Obesity, Obstructive Sleep Apnea (OSA), and Thoracic Anesthesia

Jay B. Brodsky, MD
Professor (Anesthesiology)
Stanford University Medical Center
Stanford, California
Jbrodsky@stanford.edu

February 25, 2018

Disclosure
Ambu, DK
Airway Management Advisory Board

Goals and Objectives

• Learn the advantages and disadvantages of bronchial blockers (BB) and double-lumen tubes (DLT). Which is the best lung separation technique for your patient.
• Use of airway exchange catheters (AEC) for thoracic patients with difficult airways.
• Identify and manage obese thoracic surgical patients with Obstructive Sleep Apnea (OSA).
• Select the best technique(s) for postoperative pain management for the obese thoracic surgical patient.

INDICATIONS

LUNG SEPARATION/ISOLATION (“absolute”)
Protect healthy lung hemorrhage, empyema, lung lavage
Special procedures broncho-pleural fistula, bronchial disruption, giant bullae or cysts, broncho-pulmonary lavage

SELECTIVE LUNG COLLAPSE (“relative”)
Improve Surgical Exposure
Thoracic Surgery: Lung and mediastinum
General Surgery: Esophagus
Cardiac Surgery: Heart and great vessels
Orthopedic Surgery: Spinal column – thoracic approach
Neurosurgery: Nerves and sympathetic chain

Lung Isolation and Selective Collapse

Double-lumen tube Bronchial blocker

The DLT vs BB “Controversy”

• Neustein SM. Pro: Bronchial blockers should be used routinely for providing one-lung ventilation. J Cardiothorac Vasc Anesth (2015) 29: 234-6
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.

Once the trachea is intubated lung collapse is **ALWAYS** possible!

**Single-lumen Tube (ETT) or SGA (LMA)**

- Bronchial Blocker (BB)
- Double-lumen Tube (DLT)

---

**Bronchial Blockers:** Advantages

- Can be used with any endotracheal tube (oral, nasal, tracheostomy) or LMA
- Not necessary to change to ETT if potential or planned postoperative ventilation (“difficult airway”)
- Allows selective lobar blockade
- ETT fits in very small adult airways; technique of choice in pediatrics

---

**Fiberoptic Bronchoscopy**

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


EZ-Blocker is only BB that can be placed “blindly” without bronchoscopy

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


Bronchial Blocker - Contraindications

• Bronchial Obstruction
  Extrinsic – tumor, nodes, aortic aneurysm (left)
  Intrinsic – tumor, stenosis
• Procedure on Bronchus
  Broncho-pleural fistula, Sleeve resection, Single-lung transplant

DLT can always be positioned in the opposite bronchus

Tracheal Or Carinal Origin Of Right-upper Lobe Bronchus
(5% population)

BB cannot collapse entire right lung

Double-lumen Tubes

• Two tubes molded together
• Short lumen ends in the trachea
• Longer lumen ends in either the right or left main bronchus

(1950) Carlens (1962) Robertshaw
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)

Double-lumen Tube – Laryngoscopy

Glidescope


Glidescope


Blue bronchial cuff immediately below carina in main-bronchus
No obstruction of upper-lobe bronchus


Time to lung isolation (seconds)


Quality of lung collapse over time


Number of Repositions


DLT Bronchial Blocker

- Increased risk of serious airway (tracheal and/or bronchial) trauma due to rigidity and diameter of DLT
- Less risk of trauma since BB inserted through a standard ETT


Airway Injury

Sore Throat

Postoperative Ventilation - **Double-lumen Tube**

- Ventilate with DLT or Exchange for ETT
- Deflate bronchial cuff or Deflate both cuffs
- Pull DLT above carina
- Re-inflate tracheal balloon

**Lubricate the AEC**

Test the fit between the AEC and tube before attempting tube exchange

**Laryngoscopy lifts supraglottic tissue** - facilitates tube passage at the glottis

If passage is obstructed, rotate the tube 90° counter-clockwise to avoid arytenoid or vocal cord impingement

**AEC with relatively large o.d. / DLT with relatively small i.d.**

AEC with relatively large o.d. / DLT with relatively small i.d.

**Never advance against resistance**
Do not insert past 25-26 cm at lips – risk of airway laceration

Have rescue jet ventilation available if the airway is lost

Jay B. Brodsky, MD

Obesity, OSA, and Thoracic Anesthesia
Conclusion Of Surgery - Bronchial Blocker

- Withdraw BB
- Ventilate through ETT

Favors DLT

- Displacement less frequent
- CPAP easily applied
- Allows suctioning before re-inflation of operative lung
- Lungs can be re-expanded and collapsed 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
- Technique when lung isolation absolutely essential (eg bronchopulmonary lavage)
- "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
- Small airways and pediatrics

Obstructive Sleep Apnea (OSA)

- Increased sensitivity to respiratory depressant effects of anesthetics and opioids
- Increased sensitivity to laryngo-pharyngeal dilator muscle tone to anesthetics and opioids

“Difficult airway” and OSA

70 - 90% of all patients scheduled for bariatric surgery have OSA
- Increased amount of pharyngeal tissue
- Obstruction during mask ventilation
- Increased tracheal intubation and extubation difficulties

Polysomnography (PSN) - “Sleep Study”

- # Desaturations (SpO2 > 4%) / hr
- Arousal Index (AI) - clinically or by EEG
- Apnea-Hypopnea Index (AHI) (events/hr)
  - Apnea - no airflow >10s despite continued efforts to breath against a closed airway
  - Hypopnea - airflow <50% for >10s
  - Respiratory Disturbance Index (RDI)
  - AHI = AI

National Sleep Study (Polysomnography) Procedure Pricing Summary

<table>
<thead>
<tr>
<th>National Average Price</th>
<th>National Median Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1,650</td>
<td>$1,625</td>
</tr>
<tr>
<td>$3,625</td>
<td>$3,635</td>
</tr>
</tbody>
</table>

Sleep Study (Polysomnography) Cost Averages Around the Country

- Phoenix AZ: $2,410
- Houston TX: $2,470
- Seattle WA: $3,250
- Denver CO: $2,470
- Chicago IL: $2,470
- Los Angeles CA: $3,250
- San Francisco CA: $2,470
- New York NY: $2,470
- Boston MA: $2,470

- Washington DC: $2,470
- Atlanta GA: $2,470
- Dallas TX: $2,470
- San Diego CA: $2,470
- Philadelphia PA: $2,470
- Charlotte NC: $2,470

- Orlando FL: $2,470
- Miami FL: $2,470
- Minneapolis MN: $2,470
- St Louis MO: $2,470
- Columbus OH: $2,470
- Seattle WA: $2,470
- Los Angeles CA: $3,250
- Houston TX: $2,470
- Denver CO: $2,470
- Phoenix AZ: $2,470
- Chicago IL: $2,470
- San Francisco CA: $2,470
- New York NY: $2,470
- Boston MA: $2,470
- Washington DC: $2,470
- Atlanta GA: $2,470
- Dallas TX: $2,470
- San Diego CA: $2,470
- Philadelphia PA: $2,470
- Charlotte NC: $2,470
- Orlando FL: $2,470
- Miami FL: $2,470
- Minneapolis MN: $2,470
- St Louis MO: $2,470
- Columbus OH: $2,470
- Seattle WA: $2,470
- Los Angeles CA: $3,250
- Houston TX: $2,470
- Denver CO: $2,470
# American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea.

**PRACTICE GUIDELINES FOR THE PERIOPERATIVE MANAGEMENT OF PATIENTS WITH OBSTRUCTIVE SLEEP APNEA**

*Anesthesiology* 2006; 104:1081-93

<table>
<thead>
<tr>
<th>A. Clinical signs and symptoms suggesting the possibility of OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Predisposing physical characteristics</td>
</tr>
<tr>
<td>a. BMI 35 kg/m² (95th percentile for age and gender)</td>
</tr>
<tr>
<td>b. Neck circumference 17 inches (men) or 16 inches (women)</td>
</tr>
<tr>
<td>c. Craniofacial abnormalities affecting the airway</td>
</tr>
<tr>
<td>d. Anatomical nasal obstruction</td>
</tr>
<tr>
<td>e. Tonsils nearly touching or touching in the midline</td>
</tr>
</tbody>
</table>

---

**STOP-BANG Questionnaire for Obstructive Sleep Apnea (OSA)**

<table>
<thead>
<tr>
<th>SNORE:</th>
<th>Do you snore loudly? (Snoring heard through closed door)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIRED:</td>
<td>Do you feel tired, sleepy, fatigued, during daytime?</td>
</tr>
<tr>
<td>OBSERVED:</td>
<td>Has anyone seen you stop breathing during sleep?</td>
</tr>
<tr>
<td>BLOOD PRESSURE:</td>
<td>Do you have or are you being treated for high blood pressure?</td>
</tr>
<tr>
<td>BMI:</td>
<td>Is your BMI &gt; 35kg/m²?</td>
</tr>
<tr>
<td>AGE:</td>
<td>Are you older than 50?</td>
</tr>
<tr>
<td>NECK CIRCUMFERENCE:</td>
<td>Is your neck circumference &gt; 40 cm? Size 16 collar</td>
</tr>
<tr>
<td>GENDER:</td>
<td>Are you a male?</td>
</tr>
</tbody>
</table>

+3 probable OSA<br>+5 high likelihood OSA


---

**“Safe” Sleep Disordered-Breathing Anesthetic Guidelines**


- Avoid general anesthesia and sedatives where possible
- Use short acting opioid agents
- Use “depth of anesthesia” monitors to keep agents at minimum
- Use neuromuscular monitoring to maintain block and ensure complete reversal
- Maximal use of local anesthetics and multimodal opioid-sparing agents for postoperative analgesia
- Maintain the head-up position and monitor oxygen saturation postoperatively

---

**“Restrictive” fluid management in thoracic surgery**

(1984) *Post-Pneumonectomy Pulmonary Edema (PPE)*

10 cases of fatal acute lung injury following pneumonectomy

"....the most important thing we (the surgeon) can do in terms of recognizing this problem (PPE) is to ... watch our anesthetists as they start loading the patient up with fluids ... don’t let them drown the patient”


---

**Acute Lung Injury (ALI) - risk factors**

- Preoperative alcohol abuse (p < 0.0001)
- High intraoperative ventilatory pressure (p = 0.001)
- Extent of lung resection (p = 0.002)
  (pneumonectomy 7.4% vs pulmonary resection 1.9%)
- “Excessive” fluid infusion (p = 0.023)


---

**Consensus Statement:**

- Society for Obesity and Bariatric Anaesthesia
- British Association of Day Surgery
- Obstetric Anaesthetist’s Association
- Royal College of Anaesthetists
- Resuscitation Council (UK)
- Difficult Airway Society
- Association of Anaesthetists of Greater Britain & Ireland
Possible Mechanisms PPE

- Ischemia-reperfusion injury
- Oxidative stress injury
- Pulmonary capillary stress failure
- Ventilator-induced acute lung injury (VALI)

Hypotension associated with TEA....is largely due to an unmasking of underlying hypovolemia......and can usually be alleviated with appropriate fluid replacement.”

Restrictive (limited) fluid management for thoracic surgical patients results in hypovolemia and impaired tissue perfusion

Risk of acute kidney injury after lung resection is 6-24%

GOAL Directed (GD) Fluid Management

Monitor for Inadequate Perfusion

- Non-invasive blood pressure
- Dynamic A-line BP and respiratory variability
- Pulse oximetry respiratory variability
- Stroke Volume Variation (SVV)
- Urinary output
- CVP, PAP, TEE, CI
- Intraoperative lab data
  - ABG, Lactate
  - Metanalysis

GOAL Directed (GD) Fluid Replacement

Meta-analysis 23 GD trials (non-thoracic surgery)
GD vs Liberal or vs restrictive fluid therapy
GD groups all received more fluid than restrictive groups

GD Replacement (using hemodynamic parameters)

- Less pneumonia
- Less renal complications
- Earlier return of bowel movement
- Shorter hospital stay
**Fluid Guidelines for Thoracic Surgery**

Use **Goal Directed** fluid replacement

Monitor hemodynamic parameters (ABG)

- **Crystalloids** – limit average adult to < 2.0 L during procedure (< 3.0 L during POD #1)
- **Colloids** – if additional fluid needed to maintain cardiovascular stability and renal function (intra-operatively and post-operatively)
- **Blood** - replace blood loss with blood

If increased tissue perfusion needed give additional fluids based on GD data

---

**Ultrasound imaging used to measure depth to epidural space**

Ultrasound imaging used to measure depth to epidural space

> Ultrasound imaging used to measure depth to epidural space. The correlation between estimated and actual depth of the epidural space in obese parturients. Anesth Analg 2009; 108: 1876-81

---

**During epidural placement the frequency of (a) multiple attempts, (b) vascular cannulation, (c) “wet” tap, and (d) failed block increases with increasing BMI**

---

Jay B. Brodsky, MD

Obesity, OSA, and Thoracic Anesthesia

Epidural catheter can pull out >1 cm. Advance >4 cm into epidural space.


Epidural Analgesia

- Urinary retention
- Motor block – delays ambulation
- Nausea
- Hypotension – delays ambulation
- Pruritis
- Respiratory Depression
- Neurologic Injury
  - Trauma during placement
  - Epidural hematoma
  - Epidural abscess
- Hypotension
  - Delays ambulation
- Motor block
- Delays ambulation
- Respiratory Depression
- Failed block
- Dural Puncture
  - High block
  - Spinal headache


No evidence of major advantage for TEA
- TEA has rare (but serious) risks
- TEA only for high-risk patients

Recommend Intercostal nerve block (ICN) + opioid PCA + NSAIDs (multimodal analgesia)

Paravertebral Block (ICN block)

- Intercostal nerves are not enveloped by fascial sheath
- Also blocks sympathetic ganglia, posterior intercostal rams, nerves to costovertebral joints

Meta-analysis:

Paravertebral Block (PVB) vs Thoracic Epidural Analgesia (TEA)

Hypotension following thoracotomy

FAVORS PVB    FAVORS TEA

Postoperative Analgesia

Table 1. Comparison of the analgesic efficacy and side effects of paravertebral vs epidural blockade for thoracotomy - a systematic review and meta-analysis of randomized trials.

<table>
<thead>
<tr>
<th>Group</th>
<th>Paravertebral (PVB)</th>
<th>Epidural (Epi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain at 4-6 hrs</td>
<td>Pain at 24 hrs</td>
<td>Pain at 4-6 hrs</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>12.0 (2.5)</td>
<td>13.0 (3.0)</td>
<td>9.0 (1.5)</td>
</tr>
</tbody>
</table>


Do morbidly obese patients tolerate one-lung ventilation?

- In the lateral decubitus position?
- In the supine position?

One-Lung Ventilation

Table 2. Arterial Oxygen Tensions (Mean ± SD) in Group 1 (Abdominal) and Group 2 (Thoracic) Gastric Staging Patients

<table>
<thead>
<tr>
<th>Group</th>
<th>Preoperative</th>
<th>Intubation</th>
<th>Postoperative</th>
<th>Gastric Staging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>78.0 ± 2.0</td>
<td>75.0 ± 2.0</td>
<td>76.0 ± 2.0</td>
<td>76.0 ± 2.0</td>
<td></td>
</tr>
</tbody>
</table>

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 T.J. 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 cmH₂O 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


Position and PaO₂ During OLV

Obstructive Sleep Apnea