One Lung Ventilation in Obese patients

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Lung isolation techniques are used in thoracic, esophageal, vascular, and nonthoracic surgical setting in the perioperative period.

Method current use to achieve lung isolation:
(1) Double lumen tube (DLT) technology (left and right double lumen endotracheal tubes)
(2) Bronchial blocking technology
Perioperative hypoxemia during OLV is not uncommon → caused by intrapulmonary shunt (this is related to collapse of the non-dependent lung and increased atelectatic areas in the dependent lung).

Therefore the primary aim during OLV → to provide adequate oxygenation and CO2 elimination, while the potential harmful effects of ventilatory strategy were initially disregarded.

The use of high VT and high airway pressures during OLV → increased risk of post pneumonectomy ARDS

The use of low VT → better outcome after thoracic surgery and less lung water content → 4-6 mL/kgPBW
<table>
<thead>
<tr>
<th>Device</th>
<th>Indication</th>
<th>Tube Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-sided DLT</td>
<td>Majority of elective left or right thoracic surgical procedures</td>
<td>Can be determined by measurements of the tracheal width from chest radiograph</td>
</tr>
<tr>
<td>Right-sided DLT</td>
<td>Left bronchus-distorted anatomy Left pneumonectomy</td>
<td></td>
</tr>
<tr>
<td>Univent® blockers</td>
<td>Selective lobar blockade Difficult airways</td>
<td></td>
</tr>
<tr>
<td>WEB® blockers</td>
<td>Critically ill intubated patient who requires lung isolation Selective lobar blockade Nasotracheal intubation</td>
<td>Standard endotracheal tube at least 8.0 mm ID</td>
</tr>
<tr>
<td>Fogarty occlusion catheter</td>
<td>Critically ill intubated patient who requires lung isolation Small bronchus Nasotracheal intubation</td>
<td>Standard endotracheal tube at least 6.0 mm ID</td>
</tr>
</tbody>
</table>

DLT = double-lumen tube; WEB = wire-guided endobronchial blocker; ID = inside diameter.
Conversion Measurements of Tracheal Widths Based on Chest Radiograph and Bronchial Diameter Measurements Based on Computed Tomography Scan of the Chest and the Predicted Left-sided Double-lumen Endotracheal Tube Size

<table>
<thead>
<tr>
<th>Measured Tracheal Width (mm)</th>
<th>Measured Bronchial Diameter (mm)</th>
<th>Left-sided DLT (French)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥18</td>
<td>≥12</td>
<td>41</td>
</tr>
<tr>
<td>≥16</td>
<td>12</td>
<td>39</td>
</tr>
<tr>
<td>≥15</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>≥14</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>≥12.5</td>
<td>&lt;10</td>
<td>32</td>
</tr>
<tr>
<td>≥11</td>
<td>NA</td>
<td>28</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
<td>26</td>
</tr>
</tbody>
</table>

DLT = double-lumen tube; NA = not applicable; has not been investigated. Data from Brodsky et al.,
Hannallah et al., and Fitzmaurice and Brodsky.
“Margin of Safety”

(A) Univent® bronchial blocker; the optimal position of the Univent ® in the left mainstem bronchus.
(B) Wire-guided endobronchial blocker (WEB); the optimal position of the WEB blocker in the left mainstem bronchus.
Techniques of OLV

- There are 3 techniques in OLV:
  - Double-Lumen Endotracheal Tube (DLT)
  - Single-Lumen Endotracheal Tube (SLT)
  - Bronchial Blockers (BB)

- Usually used in practice → DLT
  
- Usually used in obese patients → BB
Bronchial blockers
EZ-Blockers
EZ-Blocker is only BB that can be placed “blindly” without bronchoscopy

- Used in very small ETT (no pediatric FOB available)
- During emergencies (“blind” without FOB)
- When airway cannot be visualized ie hemorrhage

Multiport Adaptor
- Minimal risk of dislocation
- Same EZ-Blocker can isolate either lung
- Allows either lung to be collapsed and re-expanded (sequential isolation) during surgery

(A) View of the tracheal carina, towards the left side the endobronchial lumen is visible, the left main bronchus with the outer surface of the endobronchial balloon is seen below tracheal carina.

(B) View of the 3 orifices of the right upper lobe bronchus (apical, anterior, and posterior segments).

(C) Clear view of the left upper and left lower bronchus.
The DLT vs BB “Controversy”


The DLT vs BB “Controversy”

- Campos et al found both technique (DLT or BB) produce similar results in term the incidens of:
  - Failed first attempts
  - Malposition after achieving lateral decubitus position
  - Time to lung deflation or surgical exposure
Time to lung isolation (seconds)

Quality of lung collapse over time

Number of Repositions

- DLT or BB not in correct position fails to isolate the lung
  - Lung will re-expand and interfere with surgery
  - Inflated BB balloon in trachea obstructs ventilation to both lungs
  - Healthy non-operated lung can be contaminated

Favors DLT

- Displacement less frequent
- CPAP easily applied
- Allows suctioning before re-inflation of operative lung during surgery
- Used for operations on contra-lateral lung if main bronchus is obstructed
  - faster and easier to place - “blind” placement possible
  - more rapid lung deflation
  - sequential surgery
  - “split lung” ventilation in ICU

Favors BB

- Placed through ETT or LMA
- “Difficult airway” or when DLT impossible to use
- Can be used “in situ” ETT (no need to change to DL)
- Better when tube exchange dangerous, especially if postoperative ventilation needed
  - multiport adaptor allows ventilation during placement
  - less potential for serious airway trauma
  - allows selective lobar isolation
  - smaller airways and pediatrics
For most patients either a DLT or BB can be safely used - the choice is one of personal preference.

No significant differences in the quality of lung isolation.

Both have advantages in specific clinical situations.

Anesthesiologists should be skilled in both techniques.

OLV in obese patient

- Literatur mengenai OLV pada pasien obese masih langka
- Seiring meningkatnya angka obesitas, perlu di pahami mengenai OLV pada pasien obesitas
Why does it matter?

Because:
The prevalence of Obesity is increasing worldwide
What is a Difficult Airway? *

“...difficult airway .... situation in which an anesthesiologist experiences problems with (a) face mask ventilation and/or (b) tracheal intubation” **


• * <1993 “difficult airway” was called “difficult intubation”

• ** 2013 - difficulty with SGA placement/ventilation added
Difficult Airway

Obesity (mask ventilation, DL)

+  

OSA (MV, laryngoscopy)

+  

Thoracic Surgery (special tubes)
Why does it matter?

Because:
- Difficult air way access
  - short and redundant neck,
  - limited extension, and
  - Abundant fatty tissue on the neck, thoracic wall and abdomen
**Why does it matter?**

**Because:** There are physiological changes

<table>
<thead>
<tr>
<th>Physiological changes</th>
<th>Challenges for respiratory management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive oro-pharyngeal adiposity</td>
<td>Upper airway obstruction</td>
</tr>
<tr>
<td>Increased risk of pharyngeal collapse during sleep</td>
<td>Frequent sleep apnea/obesity hypoventilation syndrome</td>
</tr>
<tr>
<td>Decreased compliance (chest wall &gt; lung)</td>
<td>Decreased compliance during mechanical ventilation</td>
</tr>
<tr>
<td>Increased airway resistance</td>
<td></td>
</tr>
<tr>
<td>Increased work of breathing</td>
<td></td>
</tr>
<tr>
<td>Increase in resting VO₂</td>
<td>Frequent hypoxemic events</td>
</tr>
<tr>
<td>Decrease in FRC and EELV</td>
<td>Atelectasis</td>
</tr>
<tr>
<td>FRC &lt; closing capacity</td>
<td>Rapid oxygen desaturation</td>
</tr>
<tr>
<td>Small airway closure</td>
<td></td>
</tr>
<tr>
<td>Alveolar collapse</td>
<td></td>
</tr>
<tr>
<td>Ventilation–perfusion (V/Q) mismatch</td>
<td></td>
</tr>
<tr>
<td>Increased PA-aO₂, Decreased PaO₂</td>
<td></td>
</tr>
</tbody>
</table>

(EELV = End-expiratory lung volume; FRC = Functional residual capacity; PaO₂ = Arterial partial pressure of oxygen; PA-aO₂ = Alveolar to arterial partial pressure of oxygen; VO₂ = Oxygen consumption; V/Q = Ventilation/perfusion.)
Recommendations for intraoperative ventilation of obese patients

**Ventilatory mode**
VCV = PCV
PCV-VG may be helpful

**Airway pressure**
P/Pl≤30cmH₂O as suggested reasonable target

**PEEP**
Optimal fixed PEEP unknown
PEEP titrated to maximum Cdyn, PaO₂, or SpO₂ seems reasonable
Combined with recruitment maneuvers, more efficient in reducing atelectasis and improving oxygenation. Prepare for possible hypotension

**Tidal volume**
6-8 mL/kgPBW as suggested reasonable target

**Respiratory rate**
Titrated for normocapnia

**FiO₂**
Minimize to assure SpO₂≥90%

**Perioperative adjuvant maneuvers**
Position: head-up or reverse Trendelenburg
Encourage deep breathing: incentive spirometry, early mobilization
Consider perioperative CPAP/BiPAP (pre-induction, postoperative)
Minimize respiratory depressants, consider regional technique
Prepare for possible difficult airway management

(Cdyn=Dynamic compliance; BiPAP=Bilevel positive airway pressure; CPAP=Continuous positive airway pressure; FiO₂=Inspiratory fraction of oxygen; PaO₂=Arterial oxygen partial pressure; PBW=Predicted body weight; PCV=Pressure controlled ventilation; PCV-VG=Pressure controlled ventilation volume guaranteed; PEEP=Positive end-expiratory pressure; PIP=Peak inspiratory pressure; P/Pl=Plateau airway pressure; SpO₂=Peripheral saturation of oxygen by pulse oximetry; VCV=Volume controlled ventilation)
Lung isolation in the morbidly obese patient: a comparison of a left-sided double-lumen tracheal tube with the Arndt® wire-guided blocker

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Conclusions. There is no overall advantage of one device over the other during intubation of the morbidly obese patient.
Essential principles of ventilator management in obese patient seems **not to be different** from the choices used in non-obese patient.

**Past**: Vt of 10 – 12 ml/kgPBW during OLV was recommended to maintain gas exchange and normalize arterial oxygen and carbon dioxide values (study by Katz).

**Fact**: perioperative hypoxemia during OLV is not common, which results from an intrapulmonary shunt related to collapse of the non-dependent lung and increased atelectatic areas in the dependent lung.
Obese patient tend to suffer from collapse due to their decreased chest wall compliance.

The setting of optimal PEEP level to keep lung open may be crucial; inadequate PEEP level cannot prevent alveolar re-collapse after an alveolar recruitment maneuver.

Attention while performing recruitment maneuver:
- Temporary desaturation
- Decreased preload
- Hypotension
- Arrhythmias
- Barotrauma
PEEP is crucial to treat and prevent atelectasis and hypoxemia.

Best level of PEEP during OLV remains unclear.

Ferrando et al. : individualized PEEP in a PEEP Decremental Trial resulted in better oxygenation and lung mechanics after an alveolar recruitment maneuver than administering a standardized 5 cmH2O of PEEP.
Alveolar recruitment strategies during OLV → better oxygenation and decrease dead-space variables

Excessive airway pressure → increase pulmonary vascular resistance and shift blood flow to the non-dependent lung

Michele et al. found that:

- 5-10 cmH2O PEEP → improved oxygenation and continuous lung volume recruitment
- 15 cmH2O PEEP → overdistention and increased shunt

Although PEEP is crucial to treat and prevent atelectasis → HAVE TO BE CAREFUL when used
Position and PaO$_2$ During OLV

Airway Injury

Sore Throat

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Events</th>
<th>Total</th>
<th>DLTs</th>
<th>Total</th>
<th>Weight</th>
<th>Odds Ratio M–H, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knoll 2006</td>
<td>8</td>
<td>27</td>
<td>3</td>
<td>29</td>
<td>12.8%</td>
<td>3.65 [0.85, 15.60]</td>
</tr>
<tr>
<td>Mourisse 2013</td>
<td>11</td>
<td>45</td>
<td>5</td>
<td>47</td>
<td>23.3%</td>
<td>2.72 [0.86, 8.58]</td>
</tr>
<tr>
<td>Ruetzler 2011</td>
<td>7</td>
<td>20</td>
<td>8</td>
<td>19</td>
<td>33.6%</td>
<td>0.74 [0.20, 2.70]</td>
</tr>
<tr>
<td>Zhong 2009</td>
<td>13</td>
<td>30</td>
<td>17</td>
<td>90</td>
<td>30.3%</td>
<td>3.28 [1.34, 8.03]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>122</td>
<td>185</td>
<td>100%</td>
<td>39</td>
<td>33</td>
<td>2.34 [1.34, 4.11]</td>
</tr>
</tbody>
</table>

Total events: 39

Heterogeneity: Chi² = 4.01, df = 3 (P = 0.26); I² = 25%
Test for overall effect: Z = 2.97 (P = 0.003)

Hoarseness

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Events</th>
<th>Total</th>
<th>DLTs</th>
<th>Total</th>
<th>Weight</th>
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<td>Knoll 2006</td>
<td>12</td>
<td>27</td>
<td>7</td>
<td>29</td>
<td>23.6%</td>
<td>2.51 [0.80, 7.86]</td>
</tr>
<tr>
<td>Mourisse 2013</td>
<td>11</td>
<td>45</td>
<td>3</td>
<td>47</td>
<td>14.0%</td>
<td>4.75 [1.23, 18.35]</td>
</tr>
<tr>
<td>Ruetzler 2011</td>
<td>9</td>
<td>20</td>
<td>9</td>
<td>19</td>
<td>32.0%</td>
<td>0.91 [0.26, 3.20]</td>
</tr>
<tr>
<td>Zhong 2009</td>
<td>13</td>
<td>30</td>
<td>17</td>
<td>90</td>
<td>30.4%</td>
<td>3.28 [1.34, 8.03]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>122</td>
<td>185</td>
<td>100%</td>
<td>45</td>
<td>36</td>
<td>2.55 [1.47, 4.41]</td>
</tr>
</tbody>
</table>

Total events: 45

Heterogeneity: Chi² = 3.69, df = 3 (P = 0.30); I² = 19%
Test for overall effect: Z = 3.33 (P = 0.0009)


Volume Controlled One-Lung Ventilation
(Controversy 2006)

Protective Low Volume Ventilation
Slinger P. Pro: Low tidal volume is indicated during one-lung ventilation. Anesth Analg. 2006;103:268-70

Conventional High Volume Ventilation
Gal TJ. Con: Low tidal volumes are indicated during one-lung ventilation. Anesth Analg. 2006;103:271-3
“Protective OLV” minimizes VALI

Volume controlled OLV
Low tidal volume (4-6 ml/kg/IBW)
Dependent-lung PEEP
Lowest FiO₂ (to maintain SpO₂)
Recruitment maneuvers dependent lung
Low ventilatory pressure

“Conventional” OLV (VT 10 ml/kg, FiO2 1.0 + 0 PEEP) 
vs
“Protective” OLV (VT 6 ml/kg, FiO2 0.5. + 5 cmH20 PEEP)

PaO2 and PaO2/FiO2 higher in conventional group
Interleukin-6 and malondialdehyde increased in both groups/No differences between groups
No differences in post-operative abnormalities or CXR

NO ADVANTAGE TO “PROTECTIVE” OLV

OLV is a separation lung technique usually used in thoracic surgery.

Obese patients (moreover in morbidly obese patients) have higher risk in airway management including OLV because there are physiological changes.

There are 3 techniques in OLV, but the most commonly used in obese patient is BB or SLT with BB.

During OLV in obese patients, anaesthesiologists have to pay attention to VT, pressure, and PEEP.

Other considerations are: fluid, positions and volume control.
thank you