SURGICAL MANAGEMENT OF OBSTRUCTIVE SLEEP APNEA SYNDROME

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OUTLINE
• History of Sleep
• Medical problem
• Surgical results
• Technique
• Evaluation of the airway.

HYPNOS SLEEP MYTHOLOGY
• Greek god or spirit of Sleep, opium horn
• Nyx (night) was his mother
• Somnus was the Roman equivalent
• Thanatos (peaceful Death) was his brother

THE POSTHUMOUS PAPERS OF THE PICKWICK CLUB
(ALSO KNOWN AS THE PICKWICK PAPERS) IS THE FIRST NOVEL BY CHARLES DICKENS 1837

OBSTRUCTIVE SLEEP APNEA OSA
• “Picwickian syndrome” Charles Dickens, Posthumous papers of the pickwick club, 1837
• Burwell, 1956 1st published case
• Day time fatigue, EDS
• Sleep deprivation
• 10 sec cessation of airflow
• RDI or AHI, events/hr

SLEEP DISORDERS
• 1979: First official classification of sleep disorders
• Estimated 40% of adults experience some form of sleep disorder
• Sleep apnea
• Narcolepsy
• Insomnia
• Estimated cost: $16 billion
**SLEEP DISORDERED BREATHING**
- Snoring
- Upper Airway Resistance Syndrome (UARS)
  - Sleep disturbance without desaturation
- Sleep Apnea
  - Central
  - Obstructive
  - Mixed

**OSA : INCIDENCE**
- 1-3 % of adult population: conservative
- Higher in industrialized countries
- Middle age males: 1-16%
- Elderly males: 18-67%
- Middle age females: 1-5%
- Elderly females: 20-54%

**DIAGNOSIS: NPSG**

**Obstructive Apnea**

**Central Apnea**
OBSTRUCTIVE SLEEP APNEA
PATHOPHYSIOLOGY

- Maximal relaxation during REM sleep
- Most cases: multiple sites of obstruction

CARDIOVASCULAR DISEASE IN OSA

- HTN correlates to OSA even when other factors are controlled
- Ventricular arrhythmia
- Brady-tachy syndrome most common
- PVCs increase in OSA
- Decrease in CO = bradycardia, BP, neg pressure
- MI = BP surge, plaque fracture, vasospasm more common in AM assoc with REM
  Sleep Heart Health Study, Young, Jama

MI AND OSA

- 23 times risk of MI in high OSA
  ref Lancet

OBSTRUCTIVE SLEEP APNEA
CARDIOPULMONARY CHANGES

- Pulmonary
  - Pulmonary Hypertension
  - Polycythemia
- Cardiac
  - CHF
  - Systemic Hypertension
  - Arrhythmias
  - Decreased cardiac output

OBSTRUCTIVE SLEEP APNEA
MORBIDITY / MORTALITY

- 75% of patients that suffer from OSA have motor vehicle accidents attributable to EDS
SLEEP INDUCED DISASTERS

- In 1998, 200,000 MVAs were caused by sleepiness in the US, National comm on sleep 92.
- “Fall asleep MVA” are now one of leading causes of fatal crash, 25% Horne 94, Lamberg JAMA 96, Lyznicki JAMA 98.
- 30 – 90% of work place accidents - Chernobyl, 3 mile island, Exxon valdes, Bhopal, and Challenger disaster National comm on sleep 92, Dinges 95.

MAXILLO-MANDIBULAR ADVANCEMENT FOR THE TREATMENT OF OSA: A SYSTEMATIC REVIEW AND META-ANALYSIS, HOLTY GUILLEMINAULT, SLEEP MEDICINE REVIEWS, 14, 2010, 287

- 53 reports, 627 adults.
- Success rate 86% mean follow up at 44mo.
- Predictors: younger, lower BMI, lower pre AHI and larger maxillary advancement (not mand)
- Complication rate: 1%

OBSTRUCTIVE SLEEP APNEA
MMA: UAB EXPERIENCE
WAITE ET AL. JOMS 1989

- 23 patients
- Technique
  - 7 had UP3 also
  - 15 had HOM (high genioplasty)
  - 8 had partial glossectomy
  - No hyoid suspension
  - Septoplasty
  - Most did not have orthodontics

OBSTRUCTIVE SLEEP APNEA
MMA: UAB EXPERIENCE
RESULTS

- Strictest definition of cure: RDI <10 and no desaturations
- 65 % cured
- 100 % success in patients that had UP3 and MMA

OBSTRUCTIVE SLEEP APNEA
MMA: UAB RESULTS
N=71

<table>
<thead>
<tr>
<th>Results</th>
<th>RDI</th>
<th># SaO2</th>
<th># of Pts</th>
<th>Percent</th>
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<tr>
<td>Excellent</td>
<td>&lt;10</td>
<td>&lt;90</td>
<td>0</td>
<td>28.2</td>
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<tr>
<td>Good</td>
<td>&lt;10</td>
<td>&lt;20</td>
<td>26</td>
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<td>Satisfactory</td>
<td>&lt;20</td>
<td>&gt;20</td>
<td>15</td>
<td>21.1</td>
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<tr>
<td>Poor</td>
<td>&gt;20</td>
<td>&gt;20</td>
<td>10</td>
<td>14.1</td>
</tr>
</tbody>
</table>

LONG TERM RESULTS. ORAL AND MAXILLOFACIAL SURGERY CLINICS OF NORTH AMERICA, MAY 1995

- 15 patients, age 30-76, 9 male, 6 female
- 30mo follow-up
- Maxillary advance 8.3mm
- Mandibular advance 10.3mm
- Airway increase 7.8mm
- BMI 31.9 – 32.5
- AHI 44.3 – 9.5
- Arousal index 31.5 – 5.5
- Longest event 50 – 26 sec.
Ref:

LONG TERM RESULTS 6YRS

LONG TERM RESULTS 7YRS

TECHNIQUE: HOW I DO IT.

TECHNIQUE: 25 YRS AGO.

Pre advance
Post advance
Prediction advance
Actual advance
PEARL: PREBENT PLATES INSURE ADEQUATE ADVANCEMENT


STABILITY


PITFALL: CEPHALOMETRIC CHANGES IN PAS DO NOT EQUAL SUCCESS
QUESTION: ARE THE SURGICAL GOALS OF MMA THE SAME AS ORTHOGNATHIC SURGERY

Please rate 1-7, with 1 being strongly agree and 7 being strongly disagree.

PRESURGICAL ORTHODONTIC PLAN

- Place fixed appliances to align and de-crowd
- Torque and advance upper incisors
- Progress to full dimension arch wires and surgery
- Advancement based on OSA

Sarver DM, The role of orthodontics in the surgical treatment of OSA. OMS clinic of NA May 1995

CEPHALOMETRIC SUPERIMPOSITION

POSTERIOR AIRWAYS

1995
TG

- 40 yobm cc OSA
- 144/78, 77, 276wt, neck 18” , RDI 78
- Mallampati class 4, mueller maneuver 4
- 9-24-08: MMA, UP3, osa plates, bicortical screws and monocortical plate
- 3-2-09: post RDI 4.7
PEARL: ADVANCE THE MANDIBLE FIRST WITH ADVANCEMENT SPLINT.

Unstable splint, may change plane of occlusion.

Mandible: first more stable

PEARL: LARGE ADVANCEMENT = LARGE AIRWAY

SPECIAL PLATING.

PEARL: DOUBLE PLATE
RESORBABLES


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COMPUTATIONAL FLUID DYNAMIC ANALYSIS OF THE POSTERIOR AIRWAY SPACE AFTER MMA FOR OSAS

Funded under NIH R21 Grant

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IMAGING THE AIRWAY

FRANKFORT PLANE: FOR THE REFERENCE OF HEAD POSITION DURING PERFORMING FACIAL CT SCANS. POINT A, B AND PG WERE MEASURED IN PRE- AND POST-OP CT.
HEAD POSITION IN CT

3 MEASUREMENTS AT EACH LEVEL
• AP dimension on the mid sagittal plane
• Maximum LAT in an orientation perpendicular to the mid sagittal plane
• Cross sectional area of the airway CSA

CROSS SECTION AREA: CSA
EVALUATION
- Increase in both AP and LAT
- LAT to AP ratio; generally less postop. Except at level 3 (high retroglossal area). At this area MMA stretched the airway in a more lateral than in AP fashion.

RESULTS
- MMA increases both the AP and the LAT dimensions of the upper airway. The CSA was increased in all levels.
- The quantitative effect of MMA on the LAT/AP dimension ratio at each level was analyzed.
- Patients with the best post RDI, had airways stretched more laterally at higher levels.

RESULTS; LEVEL OF AIRWAY
- Good responders had more lateral change at higher levels
- Poor responders had less lateral change
- MMA increased CSA at all levels by both AP and LAT.
APPLICATIONS OF COMPUTER FLUID DYNAMICS

- Transportation
  - Aircrafts, automobiles, ships
- Biological
  - Blood flow, air flow through lungs
- Environmental
  - Weather prediction, spread and control of atmospheric pollutants, ocean currents

PATIENTS AND METHODS

- 8 cases
- Using pre- and post-operative helical computational tomogram data for MMA
- Created models from 3-D CT: pre- and post-op
- Simulations using computational fluid dynamics (CFD)

MESH GENERATION BASED ON CT/MRI DATA

- Noise reduction
- Segmentation
- Surface extraction
  - ITK, VTK and in-house codes
- Faceted surface
- Extracting feature lines
- Surface triangulation by a direct advancing front method
- Volume meshing
  - Tetrahedral
  - Hybrid

MESH GENERATION BASED ON CT/MRI DATA: COMPUTER FLUID DYNAMICS

DOMAIN Discretization
MULTIPLE SITES OF OBSTRUCTION

- It is now well recognized that most patients with retropalatal narrowing, have other areas of pharyngeal collapse during sleep.

CONCLUSION

- MMA increases airway in all dimensions
- Maxillary and Mandibular synergy, multiple muscles of support on the airway
- Lateral change is most important for airway.
- I suspect that if CPAP increase the airway so will MMA