Complexity and Efficacy of Mandibular Advancement Splints: Understanding their Mode of Action

Commentary on Lettieri et al. Comparison of adjustable and fixed oral appliances for the treatment of obstructive sleep apnea. *J Clin Sleep Med* 2011;7:439-445.

Fernanda Ribeiro de Almeida, D.D.S., Ph.D.

Department of Oral Health Sciences, University of British Columbia, Vancouver, BC, Canada

Mandibular advancement splints (MAS) are used to treat obstructive sleep apnea (OSA) patients by maintaining the lower jaw in a forward position. MAS are now widely used as primary therapy for the treatment of snoring and mild-moderate OSA, and also for severe OSA patients who are unwilling or unable to tolerate CPAP.¹ Although CPAP therapy is consistently more effective, patients tolerate MAS better.^{2,3} The superior patient satisfaction associated with the use of MAS reflects the relative convenience of this form of treatment. Despite the wide use and acceptance of this type of therapy, the MAS mode of action is not fully understood. In awake patients, imaging studies have shown that MAS enlarge the upper airway dimensions by specifically increasing the lateral dimensions of the velopharynx.^{4,5} But one should question if the design and complexity of a MAS may influence the efficacy of this therapy. In this issue of the *JCSM*, Lettieri and collaborators (pp. 439-445) compared the efficacy rates between fixed and titratable appliances. This article is important since previous studies have often underestimated the impact of titration of MAS and compared trials which evaluate fixed or single jaw position appliances to titratable appliances. In addition the cost-benefit analysis of therapies is often overlooked, and the evaluation of simple and cheaper therapies is necessary.

In a systematic review of types of MAS, Ahrens and colleagues⁶ concluded that there is no one MAS design feature that influences treatment efficacy, although efficacy does depend on the method used for fabrication (pre-fabricated or custom-made), the degree of mandibular protrusion and the type of MAS (fixed or titratable). In this review all the studies comparing custom-made, titratable appliances have shown similar results, implying that specific design does not influence appliance efficacy, and that the appliances' modes of action are likely very similar. Vanderveken and collaborators⁷ have shown that pre-fabricated, off-the-shelf appliances are less effective and less accepted by patients and therefore should not be used either as a therapeutic option or as a screening tool to predict MAS responders. Titratable or adjustable appliances allow progressive protrusion of the mandible, and the amount of anteroposterior mandibular movement varies considerably between patients. Previous studies have shown that MAS efficacy is related to the amount of mandibular advancement,⁸⁻¹⁰ and determining the op-

timal degree of mandibular advancement is the most important step when using MAS therapy successfully.^{11,12} As an analogy, titration of MAS is very similar to CPAP. The amount of pressure required for each patient cannot be pre-determined based on OSA severity or craniofacial characteristics; therefore, to determine the amount of CPAP pressure required for each patient, there is a need of a titration night or use of an auto-CPAP. The further complexities of CPAP, such as humidification, BiPAP, or C-Flex have not translated into more effective treatments. In other words, the complexity of CPAP required is mainly related to the adjustability of the pressure, a unique pressure of 8 is not adequate for everyone, and the complexity required for effective MAS is mainly related to it being custom-made and allowing for titration/protrusion of the mandible.

Currently there are several published randomized controlled trials (RCTs) comparing MAS to CPAP. Most of these RCTs have found that MAS and CPAP have a similar impact on daytime sleepiness and quality of life.^{2,13-15} Despite MAS being inferior to CPAP in reducing the AHI, it is hypothesized that a higher compliance to MAS likely translates into a similar adjusted AHI¹⁶ and effectiveness. However two other studies, Engleman¹⁷ and Lam,¹⁸ have shown an inferiority of MAS compared to CPAP. It is important to understand that these two studies, which are the only ones that are controversial in terms of treatment outcomes, have used a fixed, non-titratable, single jaw position appliance for their patients. Previous reports on effective single jaw positioners have proposed that, if this type of appliance is used, there should be the opportunity to remake these devices with further mandibular advancement, which represents titration with multiple appliances.¹⁹ The article published in this issue of *JCSM* reiterates that in future meta-analysis of treatment outcomes, fixed single-jaw positioners should not be evaluated together with titratable MAS, since these therapies have very different outcomes.

A second and important point to discuss is the cost-benefit analysis of a treatment. It is known that titratable appliances require consultation and adjustments provided by a dentist skilled in sleep medicine and that their fabrication is more expensive. Despite fixed MAS being typically less expensive and requiring a shorter period of adjustment, they are significantly less effective. Patients' economic status may be a factor in treat-

ment choice. A patient-tailored treatment is synonymous with good medicine, and lifelong therapies are very dependent on the patient's cooperation and adherence. We believe that it is important to include patients in the decision-making process regarding their treatment and also to offer more than one type of therapy.

REFERENCES

1. Kushida CA, Morgenthaler TI, Littner MR, et al. Practice parameters for the treatment of snoring and obstructive sleep apnea with oral appliances: an update for 2005. *Sleep* 2006;29:240-3.
2. Gagnadoux F, Fleury B, Vielle B, et al. Titrated mandibular advancement versus positive airway pressure for sleep apnoea. *Eur Respir J* 2009;34:914-20.
3. Ferguson KA, Ono T, Lowe AA, Keenan SP, Fleetham JA. A randomized crossover study of an oral appliance vs nasal-continuous positive airway pressure in the treatment of mild-moderate obstructive sleep apnea. *Chest* 1996;109:1269-75.
4. Chan AS, Sutherland K, Schwab RJ, et al. The effect of mandibular advancement on upper airway structure in obstructive sleep apnoea. *Thorax* 2010;65:726-32.
5. Ryan CF, Love LL, Peat D, Fleetham JA, Lowe AA. Mandibular advancement oral appliance therapy for obstructive sleep apnoea: effect on awake calibre of the velopharynx. *Thorax* 1999;54:972-7.
6. Ahrens A, McGrath C, Hagg U. Subjective efficacy of oral appliance design features in the management of obstructive sleep apnea: a systematic review. *Am J Orthod Dentofacial Orthop* 2010;138:559-76.
7. Vanderveken OM, Devolder A, Marklund M, et al. Comparison of a custom-made and a thermoplastic oral appliance for the treatment of mild sleep apnea. *Am J Respir Crit Care Med* 2008;178:197-202.
8. de Almeida FR, Bittencourt LR, de Almeida CI, Tsuiiki S, Lowe AA, Tufik S. Effects of mandibular posture on obstructive sleep apnea severity and the temporomandibular joint in patients fitted with an oral appliance. *Sleep* 2002;25:507-13.
9. Kato J, Isono S, Tanaka A, et al. Dose-dependent effects of mandibular advancement on pharyngeal mechanics and nocturnal oxygenation in patients with sleep-disordered breathing. *Chest* 2000;117:1065-72.
10. Kuna ST, Woodson LC, Solanki DR, Esch O, Frantz DE, Mathru M. Effect of progressive mandibular advancement on pharyngeal airway size in anesthetized adults. *Anesthesiology* 2008;109:605-12.
11. Fleury B, Rakotonanahary D, Petelle B, et al. Mandibular advancement titration for obstructive sleep apnea: optimization of the procedure by combining clinical and oximetric parameters. *Chest* 2004;125:1761-7.
12. Almeida FR, Parker JA, Hodges JS, Lowe AA, Ferguson KA. Effect of a titration polysomnogram on treatment success with a mandibular repositioning appliance. *J Clin Sleep Med* 2009;5:198-204.
13. Randerath WJ, Heise M, Hinz R, Ruehle KH. An individually adjustable oral appliance vs continuous positive airway pressure in mild-to-moderate obstructive sleep apnea syndrome. *Chest* 2002;122:569-75.
14. Tan YK, L'Estrange PR, Luo YM, et al. Mandibular advancement splints and continuous positive airway pressure in patients with obstructive sleep apnoea: a randomized cross-over trial. *Eur J Orthod* 2002;24:239-49.
15. Barnes M, McEvoy RD, Banks S, et al. Efficacy of positive airway pressure and oral appliance in mild to moderate obstructive sleep apnea. *Am J Respir Crit Care Med* 2004;170:656-64.
16. Ravesloot MJ, de Vries N. Reliable calculation of the efficacy of non-surgical and surgical treatment of obstructive sleep apnea revisited. *Sleep* 2011;34:105-10.
17. Engleman HM, McDonald JP, Graham D, et al. Randomized crossover trial of two treatments for sleep apnea/hypopnea syndrome: continuous positive airway pressure and mandibular repositioning splint. *Am J Respir Crit Care Med* 2002;166:855-9.
18. Lam B, Sam K, Mok WY, et al. Randomised study of three non-surgical treatments in mild to moderate obstructive sleep apnoea. *Thorax* 2007;62:354-9.
19. Marklund M, Stenlund H, Franklin KA. Mandibular advancement devices in 630 men and women with obstructive sleep apnea and snoring: tolerability and predictors of treatment success. *Chest* 2004;125:1270-8.

CITATION

Almeida FR. Complexity and efficacy of mandibular advancement splints: understanding their mode of action. *J Clin Sleep Med* 2011;7(5):447-8.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication August, 2011

Accepted for publication August, 2011

Address correspondence to: Fernanda R. Almeida, 2199 Wesbrook Mall, Vancouver BC, Canada V6T 1Z3; Tel: 1-604-822-3623; Fax: 1-604-822-3562; E-mail: falmeida@dentistry.ubc.ca

DISCLOSURE STATEMENT

Dr. Almeida has indicated no financial conflicts of interest.