Upper Airway Collapsibility in Habitual Snorers and Sleep Apneics: Evaluation with Drug-induced Sleep Endoscopy

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Increased upper airway collapsibility has been suspected of being involved in the pathogenesis of sleep-related diseases. It is assumed that patients with severe obstructive sleep apnea syndrome (OSAS) show a stronger collapse of the upper airway compared with habitual snorers. It was the objective of this study to analyze the patterns of upper airway collapse in habitual snorers and patients with OSAS and to correlate these results with data from polysomnography. Endoscopy was carried out during drug-induced sleep (with propofol) and collapsibility was analyzed at two major levels (palatal and tongue base). A total of 207 habitual snorers and 117 patients with OSAS underwent endoscopy after overnight polysomnography in our sleep laboratory. In 95% of cases we were able to induce snoring during drug-induced sleep. The collapsibility in the area of the base of the tongue correlated with higher values of the respiratory disturbance index (RDI) as recorded by standard polysomnography. Patients with OSAS showed significantly stronger collapsibility compared with snorers. The difference was more evident at the tongue-base level. We found no significant correlation between the applied CPAP pressure and collapsibility in patients with OSAS. These results show that collapsibility at the tongue-base level is a factor relevant in sleep-related breathing disorders. *Key words*: *airway obstruction*, *endoscopy*, *propofol*, *polysomnography*, *sleep physiology*, *sleep apnea syndrome*.

INTRODUCTION

The routine diagnostic procedure in identifying obstructive sleep apnea syndrome (OSAS) and disorders arising in the context of snoring has largely been standardized in most sleep laboratories. Normally, the procedure comprises a comprehensive patient history including a questionnaire, a medical examination covering internal, neurologic, psychiatric and ENT aspects (depending on the clinical picture of the individual patient), diagnostic imaging—particularly cephalometry, radiography of the paranasal sinuses and thorax, vigilance tests and a polysomnographic examination. A further aspect within the scope of diagnostic options available for management of sleep-related disorders is the assessment of the so-called collapsibility of the upper airways. Determination of collapsibility can be achieved by pressure measurements or by endoscopic inspection of the airways (1, 2).

A number of other techniques have been proposed to help identify the area of obstruction. These include radiologic methods such as computed tomography and cephalometry. Different endoscopic procedures such as the Müller maneuver or videoendoscopy during sleep have been described to verify the degree and location of obstruction. Even though one can assume that increased collapsibility of the pharyngeal walls may not be the only and perhaps not even the decisive component in the pathogenesis of sleep-related diseases, enhanced collapsibility is frequently found in snorers and patients with OSAS. Localization of the site of obstruction is often used to predict the outcome of surgical procedures such as uvulopalatopharyngoplasty (UPPP). Within the framework of the present study we strived to assess whether there exist principally different patterns in the endoscopically determined collapsibility of the pharynx in patients with OSAS as compared with habitual snorers. This endoscopic investigation method has been routinely applied in our laboratory in the scope of drug-induced sleep (using propofol) since 1995.

MATERIALS AND METHODS

Patients and diagnostic procedures

In the period dating from May 1995 to November 1999, 117 patients with OSAS and 207 habitual snorers were among the patients studied in our sleep laboratory. This group comprised 268 men and 56 women aged between 17 and 71 years. Routine diagnosis encompassed a precise patient history including a standard questionnaire, followed by an ENT-specific and general physical examination. If necessary, additional neurologic and/or psychiatric examinations were carried out. Rhinometry—before and after subsidence of swelling of the nasal mucosa—as well as a survey radiograph of the paranasal sinuses and the thorax were performed and, in a number of cases, a multiple sleep latency test (MSLT). Standard

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polysomnography was carried out over an average recording period of 8 h. The following parameters were recorded for each patient: age, sex, body mass index, apnea–hypopnea index, minimal and average oxygen saturation during polysomnographic analysis, grade of nocturnal snoring (0: no snoring, 1: mild snoring up to 20% of sleep time, 2: average, up to 60% sleep time, 3: severe: more than 60% of sleep time). According to the results of polysomnography the patients were assigned to the diagnostic categories of either OSAS or habitual snorers.

The criteria for assignment to the group of snorers were an apnea–hypopnea index (AHI) below 10, a minimal O_2 decrease not falling below 90% and snoring during polysomnography (grade 2 and 3).

Flexible rhinopharyngolaryngoscopy

Flexible rhinopharyngolaryngoscopy was performed with the patient in a drug-induced sleep state (using propofol) in close cooperation with the anesthesia department. The investigator was blinded to the group of snorers vs the OSAS group. Before administering propofol flexible rhinopharyngolaryngoscopy with the Müller maneuver was carried out, with the patient in an awakened state (2,6 di-isopropylphenol, Disoprivane®, Zeneca Co.). This drug is normally used to initiate narcosis by injecting a dose of 2 to 2.5 mg/kg body weight (b. wt.). For flexible rhinopharyngolaryngoscopy about 1.5 mg/kg/b.wt. were titrated until the patient was asleep. Administration of the drug was performed by an anesthetist while monitoring ECG, blood pressure, oxygen saturation and pulse. Endoscopy was conducted using a thin flexible endoscope with a suction channel which was advanced through the nose. Each patient was endoscoped in two ways. First, endoscopy was carried out in the awakened state. Here anatomic features such as the nose, nasal pharynx, velum, uvula, base of the tongue, larynx and hypopharynx were assessed. The patient was prompted to snore randomly. This was followed by the Müller maneuver in order to identify a potential collapsibility of the soft structures of the neck as to location and degree. Next, endoscopy was performed during propofol-induced sleep. After the onset of sleep the location of airway collapsibility was assessed once again. Furthermore, apneas, snoring and drop in oxygen values were assessed. In particular, the two main sites of soft-structure collapse in the upper airways—palatal and tongue base—were established, as before during the Müller maneuver, and the respective collapse determined as the percentage contraction of pharyngeal cross-section relative to the value in the awakened state. Collapse was semi-quantitatively evaluated by the investigator. The estimation was repeated 4 times for each location. The average value was used for analysis. A collapsibility of more than 80% was used as cut-off value for differentiation between moderate and severe collapsibility.

RESULTS

Typical findings

Patients who fell asleep slowly after propofol administration frequently showed an initial apnea phase. Subsequently, breathing normalized to a pattern typically found in the polysomnographic recordings as well. Moreover, snoring during propofol-induced sleep could be observed in 95% of patients ($n = 305$) in whom nocturnal snoring had been polysomnographically recorded ($n = 322$). Snoring noise appeared to originate from the following locations and causes: the palatal area in 43% of patients, falling back of the tongue base in 7%, flapping motion or aspiration of the epiglottis during inspiration in 3% and a combination of forms in 42%. A propensity to obstructive apnea phases, partly in association with a drop in oxygen saturation and explosive bursts of snoring noise when the airways reopened, was often observed in patients with sleep apnea during propofol-induced sleep.

Patients with high AHI values exhibited a more pronounced collapsibility at the base of the tongue. Very frequently, a similar obstruction was additionally observed in the area of the velopharynx. The phenomenon of epiglottis aspiration or "floppy epiglottis" with inspiratory suctioning and partly complete obstruction of the larynx was seldom noted in our series of examined patients (1.5%) and was identified as a co-determinant factor of obstructive apnea phases particularly in patients with OSAS. No ENT- or anesthesiology-related complications occurred in our patients in the scope of flexible pharyngolaryngoscopy.

Collapsibility

Collapsibility in the palatal area was significantly higher in the group of patients with OSAS as compared with the group of snorers (Mann-Whitney-U test p: 0.01). Nearly all patients showed a collapsibility of more than 80% (Fig. 1*A*). In the group of snorers collapsibility was more than 80% in only 70% of cases. A highly significant difference between the two investigated groups was found when observing collapsibility at the level of the tongue base (Mann-Whitney-U test p: 0.001). In the group of OSAS patients obstruction exceeding 80% was detected in 77% of cases (Fig. 2*A*). In the group of habitual snorers obstructions exceeding 80% were found in only 40% (Fig. 2*B*).

Within the group of snorers, obstruction of more than 80% in the area of the velum and the tongue base were found in 49 cases (23%). This proportion of patients was distinctly larger in the group of OSAS patients, reaching a total of 62 (52%). In the OSAS patients there was no significant correlation between the degree of obstruction and the AHI-values. This applied to both the area of the velum and the base of the tongue, with increased palatal obstruction being more strongly associated with high AHI values here.

DISCUSSION

Specific anatomic conditions and the degree of collapsibility in the area of the upper airways appear to play a certain role in the pathogenesis of obstructive sleep apnea (3). The assessment of collapsibility in patients with OSAS is often used for the prediction of outcome after uvulopalatopharyngoplasty (UPPP).

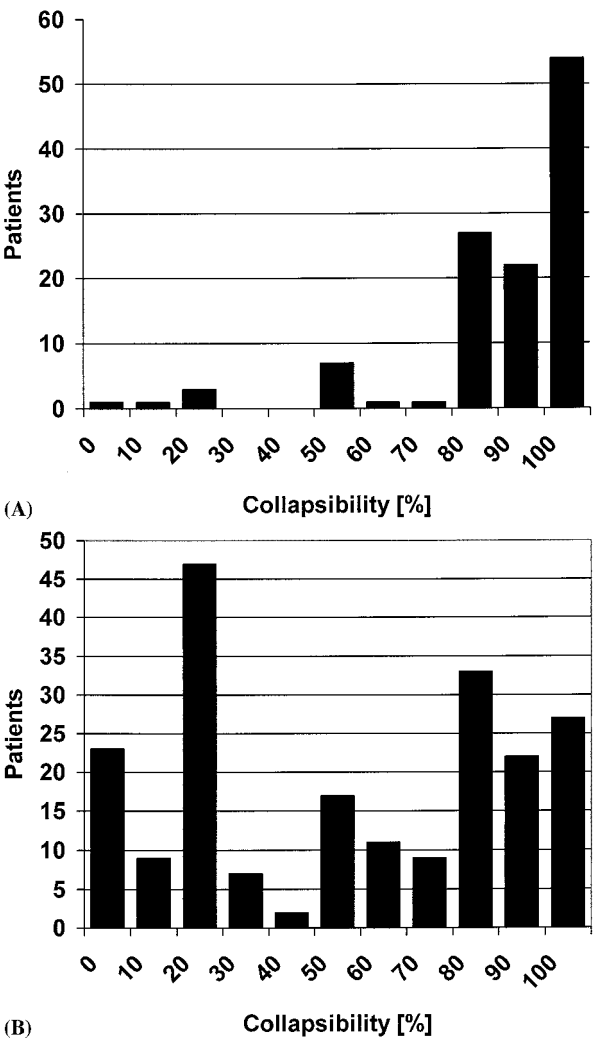

Fig. 1. (*A*) Palatal collapsibility during nasoendoscopy in patients with OSAS ($n = 117$). (*B*) Base of the tongue collapsibility during nasoendoscopy in patients with OSAS ($n = 117$).

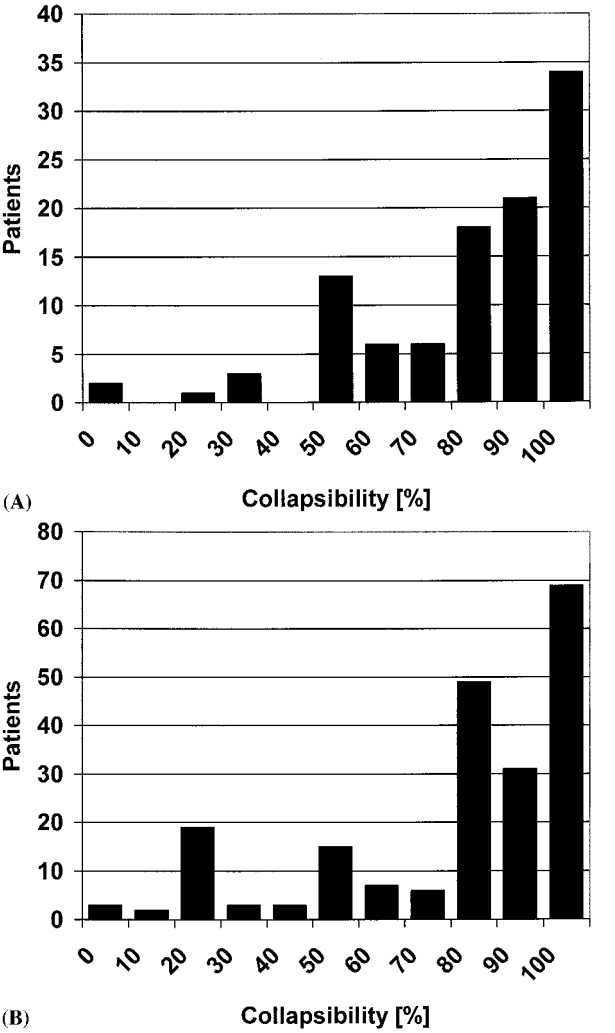

Fig. 2. (*A*) Palatal collapsibility during nasoendoscopy in patients with rhonchopathy ($n = 207$). (*B*) Base of the tongue collapsibility during nasoendoscopy in patients with rhonchopathy ($n = 207$).

Patients with retroglossal collapsibility are excluded from UPPP (4). It has been shown, however, that prediction of treatment results after surgical intervention is only possible to a limited extent and is determined not only by anatomic factors (5, 6). Prognostic certainty can be improved somewhat by taking a number of factors into account, e.g. cephalometric findings, among others (5).

The reports available to date on endoscopic findings acquired during sleep are not in uniform agreement. Increased collapsibility of the pharyngeal walls, both retrolingually and in the palatal area, was demonstrated in children with sleep apnea syndrome as compared with healthy children (7). Using drug-induced sleep endoscopy Marais failed to produce snor-

ing in nearly 20% of cases, while induced snoring was recorded in 45% of a control group of non-snorers (8). During sleep nasendoscopy in snorers Quinn et al. located the main source of noise production in the palatal area in 70% of cases (9). Comparative investigations on collapsibility between snorers and healthy subjects showed increased collapsibility in snorers at the level of the palate, yet no differences at the level of the base of the tongue (10). So the different results at the level of the base of the tongue could be interpreted as an effect of the drug-induced sleep procedure. Compared with patients with OSAS the endoscopic examination of patients with an isolated snoring disorder appears to be better able to predict the prognosis for UPPP treatment (11). In the latter case only patients who showed isolated palatal snoring during endoscopy were operated on.

Our results demonstrate that the degree of upper airway collapsibility is more pronounced in patients with OSAS than in snorers. The difference between the two groups is especially marked at the tongue base level. The strong collapse tendency at the level of the tongue base in OSAS patients could explain the comparatively poor treatment results achieved with UPPP in these patients. However, OSAS patients also show a stronger collapsibility at the palatal level than snorers. Thus, it can be assumed that upper airway collapsibility is generally more pronounced in OSAS patients than in snorers. There was a trend towards correlation of obstruction in OSAS patients with the AHI value, which, however, did not attain statistical significance. This again merely reconfirms the limited significance of collapsibility in the pathogenesis of obstructive sleep apnea.

In snoring patients a relevant obstruction in the tongue-base area is often found as well. Therefore, the indication for UPPP in snorers should be judged very discriminatingly, because ultimately about 40% of snoring patients exhibit a relevant obstruction in the tongue-base area.

Drug-induced sleep is basically not a natural form of sleep, but the endoscopic investigation is straightforward and safe to conduct in all patients, whereas endoscopic investigations during natural sleep are not well tolerated by many patients. Compared with cephalometric investigations and the Müller maneuver application of the endoscopic examination technique during drug-induced sleep allows a direct and longer-lasting assessment of the dynamic processes in the upper airways. A study comparing endoscopic findings during natural sleep with those obtained during drug-induced sleep yielded basic agreement as to the location of collapse (9). Determination of the location and degree of obstruction can also be achieved by direct pressure measurements. With pressure measurements in patients with OSAS most patients showed obstructions in different areas of the upper airway (12).

Various methods such as CT, MRI, cephalometry, esophageal pressure measurement probes and the Müller maneuver have been implemented to assess the location and degree of obstruction respiratory collapse. Endoscopic assessment of the upper airways during drug-induced sleep has been known for quite some time (13). The advantage of endoscopic examination in drug-induced sleep lies in the possibility of being able to directly assess the conditions prevailing at various locations within the upper airways. In contrast with examinations conducted during natural sleep, which are not tolerated by all patients, endoscopy during drug-induced sleep can usually be performed in all patients. The present investigation also shows that—because of the often complex patterns of obstruction—clear recommendations for surgical treatment can be derived from endoscopic assessment only in individual cases. There is still controversy over whether and which endoscopic procedure to use in the diagnostic work-up of snorers and OSAS patients. In ongoing prospective studies we are investigating the value of the collapsibility at the level of the base of the tongue as a predictor of the outcome of uvulopalatopharyngoplast y and other therapies in snorers. The value of endoscopy during drug-induced sleep remains to be evaluated.

REFERENCES

1. Aboussouan LS, Golish JA, Wood BG, Metha AC, Wood DE, Dinner DS. Dynamic pharyngoscopy in predicting outcome of uvulopalatopharyngoplasty for moderate and severe obstructive sleep apnea. Chest 1995; 107: 946–51.
2. Connolly AA, Martin J, White P. Sedation with a target-controlled propofol infusion system during assessment of the upper airway in snorers. J Laryngol Otol 1994; 108: 865–7.
3. Hudgel DW. Mechanisms of obstructive sleep apnea. Chest 1992; 101: 541–9.
4. Isono S, Shimada A, Tanaka A, Tagaito Y, Utsugi M, Konno A, et al. Efficacy of endoscopic static pressure/area assessment of the passive pharynx in predicting uvulopalatopharyngoplasty outcomes. Laryngoscope 1999; 109: 769–74.
5. Petri N, Suadicani P, Wildschiodtz G, Bjorn-Jorgensen J. Predictive value of Muller maneuver, cephalometry and clinical features for the outcome of uvulopalatopharyngoplasty. Evaluation of predictive factors using discriminant analysis in 30 sleep apnea patients. Acta Otolaryngol 1994; 114: 565–71.
6. Doghramji K, Jabourian ZH, Pilla M, Farole A, Lindholm RN. Predictors of outcome for uvulopalatopharyngoplasty. Laryngoscope 1995; 105: 311–4.
7. Isono S, Shimada A, Utsugi M, Konno A, Nishino T. Comparison of static mechanical properties of the pas-

sive pharynx between normal children and children with sleep-disordered breathing. Am J Respir Crit Care Med 1998; 157: 1204–12.
8. Marais J. The value of sedation nasendoscopy: a comparison between snoring and non-snoring patients. Clin Otolaryngol 1998; 23: 74–6.
9. Quinn SJ, Daly N, Ellis PD. Observation of the mechanism of snoring using sleep nasendoscopy. Clin Otolaryngol 1995; 20: 360–4.
10. Tsushima Y, Antila J, Svedstrom E, Vetrio A, Laurikainen E, Polo O, et al. Upper airway size and collapsibility in snorers: evaluation with digital fluoroscopy. Eur Respir J 1996; 9: 1611–8.
11. Camilleri AE, Ramamurthy L, Jones PH. Sleep nasendoscopy: what benefit to the management of snorers? J Laryngol Otol 1995; 109: 1163–5.
12. Skatvedt O. Continuous pressure measurements during sleep to localize obstructions in the upper airways in heavy snorers and patients with obstructive sleep apnea syndrome. Eur Arch Otorhinolaryngol 1995; 252: 11–4.
13. Croft CB, Pringle MB. Sleep nasendoscopy: a technique of assessment in snoring and obstructive sleep apnoe. Clin Otolaryngol 1991; 16: 504–9.

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