Regional anesthesia for the OSA patient
—
Is there a benefit and when should it be used?

Crispiana Cozowicz, MD

Nothing to disclose
OSA patients at increased risk for perioperative complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>OSA vs non-OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory failure</td>
<td>OR 2.43 p=0.003</td>
</tr>
<tr>
<td>Cardiac events</td>
<td>OR 2.07 p=0.007</td>
</tr>
<tr>
<td>ICU transfer</td>
<td>OR 2.46 p=0.006</td>
</tr>
</tbody>
</table>

Impact of Anesthesia Technique in OSA

Sleep Apnea and Total Joint Arthroplasty under Various Types of Anesthesia:
A Population-Based Study of Perioperative Outcomes

Sleep Apnea in OSA: Impact on Mechanical Ventilation, ICU stay, and LOS

Healthcare question:
- Association between type of anesthesia and perioperative outcomes in OSA

Population based analysis:
- Premier, national administrative database
- Claims data >640 US hospitals
- 30,024 OSA patients (ICD-9 code), 2006 – 2010
- GA 74%, NA 11%, GA/NA 15%

<table>
<thead>
<tr>
<th>Complications</th>
<th>NA vs GA</th>
<th>NA + GA vs GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined complications</td>
<td>OR 0.83 p=0.03</td>
<td>OR 0.89 p=0.03</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>OR 0.64 p&lt;0.0001</td>
<td>OR 0.64 p=0.0001</td>
</tr>
<tr>
<td>ICU</td>
<td>OR 0.43 p=0.0001</td>
<td>OR 0.67 p=0.0001</td>
</tr>
<tr>
<td>Prolonged length of stay</td>
<td>OR 0.75 p&lt;0.0001</td>
<td>OR 0.70 p&lt;0.0001</td>
</tr>
<tr>
<td>Increased cost</td>
<td>OR 0.88 p=0.04</td>
<td>OR 0.70 p&lt;0.0001</td>
</tr>
<tr>
<td>Pulmonary complications</td>
<td>OR 0.77 p=0.01</td>
<td>OR 0.77 p&lt;0.01</td>
</tr>
</tbody>
</table>
+ PNB → additional reduction in mechanical ventilation, ICU and LOS
Impact of Anesthesia Technique in OSA

Healthcare question
• Does anesthesia technique influence perioperative complications in OSA?

Retrospective observational analysis
• Institutional data: Thomas Jefferson University, PA
• 2005 – 2016 (ICD-9 code)
• 1,246 OSA matched to 3,738 non-OSA patients (1:3)

Complications | GA vs NA in OSA
--- | ---
Pulmonary complications | OR 4.48 p=0.004
Gastrointestinal complications | OR 4.70 p=0.02
Acute hemorrhagic anemia | OR 2.14 p=0.04
Mortality | OR 14.0 p=0.008

GA impact overall
• Pulmonary complications | OR 5.04 p<0.001
• Cardiac complications | OR 2.11 p=0.02
• Gastrointestinal complications | OR 4.60 p<0.001
• Acute hemorrhagic anemia | OR 3.58 p<0.001
• Shock | OR 3.26 p=0.003
• Wound complications | OR 13.01 p<0.001
• Mortality | OR 15.88 p<0.001

Impact of Anesthesia Technique in OSA

The prevalence of perioperative complications in patients with and without obstructive sleep apnoea: a prospective cohort study

Healthcare question
• Incidence of perioperative complications by anesthesia technique

Prospective observational study
• Institutional data: Nicolae Testemitanu University, Romania
• 2014 – 2015, Berlin questionnaire
• 400 patients; abdominal and orthopedic surgery

Results
• Highest number of complications in OSA/abdominal surgery under GA
• Best outcomes in OSA patients with orthopedic surgery under RA
• Respiratory complications most frequent
• Risk for complications depends on type of surgery and anesthesia

Complications | Abdominal cavity | Orthopedic
--- | --- | ---
Respiratory complications | +17.3% | +16.0%
ICU (unplanned) | +5.7% | +4.3%
Stroke | +0.7% | 0%
Postoperative fever | +1.4% | -2.6%
Postoperative ventilation | +20.3% | +20%
Difficult intubation | 3.5% in GA | 2.5% in GA
Prolonged awakening from anesthesia | 2.5% in GA | 13% in GA

NA + PNB ➔ additional reduction in respiratory complications
Impact of Anesthesia Technique in OSA

Postoperative Hypoxemia in Orthopedic Patients with Obstructive Sleep Apnea

Spencer S. Liu, MD - Mary F. Chidister, MD - Justin Ngov, BA - Raymond S. Juhn, BA - Pamela Shaw, BS - Yan Ma, PhD - Stavros G. Mentzoulis, MD, PhD

HSS | 2011

Healthcare question
- Incidence and risk factors for postoperative hypoxemia in OSA
- Hypoxemia: SpO2 <90% for over 5 min

Retrospective analysis
- OSA surgical patient records at the Hospital for Special Surgery (2005 – 2008)
- 527 OSA patients undergoing ambulatory orthopedic surgery (ICD-9)
  (minimum one-night PACU for continuous monitoring)

Results
- GA identified as a risk factor hypoxemia in OSA
  (+ blood loss, IV fluids and surgery type)
- Hypoxemia associated with major respiratory complications, increased LOS, and wound infections

<table>
<thead>
<tr>
<th>Anesthesia</th>
<th>Hypoxemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA only</td>
<td>29%</td>
</tr>
<tr>
<td>Spinal</td>
<td>4%</td>
</tr>
<tr>
<td>Spinal + PNB</td>
<td>1%</td>
</tr>
<tr>
<td>Epidural</td>
<td>5%</td>
</tr>
<tr>
<td>PNB</td>
<td>4%</td>
</tr>
<tr>
<td>IV-PCA</td>
<td>32%</td>
</tr>
<tr>
<td>Continuous PNB</td>
<td>4%</td>
</tr>
</tbody>
</table>

Airway Management in OSA

Complications | OSA vs non-OSA
Difficult intubation | OR 3.46 p<0.0001
Difficult mask ventilation | OR 3.39 p<0.0001
Combined | OR 4.12 p<0.0001
Supraglottic airway failure | OR 1.34 p=0.38

Is obstructive sleep apnea associated with difficult airway? Evidence from a systematic review and meta-analysis of prospective and retrospective cohort studies

Mohamad Hayek, MD, David T. Ng, PhD, Cristiana Camozzi, MD, G. Gupta, Kristina Parsamian, MD, Stanley G. Mavorouolis, PhD, Frank Chong, MD

PLoS ONE | Oct 2018
Airway Management in OSA

**Perioperative Complications in Obstructive Sleep Apnea Patients Undergoing Surgery: A Review of the Legal Literature**

Nick Fouladpour, MD,* Rajnish Jesudoss, MD,† Norman Bolden, MD,‡ Ziad Shanan, MD,† and Dennis Auckley, MD

Increasing litigation cases in OSA

Death or anoxic brain injury due to difficult airway management

- Difficult intubation
- Postoperative failure to reintubate after premature extubation

**Known or suspected OSA should be considered an independent risk factor for difficult intubation, difficult mask ventilation, or both**

Patients with known or suspected OSA should be managed according to the

**Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea**

An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Obstructive Sleep Apnea

Anesthesiology | 2014
Neuromuscular Blockade in OSA

**Healthcare Question**
- Early postoperative respiratory complications in high risk OSA after GA

**Observational prospective double cohort study**
- Institutional, Centro Hospitalar São João in Porto, Portugal
- PACU after non-cardiac, non-neurological surgery, 2011
- 340 patients (STOP-BANG)

**Results**
- Residual neuromuscular blockade more frequent in OSA
- Inability to breathe deeply more frequent in OSA
- Increased respiratory complications in OSA after GA
- Residual neuromuscular blockade independent risk factor for adverse respiratory complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>OSA</th>
<th>non-OSA</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoxia</td>
<td>9%</td>
<td>3%</td>
<td>0.012</td>
</tr>
<tr>
<td>Respiratory complications</td>
<td>39%</td>
<td>10%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Inability to breathe deeply</td>
<td>34%</td>
<td>9%</td>
<td>0.001</td>
</tr>
<tr>
<td>Residual Neuromuscular blockade</td>
<td>20%</td>
<td>16%</td>
<td>0.035</td>
</tr>
<tr>
<td>PACU LOS</td>
<td>120 min</td>
<td>99 min</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Neuromuscular Blockade in OSA

**OSA compared to non-OSA patients receiving neuromuscular blocking agents may be at increased risk of effects of**
- Postoperative residual neuromuscular blockade
- Hypoxemia
- Respiratory failure

**Full reversal of NMB should always be verified before extubation**
- Effects may persist even after the use of reversal agents
- In general population, sugammadex vs neostigmine more efficient in decreasing residual paralysis
- In OSA population, insufficient evidence to demonstrate superiority of sugammadex
Impact of Anesthesia in OSA

Postoperative Changes in Sleep-disordered Breathing and Sleep Architecture in Patients with Obstructive Sleep Apnea

Prospective observational study
- Institutional: Toronto Western and Mt. Sinai, Canada
- 58 patients, PSG preop. + postop. night 1, 3, 5, 7

Postoperative worsening of
- SDB: AHI increased, exacerbation of nocturnal hypoxia and hypercapnia OSA > non-OSA peak postoperative night 3, sustained 7 days
- Sleep architecture: REM sleep, slow wave sleep peak on postoperative night 1

Impact of Anesthesia in OSA

Factors Associated with Postoperative Exacerbation of Sleep-disordered Breathing

Prospective observational study
- Institutional: Toronto Western and Mt. Sinai, Canada
- 376 patients, orthopedic, spinal, or general surgery
- PSG preop., postop. nights 1 and 3

Result
- GA associated with increased postoperative Central Apnea Index
- 72h opioid dose positively correlated with AHI severity

Drivers of postoperative sleep-disordered breathing

Drivers of postoperative Apnea Hypopnea Index (AHI)
- Preoperative AHI
- Age
- 72 hours opioid dose

Drivers of postoperative Central Apnea Index
- Preoperative central apnea index
- Male sex
- GA
Postoperative Death and Critical Events in OSA

Commonly shared postoperative course

- Patients awake, alert, and stable (favorable sedation scores)
- Preceding high pain scores and use of pain medication e.g. PCA
- Typical or less than typical doses of narcotics and sedatives
- After going to sleep found dead or in critical condition
- Cardiorespiratory arrest

Retrospectively often deemed a preventable

- Lapses in monitoring often implicated
Critical Components of OSA Pathogenesis

Upper airway anatomy
- Narrower, higher pharyngeal collapsibility, obesity (parapharyngeal fat deposition), craniofacial abnormalities

Ability of upper airway dilator muscles to respond pharyngeal collapse during sleep
- Decreased tone of upper airway dilator muscles – obstructive events

Arousal threshold - propensity to wake up from respiratory stimulus during sleep
- Hypercapnic respiratory drive and diaphragmatically generated negative pressure during airway obstruction predispose repeated arousal
- Low arousal threshold, disruptive sleep, wake up before reaching very low oxygen saturation
- High arousal threshold - preoperative identification not feasible

Inherent instability of ventilatory control

Death and life-threatening events in OSA

Table 2 The Three Clinical Pattern Types of Unexpected Hospital Death (PUHD)

<table>
<thead>
<tr>
<th>Type</th>
<th>Clinical Pattern</th>
</tr>
</thead>
</table>
| Type I | Hyperventilation Compensated Respiratory Distress (e.g. Sepsis, PE, CHF)  
Stable PaCO2 with progressively falling PaO2 eventually yields to slow PaO2 decline (mitigated by respiratory alkalosis) and followed by precipitous PaCO2 decline when metabolic acidosis dominates |
| Type II | Progressive Unidirectional Hypoventilation (CO2 Narcosis)  
Progressive rise in PaCO2 (and etCO2) and fall in PaO2 over 15 minutes to many hours. Often due to overdosing of narcotics or sedatives |
| Type III | Sentinel Rapid Airflow/SP02 Reductions Followed by Precipitous PaO2 Fall.  
A state of "arousal dependent survival" that occurs only during sleep. Arousal failure allows precipitous hypoxemia during apnea causing terminal arousal arrest. |

Type III Pattern of ventilation and PaCO2 cycling during sleep
Instability of ventilation and/or upper airway control followed by precipitous and fatal oxygen desaturation if arousal failure is induced by narcotics and/or sedation
OSA related cycling scores of apneas due to instability of upper airway control
• Perpetual arousal dependent survival during sleep - reopening of upper airway

Sentinel instability component: arousal failure in the presence of sleep apnea
• Precipitous hypoxemia - steep fatal oxygen desaturation
• Severe arousal failure - profound cerebral hypoxemia “Lights Out Saturation” sufficient to induce central arousal arrest
• Patients dead in bed without warning from prolonged apneas

Delayed arousal
• Subgroups of OSA patients exhibit severely delayed arousals
  • Occult arousal failure
• OSA acquired arousal failure
  • Central arousal system failure in response to daily repetitive hypoxemia and
  • Sleep fragmentation
• CPAP initiation – sleep rebound
• Anesthetic, sedative and narcotic agents additional factors that delay respiratory arousal
General anesthesia and dose dependent depression of upper airway activity

Anesthetic, sedative, and narcotic drug effects

Worsened upper airway collapsibility
Depression of central respiratory activity
• Diminished ventilatory response to hypercarbia and hypoxia
• Delayed respiratory arousal response to airway occlusion
• Depression of central respiratory output to upper airway dilator muscles and upper airway reflexes (e.g. genioglossus muscle)

Depression of peripheral reflex pathways of upper airway muscle activity
Exacerbated SDB
→ May precipitate complete arousal arrest in patients with high arousal threshold
→ Sudden, unexpected death

OSA complicating opioid analgesia

Enhanced pain sensitivity conferred by OSA features

Chronic intermittent hypoxia
• Nocturnal arterial desaturation may be associated with increased pain in patients with SDB

Sleep fragmentation
• Hyperalgesia in insomnia
• CPAP with improved sleep continuity reduced pain sensitivity in OSA
OSA complicating opioid analgesia

Chronic cycling hypoxia potentiating opioid analgesic effects
- Decreased postoperative opioid consumption in OSA with recurrent nocturnal hypoxia
- Nocturnal hypoxia OSA associated with increased potency of opioids

Altered pain sensitivity and opioid potency should be considered in OSA
- Preoperative nocturnal hypoxia determinant of postoperative opioid pharmacology
- Opioid and analgesic requirements potentially lower

Healthcare question
- Impact of multimodal analgesia on opioid use and complication risk

Population based retrospective cohort study
- Premier national healthcare database
- 2006-2016; Claims-based data >540 US hospitals (25%)
- 181,182 OSA patients undergoing total hip/knee arthroplasty (ICD-9)

Intervention
- Multimodal analgesia vs opioids-only
- Systemic opioids + 1, 2, or >2 non-opioid analgesic modalities
  - NSAIDs, Cox-2 inhibitors, Acetaminophen/paracetamol, Peripheral nerve blocks, Steroids, Gabapentin/pregabalin, Ketamine

Multimodal pain management in OSA
Multimodal pain management in OSA

Results

- Stepwise beneficial effects with increasing number of non-opioid analgesic modes added to opioids
  - Opioid prescription dose
  - LOS
  - Gastrointestinal complications
  - Mechanical ventilation
  - Postoperative ICU
- Strongest opioid sparing with Cox-2 inhibitors and NSAIDs
- Lower PCA use

Conclusion

- Multimodal analgesia associated with opioid sparing and reduced complications
- dose response gradient

Comparative effectiveness: GA vs RA

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>RCTs</th>
<th>Outcomes decreased with Neuraxial anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>Memtsoudis</td>
<td>94</td>
<td>Mortality, pulmonary, renal, DVT, infections, blood transfusion</td>
</tr>
<tr>
<td>2014</td>
<td>Guay</td>
<td>117</td>
<td>30 mortality, pneumonia</td>
</tr>
<tr>
<td>2016</td>
<td>Meng</td>
<td>8</td>
<td>LOS, intraoperative hypertension and tachycardia, analgesic requirement in the PACU, PDIV</td>
</tr>
<tr>
<td>2016</td>
<td>Johnson</td>
<td>29</td>
<td>LOS</td>
</tr>
<tr>
<td>2016</td>
<td>Guay</td>
<td>117</td>
<td>Hypertension</td>
</tr>
<tr>
<td>2013</td>
<td>Barbosa</td>
<td></td>
<td>Pneumonia</td>
</tr>
<tr>
<td>2009</td>
<td>McFarlane</td>
<td>18</td>
<td>Postoperative pain, morphine consumption, opioid related adverse effects</td>
</tr>
<tr>
<td>2010</td>
<td>Luger</td>
<td>34</td>
<td>Mortality, reduced postoperative confusion, DVT, postoperative hypoxia, pneumonia</td>
</tr>
<tr>
<td>2006</td>
<td>Mauerman</td>
<td></td>
<td>DVT, PE, blood transfusions</td>
</tr>
<tr>
<td>2000</td>
<td>Parker</td>
<td>17</td>
<td>Mortality 30 day, DVT</td>
</tr>
<tr>
<td>2000</td>
<td>Rodgers</td>
<td>141</td>
<td>Mortality 30%, DVT 40%, pneumonia 50%, respiratory depression 60%, myocardial infarction, blood transfusion, wound infections renal failure</td>
</tr>
</tbody>
</table>
Quality of the Body of Evidence

**Study design**
- Lack of RCTs, mostly observational, no causality, residual confounding

**Risk of bias**
- Accuracy of OSA identification: STOP-BANG, Berlin Questionnaire, PSG rarely
- OSA severity, which subpopulations are at higher perioperative risk?
- Surgical invasiveness
- OSA treatment and compliance e.g. CPAP
- Anesthesia and analgesia/consumption of anesthetics and narcotics
- Indication bias selection bias

**Imprecision**
- Most studies do not reach OIS

**Directness**
- Sparseness of direct comparative effectiveness research in OSA
- Judgements regarding the strength of the association required

**Consistency**
- Results largely consistent in demonstrating detrimental effects of GA vs RA
- Consistency in size of effect

**Publication bias**
- Low risk

**Lack of evidence on the impact of interventions of precaution**
- e.g. CPAP, feasibility of randomization

---

**Rationale supporting regional anesthesia**

**Improved outcomes with regional anesthesia**
Reduced complications and resource utilization

**Avoidance of airway manipulation**
Difficult airway

**Avoidance of neuromuscular blockade**

**Efficient pain relief**
Altered pain and opioid sensitivity

**Reduced consumption of opioids and anesthetic medication**
Multimodal pain management
High vulnerability in patients with delayed arousal

**Suppression of surgical catabolic stress response**
Block of systemic endocrine catabolic response

**Expeditied mobilization/recovery**
What is the preferred anesthesia technique in patients with OSA?

• When applicable, RA preferable over GA in patients with OSA

• Potential for postoperative compromise should be considered in selecting intraoperative anesthetic medications

• Superficial procedures: use of local anesthesia and PNB (with/without moderate sedation)

• GA with secure airway preferable to deep sedation without secure airway

• Major conduction anesthesia (spinal/epidural) for peripheral procedures