Artículo:

Obstructive sleep apnea: anatomy, physiology and perioperative considerations

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Obstructive sleep apnea: anatomy, physiology and perioperative considerations

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SCOPE OF THE PROBLEM

- About 1 in 15 middle aged adults have moderate OSA
- Incidence in men twice that of women
- 60-90% of adult OSA patients are obese
- Incidence increases with age
- Probably 90% of sufferers are undiagnosed
- Generally obesity and older age are concentrated in the surgical population
- Incidence of OSA in surgical patients probably significantly higher than in the general population
- Given U.S. demographics, diagnosis of OSA is predicted to increase 5-10 fold in the next decade

WHO HAS OSA?

ANATOMY AND PHYSIOLOGY

- OSA is defined as cessation of airflow for > 10s, occurring ≥ 5X/hour of sleep
- Clinically results in disturbed sleep cycles, daytime sleepiness and cardiovascular changes
- Anatomy and physiology are well described, relevance to anesthetic care is clear

THE NORMAL AIRWAY

- Three collapsible pharyngeal segments (retropalatal, retroglossal and hypopharynx)
- Pharyngeal muscles actively keep airway open during inspiration

SITES OF OBSTRUCTION
Genioglossus moves the tongue anteriorly to keep the oroglossal air space open

NEGATIVE AIRWAY PRESSURE

- The greater the obstruction, the greater negative pressure developed
- Much greater demands on airway muscles to keep airway patent

THE SLEEP CYCLE

- With non-REM sleep, rhythmic activity of upper airway muscles decreases
- In REM sleep pharyngeal tone decreases, may disappear
- Airway obstruction may be a positive feedback loop

AIRWAY OBSTRUCTION IN OSA SLEEP

- Increased resistance to airflow and increased negative inspiratory pressure
- Decreased pharyngeal tone during REM sleep
- Extrinsic airway compression for tissue
- Snoring occurs in 30-40% of obese men, represents periods prior to and following airway closure

PHYSIOLOGIC EFFECTS OF OBSTRUCTION

- Decreased PaO₂
- Increased PaCO₂
- Arousal, increased sympathetic tone
  - Hypertension, systemic and pulmonary

CARDIOVASCULAR EFFECTS OF OBSTRUCTION

ANATOMY AND PHYSIOLOGY IN OSA

- With obesity there is deposition of fat in the lateral pharyngeal walls
  - Decreases airway diameter and airflow resistance
  - Alters primary axis of airway from transverse to anterior-posterior
- Mechanical efficiency of pharyngeal muscles probably reduced

Restriction of the airway during an apneic event

CARDIAC EFFECTS OF OSA

- Increased sympathetic tone
- Increased MvO₂
- Myocardial ischemia and dysrhythmias
- Systemic and pulmonary hypertension

OSA episodes likened to “…sequential administration of several hundred bolus of pressor agent each day”. Bradley, T.; Circulation 2003
Cook DJ. Obstructive sleep apnea: anatomy, physiology and perioperative considerations

CARDIAC EFFECTS OF OSA

- Chronic exposure:
  - Cardiac remodeling:
    - LVH
    - Myocyte necrosis, apoptosis
  - Worsening of LV failure
  - RV failure (cor pulmonale)

CHRONIC CARDIOVASCULAR EFFECTS

<table>
<thead>
<tr>
<th>50%</th>
<th>25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>Congestive Cardiac Failure</td>
</tr>
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</table>

OSA

<table>
<thead>
<tr>
<th>30%</th>
<th>60%</th>
</tr>
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<tbody>
<tr>
<td>Acute coronary syndromes</td>
<td>Stroke</td>
</tr>
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</table>

DIAGNOSIS OF OSA

- Sleep study is definitive
- Presumptive diagnosis:
  - Obesity (BSA > 30 kg/m²)
  - Snoring or apnea during sleep
  - Daytime drowsiness/fatigue
- In surgical patients, assume OSA risk is there

ANESTHETICS AND OSA

- All CNS depressants decrease pharyngeal dilator activity
  - Thiopental
  - Propofol
  - Narcotics (I.V. and epidural)
  - NMBs
  - Benzodiazepines
  - Nitrous oxide
- Arousal, CO₂ and O₂ responsiveness are diminished
- Interaction of anesthetics and OSA sleep cycle may last a week postoperatively

OSA AND AIRWAY MANAGEMENT

- Presumption of difficult airway
- Prior anesthetic history may be mitigating
  - Prior intubation

OSA AND POSTOP MANAGEMENT

NEGATIVE PRESSURE PULMONARY EDEMA

METHODS OF MANAGEMENT

- Medical
  - CPAP/BiPAP
  - Weight loss
- Dental splints/tongue retaining devices
- Nasopharyngeal tubes
- Sleep hygiene

- Surgical

**CPAP AND BIPAP**

- CPAP: continuous positive airway pressure
  - (typically 5-10 cm H₂O pressure)
- BiPAP: Bilevel pressure support

  **CPAP**
  - Bi-pressure: senses inspiration,
  - Provides additional pressure to increase ventilation volume

**CPAP EFFECTS**

CPAP IN PATIENTS WITH HEART FAILURE AND OSA

- 24 patients with EF ≤ 45% with OSA
- All receiving optimal Rx for heart failure
- Randomly assigned to medical therapy or CPAP
- Pre and post (1 month) respiratory and echocardiographic assessment of treatment effect (blinded)
  Kaneko Y et al NEJM 2003

Effects of CPAP on Heart Rate and Blood Pressure

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group</th>
<th>Group receiving continuous positive airway pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base line</td>
<td>1 Mo</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>67 ± 4</td>
<td>67 ± 4</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>128 ± 7</td>
<td>134 ± 8</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>60 ± 4</td>
<td>58 ± 3</td>
</tr>
</tbody>
</table>

* NS denotes not significant. Plus-minus values are means ± SE. There were no significant differences in base line values between the control group and the group given continuous positive airway pressure. Unless otherwise specified, P values are for the comparisons between base-line values and one-month values within the group.
† P = 0.09 for the comparison between the groups.
‡ P = 0.008 for the comparison between the groups.

**EJECTION FRACTION BASELINE AND AT 1 MONTH**

- In the control group, no change in ejection fraction (from 29 ± 2 to 30 ± 2 percent)
- Ejection fraction increased in all 12 subjects treated with CPAP (from 25 ± 3 to 34 ± 2 percent)
• While absolute change is small:
  Significant effect at this level of function
  Improvements in functional capacity can be meaningful

**CARDIOVASCULAR EFFECTS OF CPAP**

**METHODS OF MANAGEMENT**

• Medical
  - CPAP/BiPAP
  - Weight loss
  - Dental splints/tongue retaining devices
  - Nasopharyngeal tubes
  - Sleep hygiene

• Surgical- medical Rx fails, or surgical etiology

**SURGERY FOR OSA**

• Uvulopalatopharyngoplasty (UPPP)
• Genioglossus advancement
• Hyoid-myoid suspension
• Surgeries for non-obese OSA

**SITES OF OBSTRUCTION, SURGICAL APPROACHES**

• Radiofrequency tongue base reduction
SURGERY FOR OSA

- Genioglossus advancement

- Hyoid-myoid suspension

  The hyoid bone is pulled forward in front of the larynx, it can help stabilize the retroglossal space

- Maxillomandibular advancement

SPECIALTY SURGERY FOR OSA

- Maxillomandibular advancement
- Nasal
- Adenoid and tonsillectomy
- Tracheostomy- temporary
  Permanent (> 50/night, SpO₂ < 60%)
- (Gastric bypass)

PEDiatric OSA

- OSA symptoms in children typically differs from adults
  - Snoring, worsened by URIs,
  - More continuous, without arousals
  - Irritability/behavior disorders
  - Poor attention span
  - Mouth breathing
  - Small stature (growth hormone)
- Peak age is 2-5 years, second peak, late teens
- Common cause is adenoid and tonsillar hyperplasia
- Sleep study rarely necessary
- Surgical treatment:
  - Adenoid and tonsillectomy
  - Turbinate reduction
  - UPPP
  - Maxillofacial reconstruction
- Adult-like OSA increasing (childhood obesity)
- Children with surgery for OSA overnight observation
  - Age < 3 years
  - History severe OSA
  - Medical co-morbidities
  - Craniofacial abnormalities
  - Social factors
  - CNS dysfunction or hypotonia
- CPAP not indicated
- Document desaturations and apneic spells

DISORDERS ASSOCIATED WITH OSA

<table>
<thead>
<tr>
<th>Achondroplasia</th>
<th>Arthrogryposis multiplex congenita</th>
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<tbody>
<tr>
<td>Down syndrome</td>
<td>Beckwith-Wiedemann syndrome</td>
</tr>
<tr>
<td>Hunter’s syndrome</td>
<td>Crouzon syndrome</td>
</tr>
<tr>
<td>Klippel-Feil syndrome</td>
<td>Fragile X syndrome</td>
</tr>
<tr>
<td>Larsen’s syndrome</td>
<td>Hemifacial microsomia</td>
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<tr>
<td>Prader-Willi syndrome</td>
<td>Hurler’s syndrome</td>
</tr>
<tr>
<td>Pierre Robin sequence</td>
<td>Marfan syndrome</td>
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<tr>
<td>Riley-Day syndrome</td>
<td>Pfeiffer’s syndrome</td>
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<tr>
<td>Treacher Collins syndrome</td>
<td>Shy-Drager syndrome</td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>Arnold-Chiari malformation</td>
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<tr>
<td>Hydrocephalus</td>
<td>Hypothyroidism</td>
</tr>
<tr>
<td>Meningomyelocele</td>
<td>Myotonic dystrophy</td>
</tr>
<tr>
<td>Laryngeal neurofibroma</td>
<td>Sickle cell disease</td>
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</table>
Obstructive sleep apnea (OSA) is an epidemic that is often underdiagnosed. Higher risk groups are frequently encountered in the surgical population. The perioperative period can transform a non-OSA patient into an OSA patient. Acute and chronic effects of OSA are often underappreciated, and the response to treatment (Rx) is often dramatic.

In the pediatric population, unique considerations arise. Surgery in the airway is more likely, and many comorbid conditions may predispose to OSA. A well-defined airway and analgesic plan, both pre- and postoperatively, is crucial. Airway versus non-airway surgery requires careful consideration. Outpatient settings are very high-risk areas, and vigilance is necessary to avoid “creep” in sedation cases.

**Lymphoproliferative disorders**
- Syringobulbia/myelia
- Vascular rings

**Gastroesophageal reflux**
- Goiter

**Hypotonia**

**Fetal alcohol syndrome**

**Polio**

**Head injury**

**SUMMARY**
- Obesity is epidemic and OSA is underdiagnosed.
- Higher risk groups are frequently encountered in the surgical population.
- The perioperative period can transform a non-OSA patient into an OSA patient.
- Acute and chronic effects of OSA are underappreciated, and the response to treatment is often dramatic.
- Pediatric population unique considerations:
  - Surgery more likely to be in the airway.
  - Many comorbid conditions may predispose to OSA.
  - Neuromuscular disorders
  - CNS conditions
- Well-defined airway and analgesic plan, pre- and postoperatively:
  - Airway versus non-airway surgery
  - Outpatient settings are very high-risk areas
  - Avoid “creep” in sedation cases