ONE LUNG ANAESTHESIA

N R BURRI
a) What are the indications for ‘one lung ventilation’ (OLV)? (30%)
b) How can the risks associated with lung resection be quantified preoperatively? (30%)
c) How would you manage the development of hypoxaemia during OLV? (40%)
WHAT SURGERIES REQUIRE IT?

- Lung
- Oesophagaeal
- Mediastinal
- Spinal

INDICATIONS

- Absolute
- Relative
ABSOLUTE INDICATIONS

**ISOLATION**
1. INFECTION
2. HAEMORRHAGE

**VENTILATION**
1. BRONCHOPLEURAL FISTULA
2. TRACHEOBRONCHIAL TREE DISRUPTION
3. GIANT UNILATERAL LUNG CYST
4. SURGERY ON MAIN BRONCHI

**LAVAGE**
PULMONARY ALVEOLAR PROTEINOSIS
RELATIVE INDICATIONS

ACCESS

1. THORACIC AORTIC ANEURYSM
2. PNEUMONECTOMY
3. LOBECTOMY
4. OESOPHAGECTOMY

NON THORACIC

SPINE SURGERY
LUNG SURGERIES / CANCER

- Lobectomies: 2400/yr 2-4% mortality
- Pneumonectomies: 500/yr 6-8% mortality

3 PREREQUISITES FOR LUNG CANCER SURGERY:
1) Non small cell tumour (Squamous / Adeno).
2) Surgically resectable
3) Patient consent

BRONCHOSCOPY
CT
PET
MEDIASTINOSCOPY
TESTS OF PULMONARY FUNCTION

• Basic Spirometry
• Diffusion Capacity
• V/Q scan
• Prediction of Post Op Function
• Exercise Capability
• SpO₂ & ABGs

6 minute walk test
Shuttle walk test
CPET
BASIC SPIROMETRY:

- FEV₁
- FVC
- FEV₁ / FVC ratio
- Flow rates: Peak, mid, end expiratory
- RV

FEV₁ > 1.5L for Lobectomy & > 2L for Pneumonectomy
VITALOGRAPH: NORMAL

FEV₁ = 4.5
FVC = 5.5
FEV₁ % = 80%
AIRFLOW OBSTRUCTION

• DEFINED: $\text{FEV}_1 < 80\% ~ \& ~ \text{FEV}_1 / \text{FVC} < 0.7$

• SEVERITY OF COPD: (Based on $\downarrow \text{FEV}_1$)

  Ratio $< 0.7 \text{ FEV}_1 > 80\% ........ \text{Stage 1}$
  50–80%: Mild......................... \text{Stage 2}
  30–49%: Moderate............... \text{Stage 3}
  $< 30\%$ : Severe...................... \text{Stage 4}
NORMAL FLOW VOLUME LOOP

x-axis = volume in liters
y-axis = flow in liters/sec

ABC = inspiratory part of the loop (oval);
ACD = expiratory part of the loop (triangular);
ABCD = muscle dependent part of the loop;
DA = effort (muscle) independent part of the loop;
AC = vital capacity;
CD = peak expiratory flow (PEFR).
OBSTRUCTIVE & RESTRICTIVE PATTERNS:

OBSTRUCTIVE

RESTRICTIVE

SCOOPED OUT
VARIABLE OBSTRUCTION:

EXTRA THORACIC

INTRA THORACIC

VC PALSY, ET GOITRE

TUMOUR
DIFFUSION CAPACITY

• Amount of CO taken up by lung in unit time
• Expressed as DLCO: \( \text{mmol/kPa/mt} \)
• Alveolocapillary function
• Corrected for alv. Vol. = Transfer coefficient
• \( KCO = \text{mmol/kPa/mt/litre} \)
V/Q SCAN

• % Function of each lung
• **V**: Radioactive Xenon 133: Inhalation
• **Q**: Radiolabelled Technetium 99: IV
• **Uptake**: Gamma camera & Computer
PREDICTING POST OP LUNG FUNCTION

BASIC SPIROMETRY & FEV₁

Ex: FEV₁ is 1.6 Ltr & 80% predicted

RUL = 3 segments (Both lungs = 19)

ppo FEV₁ = 1.6 x 16/19 = 1.35 litres

80% x 16/19 = 67%

V/Q scan:

Pneumonectomy: Pre op FEV₁ x % RA non op lung

Lobectomy: Expected loss of function
EXERCISE CAPACITY

• 6 minute walk test
• Shuttle walk test
• CPET (Cardio Pulmonary Exercise Test)
RELEVANCE OF THE TESTS

• FEV$_1$ > 80%, > 2 L Pneumonectomy
• FEV$_1$ > 1.5 L Lobectomy
• Flights of stairs: 3 = > 1.7 FEV$_1$ and 5 = > 2L FEV$_1$

• DLCO < 60% increased mortality
• DLCO < 80% increased complications

• ppoFEV$_1$: 0.7 – 0.8 L advisable post lung resection
• Product of % ppoFEV$_1$ & %DLCO = 1650 !!!!!!

• VO$_2$ Max (ml/kg/mt)
  > 20 No risk (5 Flights of stairs)
  < 15 Increased risk
  < 10 40 – 50% mortality (< I Flight of stairs)
PRE OP EVALUATION
BEFORE LUNG RESECTION

Routine Lung Function Tests

FEV1 < 1.5 litre (Lobectomy)
< 2.0 litre (pneumonectomy)

Quantitative Lung Scan

% ppo FEV1 < 40%
% ppo TLCO < 40%

Exercise Testing

VO₂ max < 15ml kg⁻¹ min⁻¹

Consider other options

FEV1 > 1.5 litre suitable for lobectomy
FEV1 > 2.0 litre suitable for pneumonectomy

SURGERY

% ppo FEV1 > 40%
% ppo TLCO > 40%

VO₂ max > 15ml kg⁻¹ min⁻¹
PRE OPERATIVE EVALUATION
BEFORE LUNG RESECTON

- **ROUTINE PFT**
  - FEV$_1$ > 1.5 L: Lobectomy
  - FEV$_1$ > 2.0 L: Pneumonectomy

- **V/Q Scan**
  - ppo FEV$_1$ > 40%
  - ppo TLCO > 40%

- **CPET**
  - VO$_2$ max > 15ml/kg/mt

**FIT FOR SURGERY**
Guidelines on the Radical Management of Patients with Lung Cancer

British Thoracic Society and the Society for Cardiothoracic Surgery in Great Britain and Ireland
PHYSIOLOGY OF OLA
FACTORS TO CONSIDER

• Lateral Decubitus position
• Open chest
• Collapse of non dependent lung: Shunt
LATERAL DECUBITUS POSITION

• Gravity determined blood flow
• 60% flow to the dependent lung
• Preferential ventilation of Non dependent lung
• ↓ compliance and FRC of Dependent lung
• Elevated diaphragm

V/Q MISMATCH
OPEN CHEST

- ↑ compliance of Non dependent lung
- ↑ dead space
- ↑ shunt
- ↑ alveolar arterial oxygen gradient
COLLAPSE NON DEPENDENT LUNG

- Obligatory shunt due to non ventilation
- OLA = 50% shunt in theory

Shunt reduction:
- Gravity dependent blood flow
- 60% blood flow to dependent ventilated lung
- Regional HPV:
  - Onset: Seconds / Plateaus: 15mts / Max: 4 hrs
  - (Hypoxic Pulmonary vasoconstriction)
V/Q RELATIONSHIP

A. S/V

B. IPPV Both lungs.

C. IPPV One Lung
FACTORS AFFECTING HPV & PULMONARY BLOOD FLOW

- Inhaled agents: (< 1 MAC minimal)
- IV agents: No effect

- Vasodilators: Inhibit HPV
- Vasoconstrictors: Constriction in ventilated lung too

- $\text{FiO}_2$: Increase reduces shunt (Flow diversion)
- PEEP: Raises PVR / Increases shunt
CONDUCT OF OLA
AIMS

- ↓ airway irritability and reflexes
- Avoid inhibition of HPV
- Maintain haemodynamics

- GA with Controlled ventilation
- Agents with rapid offset
- TIVA
- GA with Thoracic Epidural Analgesia/PVB
MONITORING

• Routine
• CVP & IBP (same side)
• PV Loops
LUNG ISOLATION METHODS

- Double Lumen Tube
- Bronchial blocker (Arndt / Cohen)
- Single lumen endobronchial intubation
ROBERTSHAW & MALLINCKRODT
DLTs
ROBERTSHAW vs MALLINCKRODT

ROBERTSHAW

CONSTRUCTION
• Coated rubber Disposable
• Red rubber Reusable
• Blue bronchial limb & cuff

SIZES
• R & L
• ES, S, M & L

FEATURES
• Bite block @ T & B limb meet
• Longer slot in R bronchial cuff 21mm

CLINICAL USE
• Bulky, easy to use less likely to move
• Less easy to manipulate with FOS

MALLINCKRODT

CONSTRUCTION
• Disposable PVC & LPHV cuff design
• Blue bronchial limb & cuff
• Radio opaque markings

SIZES
• R & L
• 35 37 39 41 & 28 Left sided

FEATURES
• Variable depths of insertion
• Length markers on the side of the tube
• Small RUL ventilation

CLINICAL USE
• Not as stable as Robertshaw after insertion
• Malleable tubes useful for “railroading over FOS & Easier to use with FOS
• Standard scope over 35 F
Right DLT

- Tracheal limb
- Pilot balloon-tracheal cuff
- Tracheal ventilation lumen for left lung
- Bronchial limb
- Pilot balloon-bronchial cuff
- Bronchial curve
- Oropharyngeal curve
- Tracheal cuff
- Ventilation slot for upper right lobe
- Bronchial cuff
- Endobronchial ventilation lumen to middle and lower lobes
DLT-INSERTION DEPTH & SIZE

DEPTH OF INSERTION:
170cm tall: insertion depth: 29cm.
(For every +/- 10cm: +/- 1cm)

TRACHEAL WIDTH AND TUBE SIZE:
• 18mm = 41F
• 16mm = 39F
• 15mm = 37F
• 14mm = 35F
INSERTION OF LEFT DLT (BLIND)
INSERTION OF LEFT DLT (FOB GUIDED)
OPTIMAL POSITION - LEFT DLT
OPTIMAL POSITION - RIGHT DLT
DLT - MALPOSITIONS

• Too far out
• Too far in
• Opposite side insertion
HYPOXAEMLA DURING OLA

- Increase FiO$_2$ to 1.0
- Check DLT (Cuff Hernia / block / Kink)
- Check anaesthetic circuit & connections
- Check DLT position with FOS
- Ensure adequate cardiac output
HYPOXAEMIA DURING OLA

• Insufflate $O_2$ to non ventilated lung.
• Apply CPAP to non ventilated lung: 5-10cmH$_2$O.
• Apply PEEP to ventilated lung
• Intermittent insufflation of non ventilated lung
• Clamping appropriate PA to reduce shunt.
POST OPERATIVE CARE:

CESSATION OF OLA
• Suction before resuming 2 lung ventilation
• Inflate collapsed lung fully
• Perform Post Op CXR

COMPLICATIONS:
Sputum retention
Collapse Consolidation Oedema

PREVENTION:
Adequate pain relief: TEA / PVB
Ability to cough

HDU CARE
• Oxygen therapy
• Pain relief
• Physiotherapy
• Inhalation Therapy
• Chest drain & fluid balance.
a) What are the indications for ‘one lung ventilation’ (OLV)? (30%)
b) How can the risks associated with lung resection be quantified preoperatively? (30%)
c) How would you manage the development of hypoxaemia during OLV? (40%)