Remotely controlled mandibular positioning

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Obstructive sleep apnea (OSA) - upper airway

- Collapsible segment

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Anatomical OSA traits

- Small, collapsible upper airway
- Site of upper airway collapse

- Diagnostic evaluation of anatomy:
  - Drug-induced sleep endoscopy (DISE)
General measures/ lifestyle changes
- Weight reduction
- Avoidance of alcohol consumption
- No sedatives
- Smoking cessation

Non-surgical
- Continuous positive airway pressure (CPAP)
- Mandibular advancement device (MAD)
- Positional therapy

Surgical
- ENT surgery
- Oral & Maxillofacial surgery
Mandibular advancement devices (MAD) are the most common type of oral appliances

- Advance the mandible during the night
- Increase the upper airway volume
Titratable MAD – Target protrusion

- Custom-made, titratable oral appliances
  - Gradual mandibular advancement until optimal mandibular protrusion
    - Tolerability
    - Positive effects on sleep-disordered breathing
- Target protrusion position needs to be determined individually
- Effect varies largely between patients
Titratable MAD – Target protrusion

- No consensus on titration protocol = trial and error
- Different titration procedures
  - Subjective titration = ‘conventional titration’
  - Subjective titration with objective feedback
  - Objective titration
    - With awakening of the patient
    - Without awakening of the patient
      = ‘remotely controlled mandibular positioning’ (RCMP)
Historical prototypes:

- Hydraulic
- Motorized

Commercially available:

- Remotely controlled
- Feedback controlled

• Remotely Controlled Mandibular Positioner (RCMP)
  • Allows for progressive mandibular repositioning
  • Remotely controlled without awakening the patient
  • With a temporary appliance prior to MAD fitting

Aims of RCMP

- To prospectively identify good candidates for MAD therapy
- To determine an effective target protrusive position (ETPP) during titration polysomnography (PSG)

~ CPAP titration PSG

• Simulate mechanical action of a MAD by
  • Progressively protruding the mandible during sleep
  • Examining the effects on respiratory events
    • If respiratory events are eliminated → MAD can be an effective therapy
  • Minimum effective protrusion = ETPP for the final MAD appliance
## RCMP during PSG

<table>
<thead>
<tr>
<th>Authors, year of publication</th>
<th>Positive Predictive Value</th>
</tr>
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<tbody>
<tr>
<td>Pételle et al., 2002</td>
<td>100%</td>
</tr>
<tr>
<td>Tsai et al., 2004</td>
<td>90%</td>
</tr>
<tr>
<td>Dort et al., 2006</td>
<td>80%</td>
</tr>
<tr>
<td>Remmers et al., 2013</td>
<td>94%</td>
</tr>
<tr>
<td>Remmers et al., 2015 [abstract]</td>
<td>90%</td>
</tr>
</tbody>
</table>

### RCMP during PSG

<table>
<thead>
<tr>
<th>Degree of mandibular protrusion determination of titration</th>
<th>Type of MAD</th>
<th>ΔAHI (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>non-custom, non-titratable</td>
<td>6.3/h (3.0-10.0)</td>
</tr>
<tr>
<td>Conventional titration</td>
<td>custom, titratable</td>
<td>13.8/h (3.5-44.8)</td>
</tr>
<tr>
<td></td>
<td>custom, non-titratable</td>
<td>12.5/h (3.0-24.2)</td>
</tr>
<tr>
<td>RCMP titration</td>
<td>custom, titratable</td>
<td>17.8/h (5.1-47.3)</td>
</tr>
</tbody>
</table>

- Overall greatest decrease in AHI when using a custom titratable MAD after RCMP titration
- Upfront selection of patients for MAD


• RCMP high accuracy but risk of bias.
• Validity of predictive index test useful
• Clinical practice: greater disease management

RCMP during PSG
• Commerically available RCMP
• Titration during PSG, well tolerated
• Validation of RCMP method for MAD treatment outcome

• n=33, AHI >10 events/h
  • Prediction in a clinical sleep laboratory setting
    • Success: AHI < 10 events/h with 50% reduction
• RCMP test:
  • Prediction:
    • Success n=10
    • Failure n=15
    • Inconclusive n=8

n = 25 commenced MAD: treatment outcome prediction

RCMP – clinical validation

• RCMP results (n=25 commenced MAD):
  • n = 3 misclassified
  • sensitivity 81.8%
  • specificity 92.9%
  • positive predictive value 90%
  • negative predictive value 86.7%

But:
• High rate of inconclusive RCMP tests: 24% (n=8/33)
• PSG: time consuming and labor intensive

alternative (direct, dynamic evaluation)?
Drug-induced sleep endoscopy (DISE)

- Evaluation of upper airway anatomy
- Dynamic
- Real-time
- Collapsible segment
- Site of obstruction and snoring
Drug-induced sleep endoscopy (DISE)
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LEVEL
- Palate
- Oropharynx
- Tongue base
- Hypopharynx
- Epiglottis

DEGREE
- None
- Partial
- Complete

Introduction

**MAD / RCMP**

**DISE**

**Conclusions**

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**Drug-induced sleep endoscopy (DISE)**

- **LEVEL**
  - P: Palate
  - OP: Oropharynx
  - TB: Tongue base
  - HP: Hypopharynx
  - E: Epiglottis

- **DEGREE**
  - None
  - Partial
  - Complete

- **CONFIGURATION**
  - Anteroposterior
  - Laterolateral
  - Circular

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Drug-induced sleep endoscopy (DISE)

**Introduction**

Drug-induced sleep endoscopy (DISE) is a diagnostic tool used to assess the sleep-disordered breathing in patients taking medications. It involves the use of endoscopy to visualize the upper airway and identify any obstructions or pathologies that may contribute to sleep apnea or other respiratory issues.

**MAD / RCMP**

The acronym MAD stands for Multiple Apnea Diagnostic, while RCMP refers to Respiratory Compromise Management. These terms are often used to describe the approach to managing patients with sleep-disordered breathing.

**DISE**

Drug-induced sleep endoscopy (DISE) is a term used to describe the specific type of endoscopy used in the context of monitoring and assessing the effects of medications on sleep-disordered breathing.

**Conclusions**

Drug-induced sleep endoscopy (DISE) has been shown to be a valuable tool in the assessment and management of sleep-disordered breathing, particularly in patients taking medications that may affect sleep structure. Further research and clinical trials are needed to fully understand the role of DISE in patient care.

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DISE-assisted RCMP titration
DISE-assisted RCMP

- **Feasibility assessment**
- **Elimination of**
  - Upper airway collapse
  - Snoring
  - Oxygen desaturation
- **ETPP determination**

Vanderveken OM, Vroegop AV, Van de Heyning PH, Braem MJ. Drug-induced sleep endoscopy completed with a simulation bite approach for the prediction of the outcome of treatment of obstructive sleep apnea with mandibular repositioning appliances. *Operative techniques in otolaryngology - head and neck surgery* 2011
DISE-assisted RCMP

- **n = 10**
  - **n = 8**, ETPP determination
  - **n = 1**, RCMP removed due to clenching
  - **n = 1**, beyond max. protrusion

- Dose-dependent effect of protrusion and retrusion
- Large ETPP range, to be determined individually

<table>
<thead>
<tr>
<th>RCMP-id</th>
<th>Retrusion to ETPP</th>
<th>ROM</th>
<th>Retrusion to ETPP % of ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCMP-1</td>
<td>6.5</td>
<td>7.5</td>
<td>87</td>
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<tr>
<td>RCMP-2</td>
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<tr>
<td>RCMP-3</td>
<td>†</td>
<td>8.0</td>
<td>†</td>
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<td>RCMP-4</td>
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<td>RCMP-5</td>
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<td>RCMP-6</td>
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<td>RCMP-7</td>
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<tr>
<td>RCMP-8</td>
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<tr>
<td>RCMP-9</td>
<td>4.0</td>
<td>11.0</td>
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</tr>
<tr>
<td>RCMP-10</td>
<td>4.3</td>
<td>8.2</td>
<td>52</td>
</tr>
<tr>
<td>RCMP-Mean</td>
<td>7.3 ± 2.5</td>
<td>9.9 ± 3.4</td>
<td>67 ± 18.9</td>
</tr>
</tbody>
</table>
It is feasible to perform RCMP during DISE and to determine the ETPP.

The predictive value of the ETPP, as determined during DISE, has to be evaluated (in comparison with RCMP PSG titration and/ or conventional titration).

DISE-assisted RCMP
Conclusions

- Remotely controlled mandibular positioner (RCMP)
  - RCMP = promising tool
  - Allows to determine the effective target protrusive position (ETPP)
  - Predicted therapeutic outcome with mandibular advancement device (MAD) with significant accuracy during PSG
  - Greater treatment success than conventional titration
  - Prior to MAD fitting
  - Feasible to perform titration during DISE
    - Direct, quick, dynamic assessment
• Remotely controlled mandibular positioner (RCMP)
• Titration tool
• Patient selection tool