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Surgery for sleep-disordered breathing in female patients

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The average physician and layperson envision Joe, the fat boy of the Pickwick Club, when the medical condition obstructive sleep apnea syndrome (OSAS) is discussed. Charles Dickens depicted Joe as a morbidly obese, hypersomnolent boy who snored. Initial research and clinical guidelines that have been established for the evaluation and treatment of this disorder have been based primarily on patients who resemble Joe. During the past 10 years, however, it has become apparent that young and old, male and female, and obese and nonobese patients may be afflicted with sleep-disordered breathing (SDB). Presenting symptoms may vary depending on the age and gender of the patient. A child with OSAS may be hyperactive, whereas an adult with the same condition typically has the opposite symptom of hypersomnolence. Clinical response to positive airway pressure and surgical treatment varies as well. The astute physician needs to recognize these differences when evaluating and treating patients with sleep disorders.

Epidemiology of sleep-disordered breathing: male versus female sleep-disordered breathing

Young et al [1] were the first group to perform a large population-based study of sleep apnea that included women. Prior to this publication in 1993, other large population-based studies of OSAS included only male patients [2–4]. In addition to these population-based studies, reports that focused on the clinical population of patients with OSAS again focused on the male patients. Review articles from the 1970s and 1980s suggested that the male-to-female ratio for OSAS in a clinical population varied from 10:1 to 60:1

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[5]. The conclusion that was extrapolated from these articles was that OSAS was a disorder of male patients. The article published by Young et al [1] changed the perception of this disease. This group of investigators studied 602 patients (352 men, 250 women) who were from a middle-aged and working population in Wisconsin. The results of this study revealed that 9% of women and 24% of men had SDB. Sleep-disordered breathing was defined as an apnea-hypopnea score of five or more. They also estimated that 2% of women and 4% of men, in a middle-aged working population, have OSAS. The diagnostic criterion that was used to define a diagnosis of sleep apnea syndrome was an apnea-hypopnea score of five or more that was associated with daytime hypersomnolence. Young et al showed that approximately 33% of the sleep apnea population is made up of women. In another study, Ohayon et al [6] conducted a telephone-interview survey of 4972 people in the United Kingdom that concluded that approximately 30% of patients with OSAS are women.

Clinical population studies examine only the population that presents to physicians for evaluation of symptoms, whereas population-based studies focus on the general population. At this time, population-based studies are reporting that one third of the apnea population is female. Yet in studies published in the 1990s that evaluated a clinical population, only 10% to 25% of the patients were female [7,8]. Therefore, gender-related differences are much less pronounced in recent population-based studies than previous clinical studies indicated.

Gender differences in symptoms of obstructive sleep apnea syndrome

In 1996, Young et al [9] addressed the gender bias in the sleep apnea population using data from the Wisconsin Sleep Cohort Study. Multiple hypotheses were evaluated to attempt to explain why sleep apnea is underdiagnosed in women. One hypothesis is that the diagnosis of women with sleep apnea is missed because they have different symptoms than men. The findings of Young et al do not support this hypothesis, however. For both men and women, the significant predicators of SDB are snoring, breathing pauses, and hypersomnolence. Although these classic symptoms are found in both men and women, women reported higher rates of morning headaches, depression, and anxiety at presentation in addition to classic symptoms. Morning headaches were reported more commonly in women than in men in a surgical population of apneic patients as well [10]. Morning headaches, depression, and anxiety are not as well recognized as the "classic symptoms" of sleep apnea. Another hypothesis that has been proposed is that the reporting of these "atypical" complaints may lead physicians to consider other diagnostic possibilities. For example, if an obese female patient reports fatigue, typically thyroid function studies are obtained. If an obese male patient reports fatigue, however, it is much more likely that a polysomnogram will be ordered. The stereotype of "Joe the fat boy," from Dickens' *Pickwick*

Papers, is difficult to erase. Physicians need to be educated about the prevalence of SDB in female patients and the need to take sleep histories in women as well.

Preoperative evaluation

Sleep history

Many patients present to an otolaryngologist with the simple complaint of snoring. Unless a sleep history is taken, symptoms of sleep apnea often are not mentioned by the patient. The patient's focus is usually on the snoring sound he or she produces and the disruption of his or her bed partner's sleep. Men are "brought in" by their wives to be "fixed," whereas women often present without prompting because of their embarrassment about their snoring. It is the physician's responsibility to inquire about the other sleep habits and daytime symptoms before the treatment of snoring can occur, however. In addition, the history should include (1) typical bedtime and arousal time; (2) the use of sleep aids, such as sedatives or alcohol; (3) a history of nocturnal reflux; and (4) daytime stimulant use, for example, caffeine intake. Sleepiness is a subjective complaint that can be evaluated more objectively with a standard questionnaire such as the Epworth or Stanford Sleepiness Scale. Additional information pertaining to history that is specific to women includes pregnancy status and the use of hormone-replacement therapy (HRT). Most female patients diagnosed with OSAS are postmenopausal [11–15]. The use of HRT may have a protective effect in the postmenopausal woman. The prevalence of sleep apnea is similar in premenopausal and postmenopausal women on HRT (0.6% and 0.5%, respectively). The prevalence is significantly higher in postmenopausal women who are not receiving HRT (2.7%), however. With recent research showing that HRT may not be as useful as once believed, it is plausible that the number of apneic women will increase as women choose to proceed through menopause without HRT. Although a pregnant patient rarely would undergo any kind of elective surgical procedure, it seems that the hormonal changes that take place during a pregnancy have a protective effect toward SDB [16,17].

Other special cases include women with Turner's syndrome and polycystic ovary syndrome in whom hormonal status is altered. Turner's syndrome is a common X-linked aneuploidy (XO) characterized by a female phenotype, retarded growth, infertility, and craniofacial abnormalities, in some cases [18]. The upper airway abnormalities and the hormonal status predispose this group of women to SDB. Women with polycystic ovary syndrome are predisposed to SDB because of the obesity and androgen excess typically seen in patients with this disorder [19]. Exogenous administration of testosterone to female and male patients has been reported to increase the respiratory disturbance index (RDI) or to induce sleep apnea in a small group of patients [20,21].

Physical examination

The physical examination of the patient with SDB should include vital signs, height, weight, neck circumference, and a complete head-and-neck examination. In general, a flexible endoscopic examination is needed to assess the laryngeal airway and hypopharynx. A body mass index (BMI) should be calculated (the weight in kilograms divided by the square of the height in meters). The neck circumference usually is measured at the cricothyroid membrane, although in the obese neck, the laryngeal landmarks are often difficult to discern. Obesity is the most important predisposing factor in OSAS [1,4,22]. In the author and colleagues' surgical study of 686 patients (111 women and 575 men) diagnosed with OSAS, female patients had a significantly higher BMI when compared with the male patients at presentation [10]. The BMI versus RDI was evaluated to determine whether gender modified the effect of BMI on RDI. It was found that for women, there was a weaker correlation between BMI and RDI as compared with men. Young et al [9] reported similar findings in the Wisconsin Sleep Cohort Study, in which 551 men and 388 women were studied. Women with an RDI of 15 or more had a significantly greater BMI when compared with men. Classically, men have a predominantly android or upper-body fat distribution, and women have a gynecoid or lower-body fat distribution [23]. Women with a diagnosis of OSAS are typically more obese than their male counterparts. A patient's BMI is used to determine his or her weight status (Table 1). Another term often used, *morbid obesity*, is defined as a BMI greater than 35 kg/m^2. A BMI can be calculated quickly in a clinic setting using a BMI chart.

Upper-body obesity, seen predominantly in men, may partly explain why men have OSAS more frequently than women. The overall neck circumference, commonly much larger in men than women, is correlated with airway obstruction in men [24]. This upper-body obesity would lead one to predict that men with OSAS have a smaller pharynx than women with the same disorder. The opposite is true. Brooks and Strohl [25] found that normal men have a significantly larger pharynx than women. Men also have been shown to have a larger change in the pharyngeal area with lung-volume change.

Table 1
Weight-classification system

Category	BMI (kg/m^2)
Underweight	Less than 18.5
Healthy weight	18.5–24.9
Overweight	25.0–29.9
Obesity (class 1)	30.0–34.9
Obesity (class 2)	35.0–39.9
Severe obesity (class 3)	40 or more

Normal men may have a greater tendency to collapse their airways, which may account for the gender differences in the development of SDB. Mohsenin [26] demonstrated that in middle-aged men and women with a diagnosis of OSAS, women had a smaller pharynx than did men. This study demonstrated that pharyngeal size was correlated with apnea severity in men but not in women with OSAS.

The awareness of gender-related differences in the physical examination is critical when determining a treatment plan for patients with OSAS. Recent research has identified the following trends in physical differences between men and women with OSAS:

1. Women have a significantly higher BMI as compared with men.
2. Women have lower-body obesity and men have upper-body obesity.
3. Men have larger necks than women.
4. Women have a smaller pharynx than men.

Polysomnographic findings

Female patients with a diagnosis of OSAS have been noted to have a lower RDI when compared with men [10]. In a group of 686 patients (111 women and 575 men) who presented for a surgical evaluation, the mean RDI for women was 37, versus 42 in men. This difference was statistically significant. Mohsenin [26] reported polysomnographic findings in 130 patients referred for evaluation of SDB. The RDI was lower in the female patients (24 versus 62 in men). Leech et al [27] noted that among 118 patients with OSAS (77 men and 41 women), women have more hypopneas rather than apneas, and the length of their apneic events was shorter. O'Connor et al [28] categorized patients as having one of three main patterns of apnea: (1) obstructive sleep apnea that occurred in the supine position, (2) non–positional-related obstructive sleep apnea, and (3) rapid-eye-movement–related apnea. Women were found to have rapid-eye-movement–related apnea more often than male patients (62% versus 24%). In contrast, supine and non-positional apnea patterns were much more common in men. The polysomnographic findings in women diagnosed with OSAS differ from male patients with the same disorder. The RDI is lower in women, the proportion of the RDIs made up of hypopneas is greater, and rapid-eye-movement–related apnea is more common in women.

Surgical treatment

Little information can be obtained from the surgical literature regarding response rates of women undergoing various surgical procedures for the treatment of OSAS. Just as there is no standardization within the medical community regarding interpretation of a polysomnogram, the analysis of postoperative data varies significantly in surgical publications. Another

limitation of studying female patients undergoing surgical treatment is the paucity of patients. In most surgical series examining uvulopalatopharyngoplasty or laser assisted uvulopalatoplasty (LAUP), less than 20% of the patients are women [10,29,30]. Meaningful data on more extensive procedures in women, such as genioglossus advancement with hyoid myotomy-suspension and maxillary-mandibular advancement, are not available. In Riley et al's classic report [31] on 306 surgical patients, only 35 were women. Despite all of these limitations and the critical need for further investigation, some information is available.

Mickelson and Ahuja [29] reported their results on 36 patients with OSAS who underwent laser-assisted uvulopalatoplasty. In this series, the female data were not analyzed specifically, but the individual raw data were presented. Seven of the 36 patients were female. The author's group [10] also studied patients with OSAS who underwent LAUP treatment. Preoperative and postoperative data from both series are shown in Table 2. Mickelson and Ahuja's series demonstrates a nonsignificant decrease in the RDI ($P = 0.2834$) and an increase in the lowest oxygen saturation ($P = 0.3830$) after LAUP treatment for OSAS. In general, a successful surgical outcome is defined as a postoperative RDI of 10 or less. Of these patients, 43% had an RDI of 10 or less after treatment. In the author's series of 16 female patients, a significant decrease in the RDI ($P = 0.0042$) and a nonsignificant increase in the lowest oxygen saturation ($P = 0.1141$) were noted. Of these 16 patients, 81% had a postoperative RDI of 10 or less.

At this time, only preliminary data are available on the surgical treatment of female patients. These data only reflect LAUP procedure results; results from other palatal surgery, specifically uvulopalatopharyngoplasty, are not available. Based on these early findings, palatal surgery treatment for female patients with OSAS is certainly a viable option. Initial impressions suggest that women respond as well as or more favorably to palatal surgery when compared with male patients. Further studies are necessary before any guidelines can be established for female patients.

Table 2
Female patients with OSAS treated with LAUP

	Mickelson and Ahuja [29] (n = 7) Mean ± SD	Walker et al [10] (n = 16) Mean ± SD
Age	58.1 ± 8.6	54.6 ± 12.7
BMI	35.2 ± 11.8	32.4 ± 7.8
Preoperative RDI	26.1 ± 13.8	18.7 ± 13.9
Postoperative RDI	17.9 ± 13.6	6.5 ± 7.5
Preoperative LSAT	76.1 ± 11.3	84.0 ± 4.7
Postoperative LSAT	80.9 ± 11.8	86.7 ± 4.2

Abbreviations: BMI, body mass index (kg/m^2); LSAT, lowest oxygen saturation; RDI, respiratory distrubance index (events/hour); SD, standard deviation.

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References

[1] Young T, Palta M, Dempsey J, et al. The occurrence of sleep disordered breathing among middle-aged adults. N Engl J Med 1993;328:1230–5.
[2] Gislason T, Almqvist M, Eriksson G, et al. Prevalence of sleep apnea syndrome among Swedish men: an epidemiological study. J Clin Epidemiol 1988;41:571–6.
[3] Haraldsson PO, Carenfelt C, Tingvall C. Sleep apnea syndrome symptoms and automobile driving in a general population. J Clin Epidemiol 1992;45:821–5.
[4] Stradling JR, Crosby JH. Predictors and prevalence of obstructive sleep apnea and snoring in 1001 middle aged men. Thorax 1991;46:85–90.
[5] Chaudhary BA, Speir WA Jr. Sleep apnea syndromes. South Med J 1982;75:39–45.
[6] Ohayon MM, Guilleminault C, Priest RG, et al. Snoring and breathing pauses during sleep: telephone interview survey of a United Kingdom population sample. BMJ 1997; 314:860–3.
[7] Hoffstein V, Szalai P. Predictive value of clinical features in diagnosing obstructive sleep apnea. Sleep 1993;16:118–22.
[8] Kapsimalis F, Kryger M. Gender and obstructive sleep apnea syndrome, part 2: mechanisms. Sleep 2002;25:499–506.
[9] Young T, Hutton R, Finn L, et al. The gender bias in sleep apnea diagnosis: are women missed because they have different symptoms? Arch Intern Med 1996;156:2445–51.
[10] Walker R, Durzao-Arvizu R, Wachter B, et al. Preoperative differences between male and female patients with sleep apnea. Laryngoscope 2001;111:1501–5.
[11] Bixler E, Vgontza A, Lin H, et al. Prevalence of sleep-disordered breathing in women—effects of gender. Am J Respir Crit Care Med 2001;163:608–13.
[12] Dancey RD, Hanley PJ, Soong C, et al. Impact of menopause on the prevalence and severity of sleep apnea. Chest 2001;120:151–5.
[13] Guilleminault C, Quera-Salva MA, Partinen M, et al. Women and obstructive sleep apnea syndrome. Chest 1988;93:104–9.
[14] Guilleminault C, Stoohs R, Jim Y, et al. Upper airway sleep-disordered breathing in women. Ann Intern Med 1995;122:493–501.
[15] Smith R, Ronald J, Delaive K, et al. What are obstructive apnea patients being treated for prior to this diagnosis? Chest 2002;121:164–72.
[16] Brownell LG, West P, Kryger MH. Breathing during sleep in normal pregnant woman. Am Rev Respir Dis 1986;133:38–41.
[17] Maasilta P, Bachour A, Teramo K, et al. Sleep-related disordered breathing during pregnancy in obese women. Chest 2001;120:1448–54.
[18] Orliaguet O, Pepin JL, Bettega G, et al. Sleep apnoea and Turner's syndrome. Eur Respir J 2001;17:153–5.
[19] Fogel RB, Malhorta A, Pillar G, et al. Increased prevalence of obstructive sleep apnea in obese women with polycystic ovary syndrome. J Clin Endocrinol Metab 2001;86:1175–80.
[20] Johnson MW, Anch AM, Remmers JE. Induction of the obstructive sleep apnea syndrome in a woman by exogenous androgen administration. Am Rev Respir Dis 1984;129:1023–5.
[21] Schneider BK, Pickett C, Zwillich CW, et al. Influence of testosterone on breathing during sleep. J Appl Physiol 1986;61:618–23.
[22] O'Donnell CP, Schwartz AR, Smith PL. Upper airway collapsibility: the importance of gender and adiposity. Am J Respir Crit Care Med 2000;162:1606–7.
[23] Millman R, Carlisle C, McGarvey S. Body fat distribution and sleep apnea severity in women. Chest 1995;107:362–6.

[24] Kapsimalis F, Kryger M. Gender and obstructive sleep apnea syndrome, part 1: clinical features. Sleep 2002;25:412–9.
[25] Brooks LJ, Strohl KP. Size and mechanical properties of the pharynx of healthy men and women. Am Rev Respir Dis 1992;146:1394–7.
[26] Mohsenin V. Gender differences in the expression of sleep-disordered breathing—role of upper airway dimensions. Chest 2001;120:1442–7.
[27] Leech J, Onal E, Dulberg C, et al. A comparison of men and women with occlusive sleep apnea syndrome. Chest 1988;94:983–7.
[28] O'Connor C, Thornley K, Kanly P. Gender differences in the polysomnographic features of obstructive sleep apnea. Am J Respir Crit Care Med 2000;161:1465–72.
[29] Mickelson S, Ahuja A. Short-term objective and long-term subjective results of laser-assisted uvulopalatoplasty for obstructive sleep apnea. Laryngoscope 1999;109:362–7.
[30] Millman R, Carlisle C, Rosenberg C, et al. Simple predictors of uvulopalatopharyngoplasty outcome in treatment of obstructive sleep apnea. Chest 2000;118:1025–30.
[31] Riley RW, Powell NB, Guilleminault C. Obstructive sleep apnea syndrome: a review of 306 consecutively treated surgical patients. Otolaryngol Head Neck Surg 1993;108:117–25.