Management of OSA
saurabh maji
INTRODUCTION

Obstructive sleep apnea is a major public health problem

Prevalence of OSAS in INDIA is 2.4% to 4.96% in men and 1% to 2 % in women

In the rest of the world prevalence rate 4% in men and 2% in women

93% of women and 82% of men with moderate severe OSAS are never diagnosed

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Management

1. POSITIVE AIRWAY PRESSURE DEVICE
2. ORAL APPLIENCES
3. VARIOUS UPPE AIRWAY SURGERY
4. WEIGHT REDUCTION
General measures for treating OSA

- Counselling regarding smoking cessation
- Avoidance of alcohol, sedatives and nicotine
- Treatment of nasal obstruction in consultation with otolaryngologist
- Weight reduction
- Positional therapy
- Sleep hygiene and avoidance of sleep deprivation

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Indication of PAP therapy

AHI or RDI ≥15 events/hour

Or

AHI or RDI ≥5 but <15 events/hour with any one of the following symptoms:
- Excessive daytime sleepiness
- Neurocognitive impairment
- Hypertension
- Coronary artery disease
- Cardiac arrhythmias
- Pulmonary hypertension
- History of stroke

Am J Respir Crit Care Med. 2012;186(7):677-683
POSITIVE AIRWAY PRESSURE

Mainstay of treatment of OSA

Patient compliance is a major issue
Counseling is necessary

PAP creates a pneumatic splint in the upper airway which prevents collapse of the pharyngeal airway

PAP therapy improves quality of life
Significant reduction in daytime sleepiness
Driving performance
Neuro-cognitive performance and
Cardiovascular outcomes including overall mortality

Am J Respir Crit Care Med. 2012;186(7):677-683
Description and methodology of manual PAP titration

<table>
<thead>
<tr>
<th>PAP TITRATION</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>AGE BELOW 12 YRS</td>
<td>AGE MORE THAN 12 YEARS</td>
</tr>
<tr>
<td>CPAP minimum of 4 cm of water and maximum of 15 cm of water</td>
<td>CPAP minimum of 4 cm of water and maximum of 20 cm of water</td>
</tr>
</tbody>
</table>
Increase pressure by one cm of water at an interval of no less than five minutes in following cases-

<table>
<thead>
<tr>
<th>Patient&lt;12 yr</th>
<th>Patient&gt;12 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 obstructive apnoea</td>
<td>2 obstructive apnoeas</td>
</tr>
<tr>
<td>1 hypopnoea</td>
<td>3 hypopnoeas</td>
</tr>
<tr>
<td>3 RERAS</td>
<td>5 RERAS</td>
</tr>
<tr>
<td>1 min of loud unambiguous snoring</td>
<td>3 min of loud unambiguous snoring</td>
</tr>
</tbody>
</table>
Titration guideline for when and how to switch to BIPAP

Uncomfortable or is intolerant of high CPAP pressures

When CPAP level is 15 cm H2O and respiratory disturbances continue
Patient has OSA and OHS
Patient with OSA and COPD

Begin BPAP at EPAP 4 cm H2O or the CPAP level at which obstructive apnea was eliminated; set IPAP 4 cm H2O higher

Am J Respir Crit Care Med. 2012;186(7):677-683
<table>
<thead>
<tr>
<th>PATIENT&lt;12 YRS</th>
<th>Patients &gt;12 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum IPAP 8 cm of water, EPAP 4 cm of water</td>
<td>Minimum IPAP 8 cm of water, EPAP 4 cm of water</td>
</tr>
<tr>
<td>Maximum IPAP 20 cm of water</td>
<td>Maximum IPAP 30 cm of water</td>
</tr>
<tr>
<td>Minimum I/E difference 4 cm of water</td>
<td>Minimum I/E difference 4 cm of water</td>
</tr>
<tr>
<td>Maximum I/E difference 10 cm of water</td>
<td>Maximum I/E difference of 10 cm of water</td>
</tr>
</tbody>
</table>

AASM clinical guideline for manual titration of PAP in OSA patients – update 2012
Increase both IPAP and EPAP pressures by a minimum of 1 cm H2O with an interval of no less than 5 minutes when the following occur

<table>
<thead>
<tr>
<th>Patient age &lt;12 yrs</th>
<th>Patient age &gt;12 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>One obstructive apnoea</td>
<td>Two obstructive apnoeas</td>
</tr>
</tbody>
</table>
Increase IPAP pressure by a minimum of 1 cm H2O with an interval of no less than 5 minutes when the following occurs:

<table>
<thead>
<tr>
<th>&lt;12 years</th>
<th>&gt;12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>One hypopnoea</td>
<td>Three hypopnoeas</td>
</tr>
<tr>
<td>Three RERAS</td>
<td>Five RERAS</td>
</tr>
<tr>
<td>One min of loud or unambiguous snoring</td>
<td>Three min of loud or unambiguous snoring</td>
</tr>
</tbody>
</table>
DETERMINING THE OPTIMUM PRESSURE

The patient must be able to sleep in order for PAP titration to be successful. If the patient awakens and complains the pressure is too high, the pressure should be reduced to a level at which the patient is able to return to sleep.

Mask and mouth leaks should be promptly addressed.

Pressure relief technologies may be implemented to improve patient comfort.

BPAP may be utilized for patients who are intolerant of high CPAP pressures.
Supplemental Oxygen

when awake supine SpO2 on room air is less than 88% for 5 minutes or longer

Supplemental O2 may also be added during the PAP titration when SpO2 is ≤88% for ≥5 minutes in the absence of obstructive respiratory events

Supplemental oxygen should be introduced into the PAP device at the device tubing connection using a T connector, not at the PAP mask
The recommended minimum starting rate for adult and pediatric patients is 1 L/min

Titrate O2 in 1 L/min increments with an interval of no less than 15 minutes until SpO2 is between 88% and 94%
TYPE OF TITRATION ACHIEVED

1. OPTIMAL
2. GOOD
3. ACCEPTABLE
4. UNACCEPTABLE
Optimal titration

The Respiratory Disturbance Index (RDI) is < 5 per hour for a period of at least 15 minutes at the selected pressure and within the manufacturer’s acceptable leak limit

The SpO2 is above 90% at the selected pressure

Supine REM sleep at the selected pressure is not continually interrupted by spontaneous arousals or awakenings
GOOD TITRATION

The Respiratory Disturbance Index (RDI) is < 10 per hour (or is reduced by 50% if the baseline RDI was <15) for a period of at least 15 minutes

The SpO2 is above 90% at the selected pressure

Supine REM sleep at the selected pressure is not continually interrupted by spontaneous arousals or awakenings
ADEQUATE TITRATION

Which does not reduces overnight RDI<10 per hour but reduces RDI>75% of baseline in severe OSA patients

or

in which titration grading criteria of optimal or good titration are achieved with exception that supine REM does not occur at selected pressure
AUTO PAP

Continuously adjusting positive airway pressure to meet the patient's variable needs to maintain a patent airway

Reducing the overall mean airway pressure

Unattended setting such as the patient's home

Enhances tolerability and compliance
Purpose of APAP devices

Replacement of in-laboratory manual titration

Reducing mean airway pressures for achieving better compliance with PAP

Adapting PAP levels to changes in severity of OSA in response to changes in sleep state, weight and body position

Cochrane Database Syst Rev. 2009;(4)
AUTO PAP

APAP when used in level 3 and 4 to diagnose OSA, has been shown to achieve benefits comparable to CPAP levels derived from in-lab attended polysomnography.

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Should not be used with significant co-morbidity that lead to hypoventilation, such as morbid obesity, COPD and CHF.

Am J Respir Crit Care Med. 2012;186(7):677-683
Auto-titrating versus fixed continuous positive airway pressure for the treatment of obstructive sleep apnea: a systematic review with meta-analyses

Stanley Ip¹, Carolyn D'Ambrosio¹,², Kamal Patel¹, Ndidiemaka Obadan¹, Georgios Kitsios¹, Mei Chung¹ and Ethan M Balk¹*
REGARDING COMPLIANCE
Figure 3 AHI (events/hour) with APAP versus fixed CPAP: meta-analysis, with subgroup analyses by minimum AHI threshold. See Figure 2 legend. Note that studies favoring APAP are to the left of the vertical 0 line. Senn A and Senn B were comparisons of two different APAP devices versus fixed CPAP reported in the same study. Base AHI: baseline apnea-hypopnea index (events/hour) in fixed CPAP group; fixed: fixed CPAP.
Figure 4 ESS with APAP versus fixed CPAP: meta-analysis, with subgroup analyses by minimum AHI threshold. See Figure 2 legend. Note that studies favoring APAP are to the left of the vertical 0 line. Senn A and Senn B, and Sériès A and Sériès B, were comparisons of two different APAP devices versus fixed CPAP reported in the same study, respectively. Base AHI: baseline apnea-hypopnea index (events/hour) in fixed CPAP group; base ESS: baseline Epworth Sleepiness Scale (no units) in fixed CPAP group; fixed: fixed CPAP.
MINIMUM OXYGEN SATURATION

Figure 6 Minimum oxygen saturation (%) with APAP versus fixed CPAP: meta-analysis, with subgroup analyses by minimum AHI threshold. See Figure 2 legend. Note that studies favoring APAP are to the left of the vertical 0 line. Senn A and Senn B were comparisons of two different APAP devices versus fixed CPAP reported in the same study. Base AHI: baseline apnea-hypopnea index (events/hour) in fixed CPAP group; Base min O2: baseline minimum oxygen saturation (%) in fixed CPAP group; fixed: fixed CPAP.
APAP improved compliance by 11 minutes per night.

Day time sleepiness as measured by the Epworth Sleepiness Scale improved by 0.5 points in APAP arm.

Fixed CPAP improved minimum oxygen saturation by 1.3% more than APAP.

Therapy of choice should depend on other factors such as patient preference, specific reasons for non-compliance and cost.
Figure 5-1: Comprehensive Approach to PAP Prescription
FOLLOW UP

**Figure 5-2: Suggested follow-up after PAP prescription.**

- **PAP prescription**
  - Education
  - Appropriate interface
  - Follow up plan
  - Obtain Compliance data
  - Adequate
    - Continue PAP with regular follow up
  - Inadequate
    - Troubleshoot PAP issues
      - Consider Ramp, Pressure Relief, Auto-PAP, BPAP
    - Compliance Improves
    - No improvement
      - **Alternate Treatment**
        1. Oral Appliance
        2. Surgery
        3. Behavioural therapy
Oral appliances

OAs by maintaining the patency of the posterior pharynx

Fit by a qualified dentist

Maintain pharyngeal patency by advancing the mandible forward (mandibular repositioning appliances) or maintaining the tongue in an anterior position (tongue-retaining devices) or both

Oral appliances

Indicated for patients with mild to moderate OSA and for patients with severe OSA who are intolerant or choose not to use CPAP therapy

More recent data demonstrate that a trial of this approach to therapy may also be reasonable for patients with more severe disease (AHI >30 events per hour)

Thorpy M Sleep 2012;18:511-513
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Oral appliances for obstructive sleep apnoea (Review)

Lim J, Lasserson TJ, Fleetham J, Wright JJ
Analysis 1.3. Comparison 1 Active oral appliance versus control appliance, Outcome 3 Apnoea Hypopnea Index - first arm/parallel studies.

Review: Oral appliances for obstructive sleep apnoea

Comparison: 1 Active oral appliance versus control appliance

Outcome: 3 Apnoea Hypopnea Index - first arm/parallel studies

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Active appliance</th>
<th>Control appliance</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV:Fixed,95% CI</td>
</tr>
<tr>
<td>Blanco 2005</td>
<td>8</td>
<td>9.6 (12.1)</td>
<td>7</td>
<td>11.7 (7.9)</td>
<td>21.6 %</td>
</tr>
<tr>
<td>Gotsopoulos 2002</td>
<td>36</td>
<td>13.54 (12.95)</td>
<td>37</td>
<td>24.22 (14.12)</td>
<td>58.5 %</td>
</tr>
<tr>
<td>Hans 1997</td>
<td>12</td>
<td>21.1 (21.4)</td>
<td>12</td>
<td>46.8 (46.9)</td>
<td>2.7 %</td>
</tr>
<tr>
<td>Johnston 2002</td>
<td>12</td>
<td>18.04 (18.08)</td>
<td>8</td>
<td>40.9 (21.21)</td>
<td>7.0 %</td>
</tr>
<tr>
<td>Mehta 2001</td>
<td>12</td>
<td>11.65 (9.38)</td>
<td>12</td>
<td>29.11 (24.46)</td>
<td>10.3 %</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>80</td>
<td></td>
<td>76</td>
<td></td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

Heterogeneity: Chi² = 6.30, df = 4 (P = 0.18); I² =37%
Test for overall effect: Z = 4.45 (P < 0.00001)
Test for subgroup differences: Not applicable
Figure 2. Forest plot of comparison: 1 Active oral appliance versus control appliance, outcome: 1.1 Epworth sleepiness score - first arm data/parallel studies.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Active appliance</th>
<th>Control appliance</th>
<th>Mean Difference</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Total</td>
<td>Mean</td>
</tr>
<tr>
<td>Blanco 2005</td>
<td>5.1</td>
<td>1.9</td>
<td>8</td>
<td>13.8</td>
</tr>
<tr>
<td>Gotsopoulos 2002</td>
<td>7.81</td>
<td>4.78</td>
<td>36</td>
<td>8.51</td>
</tr>
<tr>
<td>Hans 1997</td>
<td>8.2</td>
<td>4</td>
<td>12</td>
<td>12.5</td>
</tr>
<tr>
<td>Johnston 2002</td>
<td>13</td>
<td>6.91</td>
<td>11</td>
<td>11.43</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td></td>
<td></td>
<td>63</td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 10.08$, df = 3 (P = 0.02); $I^2 = 70$

Test for overall effect: $Z = 2.38$ (P = 0.02)
Figure 4. Forest plot of comparison: 2 Oral appliance versus continuous positive airways pressure, outcome: 2.1 Epworth sleepiness scale - first arm data/parallel studies.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Oral appliance</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference</th>
<th>IV, Random, 95% CI</th>
<th>Mean Difference</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleetham 1998</td>
<td>9.3</td>
<td>4.7</td>
<td>50</td>
<td>9.5</td>
<td>4.5</td>
<td>51</td>
<td>45.5%</td>
<td>-0.20</td>
<td>[-2.00, 1.60]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoekema 2006</td>
<td>6.9</td>
<td>5.5</td>
<td>49</td>
<td>5.9</td>
<td>4.8</td>
<td>50</td>
<td>35.4%</td>
<td>1.00</td>
<td>[-1.04, 3.04]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lam 2007</td>
<td>9</td>
<td>5.83</td>
<td>34</td>
<td>7</td>
<td>5.83</td>
<td>34</td>
<td>19.1%</td>
<td>2.00</td>
<td>[-0.77, 4.77]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>133</strong></td>
<td></td>
<td></td>
<td><strong>135</strong></td>
<td></td>
<td></td>
<td>100.0%</td>
<td>0.64</td>
<td>[-0.57, 1.86]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.00; Chi² = 1.89, df = 2 (P = 0.39); I² = 0%
Test for overall effect: Z = 1.04 (P = 0.30)
Oral appliances

CPAP is more effective at resolving OSA events and improving oxygen saturations, although oral appliances tend to improve symptoms of daytime sleepiness to a similar degree as CPAP.

The impact of oral appliance therapy on hypertension, other cardiovascular outcomes, and mortality is not clear.
Limiting factors

Cost
Difficulty in predicting success
Tolerability prior to initiating therapy
Inability to monitor compliance with treatment
Predictor of success

Female sex
Younger age
Lower BMI
Smaller Neck circumference
Cephalometric parameters:
  Short palate
  Large retro-palatal airway space
Narrow anterior posterior position of mandible
Higher anterior posterior position of the maxilla

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TYPES

MANDIBULAR REPOSITIONING APPLIANCE (MRA)
Bringing the mandible forward, so increasing the airway volume

Fixed (pre-determined advancement)
Titratable (adjustable) allows progressive advancement of the mandible after initial construction until the optimal mandibular position is achieved
TONGUE RETAINING POSITION

Large tongue

When use of MRA is limited due to edentulous ridge
Contraindication to OA therapy

Inadequate number of healthy teeth in upper and lower dental arch (At least 6-10 teeth in each arch desirable)

Periodontal diseases

Patients with full artificial dentures

Limitation in forward protrusion of mandible and jaw opening

Temporo-mandibular joint diseases

Adverse effect of OAS

Excessive salivation
Temporary discomfort after awakening
Mucosal dryness
Transient discomfort in teeth, gum and TMJ
Headache
Distal migration of upper dentition

COMPLIANCE WITH OA

Depends on benefits and discomfort

Ranges from 51% to 88%. Among the various types of oral appliances

MAD has more compliance than any other appliance

conclusion

Appropriate for use in patients having primary snoring

Patients with mild to moderate OSA
  who prefer oral appliances to CPAP, or
  who do not respond to CPAP

In severe OSA, initial trial with PAP should be given before treating with OAs

Nasal expiratory positive airway pressure

Potential treatment alternative to PAP therapy for OSA
Increasing upper airway patency by creating expiratory positive airway pressure (EPAP)

Greatest benefit was observed in those with mild disease

Berry RB Sleep 2011;34:479-85
MECHANISM OF nEPAP

Increased the functional residual capacity

Produce tracheal traction

Reducing upper airway collapsability

Passive dilation of upper airway by producing expiratory pressure carrying over into inspiration

Berry RB Sleep 2011;34:479-85
Oral negative pressure therapy

Alternative to applying positive pressure to maintain the patency of the upper airway

This device generates negative oral pressure by drawing the tongue and soft palate in more anterior positions via a mouthpiece connected to a suction mechanism.
Upper airway muscle stimulation therapy

Stimulation of hypoglossal nerve improved upper airway patency via stimulation of the genioglossus muscle, resulting in protrusion of the tongue.

Several companies have developed hypoglossal nerve stimulation (HGNS) device.

This device has a neurostimulator that is implanted under the skin in the upper chest (similar to a cardiac pacemaker).
Upper airway muscle stimulation therapy

A stimulation electrode placed on the hypoglossal nerve

Sensing lead that is placed between the internal and external intercostal muscles to detect ventilatory effort

The device is activated prior to bedtime and deactivated in the morning after awakening
Bariatric surgery

Surgical weight loss via various bariatric procedures has been associated with even greater reductions in weight as well as improvements in OSA.

Dose-dependent improvements in OSA for a given amount of weight loss.

Most patients, regardless of the method of surgical weight loss, have residual OSA despite significant reductions in weight.

Effects of Surgical Weight Loss on Measures of Obstructive Sleep Apnea: A Meta-Analysis

David L. Greenburg, MD, MPH, Christopher J. Lettieri, MD, Arn H. Eliasson, MD

Greenburg et al. Surgical Weight Loss and Measures of OSA Severity

![Figure 2](image-url)

**Figure 2** AHI at baseline and after bariatric surgery. AHI = apnea-hypopnea index; CI = confidence interval.
Bariatric surgery

Many patients may be left with significant residual OSA requiring other treatments.

Weight loss via diet or bariatric procedures should not be considered a primary therapy for OSA across the spectrum of disease severity and should be recommended as a secondary therapy or intervention that supplements a primary treatment such as CPAP or oral appliances.

Nasal and Nasopharyngeal Surgery

Not a useful method of treatment of moderate to severe sleep apnea

It improves the compliance with PAP and also improves its effectiveness

Am J Rhinol Allergy. 2011 Jan-Feb;25(1):45-9
Uvulopalatopharyngoplasty (UPPP)

Patients with retropalatal obstruction

A significant difference in favour of LUP was reported in terms of apnoea hypopnoea index (AHI) and frequency and intensity of snoring


UPPP versus oral appliance: AHI was significantly lower with OA therapy than with UPPP. No significant differences were observed in quality of life

Cochrane Database Syst Rev. 2005 Oct 19;(4)