R = respiratory exchange ratio (usually 0.80) and F is a small correction factor of 2
- $[P_AO_2 - P_aO_2]$ gives the A-a gradient, which should be less than 7 (normal gradient increases with age, [2.5 + (age x 0.21)] is a formula used to estimate normal values)
- If a true shunt exists, the application of supplemental oxygen will not entirely resolve the hypoxia, because the higher Fi O_2 only reaches alveoli that are already ventilated. The Hb passing by these alveoli is already on the 'flat part' of the Hb/O_2 curve and exposing them to higher O_2 will only result in a very small increment in CaO_2.

Quantification



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- The shunt equation can be used to quantify the venous admixture
- Q_T = cardiac output, Q_S = 'shunt' blood flow, $C_{c'}O_2$ = O_2 content at end of pulmonary capillary, C_aO_2 = arterial oxygen content and C_vO_2 = mixed venous oxygen content
- Remember that oxygen content = [(1.34 x Hb x saturation) + (0.003 x PaO2)]
- C_aO_2 can be calculated with an arterial blood gas using the above equation
- C_vO_2 can be calculated using the same equation with P_vO_2 and S_vO_2 from a pulmonary artery catheter sample
- $C_{c'}O_2$ can be estimated using the P_AO_2 (from above) as an indicator of P_aO_2, and 100% as the Hb saturation
- From this the amount of blood 'shunted' from right to left heart without exposure to oxygen can be calculated, and that % of blood volume = venous admixture