PHYSIOLOGICAL CONSEQUENCE OF OLV

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INTRODUCTION & DISCLOSURE

- This is a massive topic – I will only focus on the main topics and elaborate on some
- I have made every effort to ensure these notes are accurate, but it has not been peer reviewed

INTRODUCTION

- Selective ventilation of one lung was fist described in 1931
- Before then thoracic surgery was limited to simple procedures only in patients breathing spontaneously
- The limiting factor – Respiratory acidosis and severe hypoxia
- This can be explained by 2 phenomena:
  - Pendel-luft airflow
  - Mediastinal shift

PENDEL-LUFT AIRFLOW MOVEMENT

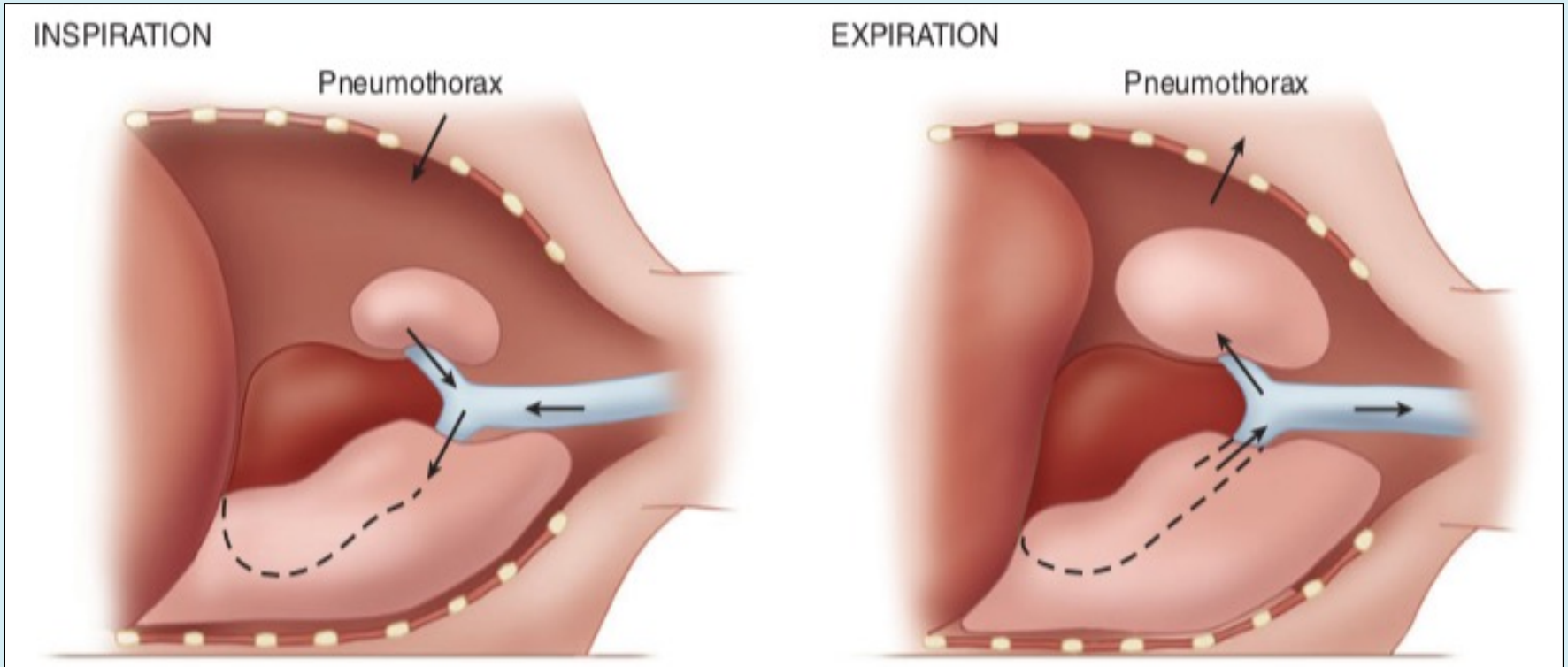
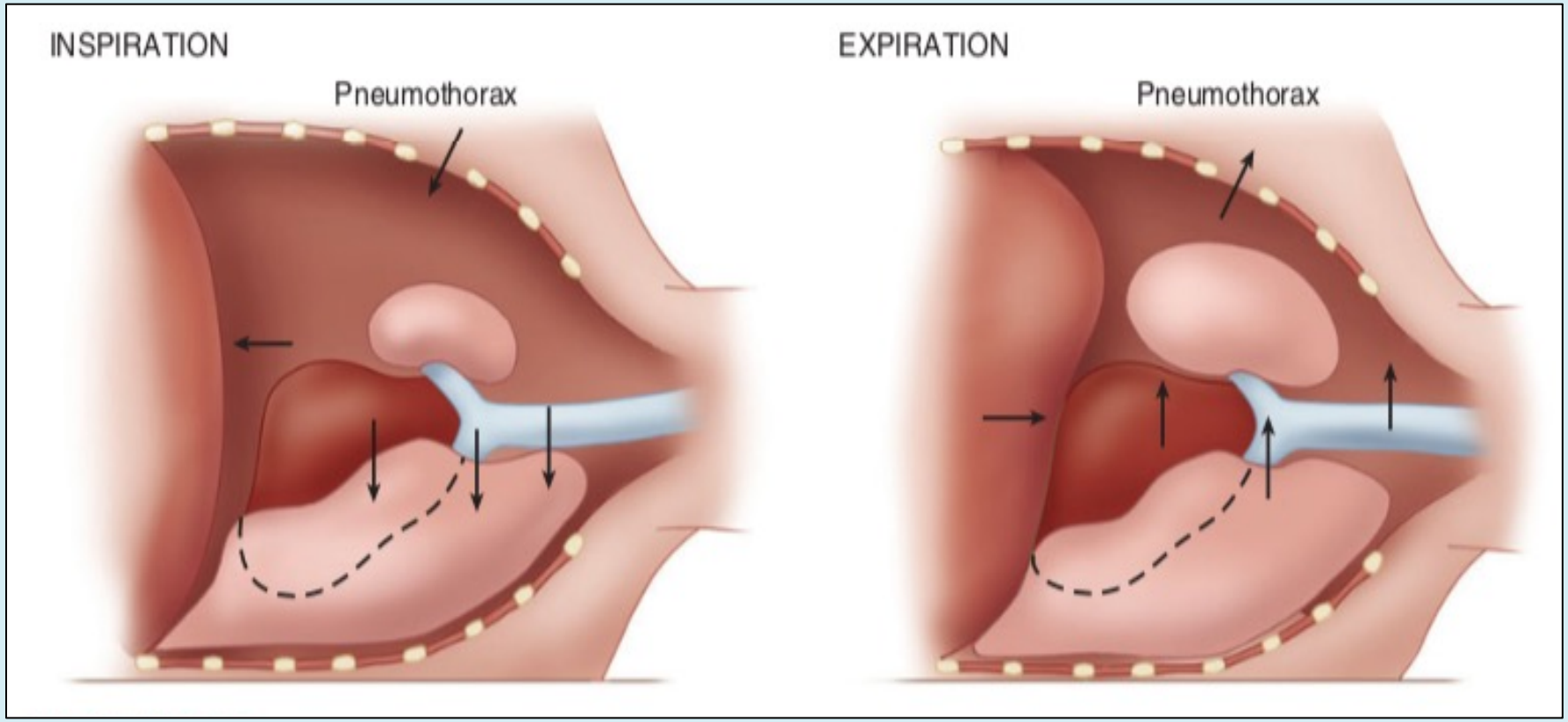


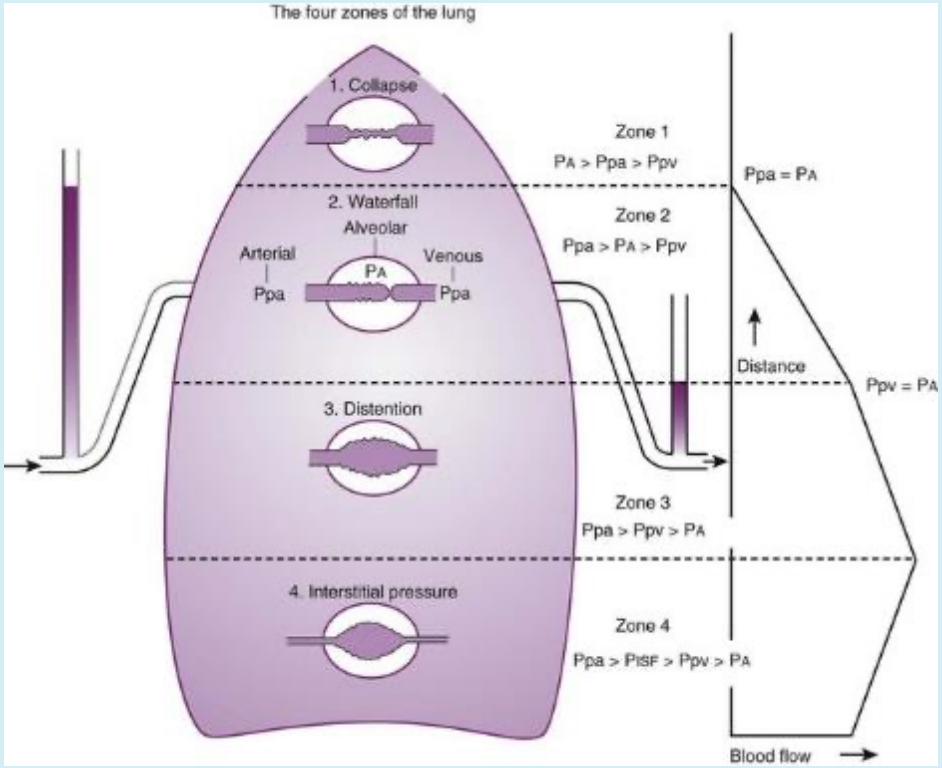
FIGURE 25–4 Paradoxical respiration in spontaneously breathing patients on their side. (Reproduced, with permission, from Tarhan S, Moffitt EA: Principles of thoracic anesthesia. Surg Clin North Am 1973;53:813.)

MEDIASTINAL SHIFT



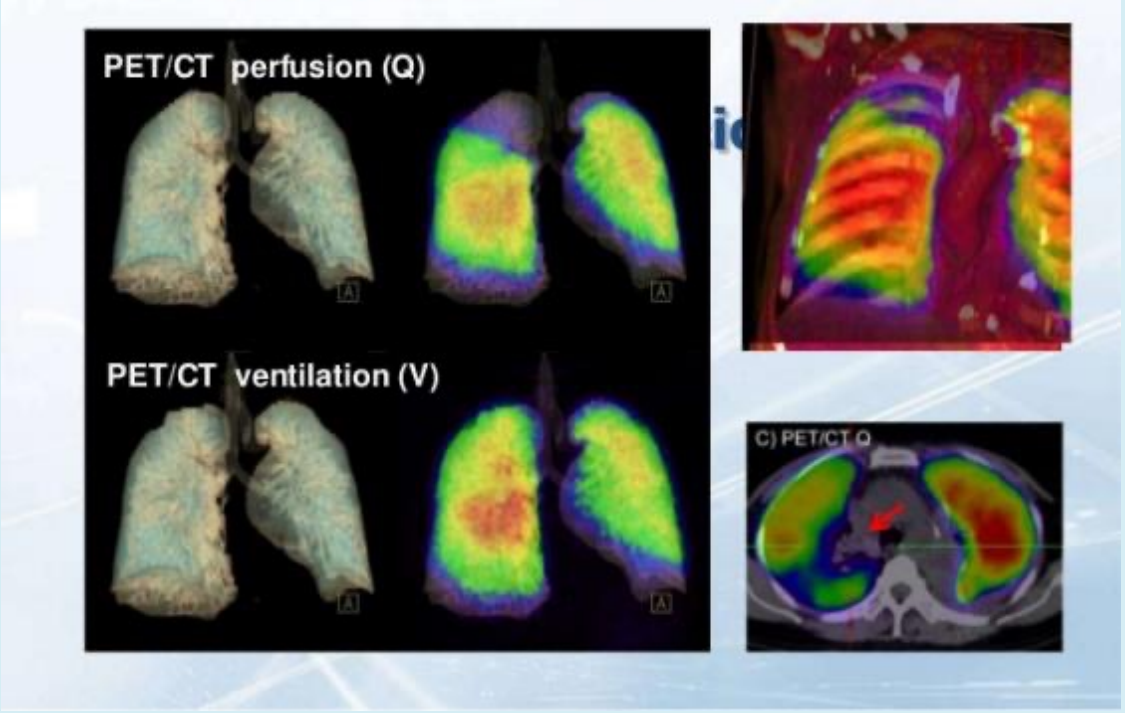
PERFUSION

- Perfusion is not uniform across the lung
  - P_{pa} and P_{pv} are dependent on the relative elevation above the heart
  - 1cm H_2O for each centimetre above/below the heart



PERFUSION

- West zones are an oversimplified static presentation of a dynamic cyclic system
- A single lung regions may move through various zones depending on the stage of the cardiac and respiratory cycle



HPV

- Low partial pressure of O_2 results in the inhibition of K^+ currents
- Subsequent membrane depolarisation will lead to Ca^{2+} influx from the L-type calcium channels and the release from the SR
- Subsequent smooth muscle contraction and vasoconstriction

- HPV is maximum when 30% - 70% of the lung is hypoxic and most effective in low-resistance pulmonary arteries.

- The primary stimulus of HPV is P_AO_2 but the P_VO_2 also plays a role
  - HPV is maximal at normal P_VO_2 levels

CARDIAC OUTPUT AND ARTERIAL OXYGENATION

- Direct correlation between increasing CO and improving oxygenation during OLV (Slinger & Scott 1995)
- CO augmentation with a low dose of dobutamine (5 mcg/kg/min) improves arterial oxygenation and decreases shunt fraction
- Supranormal CO will increase the mixed venous oxygenation, but this is overridden with an increased shunt fraction

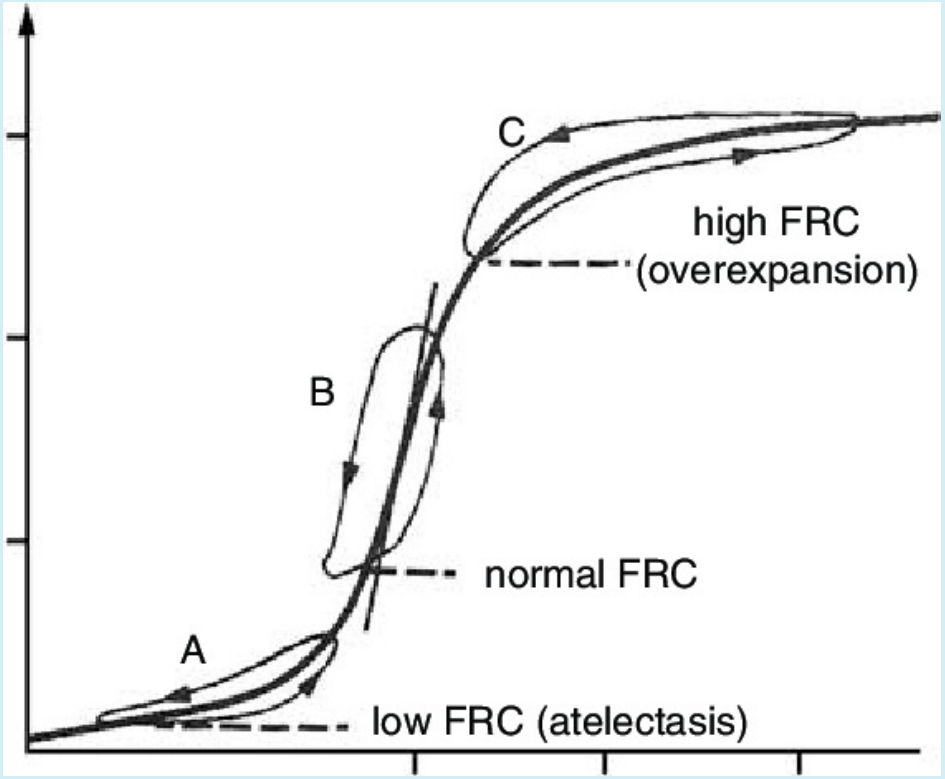
- Therefore “normal” CO must be maintained for adequate oxygenation during OLV

VENTILATION

- Gravitational forces also affect the distribution of ventilation throughout the lung
- Normal tendency in upright lung
  - Collapse of the lung away from the apex chest wall
    - Adds to the negative pleural pressure at the top of the lung
  - Tendency of the dependent lung is to push outwards
    - Decreases the negative pressure
- Resultant pressure gradient accounts for a pressure change of 0.25cm H_2O per centimetre of vertical distance above the lung
- The distending force (P_A) is the same for all the alveoli, but the transpulmonary pressure changes ($P_A - P_{pl}$)
  - Transpulmonary pressure is higher at the top of the lung
  - larger alveolar volume compared to the bottom)

VENTILATION

- Net effect:
  - The dependent alveoli are relatively small and compressed, but fall on the steep potion of the volume-compliance curve
  - The upper lung fall on the flat portion of the volume compliance curve and therefore changes little during tidal respiration



V/Q MATCHING IN THE ANAESTHETISED PATIENT

- Induction of anaesthesia decreases the diaphragmatic and inspiratory muscle tone
  - FRC drop of 15 – 20% in both lungs

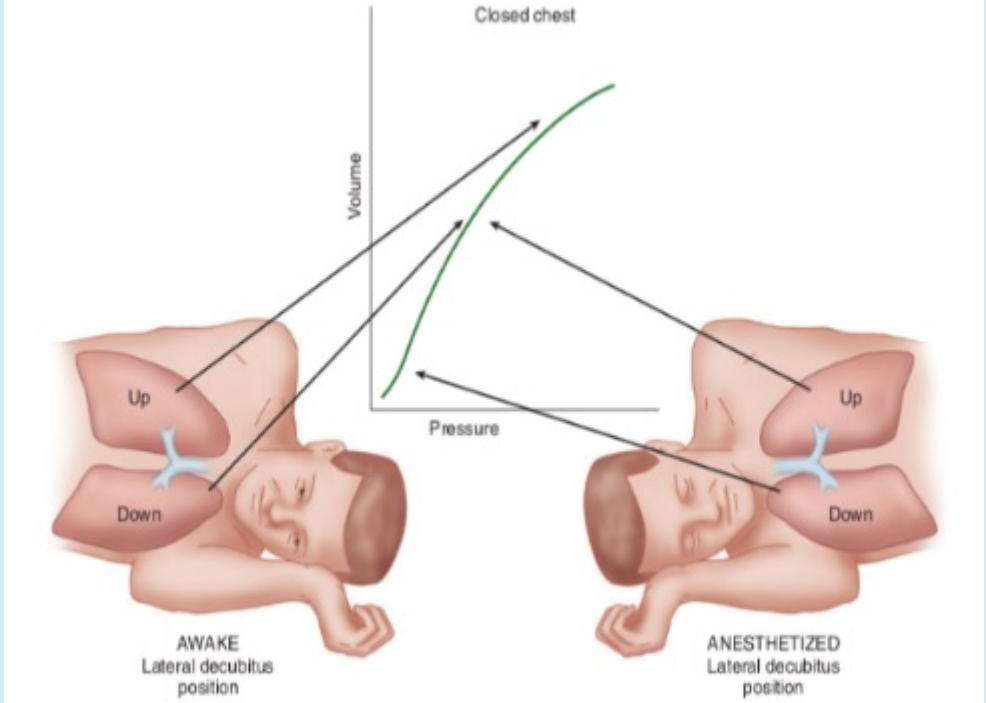


FIGURE 25–2 The effect of anesthesia on lung compliance in the lateral decubitus position. The upper lung assumes a more favorable position, and the lower lung becomes less compliant.

REFERENCES

- Principle and practice of anesthesia for thoracic surgery (Slinger et al.)
- Morgan & Mikhail's Clinical Anesthesiology. 5th edition
- *Hypoxic pulmonary vasoconstriction* published in BJA 2017 (Tarry & Powell)
- West's Respiratory Physiology
- Miller's Anesthesia