Pulmonary Barotrauma

Pulmonary Overpressure Syndrome (POS)

- POS
  - Pneumomediastinum, subQ emphysema
  - Pneumothorax (rarely seen in diving)
  - AGE
- Overexpansion of lungs (breathing compressed gas) & can't properly ventilate expanding gas volume with ↓press
  - Boyle's law: Largest volume changes near surface, breath-hold ascent from 4fsw sufficient
  - Air tracks along bronchi to outside the lung, or into adjacent blood vessels
  - Extrinsic: breath-holding on ascent – panic, out of air, buddy breathe, laryngospasm, sub escape
  - Intrinsic – obstruction or restrictive lung disease -> local air trapping, Δlung tissue compliance
- Most pathological studies indicate shear at terminal bronchioles and marginal alveoli rather than rupture of alveoli
- ?Blebs and bullae
  - COPDers with B&B don't have ↑incidence of PBT during HBOT (BUT no immersion, slow ascent rates)
  - B&B found post PBT may be either cause or consequence
- ? Role of obstructive airways. Mixed evidence
  - FEV 1 has low correlation to PBT risk
  - MEF 25 has moderate correlation to PBT risk
  - FEV1/FVC does not correlate
  - Asthmatics don't bear a much greater risk for diving-related intrinsic PBT than non-asthmatics
  - 50% of PBT/AGE survivors, no abnormality of lung fx detected
- ? Role of compliance
  - Pathology more consistent with shear than rupture, implies regional differential compliance
  - FVC correlated with PBT risk
  - Chest binding (reducing relative regional difference in compliance) ↓risk for PBT
  - Higher incidence PBT while immersed vs RCC (pulm blood pooling with immersion reduces interstitial compliance)
  - Pathology - weak correlation between shear site and location of pre-existing scars/fibrosis

POS

- S/Sx
  - Asx or if sx, usually on ascent or shortly after surface – cough, hemoptysis, CP, SOB, resp distress, pleuritic/substernal CP
  - +/- sx of AGE
  - Pneumomediastinum – decreased heart sounds, dysphonia (brassy, monotone), Hamman's sign, recurrent laryngeal paresis, pseudo-tamponade
  - SubQ emphysema – crepitations felt in soft tissues
- CXR
  - Free gas at margin of heart/vessels, pseudo-pneumopericardium, subQ gas
  - Pneumothorax
  - Pleural effusion
  - Intravascular gas with massive AGE
- Tx - ABCs
  - O2
  - Needle deco/CT for tension pneumo (rare)
  - RCC only if AGE
  - Supportive SC/mediastinal emphysema
  - ER/Thoracic referral – urgency based on sx
- Screening – controversial
  - CXR low predictive power
  - CT – many abnormalities (?clinical significance), expensive, ++radiation
  - Spiro – poor correlation to PBT risk
    - FEF 25-75% abnormalities – small airway Fx (ensure adequate curve before interpreting numbers)
  - MTC – not adequate sens/spec
  - Asthma Exercise Challenge
    - 80% HHR x 8 mins with FEV1 at 15, 30, 60 mins post
    - FEV1 decrease by 15% or more is positive
  - Eucapnic voluntary hypercapnea, hypertonic (4.5% saline) and mannitol
- Disposition (case by case)
  - CDSM/AUMB based on cause, investigations
  - PFT, HRCT (insp, expiration)
  - 'Deserved' with normal f/u invs – potential RTD
  - 'Undeserved' or persistent sx/pathology – likely unfit diving

PBT of Descent (Lung Squeeze)

- Risk with deep breath hold diving
  - As descend, ambient pressure compresses lungs (Boyle's law, gas is compressible)
    - At surface, hold ~6L
    - At 6 ATA (50 msw) ~1L
    - Breath hold divers go much deeper than this! >150msw
  - Lungs begin to fill with fluid and blood, now more liquid and less compressible