REVIEW

Sleep and Allergic Rhinitis

J Mullol,[1,2,3,4] M Maurer,[4,5] J Bousquet [4,6,7]

[1] Rhinology Unit and Smell Clinic, ENT Department, Hospital Clínic, Barcelona, Spain
[2] Clinical and Experimental Respiratory Immunoallergy (IRCE), IDIBAPS, Barcelona, Spain
[3] Spanish Network of Centers for Biomedical Research on Respiratory Diseases (CibeRes), Spain
[4] GA²LEN (Global Allergy and Asthma European Network), supported by EU Framework Programme for Research, Contract No FOOD-CT-2004-506378
[5] University Hospital Charité, Berlin Medical University, Department of Dermatology and Allergy. Berlin, Germany
[6] University of Montpellier, Montpellier, France
[7] INSERM, France

Abstract

Patients with chronic diseases, including chronic respiratory diseases, usually have considerably impaired sleep quality that may increase the frequency of exacerbations and severity of symptoms, lead to difficulty in patient management, and reduce quality of life (QOL). During the last few decades, several studies have shown that, in addition to the classic signs of sneezing, nasal itching, rhinorrhea, and nasal obstruction, allergic rhinitis has an important impact on the QOL of adults and children. In 2001, the ARIA (Allergic Rhinitis and its Impact on Asthma) report based its new severity classification on the impact of rhinitis on QOL, with the inclusion of sleep disturbances. Thus, allergic rhinitis patients may also suffer from sleep disorders, emotional problems, as well as impairment in daily activities and social functioning. Given that sleep is fundamental for physical and mental health, the present document reviews the methods and questionnaires used to assess the quality of sleep, the importance of sleep in allergic rhinitis, impairment and improvement of sleep in allergic rhinitis by using medications (antihistamines, topical nasal corticosteroids, nasal decongestants, antileukotrienes) and, finally, the relationship between the sleep apnea syndrome with allergic rhinitis and its treatment.

Key words: Allergic rhinitis. Quality of life. Sleep. Antihistamines. Nasal corticosteroids. ARIA.

Resumen

Los pacientes con enfermedades crónicas, incluyendo las enfermedades crónicas respiratorias, suelen tener una alteración importante de su calidad del sueño lo cual a su vez puede aumentar la gravedad y exacerbaciones de sus síntomas, aumentar la dificultad en el manejo del paciente y reducir su Calidad de Vida (CdV). Durante las últimas décadas una serie de estudios han demostrado que la rinitis alérgica, además de los síntomas clásicos de estornudos, picor nasal, rinorrea, y obstrucción nasal, ejerce un impacto importante sobre la CdV tanto en adultos como en niños. En 2001, el documento ARIA (La Rinitis Alérgica y su Impacto sobre el Asma) basó su nueva clasificación de gravedad en el impacto de la rinitis en la CdV, con la inclusión de la alteración del sueño. Por tanto, los pacientes con rinitis alérgica pueden sufrir también de alteraciones del sueño, de problemas emocionales, así como de un deterioro de las actividades diarias y la función social. Dado que el sueño es fundamental para la salud física y mental, este artículo revisa los métodos y cuestionarios para determinar la calidad del sueño, la importancia del sueño en la rinitis alérgica, el deterioro y la mejoría del sueño en la rinitis alérgica tras el uso de medicación (antihistamínicos, corticoides tópicos nasales, descongestionantes nasales, antileucotrienos) y, finalmente, la relación entre el Síndrome de la Apnea del Sueño con la rinitis alérgica y su tratamiento.

Palabras clave: Rinitis alérgica. Calidad de vida. Sueño. Antihistamínicos. Corticoides tópicos nasales. ARIA.

Quality of sleep is crucial for physical and mental health. Chronic diseases usually have an important impact on the quality of sleep and this can increase symptom exacerbations and severity, lead to more difficult patient management, and reduce quality of life (QOL) [1]. Allergic disorders affect up to 40% of the general population in developed countries and this prevalence is increasing. Their effect on sleep can impair a patient's quality of life [2-6].

It has been 40 years since Cottle suggested that "sleeping patterns are in great measure dependent on good nasal

function" [7]. Allergic rhinitis is one of the major causes of impaired nasal function. It is caused by airborne particles that affect people who are allergic to them [8], and its symptoms are brought about by the activation of mast cells, basophils, and other proinflammatory cells of the nasal mucosa [9]. It is now recognized that the symptoms reported by patients with allergic rhinitis comprise more than the classic symptoms of sneezing, rhinorrhea, and nasal obstruction. Impairments in performance of daily activities and QOL affect both adults [10] and children, and patients may also suffer from sleep disorders, emotional problems, and impaired social functioning [11].

Methods to Assess the Quality of Sleep

Objective and subjective instruments are available to measure the extent to which the sleep of affected patients is compromised [12].

Disease-specific QOL questionnaires, such as the Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ), are widely used to assess the impact of the disease on health, and many include questions on sleep [13-16]. Both generic and disease-specific QOL questionnaires, together with an evaluation of symptoms, have been used in clinical trials to obtain information on the effect of medication. However, it is not only the disease that can adversely affect health-related quality of life; therapy, although intended to be beneficial, may also impair health. Questionnaires with strong evaluative and discriminative measurement properties, such as the Nocturnal Rhinoconjunctivitis Quality of Life Questionnaire (NRQLQ) [17], have been specially designed to measure the functional problems that are most troublesome to patients with nocturnal allergic rhinoconjunctivitis. In patients with nocturnal allergic rhinoconjunctivitis, the use of the NRQLQ in clinical practice and research enables us to measure the most troublesome functional impairments. An analysis of sleep quality reveals aspects of allergic rhinitis that cannot be established by analyzing daytime symptoms.

Available objective measurements include polysomnography, the Multiple Sleep Latency Test, the Maintenance of Wakefulness Test, and learning and performance testing [12], and these allow us to assess the effects of allergic rhinitis on sleep.

Sleep in Patients With Allergic Rhinitis

The effect of rhinitis on a patient goes beyond specific anterior nasal symptoms. Nasal obstruction can cause sleep disturbances that reduce a patient's daytime concentration and lead to daytime sleepiness [18]. Consequently, many patients complain of an impaired social life [19]. Disease-specific QOL questionnaires show how sleep is impaired in a similar fashion to other dimensions [15,20].

Changes in daytime sleepiness, QOL and objective sleep patterns in seasonal allergic rhinitis have been extensively studied in a controlled clinical trial [19] involving 25 patients with seasonal allergic rhinitis and 25 healthy volunteers. The authors assessed daytime sleepiness and QOL using the Epworth Sleepiness Scale and the SF-36, and nighttime sleep using polysomnography before and during the pollen season. Statistically significant differences between groups were found for daytime sleepiness and selected QOL parameters—both were related to the severity of the disease. Statistically significant differences were also found for other parameters, although these were minimal and all values fell within normal ranges.

Bousquet et al [21] studied the severity of allergic rhinitis in 3052 primary care patients using the ARIA classification and observed that mild intermittent rhinitis affected 11% of patients, mild persistent rhinitis affected 8%, moderate-severe intermittent affected 35%, and moderate-severe persistent affected 46%. The impact of the severity of rhinitis on QOL—including sleep, daily activities, and work performance—was shown to be stronger than the duration of rhinitis. Over 80% of the patients with moderate-severe rhinitis reported impaired activities compared with only 40% of patients with mild rhinitis. A national controlled cross-sectional epidemiological study involving 260 French otorhinolaryngologists and allergologists and 591 patients with allergic rhinitis of at least 1 year's duration assessed sleep disorders, quality of sleep, and allergic rhinitis using validated tools (Sleep Disorders Questionnaire, Epworth Sleepiness Scale, and Score for Allergic Rhinitis) [22]. The severity of allergic rhinitis was assessed using the ARIA classification. The impact of the severity of rhinitis, but not its frequency, was significant for insomnia, severe insomnia, hypersomnia, respiratory arrest, observed apnea, sleepiness, and regular use of sedatives.

Poorly controlled symptoms of allergic rhinitis may also contribute to sleep loss or disturbances [23,24], secondary daytime fatigue, and decreased overall cognitive functioning.

Leger et al [22] revealed that 43.7% of allergic rhinitis patients reported a feeling of fatigue on awakening despite a normal night's sleep. Headache on awakening, anxiety, and depression as "sleep-blockers," and daytime somnolence were significantly more frequently reported by patients with allergic rhinitis than by controls. The severity of allergic rhinitis significantly influenced the mean duration of nocturnal sleep, the frequency of daytime sleepiness, and sleep latency.

The reasons for poor sleep in allergic rhinitis are not clearly understood, but may be related, at least in part, to nasal congestion [25]. Several studies have shown the relationships between allergic rhinitis and nasal obstruction and abnormal breathing during sleep [26].

Allergic rhinitis is a risk factor for habitual snoring in children [27,28]. The Childhood Asthma Prevention Study (CAPS) attempted to determine the role of allergic rhinitis in snoring and found that, in children with symptoms of rhinitis at age 5 years (n = 219 out of 516 cohort members), 127 (60%) snored and 56 (26%) snored more than 3 times per week [29]. Snoring was significantly more common in patients with rhinitis than in controls [22].

Interestingly, a recent study on the role of perennial noninfectious rhinitis in the development of sleep disturbances in patients with asthma found rhinitis to be an important, independent risk factor for difficulty in

maintaining sleep, early morning awakenings, and daytime sleepiness [30].

Impairment of Sleep by Medication

Because of their effect on central H_1 receptors, H_1 histamines are classically associated with central nervous system effects such as sedation. Although the patient does not always perceive these effects, they are evident with objective performance testing, and positron emission tomography scanning has directly demonstrated central H_1 receptor occupancy. First-generation H_1 antihistamines have been shown to cause subjective drowsiness and objective performance impairment [31-33], and have been a cause for concern among patients with safety-critical occupations [34]. Second-generation H_1 antihistamines reduce central H_1 receptor occupancy and considerably reduce or eliminate sedative effects. Therefore, CNS effects are avoidable, and first-generation H_1 antihistamines should no longer be used in the management of allergic rhinitis when nonsedative drugs are available [35].

The second-generation H_1 antihistamines desloratadine and fexofenadine have proven to be almost free of adverse effects in terms of subjective sleepiness, daytime sleep latency, and psychomotor performance. These findings support the use of antihistamines in patients involved in activities requiring increased attention (skilled work, driving).

Decongestants decrease nasal congestion but their effect on sleep has not been adequately studied. Antihistamine-decongestant combinations are used routinely for the treatment of seasonal allergic rhinitis. Insomnia has been reported in trials using oral pseudoephedrine combined with an H_1 receptor antagonist [39-42].

Use of Medication to Improve Sleep in Patients With Allergic Rhinitis

Intranasal corticosteroids reduce congestion, improve sleep and sleep problems, and reduce daytime sleepiness, fatigue, and inflammation. These include budesonide [43-46], flunisolide, triamcinolone acetonide [47], fluticasone propionate [48], and fluticasone furoate [49]. There is a correlation between the reduction in nasal congestion and the improvement in sleep and daytime somnolence [50]. In one study, 20 patients with allergic rhinitis and symptoms of daytime sleepiness underwent therapy with flunisolide, which significantly improved sleep quality and congestion, although not daytime sleepiness [51]. In another study [48], fluticasone propionate improved nasal congestion and quality of sleep; however, there were no significant changes in objective sleep measurements recorded using polysomnography.

Oral H_1 receptor antagonists have been shown to improve sleep and QOL in studies using generic [52] or disease-specific QOL instruments [53-54]. Montelukast has proven effective in the treatment of the nighttime symptoms of seasonal allergic rhinitis [55]. These symptoms were evaluated as an average of 3 individual symptom scores—difficulty falling asleep, nighttime awakening, and nasal congestion on awakening—in 7 multicenter, double-blind, parallel-group trials. Adult patients were randomized to receive montelukast 10 mg (n = 1751), placebo (n = 1557), or loratadine 10 mg (n = 1616). Changes from baseline in the nasal symptom score (mean [SE]) were –0.28 (0.01), –0.16 (0.01), and –0.24 (0.01) for the montelukast, placebo, and loratadine groups, respectively. The changes in least-squares mean from baseline were –0.11 (95% confidence interval [CI], –0.14 to –0.08; $P < .001$) for montelukast and –0.09 (95% CI, –0.12 to –0.06; $P < .001$) for loratadine compared with placebo. The nasal symptom score and 2 of its individual symptoms showed strong baseline correlations ($R > 0.70$; $P < .001$) with the sleep domain of the RQLQ. This demonstrates the importance of measuring nighttime morbidity in patients with seasonal allergic rhinitis. Therefore, montelukast is a valid option for reducing the nighttime symptoms of seasonal allergic rhinitis.

Sleep Apnea Syndrome

There is an increased prevalence of perennial allergic rhinitis in patients with the obstructive sleep apnea syndrome (OSAS).

Nasal obstruction, enlarged adenoids and tonsils, and an elongated face cause reduced upper airway size and, thus, increase the risk of OSAS. Allergic rhinitis appears to increase the risk of OSAS in children. Adequate treatment of allergic rhinitis can reduce the severity of OSAS and prevent the emergence of an elongated face, which predisposes patients to OSAS. It may also reduce the severity of existing OSAS.

Intranasal fluticasone is of benefit to some patients with OSAS and rhinitis. Data suggest that this form of nasal obstruction may contribute to the pathophysiology of OSAS [57].

First-line treatment for OSAS is usually based on nasal continuous positive airway pressure (CPAP). However, nasal CPAP can induce nasal discomfort to such an extent that as many as 50% of patients are unable to tolerate therapy. In addition, nasal CPAP has induced early nasal inflammation [58], while nasal airway obstruction correlated with CPAP tolerance [59]. Using nasal peak inspiratory flow measurements has revealed the efficacy of adding heated humidification during nasal CPAP in the treatment of OSAS [60,61].

Based on subjective criteria (snoring loudly everyday and daytime sleepiness), sleep apnea syndrome has also been found to be more prevalent in allergic rhinitis than in controls [22].

References

1. Baiardini I, Braido F, Cauglia S, Canonica GW. Sleep disturbances in allergic diseases. Allergy. 2006;61:1259-67.
2. Canonica GW, Bousquet J, Mullol J, Scadding GK, Virchow JC. A survey of the burden of allergic rhinitis in Europe. Allergy. 2007;62(Suppl 85):17-25.
3. Magnan A, Meunier JP, Saugnac C, Gasteau J, Neukirch F. Frequency and impact of allergic rhinitis in asthma patients

in everyday general medical practice: a French observational cross-sectional study. Allergy. 2007;63:292-8.
4. Schatz M. A survey of the burden of allergic rhinitis in the USA. Allergy. 2007;62(Suppl 85):9-16.
5. Bieber T, Vick K, Folster-Holst R, Belloni-Fortina A, Stadtler G, Worm M, Arcangeli F. Efficacy and safety of methylprednisolone aceponate ointment 0.1% compared to tacrolimus 0.03% in children and adolescents with an acute flare of severe atopic dermatitis. Allergy. 2007;62:184-9.
6. Humbert M, Holgate S, Boulet LP, Bousquet J. Asthma control or severity: that is the question. Allergy. 2007;62:95-101.
7. Chen W, Kushida CA. Nasal obstruction in sleep-disordered breathing. Otolaryngol Clin North Am. 2003;36:437-60.
8. Wohrl S, Vigl K, Binder M, Stingl G, Prinz M. Automated measurement of skin prick tests: an advance towards exact calculation of wheal size. Exp Dermatol. 2006;15:119-24.
9. Falcone FH, Zillikens D, Gibbs BF. The 21st century renaissance of the basophil? Current insights into its role in allergic responses and innate immunity. Exp Dermatol. 2006;15:855-64.
10. Bousquet J, Bullinger M, Fayol C, Marquis P, Valentin B, Burtin B. Assessment of quality of life in patients with perennial allergic rhinitis with the French version of the SF-36 Health Status Questionnaire. J Allergy Clin Immunol. 1994;94:182-8.
11. Juniper EF, Thompson AK, Ferrie PJ, Roberts JN. Validation of the standardized version of the Rhinoconjunctivitis Quality of Life Questionnaire. J Allergy Clin Immunol. 1999;104:364-9.
12. Pratt EL, Craig TJ. Assessing outcomes from the sleep disturbance associated with rhinitis. Curr Opin Allergy Clin Immunol. 2007;7:249-56.
13. van Oene CM, van Reij EJ, Sprangers MA, Fokkens WJ. Quality-assessment of disease-specific quality of life questionnaires for rhinitis and rhinosinusitis: a systematic review. Allergy. 2007;62:1359-71.
14. Juniper EF, Riis B, Juniper BA. Development and validation of an electronic version of the Rhinoconjunctivitis Quality of Life Questionnaire Allergy. 2007;62:1091-3.
15. Valero A, Alonso J, Antépara I, Baró E, Colás C, del Cuvillo A, Ferrer M, Herdman M, Marti-Guadaño E, Monclús L, Navarro-Pulido AM, Sastre J, Izquierdo I, Mullol J. Health-related quality of life in allergic rhinitis: comparing the short form ESPRINT-15 and MiniRQLQ questionnaires. Allergy. 2007;62:1372-8.
16. ESPRINT Study Group: Valero A, J Alonso, I Antépara, E Baró, C Colás, A del Cuvillo, M Ferrer, M Herdman, E Martí-Guadaño, L Monclús, J Mullol, AM Navarro-Pulido, C Navas, J Sastre. Development and validation of a new spanish instrument to measure Health-Related Quality of Life in patients with allergic rhinitis: the ESPRINT questionnaire. Value Health. 2007;10:466-77.
17. Juniper EF, Rohrbaugh T, Meltzer EO. A questionnaire to measure quality of life in adults with nocturnal allergic rhinoconjunctivitis. J Allergy Clin Immunol. 2003;111:484-90.
18. Juniper EF, Stahl E, Doty RL, Simons FE, Allen DB, Howarth PH. Clinical outcomes and adverse effect monitoring in allergic rhinitis. J Allergy Clin Immunol. 2005;115:S390-413.
19. Stuck BA, Czajkowski J, Hagner AE, Klimek L, Verse T, Hormann K, et al. Changes in daytime sleepiness, quality of life, and objective sleep patterns in seasonal allergic rhinitis: a controlled clinical trial. J Allergy Clin Immunol. 2004;113:663-8.
20. Bousquet PJ, Combescure C, Neukirch F, Klossek JM, Méchim H, Daures JP, Bousquet J. Visual analog scales can assess the severity of rhinitis graded according to ARIA guidelines. Allergy. 2007;62:367-72.
21. Bousquet J, Neukirch F, Bousquet PJ, Gehano P, Klossek JM, Le Gal M, Allaf B. Severity and impairment of allergic rhinitis in patients consulting in primary care. J Allergy Clin Immunol. 2006;117:158-62.
22. Léger D, Annesi-Maesano I, Carat F, Rugina M, Chanal I, Pribil C, El Hasnaoui A, Bousquet J. Allergic rhinitis and its consequences on quality of sleep: an unexplored area. Arch Intern Med. 2006;166:1744-8.
23. Olsen KD, Kern EB, Westbrook PR. Sleep and breathing disturbance secondary to nasal obstruction. Otolaryngol Head Neck Surg. 1981;89:804-10.
24. Craig TJ, Teets S, Lehman EB, Chinchilli VM, Zwillich C. Nasal congestion secondary to allergic rhinitis as a cause of sleep disturbance and daytime fatigue and the response to topical nasal corticosteroids. J Allergy Clin Immunol. 1998;101:633-7.
25. Meltzer EO. Introduction: Stuffy is also related to Sleepy and Grumpy--the link between rhinitis and sleep-disordered breathing. J Allergy Clin Immunol. 2004;114(5 Suppl):S133-4.
26. Young T, Finn L, Kim H. Nasal obstruction as a risk factor for sleep-disordered breathing. The University of Wisconsin Sleep and Respiratory Research Group. J Allergy Clin Immunol. 1997;99:S757-62.
27. Kaditis AG, Finder J, Alexopoulos EL, Starantzis K, Tanou K, Gampeta S, Agorogiannis E, Christodoulou S, Pantazidou A, Gourgoulianis K, Molyvdas PA. Sleep-disordered breathing in 3,680 Greek children. Pediatr Pulmonol. 2004;37:499-509.
28. Ng DK, Chan CH, Kwok KL, Cheung JM. Allergic rhinitis as a risk factor for habitual snoring in children. Chest. 2005;127:2285-2286.
29. Marshall NS, Almqvist C, Grunstein RR, Marks GB. Predictors for snoring in children with rhinitis at Age 5. Pediatr Pulmonol. 2007;42:584-91.
30. Hellgren J, Omenaas E, Gíslason T, Jögi R, Franklin KA, Lindberg E, Janson C, Torén K, RHINE Study Group, North Europe. Perennial non-infectious rhinitis-an independent risk factor for sleep disturbances in Asthma. Respir Med. 2007;101:1015-20.
31. Qidwai JC, Watson GS, Weiler JM. Sedation, cognition, and antihistamines. Curr Allergy Asthma Rep. 2002;2:216-22.
32. Wilken JA, Kane RL, Ellis AK, Rafeiro E, Briscoe MP, Sullivan CL, Day JH. A comparison of the effect of diphenhydramine and desloratadine on vigilance and cognitive function during treatment of ragweed-induced allergic rhinitis. Ann Allergy Asthma Immunol. 2003;91:375-85.
33. Tagawa M, Kano M, Okamura N, Higuchi M, Matsuda M, Mizuki Y, Arai H, Fujii T, Komemushi S, Itoh M, Sasaki H, Watanabe T, Yanai K. Differential cognitive effects of ebastine and (+)-chlorpheniramine in healthy subjects: correlation between cognitive impairment and plasma drug concentration. Br J Clin Pharmacol. 2002;53:296-304.
34. Mohler SR, Nicholson A, Harvey P, Miura Y, Meeves SG. The use of antihistamines in safety-critical jobs: a meeting report. Curr Med Res Opin. 2002;18:332-7.
35. Santos CB, Pratt EL, Hanks C, McCann J, Craig TJ. Allergic rhinitis and its effect on sleep, fatigue, and daytime somnolence. Ann Allergy Asthma Immunol 2006; 97: 579-86.
36. Nicholson AN, Handford AD, Turner C, Stone BM. Studies on performance and sleepiness with the H1-antihistamine, desloratadine. Aviat Space Environ Med. 2003;74:809-15.

37. Mansfield L, Mendoza C, Flores J, Meeves SG. Effects of fexofenadine, diphenhydramine, and placebo on performance of the test of variables of attention (TOVA). Ann Allergy Asthma Immunol. 2003;90:554-9.
38. Hampel F, Ratner P, Mansfield L, Meeves S, Liao Y, Georges G. Fexofenadine hydrochloride, 180 mg, exhibits equivalent efficacy to cetirizine, 10 mg, with less drowsiness in patients with moderate-to-severe seasonal allergic rhinitis. Ann Allergy Asthma Immunol. 2003;91:354-61.
39. Bronsky E, Boggs P, Findlay S, Gawchik S, Georgitis J, Mansmann H, Sholler L, Wolfe J, Meltzer E, Morris R. Comparative efficacy and safety of a once-daily loratadine-pseudoephedrine combination versus its components alone and placebo in the management of seasonal allergic rhinitis. J Allergy Clin Immunol. 1995;96:139-47.
40. Bertrand B, Jamart J, Marchal JL, Arendt C. Cetirizine and pseudoephedrine retard alone and in combination in the treatment of perennial allergic rhinitis: a double-blind multicentre study. Rhinology. 1996;34:91-6.
41. Kaiser HB, Banov CH, Banov CH, Berkowitz RR, Bernstein DI, Bronsky EA, Georgitis JW, Mendelson LM, Rooklin AR, Sholler LJ, Striker WW, Harrison JE, Danzig MR, Lorber RR. Comparative Efficacy and Safety of Once-Daily Versus Twice-Daily Loratadine-Pseudoephedrine Combinations Versus Placebo in Seasonal Allergic Rhinitis. Am J Ther. 1998;5:245-51.
42. Moinuddin R, deTineo M, Maleckar B, Naclerio RM, Baroody FM. Comparison of the combinations of fexofenadine-pseudoephedrine and loratadine-montelukast in the treatment of seasonal allergic rhinitis. Ann Allergy Asthma Immunol. 2004;92:73-9.
43. Mansfield LE, Diaz G, Posey CR, Flores-Neder J. Sleep disordered breathing and daytime quality of life in children with allergic rhinitis during treatment with intranasal budesonide. Ann Allergy Asthma Immunol. 2004;92:240-44.
44. Hughes K, Glass C, Ripchinski M, Gurevich F, Weaver TE, Lehman E, Fisher LH, Craig TJ. Efficacy of the topical nasal steroid budesonide on improving sleep and daytime somnolence in patients with perennial allergic rhinitis. Allergy. 2003;58:380-85.
45. Gurevich F, Glass C, Davies M, Wei W, McCann J, Fisher L, Chegini S, Mende C, Craig T. The effect of intranasal steroid budesonide on the congestion-related sleep disturbance and daytime somnolence in patients with perennial allergic rhinitis. Allergy Asthma Proc. 2005;26:268-74.
46. Mansfield LE, Posey CR. Daytime sleepiness and cognitive performance improve in seasonal allergic rhinitis treated with intranasal fluticasone propionate. Allergy Asthma Proc. 2007;28:226-9.
47. Mintz M, Garcia J, Diener P, Liao Y, Dupclay L, Georges G. Triamcinolone acetonide aqueous nasal spray improves nocturnal rhinitis-related quality of life in patients treated in a primary care setting: the Quality of Sleep in Allergic Rhinitis study. Ann Allergy Asthma Immunol. 2004;92:255-61.
48. Craig TJ, Mende C, Hughes K, Kakumanu S, Lehman EB, Chinchilli V. The effect of topical nasal fluticasone on objective sleep testing and the symptoms of rhinitis, sleep, and daytime somnolence in perennial allergic rhinitis. Allergy Asthma Proc. 2003;24:53-8.
49. Fokkens WJ, Jogi R, Reinartz S, Sidorenko I, Sitkauskiene B, van Oene C, Faris MA, Ellsworth A, Caldwell MF. Once daily fluticasone furoate nasal spray is effective in seasonal allergic rhinitis caused by grass pollen. Allergy. 2007;62:1078-84.
50. Craig TJ, Hanks CD, Fisher LH. How do topical nasal corticosteroids improve sleep and daytime somnolence in allergic rhinitis? J Allergy Clin Immunol. 2005;116:1264-66.
51. Kakumanu S, Glass C, Craig T. Poor sleep and daytime somnolence in allergic rhinitis: significance of nasal congestion. Am J Respir Med. 2002;1:195-200.
52. Bousquet J, Duchateau J, Pignat JC, Fayol C, Marquis P, Mariz S, Ware JE, Valentin B, Burtin B. Improvement of quality of life by treatment with cetirizine in patients with perennial allergic rhinitis as determined by a French version of the SF-36 questionnaire. J Allergy Clin Immunol. 1996;98:309-16.
53. Pradalier A, Neukirch C, Dreyfus I, Devillier P. Desloratadine improves quality of life and symptom severity in patients with allergic rhinitis. Allergy. 2007;62:1331-4.
54. Bachert C, J Bousquet, GW Canonica, SR Durham, L Klimek, J Mullol, PB Van Cauwenberge, G Van Hammée and the XPERT Study Group. Levocetirizine improves quality of life and reduces costs in long-term management of persistent allergic rhinitis. J Allergy Clin Immunol 2004;114:838-44.
55. Meltzer EO, Philip G, Weinstein SF, LaForce CF, Malice MP, Dass SB, Santanello NC, Reiss TF. Montelukast effectively treats the nighttime impact of seasonal allergic rhinitis. Am J Rhinol. 2005;19:591-8.
56. Ng DK, Chan CH, Hwang GY, Chow PY, Kwok KL. A review of the roles of allergic rhinitis in childhood obstructive sleep apnea syndrome. Allergy Asthma Proc. 2006;27:240-2.
57. Kiely JL, Nolan P, McNicholas WT. Intranasal corticosteroid therapy for obstructive sleep apnoea in patients with co-existing rhinitis. Thorax. 2004;59:50-5.
58. Almendros I, Acerbi I, Vilaseca I, Montserrat JM, Navajas D, Farré R. Continuous positive airway pressure (CPAP) induces early nasal inflammation. Sleep. 2008;31:127-31.
59. Morris LG, Setlur J, Burschtin OE, Steward DL, Jacobs JB, Lee KC. Acoustic rhinometry predicts tolerance of nasal continuous positive airway pressure: a pilot study. Am J Rhinol. 2006;20:133-7.
60. Massie CA, Hart RW, Peralez K, Richards GN. Effects of humidification on nasal symptoms and compliance in sleep apnea patients using continuous positive airway pressure. Chest. 1999;116:403-8.
61. Winck JC, Delgado JL, Almeida JM, Marques JA. Heated humidification during nasal continuous positive airway pressure for obstructive sleep apnea syndrome: objective evaluation of efficacy with nasal peak inspiratory flow measurements. Am J Rhinol. 2002;16:175-7.

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Joaquim Mullol

Unitat de Rinologia i Clínica de l'Olfacte
Servei d'ORL, Hospital Clínic
Villarroel 170, 08036 Barcelona
Catalunya, Spain
jmullol@clinic.ub.es