Remotely controlled mandibular positioning

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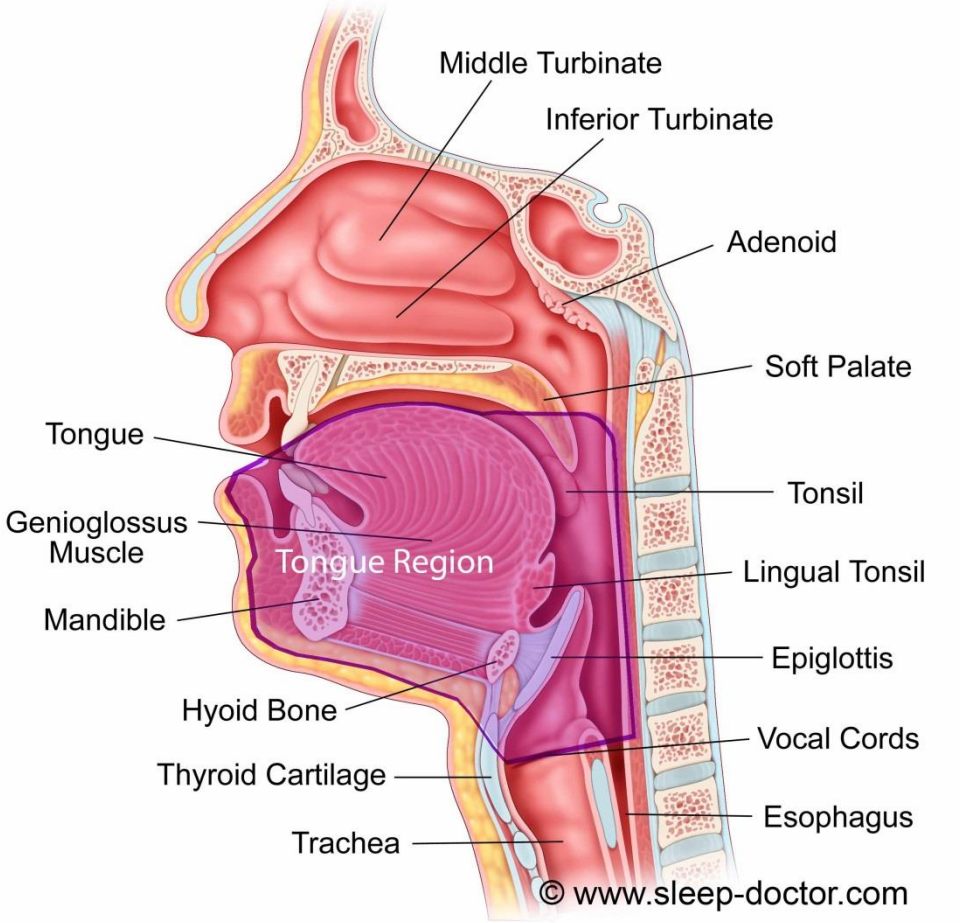
Obstructive sleep apnea (OSA) - upper airway

- Collapsible segment



Anatomical OSA traits

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

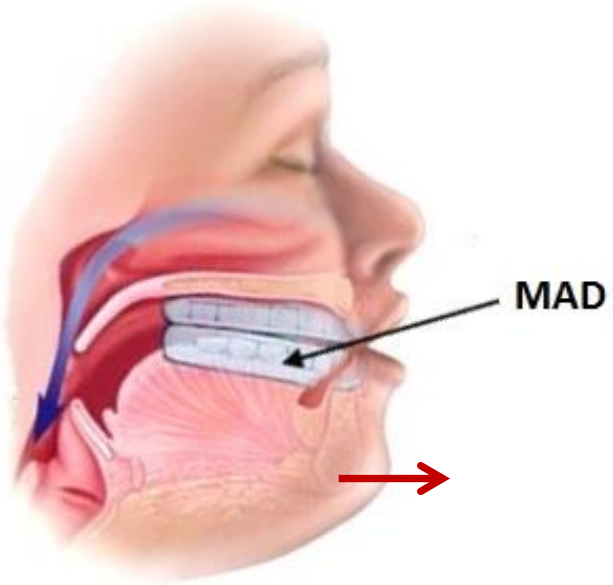
- Diagnostic evaluation of anatomy:
  - Drug-induced sleep endoscopy (DISE)

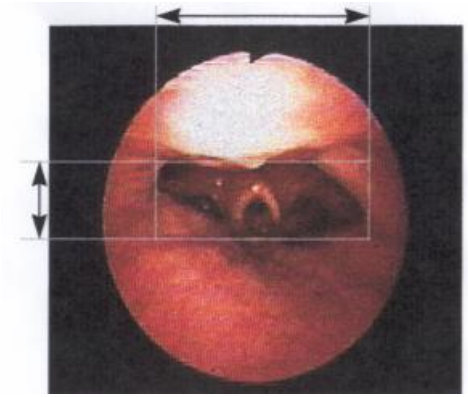
OSA treatment

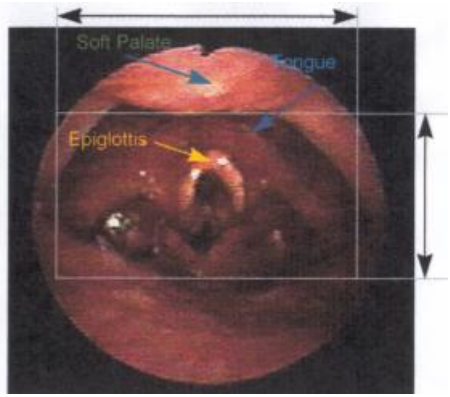
- General measures/ lifestyle changes
  - Weight reduction
  - Avoidance of alcohol consumption
  - No sedatives
  - Smoking cessation
- Non-surgical
  - Continous positive airway pressure (CPAP)
  - **Mandibular advancement device (MAD)**
  - Positional therapy
- Surgical
  - ENT surgery
  - Oral & Maxillofacial surgery

MAD

- Mandibular advancement devices (MAD) are the most common type of oral appliances
  - Advance the mandible during the night
    - Increase the upper airway volume

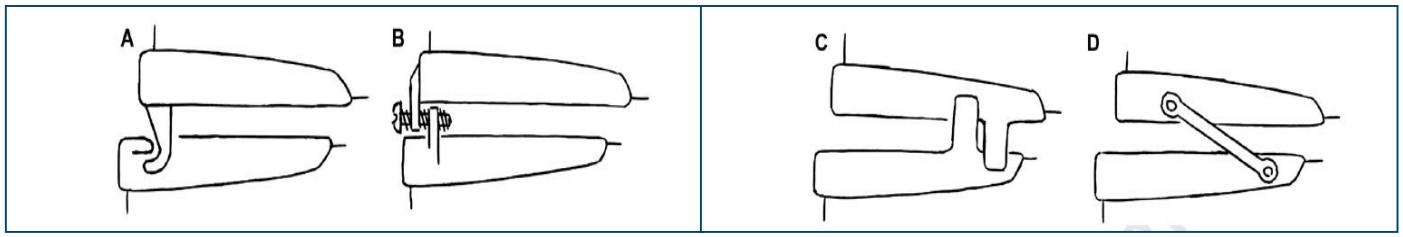






Titratable MAD – Target protrusion

- 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



Dieltjens M, Vanderveken OM, Heyning PH, Braem MJ. Current opinions and clinical practice in the titration of oral appliances in the treatment of sleep-disordered breathing. Sleep medicine reviews. 2012;16:177-85

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)

Dieltjens M, Vanderveken OM, Heyning PH, Braem MJ. Current opinions and clinical practice in the titration of oral appliances in the treatment of sleep-disordered breathing. Sleep medicine reviews. 2012;16:177-85

RCMP

Historical prototypes:

Hydraulic

Motorized

Commercially available:

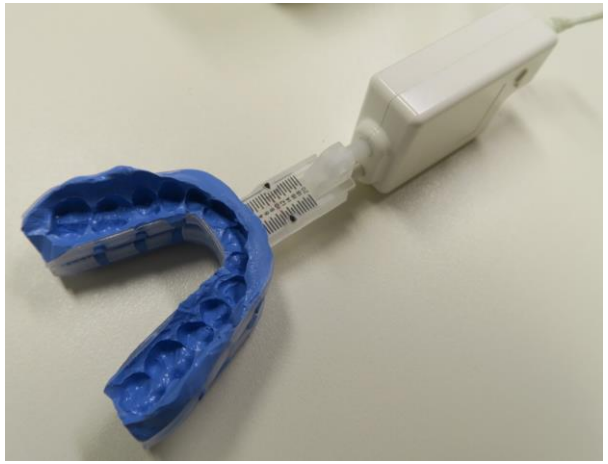
Motorized

- Remotely controlled
- Feedback controlled

Kastoer C, Dieltjens M et al. The Use of Remotely Controlled Mandibular Positioner as a Predictive Screening Tool for Mandibular Advancement Device Therapy in Patients with Obstructive Sleep Apnea through Single-Night Progressive Titration of the Mandible: A Systematic Review. J Clin Sleep Med 2016; 12(10): 1411-1421.

RCMP

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



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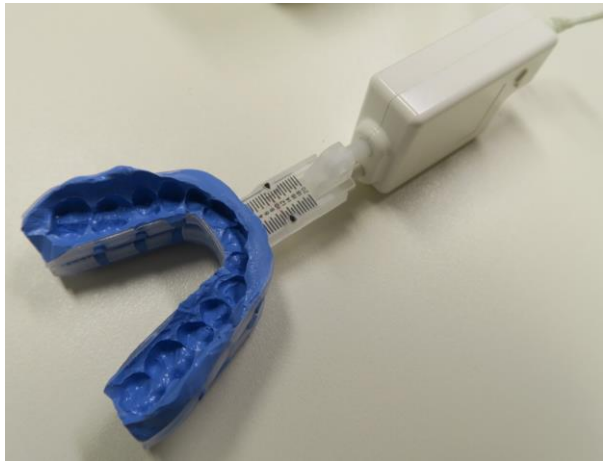
RCMP

- 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



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RCMP

- 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

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RCMP during PSG

Authors, year of publication	Positive Predictive Value
Pételle et al., 2002	100%
Tsai et al., 2004	90%
Dort et al., 2006	80%
Remmers et al., 2013	94%
Remmers et al., 2015 **[abstract]**	90%

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RCMP during PSG

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

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

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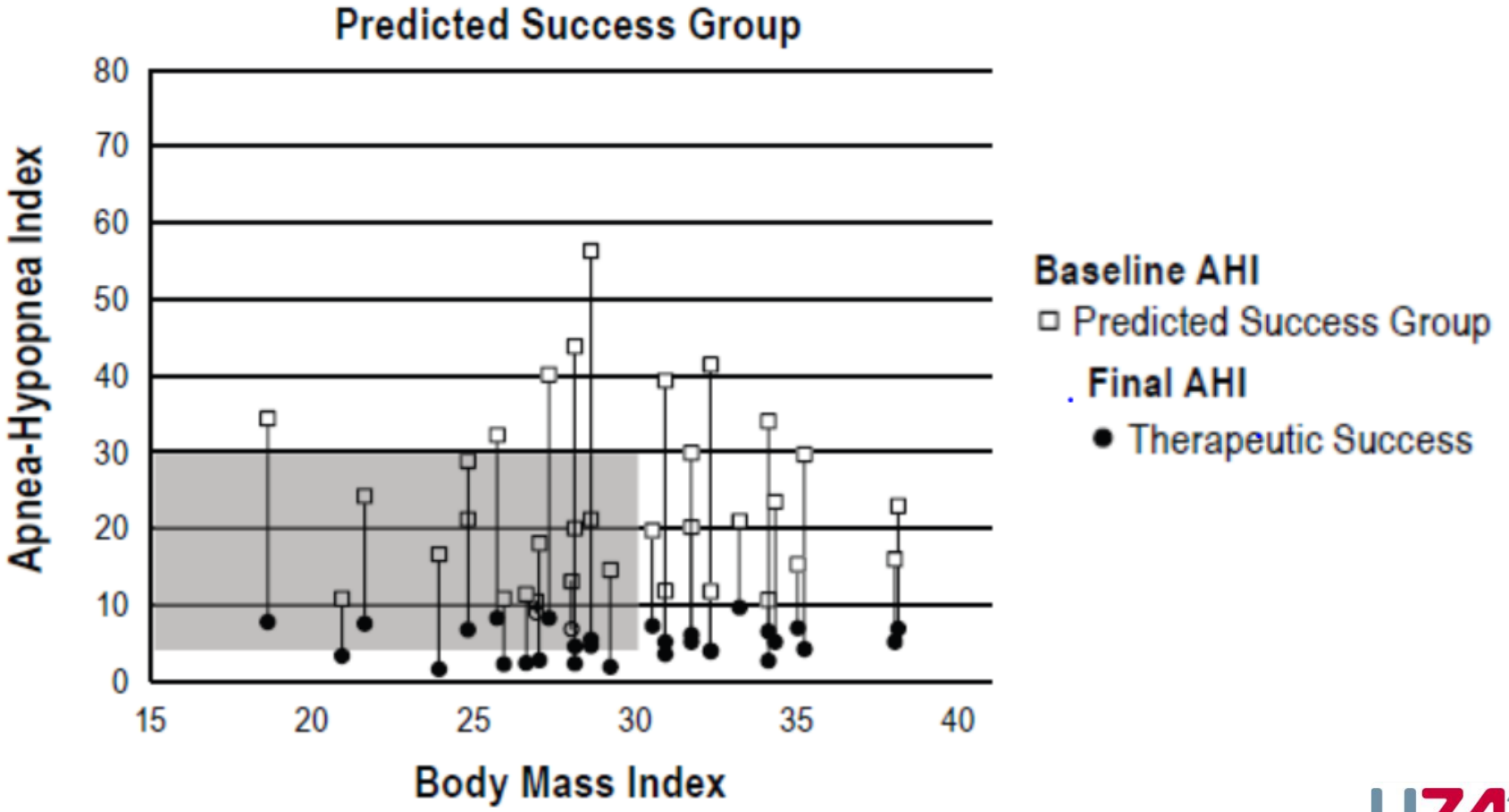
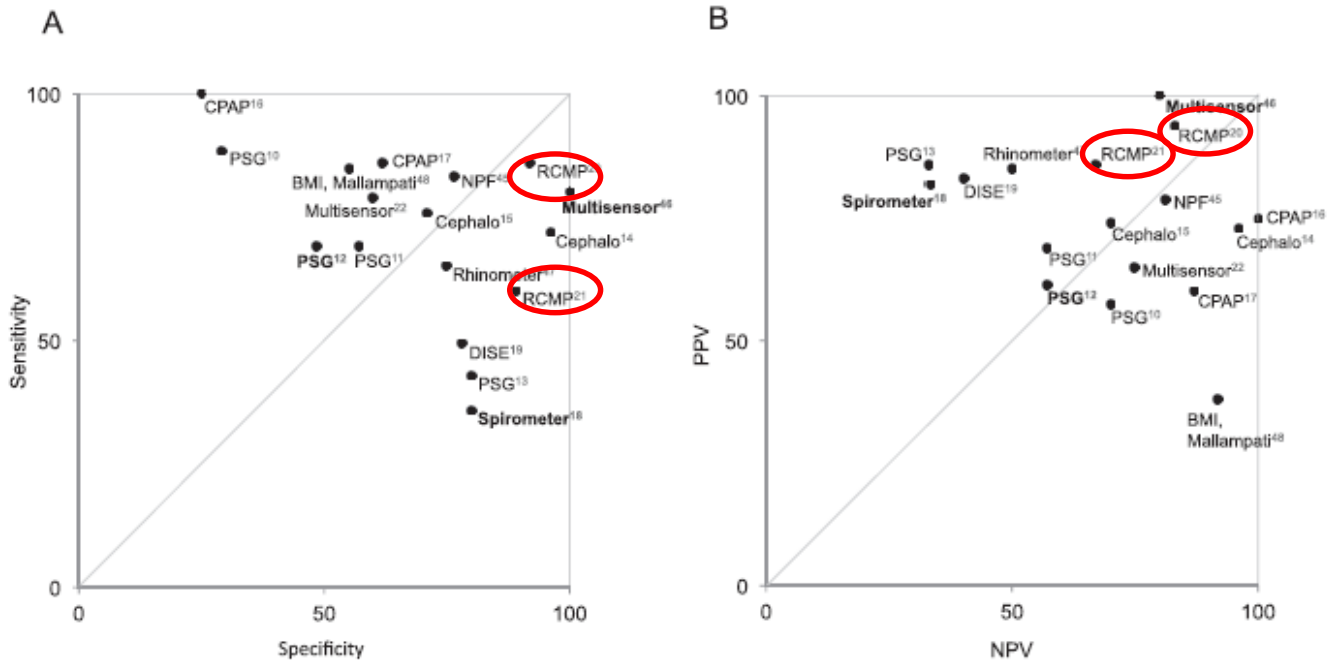
RCMP during PSG



Remmers J, Charkhandeh S, Grosse J, Topor Z, Brant R, Santosham P, Bruehlmann S. Remotely controlled mandibular protrusion during sleep predicts therapeutic success with oral appliances in patients with obstructive sleep apnea. *Sleep* 2013; 36: 1517-25

RCMP during PSG



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

Okuno K., et al. "Prediction of oral appliance treatment outcomes in obstructive sleep apnea: A systematic review." Sleep Med Rev 2016; 30: 25-33.

RCMP – clinical validation

- 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

Sutherland K, Ngiam J, Cistulli PA. Performance of remotely controlled mandibular protrusion sleep studies for prediction of oral appliance treatment response. J Clin Sleep Med. 2016 Nov 28.

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:

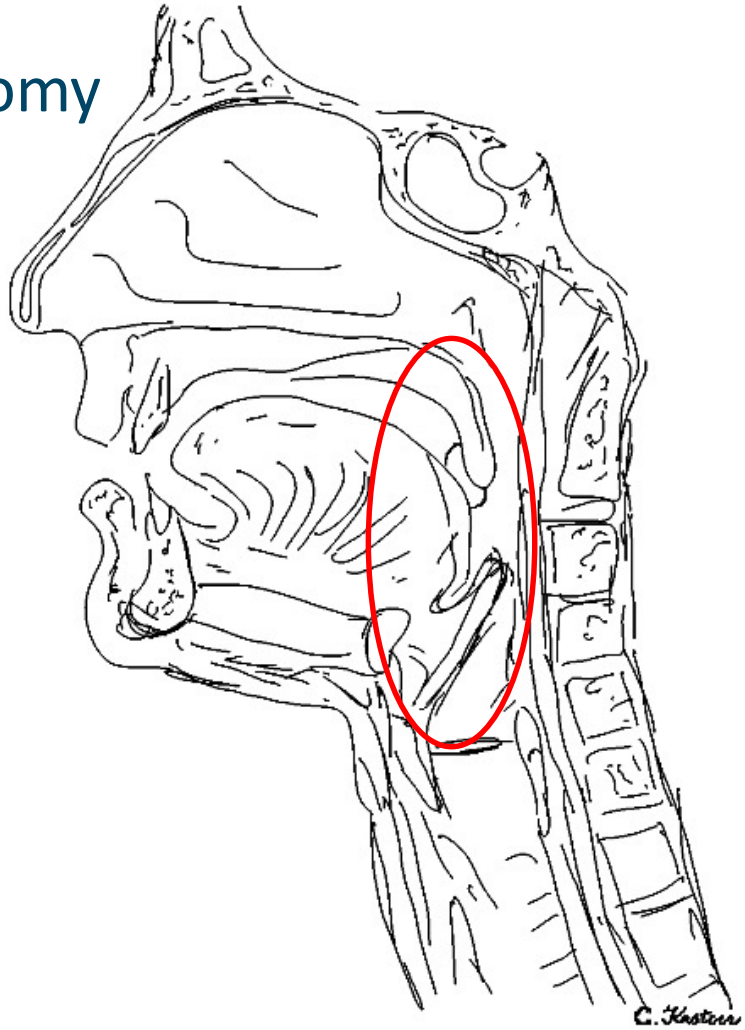
- High rate of inconclusive RCMP tests: **24%** (n=**8**/33)
- PSG: time consuming and labor intensive

→ **alternative (direct, dynamic evaluation)?**

Sutherland K, Ngiam J, Cistulli PA. Performance of remotely controlled mandibular protrusion sleep studies for prediction of oral appliance treatment response. J Clin Sleep Med. 2016 Nov 28.

Drug-induced sleep endoscopy (DISE)

- Evaluation of upper airway anatomy
- Dynamic
- Real-time
- Collapsible segment
- Site of obstruction and snoring



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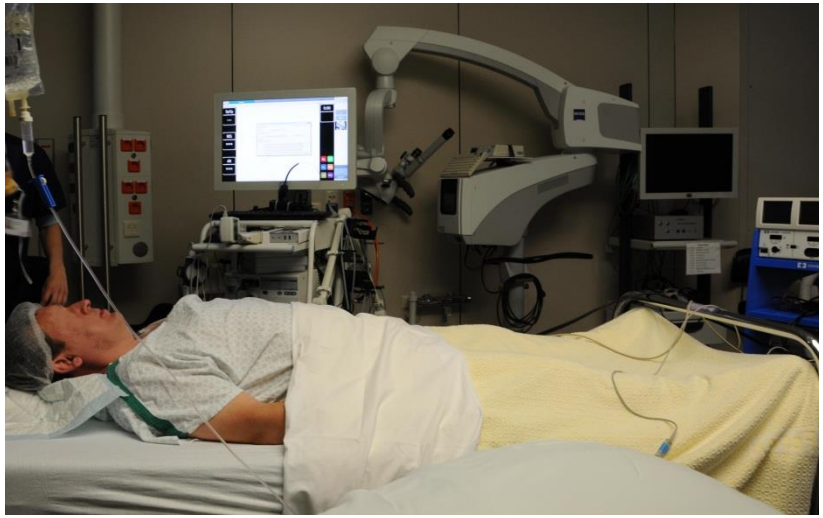

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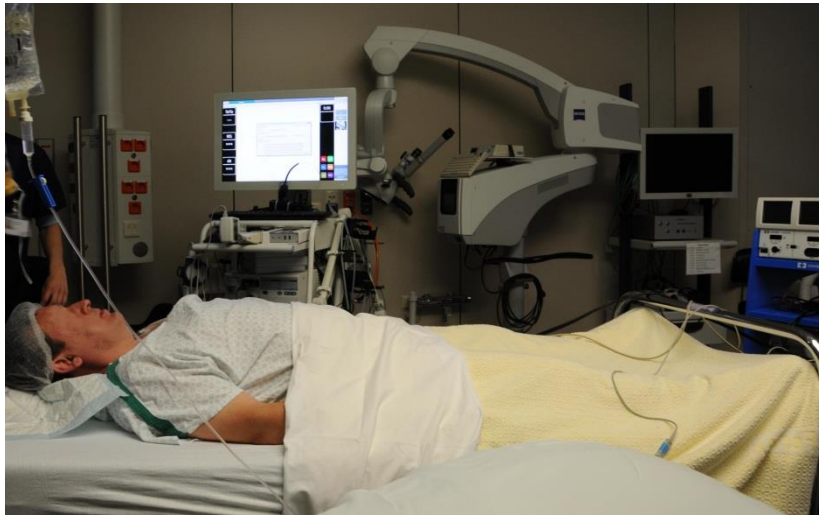

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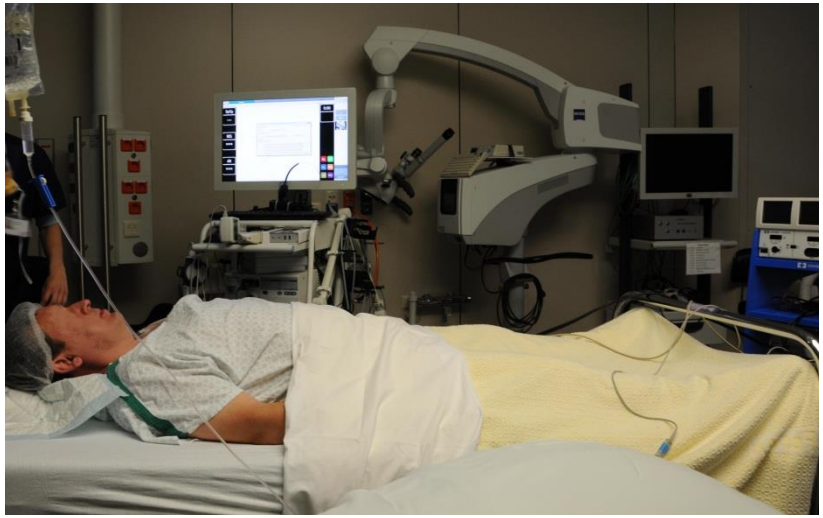

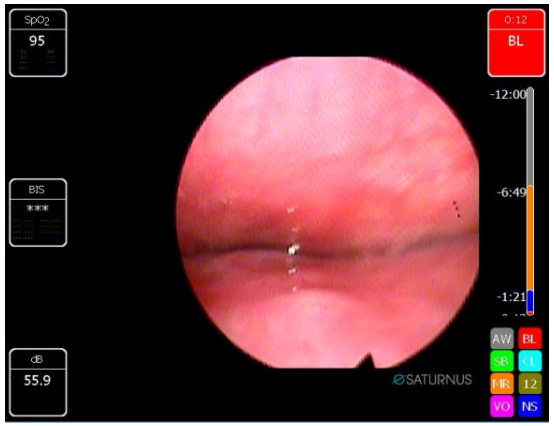

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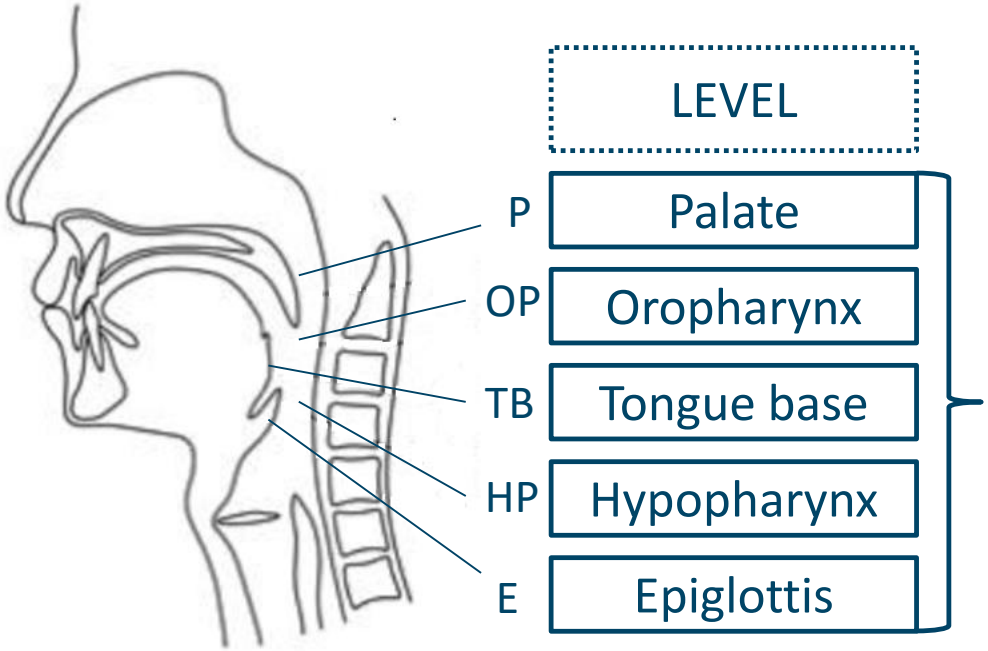

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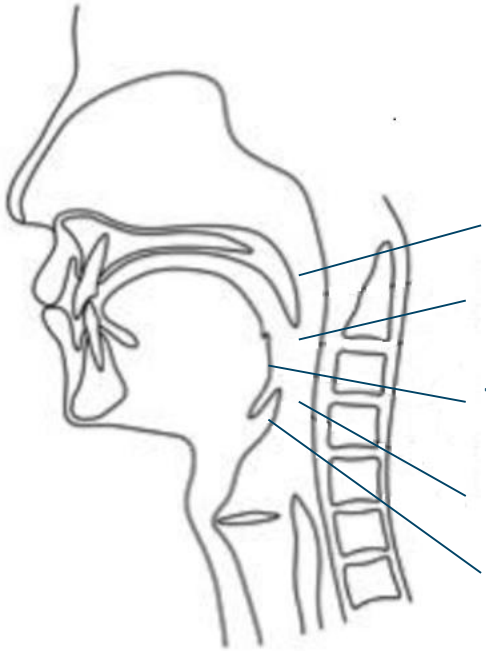

LEVEL		DEGREE
P	Palate	None
OP	Oropharynx	Partial
TB	Tongue base	Complete
HP	Hypopharynx	
E	Epiglottis	

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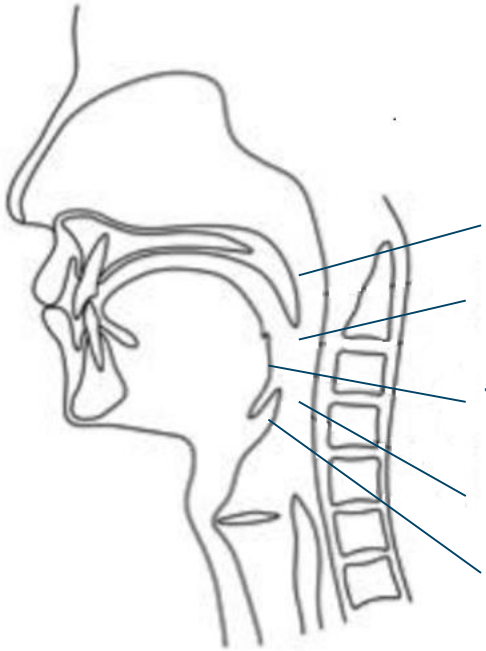

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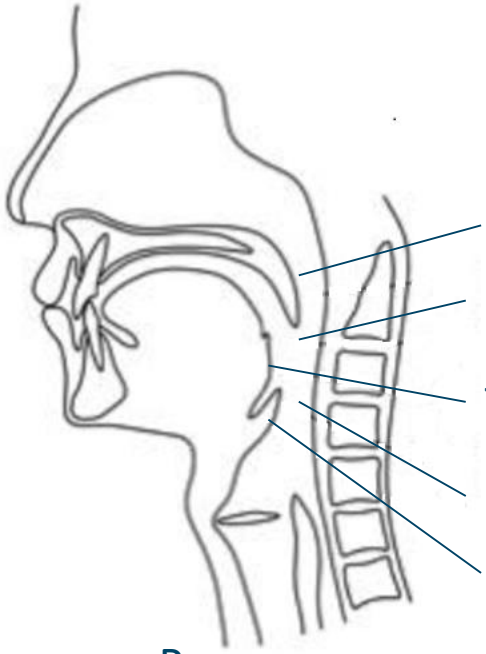

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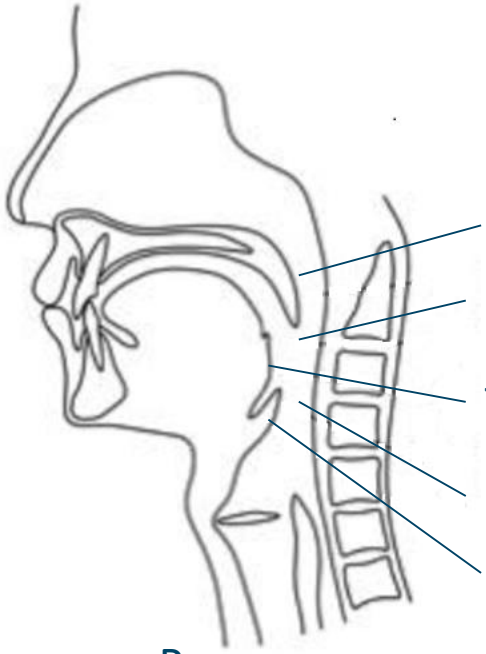

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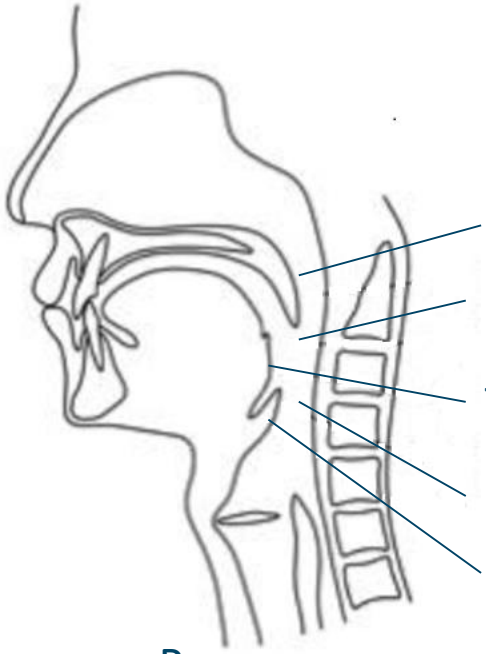

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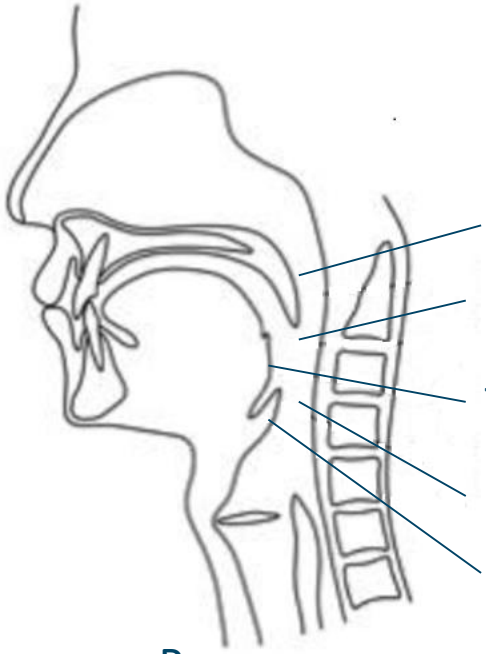

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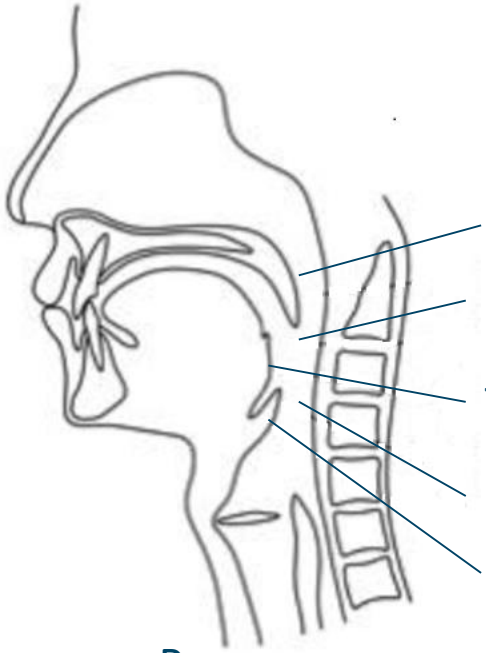

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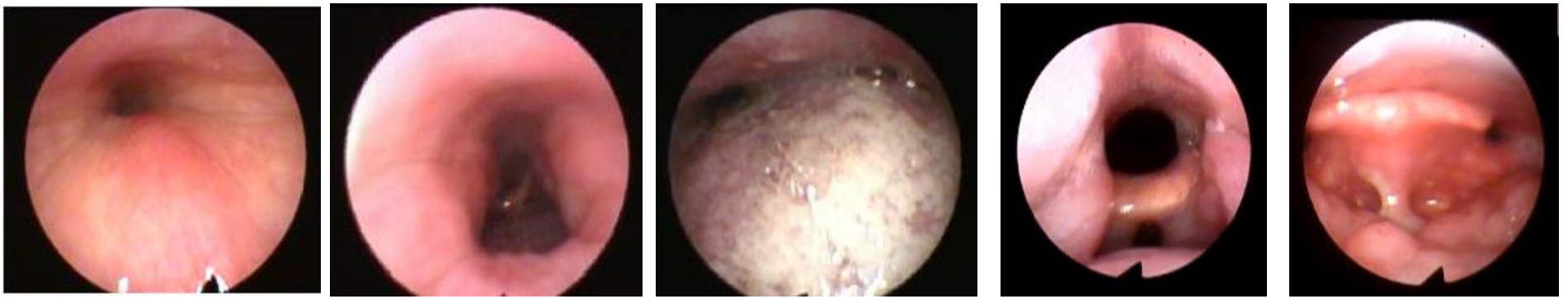

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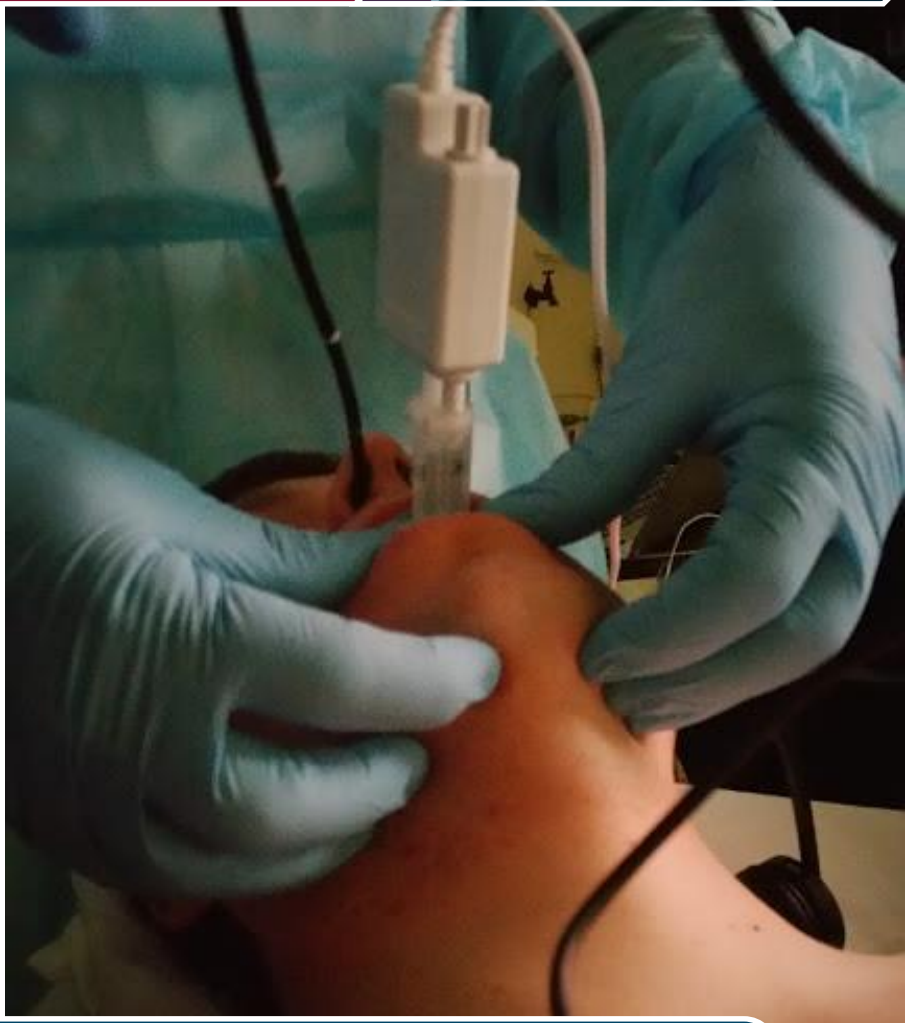
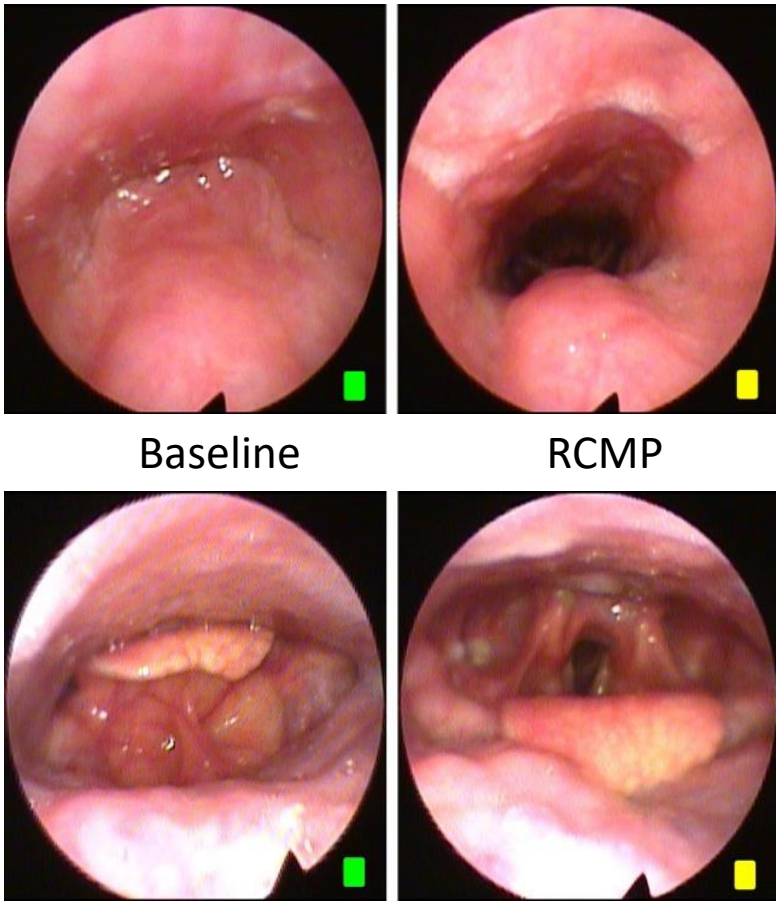


DISE-assisted RCMP titration

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

RCMP-id	Retrusion to ETPP	ROM	Retrusion to ETPP %of ROM
RCMP-1	6.5	7.5	87
RCMP-2	9.0	13.5	67
RCMP-3	†	8.0	†
RCMP-4	10.8	13.0	83
RCMP-5	10.1	14.0	72
RCMP-6	$	3.5	$
RCMP-7	7.3	8.3	88
RCMP-8	6.2	12.2	51
RCMP-9	4.0	11.0	37
RCMP-10	4.3	8.2	52
RCMP-Mean	**7.3 ± 2.5**	**9.9 ± 3.4**	**67 ± 18.9**

Kastoer C, Dieltjens M et al. Remotely Controlled Mandibular Positioning During Drug-Induced Sleep Endoscopy Toward Mandibular Advancement Device Therapy: Feasibility and Protocol. *Journal of Clinical Sleep Medicine 2018 14(8):1409-1413*

DISE-assisted RCMP

➡ 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).

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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

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Conclusions

- **Remotely controlled mandibular positioner (RCMP)**
  - **Titration tool**
  - **Patient selection tool**

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