

Continuous Positive Airway Pressure Titration: Manual, Automatic, or Empirical?

J.F. Masa

Sección de Neumología, Hospital San Pedro de Alcántara, Cáceres, Spain.

Sleep apnea hypopnea-syndrome is a common diagnosis in 4% of men and 2% of women,¹ and prevalence increases with age.² The most telling symptom is excessive daytime sleepiness³ and the main repercussions are traffic accidents^{4,7} and increased cardiovascular risk related to hypertension.^{2,8,9}

The first-line treatment for this syndrome is continuous positive airway pressure (CPAP).¹⁰ According to Spanish¹¹ and international¹² standards, CPAP treatment requires polysomnographic titration to determine the optimal CPAP pressure after a diagnostic polysomnographic study has been completed. In polysomnographic titration, the technician increases pressure manually until apneic episodes cease. The problem with this titration process is that it is expensive and consumes a great deal of polysomnographic time that could be used to perform diagnostic studies, meaning that CPAP titration has a negative impact on waiting lists.

Various solutions have been proposed as alternatives to conventional titration: "partial-night" trials,¹³ automatic titration with auto-CPAP devices,^{14,15} and pressure prediction using mathematical formulas.^{16,17}

Split- or partial-night studies use half the night for diagnosis and the rest of the time for titration. Their main drawback is that the second half of the night is often insufficient to complete titration. Therefore, using a shorter period for diagnosis and a longer one for titration has been proposed.^{18,19} However, a second disadvantage of split-night CPAP titration is that during the first part of the night (diagnosis) the severity of the sleep apnea-hypopnea syndrome may not be detected because apneic episodes predominate toward the end of a night's sleep. For these reasons it is recommended to use split-night titration with patients who have more severe symptoms (and who are theoretically more seriously ill). Even though this method eliminates the need for a separate diagnostic study, however, polysomnography itself must still be performed.

Auto-CPAP devices detect snoring, upper airway flow and flow limitation and react by increasing or decreasing pressure in accordance with algorithms. Some authors have suggested that these devices can be used unattended, as an alternative to conventional polysomnography, for

titration in "virgin" patients (never previously treated with CPAP). However, that assertion is based on only 3 case series,²⁰⁻²² one of which had negative results,²¹ and a single randomized controlled trial.²³ This last study demonstrated clinical improvement and good compliance with CPAP, but unfortunately, no polysomnographic studies were performed during follow up in that trial, meaning that no data on the apnea-hypopnea index or other polysomnographic variables were available for the patients treated at pressures set by way of auto-CPAP titration. Therefore, the evidence in favor of applying this method in clinical practice is considered inadequate.²⁴

One study estimated the optimal pressure using a model that took into consideration the apnea-hypopnea index, body-mass index, and neck circumference.¹⁶ The pressure established by this mathematical approach fell within 2 cm H₂O above or below the optimal pressure set by polysomnography for 83% of the patients, and the authors recommended using the estimated pressure as a starting point to optimize and shorten the conventional polysomnographic titration time. A recent study enrolling 18 patients demonstrated the efficacy of CPAP relying on mathematical titration (based on an algorithm) plus self-adjustment by the patients at home.¹⁷ During a 5-week follow-up period, the clinical and polysomnographic results with the novel titration procedure were similar to those of CPAP with conventional titration. This study undoubtedly opens up the possibility of a "semi-empirical" titration approach whose importance rests on savings in polysomnography. Like titration by auto-CPAP, this alternative might shorten waiting lists and reduce costs as well as provide immediate treatment for diagnosed patients (who would not have to wait for a titration study) at an even lower cost than auto-CPAP titration (as no additional device would be needed). However, the study left unanswered questions. Although the trial used a crossover design, the sample was small—18 patients—and as a result statistical power was not very high. Moreover, the optimal final pressure for the group using the mathematically estimated pressure plus home adjustment was so high (10.1±2.0) that one wonders if it would lead to a higher rate of side effects and lower compliance over the long term in a larger population of patients.

CPAP titration by polysomnography surely has its days numbered in the short- or medium-term owing to either greater use of auto-CPAP devices and/or reliance on mathematically estimated titration with later individualized

Correspondence: Dr. J.F. Masa.
Servicio de Neumología, Hospital San Pedro de Alcántara.
Avda. Pablo Naranjo, s/n. 10005 Cáceres, España.

adjustment. Nevertheless, before this happens larger randomized controlled trials are needed to demonstrate that CPAP treatment based on automatic titration or algorithmic estimation is effective and equivalent to that based on conventional titration by polysomnography, with effectiveness demonstrated in terms of both symptoms and polysomnographic parameters.

Future studies of auto-CPAP must also settle the question of how optimal pressure is chosen. In general, the pressure used is the one suggested by the 95th percentile, that is, the level that covers 95% of the study period and whose value is provided by the auto-CPAP device itself. However, authors who have estimated the pressure by visual inspection of raw data from the device (90th percentile)^{25,26} have achieved effective treatment at lower pressures than those recommended based on the 95th percentile.²⁷ Another question that must be answered is whether unattended automatic titration can be carried out in a patient's home in a single night. Series²⁰ suggests that the optimal pressure based on recordings stored in the auto-CPAP device over a week or two can be used,²⁰ but the problem with this is that the cost-benefit ratio worsens if every titration keeps an auto-CPAP device tied up for so much time. Furthermore, not all auto-CPAP devices measure the same parameters, nor do they respond in the same way or with the same efficacy when hypopneas appear.²⁸ As a result, future studies must also establish which types of auto-CPAP devices are useful for automatic titration.

Several trials are being carried out to answer these questions. In Spain, a randomized controlled trial enrolling a very large population of 360 patients is under way to assess the efficacy of CPAP titrated automatically in a single night in the patient's home (with optimal pressure estimated based on visual inspection of raw data) and CPAP with the pressure level initially estimated by an algorithm and later adjusted at home. Both methods are compared with conventionally titrated CPAP.²⁹ We shall have to wait and see.

REFERENCES

- Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle aged adults. *N Engl J Med* 1993;328:1230-5.
- Durán J, Esnaola S, Rubio R, Iztueta A. Obstructive sleep apnea-hypopnea and related clinical features in a population-based sample of subjects aged 30 to 70 years. *Am J Respir Crit Care Med* 2001;163:685-9.
- Barbé F, Mayorals LR, Durán J, Masa JF, Maimó A, Montserrat JM, et al. Treatment with continuous positive airway pressure is not effective in patients with sleep apnea but no daytime sleepiness. *Ann Intern Med* 2001;134:1015-23.
- Masa JF, Rubio M, Findley LJ, and the Cooperative Group. Habitually sleepy drivers have a high frequency of automobile crashes associated with respiratory disorders during sleep. *Am J Respir Crit Care Med* 2000;162:1407-12.
- Masa JF, Rubio M, Findley LJ, Riesco JA, Sojo A, Disdier C. Los conductores somnolientos tienen alta frecuencia de accidentes de tráfico asociados a un exceso de RERAS (respiratory effort-related arousal). *Arch Bronconeumol* 2003;39:153-8.
- Terán-Santos J, Jiménez Gómez A, Cordero-Guevara J, and the Cooperative Group Burgos-Santander. The association between sleep apnea and the risk of traffic accidents. *N Engl J Med* 1999;340:847-51.
- Barbé F, Pericás J, Muñoz A, Findley L, Antó JM, Agustí AGN. Automobile accidents in patients with sleep apnea syndrome. *Am J Respir Crit Care Med* 1998;158:18-22.
- Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep-disordered breathing and hypertension. *N Engl J Med* 2000;342:1378-84.
- Nieto FJ, Young TB, Lind BK, Shahar E, Samet JM, Redline S, et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. *Sleep Heart Health Study*. *JAMA* 2000;283:1829-36.
- Montserrat JM, Amilibia J, Barbé F, Capote F, Durán J, Mangado NG, et al. Grupo de Trabajo del Área de Insuficiencia Respiratoria y Trastornos del Sueño. Tratamiento del síndrome de las apneas-hipopneas durante el sueño. *Arch Bronconeumol* 1998;34:204-6.
- Barbé Illá F, Amilibia Alonso J, Capote Gil F, Durán Cantolla J, González Mangado N, Jiménez Gómez A, et al. Grupo de Trabajo de Área de Insuficiencia Respiratoria y Trastornos del Sueño. Diagnóstico del síndrome de apneas obstructivas durante el sueño. *Arch Bronconeumol* 1995;31:460-2.
- Loube DI, Gay PC, Strohl KP, Pack AI, White DP, Collop NA. Indications for positive airway pressure treatment for adult obstructive sleep apnea patients: a consensus statement. *Chest* 1999;115:863-6.
- Sanders MH, Kern NB, Costantino JP, Stiller RA, Studnicki K, Coates J, et al. Adequacy of prescribing positive airway pressure therapy by mask for sleep apnea on the basis of a partial-night trial. *Am Rev Respir Dis* 1993;147:1169-74.
- Ficker JH, Wiest GH, Lehnert G, Wiest B, Hahn EG. Evaluation of an autoCPAP device for treatment of obstructive sleep apnoea. *Thorax* 1998;53:643-8.
- Meurice JC, Marc I, Series F. Efficacy of autoCPAP in the treatment of obstructive sleep apnea/hypopnea syndrome. *Am J Resp Crit Care Med* 1996;153:794-8.
- Oliver Z, Hoffstein V. Predicting effective continuous positive pressure. *Chest* 2000;117:1061-4.
- Fitzpatrick MF, Alloway CED, Wakeford TM, Maclean AW, Munt PW, Day AG. Can patients with obstructive sleep apnea titrate their own continuous positive airway pressure? *Am J Respir Crit Care Med* 2003;167:716-22.
- Masa JF, Sojo MA, Sánchez de Cos J, Disdier C, Hernández M, Martín MJ, et al. Diagnóstico y tratamiento del síndrome de apneas de sueño en una sola noche. *Arch Bronconeumol* 1995;31(Supl 1):13.
- Yamashiro Y, Kryger MH. CPAP titration for sleep apnea using a split-night protocol. *Chest* 1995;107:62-6.
- Series F. Accuracy of unattended home CPAP titration in the treatment of obstructive sleep apnea. *Am J Respir Crit Care Med* 2000;162:94-7.
- Berkani M, Lofaso F, Chouaid C, et al. CPAP titration by an auto-CPAP device based on snoring detection: a clinical trial and economic considerations. *Eur Respir J* 1998;12:759-63.
- Fletcher EC, Stich J, Yang KL. Unattended home diagnosis and treatment of obstructive sleep apnea without polysomnography. *Arch Fam Med* 2000;9:168-74.
- Stradling JR, Barbour C, Pitson DJ, Davies RJ. Automatic nasal continuous positive airway pressure titration in the laboratory: patient outcomes. *Thorax* 1997;52:72-5.
- Berry RB, Parish JM, Hartse KM. The use of auto-titrating continuous positive airway pressure for treatment of adult obstructive sleep apnea. *Sleep* 2002;25:148-73.
- Molina M, Hernández L, Durán J, et al. Protocolo para evaluar una CPAP automática. Valoración de la utilidad del Autoset-T para determinar la presión de CPAP óptima en el síndrome de apnea-hipopnea del sueño. *Arch Bronconeumol* 2003;39:118-25.
- Lloberes P, Ballester E, Montserrat JM, et al. Comparison of manual and automatic CPAP titration in patients with sleep apnea/hypopnea syndrome. *Am J Respir Crit Care Med* 1996;154:1755-8.
- Gagnadoux F, Rakotonanahary D, Martins de Araujo MT, et al. Long-term efficacy of fixed CPAP recommended by Autoset for OSAS. *Sleep* 1999;22:1095-9.
- Farré R, Montserrat JM, Rigau J, Trepal X, Pinto P, Navajas D. Response of automatic continuous positive airway pressure devices to different sleep breathing patterns. *Am J Respir Crit Care Med* 2002;166:469-73.
- Masa Jiménez JF, Rubio González M, Jiménez Gómez A, Durán Cantolla J, Capote Gil F, Monasterio Ponsa C, et al. Eficacia de la CPAP obtenida mediante titulación automática y matemática (datos exploratorios). *Arch Bronconeumol* 2003;39(Suppl 2):44.