

# Efficacy of Upper Gastrointestinal Endoscopic Examination to Identify Patients with Obstructive Sleep Apnea Syndrome: A Retrospective Cross-Sectional Study

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## Keywords

Obstructive sleep apnea syndrome · Gastrointestinal endoscopy · Upper airway obstruction · Polysomnography

## Abstract

**Background/Aims:** Despite the high prevalence of obstructive sleep apnea syndrome (OSAS), most individuals are unaware of its diagnosis. We assessed whether an upper gastrointestinal (GI) endoscopy can accurately predict the incidence of OSAS. **Methods:** After endoscopic evaluation of laryngo-pharyngeal collapse, a total of 154 subjects with laryngo-pharyngeal collapse and 52 control subjects underwent polysomnography. Based on the modified Fujita Classification, upper airway obstruction was classified into 3 different types: oropharyngeal, supraglottic and combined type, and associations between upper airway obstruction

and OSAS were evaluated. **Results:** Of 154 subjects with laryngo-pharyngeal collapse, 108 (70.1%) were diagnosed as OSAS, while only 4 (7.7%) control subjects were diagnosed as OSAS ( $p < 0.001$ ). The sensitivity and specificity of endoscopic diagnosis were 96.4 and 51.1%, respectively. Oropharyngeal involvement was frequently found in 90.2% of the subjects (139/154). The severity of upper airway obstruction was significantly correlated with the apnea-hypopnea index score ( $r = 0.55$ ,  $p < 0.001$ ). A multivariate logistic regression analysis revealed that a male sex (OR 5.20; 95% CI 2.65–10.2,  $p < 0.001$ ), body mass index  $\geq 25$  kg/m<sup>2</sup> (OR 4.98; 95% CI 2.23–11.2,  $p = 0.02$ ) and severe obstruction (OR 7.79; 95% CI 3.34–18.2,  $p < 0.001$ ) were significant independent predictors of severe OSAS. **Conclusion:** A conventional upper GI endoscopic examination might be useful as a diagnostic modality for OSAS.

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## Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by repetitive upper airway collapse during sleep, impairing ventilation and potentially resulting in intermittent hypoxemia. Recently, the prevalence of OSAS has been reportedly increasing worldwide, in parallel with the ongoing obesity epidemic [1]. This breathing disorder is a result of upper airway anomalies superimposed on reduced muscle tone [2]. The typical symptoms of OSAS patients include snoring, daytime sleepiness, and fatigue. Importantly, OSAS is not only associated with a decreased quality of life, but also with an increased risk of cardiovascular diseases [3, 4]. Therefore, the early and efficient diagnosis of OSAS can help to improve cardiovascular morbidity and mortality, and eventually reduce health care costs.

Although overnight polysomnography (PSG) is considered to be the gold standard for the assessment of sleep-disordered breathing [5], it remains an unappealing and cumbersome study with costly labor requirements. Meanwhile, the diagnostic accuracy of simple screening tools, such as the Epworth Sleepiness Scale, is reportedly insufficient to predict the presence of OSAS [6, 7]. Therefore, most individuals with OSAS are unaware of their diagnosis, despite at least some of them requiring therapeutic intervention [8].

Recently, drug-induced sleep endoscopy (DISE) has been used by otorhinolaryngologists to evaluate the pattern and level of upper airway obstruction in OSAS patients [9–11]. A benefit of DISE is its potential to provide a dynamic visualization of the anatomical areas responsible for the obstruction under conditions that mimic natural sleep. Therefore, it tends to be used only in patients in whom the need for therapeutic intervention is already being considered. On the contrary, an upper gastrointestinal (GI) endoscopy is often performed in clinical practice and is often included in opportunistic screening for gastric cancer in Asian countries [12]. Recent advances in endoscopic modalities have enabled the detection of superficial laryngo-pharyngeal cancer as well as GI cancer [13], suggesting that upper airway obstructions can also be evaluated using conventional upper GI endoscopy.

Therefore, we conducted this study to reveal whether the endoscopic evaluation of laryngo-pharyngeal collapse can accurately predict the incidence of OSAS. Additionally, we examined predictors of severe OSAS requiring therapeutic intervention. Our results will help to understand whether GI endoscopy can contribute to the early diagnosis of OSAS and a subsequent improvement in patient prognosis.

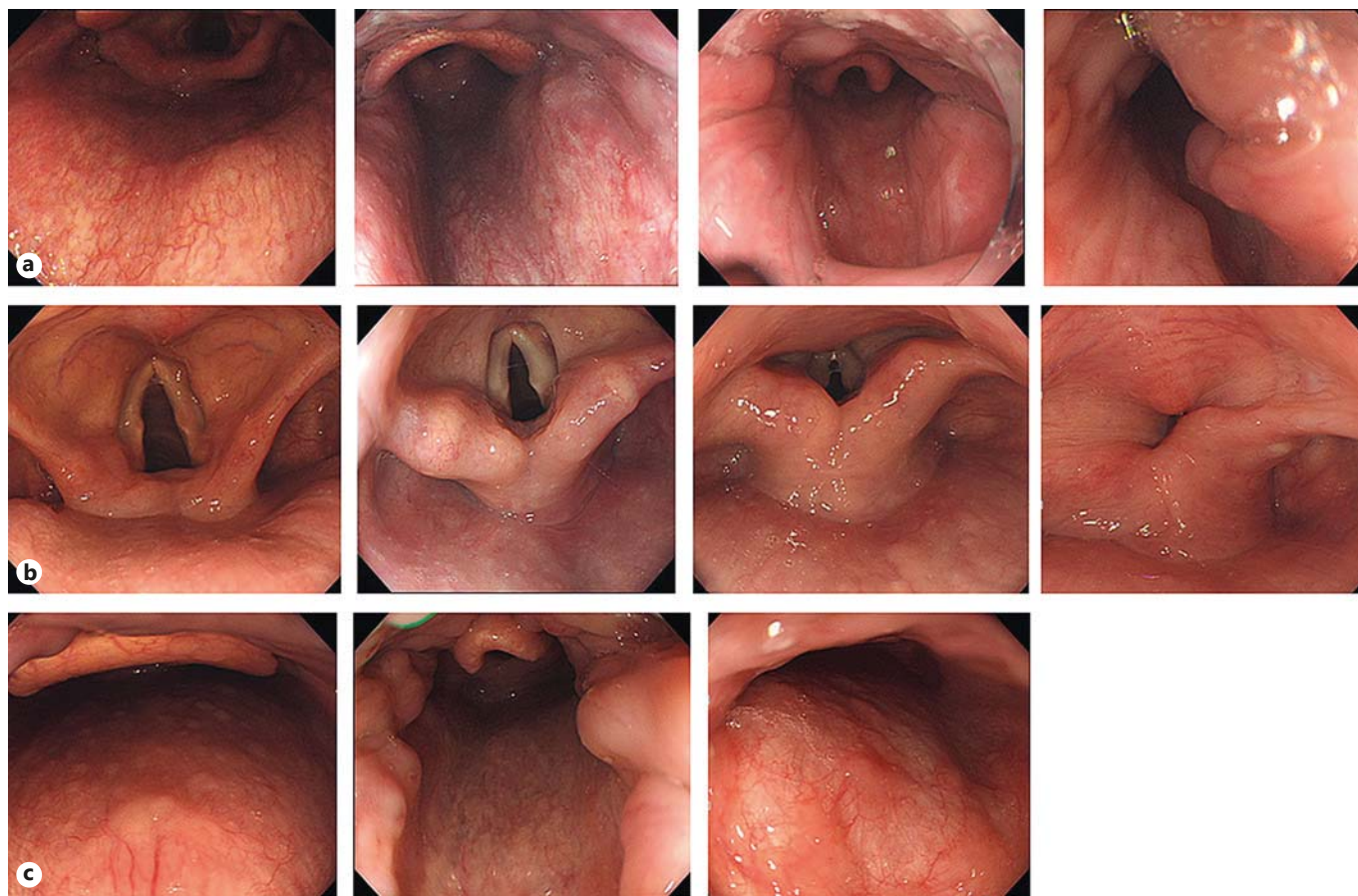
## Methods

### *Study Design and Patients*

This retrospective cross-sectional study was designed to reveal the efficacy of endoscopic examination for the identification of potential OSAS patients. All the procedures were conducted at Yamaga Chuo Hospital and NTT Medical Center Tokyo, between January 2009 and October 2015. Since we targeted subjects who were receiving a routine medical check-up, a large number of healthy asymptomatic subjects were included. We asked subjects who were scheduled to undergo an upper GI endoscopy under sedation to participate in this study, and a total of 4,980 subjects were consecutively enrolled. Of 289 subjects who were found to have laryngo-pharyngeal collapse, 154 subjects agreed to undergo a subsequent PSG examination and were included as the obstructive group. Meanwhile, 52 subjects without laryngo-pharyngeal collapse also agreed to undergo PSG examination and were included as control subjects. Subjects with enlarged tonsils (Mackenzie Classification grade  $\geq 3$ ), an ASA score  $\geq 3$ , or contraindications for sedatives were excluded from the study. We registered the patient data, including the age, sex, body mass index (BMI), and comorbidities that are reportedly associated with OSAS (hypertension, cardiovascular disease, cerebral infarction, and diabetes) [14], which were collected as clinical database at the time of initial endoscopic examination. Daytime sleepiness, one of the chief symptoms of OSAS, was assessed simultaneously with PSG and regarded as significant when the Epworth Sleepiness Scale score was greater than 10. The study protocol was approved by the Ethics Committees of our institutions (Institutional ID: 13–126). Written informed consent was obtained from all the subjects prior to their participation in the study.

### *GI Endoscopic Examination*

Endoscopic examination was performed by 4 experienced GI endoscopists. All the procedures were carried out under sedation using midazolam and pethidine hydrochloride. Midazolam was administered intravenously up to approximately 0.06 mg/kg per patient to achieve a sufficient sedation level (Richmond Agitation-Sedation Scale –3 to –4). Endoscopic OSAS signs, including the presence of upper airway obstruction and snoring, were evaluated during the endoscopic examination under sedation. During the procedures, the cardiorespiratory parameters were monitored, and the subjects received oxygen supplementation when their oxygen saturation dropped below 90%. After the subjects were placed in a left lateral position with their jaws thrust forward, a flexible endoscope (GIF-H260Z; Olympus Optical, Tokyo, Japan) was introduced perorally. The obstruction sites were then classified into 3 different subtypes based on the modified Fujita Classification: oropharyngeal, supraglottic, and combined type [15]. In addition, the level of obstruction (non-significant obstruction: 0–25%, mild: 25–50%, moderate: 50–75%, severe: >75%) and the dynamic pattern of collapse (antero-posterior, latero-lateral, and circumferential) were also evaluated. Representative images of the obstruction sites are shown in Figure 1. Subsequent to the laryngo-pharyngeal examination, a conventional observation was performed to identify upper GI abnormalities. All the videos were recorded, and laryngo-pharyngeal collapse was subsequently evaluated by another GI endoscopist who was blinded to the case data. To confirm the concordance in the grade of upper airway obstruction, intra-observer differences



**Fig. 1.** Representative endoscopic images of the upper airway obstruction. Endoscopic examination was performed under sedation. Each of the images was captured during the inspiratory phase. Combined type was diagnosed when both the oropharyngeal and supraglottic obstruction was confirmed simultaneously in a patient. **a** The level of oropharyngeal obstruction. Non-significant (most left), mild (2nd left), moderate (2nd right), and severe (most right). **b** The level of supraglottic obstruction. Non-significant

(most left), mild (2nd left), moderate (2nd right), and severe (most right). **c** Dynamic pattern of collapse. Antero-posterior type (left), latero-lateral type (middle), and circumferential type (right). The kappa value was calculated as 0.77. For the diagnosis of OSAS, the diagnostic accuracy, sensitivity, and specificity of the presence of laryngo-pharyngeal collapse were 75.7, 96.4, and 51.1%, respectively.

between the real-time observations and the review were calculated using kappa statistics. If any discrepancies occurred, the findings were reviewed simultaneously by both GI endoscopists, and a consensus was reached.

#### PSG Examination

Subsequent to the endoscopic examination, PSG was performed to identify sleep-disordered breathing using the Alice 5 system (Respironics Inc., MA, USA), as previously described [16]. In summary, a number of physiological parameters (air flow, oxygen saturation, body position, electroencephalogram, electrocardiogram, electromyogram, and thoraco-abdominal movement) were recorded overnight and were verified by an experienced physician of sleep medicine. Respiratory sensors detected decrements in ventilation, and the apnea-hypopnea index (AHI) was calculated as the total number of apneas (cessation of airflow  $\geq 10$  s) and hypopneas (partial decrease of airflow  $\geq 10$  s

with more than 4% oxyhemoglobin desaturation) per hour [17]. OSA was defined as an AHI  $\geq 5$ /h and was further categorized as follows: mild, 5–15/h; moderate, 15–30/h; and severe,  $\geq 30$ /h. OSAS was diagnosed according to the recommendations of the American Academy of Sleep Medicine (AASM) when AHI  $\geq 15$ /h or AHI  $\geq 5$ /h with the simultaneous occurrence of typical clinical symptoms [5].

#### Statistical Analysis

Continuous data are shown as mean  $\pm$  SD. The statistical significances of the differences in the values of the clinical parameters were evaluated using the Fisher's exact test and an unpaired Student *t* test. Comparisons of the clinical parameters among the 3 different obstruction types were performed using the chi-squared test or an analysis of variance. The correlation between the severity of upper airway obstruction with the AHI score was evaluated by using the Pearson's correlation coefficient. Univar-



**Table 1.** Characteristics of patients enrolled in this study

	Obstructive group	Control group	<i>p</i> value
Number	154	52	
Gender, <i>n</i> (%)			0.62
Male	93 (60.4)	34 (65.4)	
Female	61 (39.6)	18 (34.6)	
Age, years, mean $\pm$ SD	60.3 $\pm$ 13.0	59.3 $\pm$ 15.3	0.62
BMI, kg/m <sup>2</sup> , mean $\pm$ SD	25.7 $\pm$ 3.9	23.3 $\pm$ 3.3	<0.001
OSA, <i>n</i> (%)	147 (95.5)	27 (51.9)	<0.001
OSAS, <i>n</i> (%)	108 (70.1)	4 (7.7)	<0.001
AHI, mean $\pm$ SD	25.8 $\pm$ 17.9	7.0 $\pm$ 5.0	<0.001
Comorbidity, <i>n</i> (%)			
Hypertension	76 (49.4)	12 (23.1)	0.001
Cardiovascular disease	26 (16.9)	5 (9.6)	0.26
Cerebral infarction	21 (13.6)	5 (9.6)	0.63
Diabetes	48 (31.2)	8 (15.4)	0.03

Patients who endoscopically identified laryngo-pharyngeal collapse were classified into the obstructive group. OSA was defined as an AHI  $\geq$ 5/h. OSAS was diagnosed when an AHI  $\geq$ 15/h or an AHI  $\geq$ 5/h with the simultaneous occurrence of typical clinical symptoms was present.

*p* values were analyzed using the Fisher's exact test or the Student *t* test.

OSAS, obstructive sleep apnea syndrome; BMI, body mass index; AHI, apnea-hypopnea index.

iate and multivariate logistic regression analyses were performed to identify predictors of severe OSAS. All the analyses were performed using SPSS, version 11.0 (SPSS Inc., Chicago, IL, USA).

## Results

### Patient Characteristics

The demographic and clinical characteristics of the enrolled subjects are given in Table 1. The patient age was 60.1  $\pm$  13.6 years, and the majority of subjects were male (61.7%). There were no significant differences in age or sex among the obstructive and control groups (60.3  $\pm$  13.0 vs. 59.3  $\pm$  15.3 years, *p* = 0.62 and 61.1 vs. 40.0%, *p* = 0.18, respectively). The average BMI was significantly higher within the obstructive group (25.7  $\pm$  3.9 vs. 23.3  $\pm$  3.3, *p* < 0.001). As for the differences in comorbidity rates, hypertension and diabetes were predominantly identified in the obstructive group (49.4 vs. 23.1%, *p* = 0.001 and 31.2 vs. 15.4%, *p* = 0.003, respectively). PSG showed that most of the subjects with laryngo-pharyngeal collapse (95.5%) harbored at least mild OSA (AHI  $\geq$ 5/h). Of the 154 subjects with laryngo-pharyngeal collapse, 108 (70.1%) were diagnosed as having OSAS, while only 4 (7.7%) control subjects were diagnosed as having OSAS (*p* < 0.001).

### Diagnostic Accuracy of GI Endoscopic Examination

Almost all the upper airway observations were completed within one minute (40.9  $\pm$  17.3 s), and did not disturb subsequent conventional GI screening. Among 206 subjects enrolled in this study, the grade of airway obstruction was endoscopically evaluated as follows: 52 subjects (25.2%) had no obstruction, 53 subjects (25.7%) had mild obstruction, 36 subjects (17.4%) had moderate obstruction, and 65 subjects (31.6%) had severe obstruction, respectively. For the diagnosis of OSAS, the diagnostic accuracy, sensitivity, and specificity of the presence of laryngo-pharyngeal collapse were 75.7, 96.4, and 51.1%, respectively.

### Association between the Levels of Upper Airway Obstruction and the Severity of OSAS

The distributions of the obstruction sites and dynamic collapse patterns are shown in Table 2. An endoscopic anatomical evaluation revealed that oropharyngeal involvement was frequently found in 90.2% of subjects (139/154). Of the 139 subjects with oropharyngeal collapse, 26 were classified into combined-type and had an obstruction level that was significantly severe, compared with the other types (*p* = 0.004). Meanwhile, supraglottic involvement was only found in 26.6% (41/154). Subjects with isolated supraglottic collapse tended to be older women with a relatively low BMI. As for the dynamic col-

**Table 2.** Differences among the three subtypes of upper airway obstruction

	Oropharyngeal type	Supraglottic type	Combined type	<i>p</i> value
Number	113	15	26	
Gender, <i>n</i> (%)				0.18
Male	69 (61.1)	6 (40.0)	18 (69.2)	
Female	44 (38.9)	9 (60.0)	8 (30.8)	
Age, years, mean $\pm$ SD	59.0 $\pm$ 13.2	69.6 $\pm$ 8.9	60.0 $\pm$ 12.3	0.008
BMI, kg/m <sup>2</sup> , mean $\pm$ SD	25.8 $\pm$ 4.2	24.4 $\pm$ 2.8	26.0 $\pm$ 2.8	0.39
Collapse pattern, <i>n</i> (%)				0.16
Antero-posterior	9 (8.0)	0 (0)	0 (0)	
Llateral-lateral	87 (77.0)	12 (80.0)	25 (96.2)	
Circumferential	17 (15.0)	3 (20.0)	1 (3.8)	
Level of obstruction, <i>n</i> (%)				0.004
Mild	46 (40.7)	3 (20.0)	4 (15.3)	
Moderate	29 (25.7)	4 (26.7)	3 (11.5)	
Severe	38 (33.6)	8 (53.3)	19 (73.1)	
OSAS, <i>n</i> (%)	79 (69.9)	8 (53.3)	21 (80.8)	0.18
AHI, mean $\pm$ SD	26.0 $\pm$ 18.2	17.7 $\pm$ 10.6	29.7 $\pm$ 18.9	0.12

OSAS was diagnosed when AHI  $\geq$ 15 or AHI  $\geq$ 5 with simultaneous occurrence of typical clinical symptoms. *p* values were analyzed using the Chi-squared test or an ANOVA.

OSAS, obstructive sleep apnea syndrome; BMI, body mass index; AHI, apnea-hypopnea index.

lapse pattern, latero-lateral collapse was the most common obstruction pattern, while antero-posterior collapse was only identified in subjects with oropharyngeal collapse. The kappa values were calculated for obstruction sites, level of obstruction and dynamic pattern, and confirmed a good level of consistency between the real-time observations and review with a value of 0.81, 0.77, and 0.73, respectively.

There were no significant differences in the AHI scores (26.0  $\pm$  18.2, 17.7  $\pm$  10.6, and 29.7  $\pm$  18.9, *p* = 0.12) or the prevalence of OSAS (69.9, 53.3, and 80.8%, *p* = 0.18) among the 3 different obstructive groups (oropharyngeal, supraglottic, and combined type, respectively). As shown in Figure 2, the severity of upper airway obstruction was significantly correlated with the AHI score (*r* = 0.55, *p* < 0.001).

#### Predictors of Severe OSAS

Of 154 subjects with laryngo-pharyngeal collapse, 59 (38.3%) patients were diagnosed as having severe OSAS. The selected variables and results are shown in Table 3. A univariate logistic regression analysis identified a male sex (OR 4.34; 95% CI 2.04–9.21, *p* < 0.001), BMI  $\geq$ 25 kg/m<sup>2</sup> (OR 5.20; 95% CI 2.65–10.2, *p* < 0.001), combined obstruction (OR 2.43; 95% CI 1.05–5.62, *p* = 0.04), severe obstruction (OR 8.04; 95% CI 4.09–15.8, *p* < 0.001), and

the presence of snoring (OR 4.72; 95% CI 2.47–9.00, *p* < 0.001) as significant factors predicting severe OSAS. As the results of a multivariate logistic regression analysis, a male sex (OR 5.20; 95% CI 2.65–10.2, *p* < 0.001), BMI  $\geq$ 25 kg/m<sup>2</sup> (OR 4.98; 95% CI 2.23–11.2, *p* = 0.02), and severe obstruction (OR 7.79; 95% CI 3.34–18.2, *p* < 0.001) remained as independent significant predictors of severe OSAS.

#### Discussion

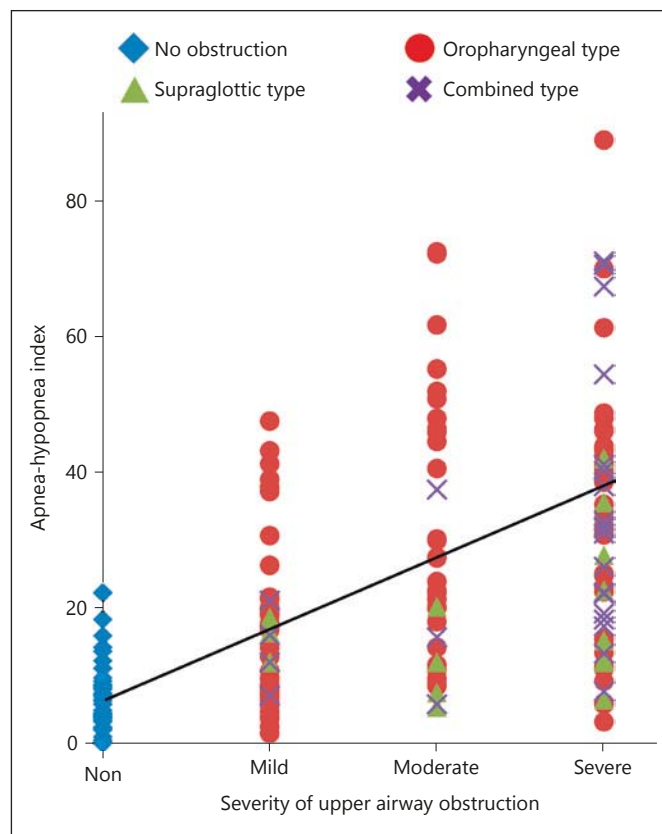
In the present study, we revealed the efficacy of endoscopic evaluations for upper airway obstruction for the diagnosis of OSAS. Although several reports have investigated the usefulness of DISE as a diagnostic tool for OSAS, examinations were usually performed after the diagnosis of OSAS to determine whether therapeutic interventions were needed [9–11]. In contrast, we used endoscopy as a screening modality for OSAS in the present study. Importantly, upper airway obstructions could be conveniently assessed within a few minutes during conventional GI endoscopy, and the assessments accurately predicted the incidence of OSAS.

Recently, the repetitive nocturnal hypoxemia experienced in OSAS patients has been revealed to be associ-

ated with increased sympathetic activity, endothelial dysfunction, systemic inflammation, oxidative stress, and metabolic anomalies [3], suggesting that OSAS should be considered as a systemic disease. Peppard et al. [8] reported that patients with moderate to severe OSA had a 3-fold increased risk in developing new hypertension after the initial diagnosis. In addition, Qian et al. [18] reported that OSA is associated with an increased risk of metabolic syndrome, independent of BMI. Of note, each mechanism and physical condition is implicated in the initiation and progression of cardiovascular disease [3]. Consistent with previous reports, we confirmed a significantly higher prevalence of hypertension and diabetes among subjects with OSAS, although the significance of the difference in the prevalence of cardiovascular disease was borderline. Since OSAS is reportedly common in patients with prior cardiovascular disease [19], early diagnosis and subsequent therapeutic intervention are important to improve their prognosis.

The high prevalence of undiagnosed OSAS and its attendant morbidity and mortality provide a strong impetus to improve recognition of this disorder. According to a practice-based research network study, only 20% of patients with sleep-related symptoms spontaneously complained of their symptoms to their clinicians [20]. Since most clinicians do not routinely screen for OSAS, the early identification of OSAS in primary care settings seems particularly challenging. In the present study, the sensitivity of laryngo-pharyngeal collapse was calculated as 96.4%, suggesting that GI endoscopy can be useful as a screening modality for the diagnosis of OSAS. Importantly, such examinations can be performed within a few minutes in daily clinical practice. The Japanese government introduced endoscopic screening for gastric cancer in 2015 as a public policy based on the Japanese guidelines for gastric cancer screening [21]. Additionally, upper GI endoscopic screening has also become more common in other developed countries (e.g., for the diagnosis of reflux esophagitis and/or Barrett's esophagus) [22]. We recommend the assessment of laryngo-pharyngeal collapse prior to GI observation, which would enable the early identification of individuals with a risk of OSAS.

As expected, obesity was identified as a strong predictor of severe OSAS [23]. The Wisconsin Sleep Cohort noted an approximately 3% change in the severity of OSA for every 1% weight gain [24]. Importantly, we also revealed a significant association between the severity of the upper airway obstruction and the AHI score. Since



**Fig. 2.** Association between the severity of upper airway obstruction and the AHI score. The obstruction sites were classified into 3 different subtypes based on the modified Fujita Classification. The obstruction level was defined as non-significant obstruction (0–25%), mild (25–50%), moderate (50–75%), or severe (>75%). The severity of upper airway obstruction was significantly correlated with the AHI score ( $r = 0.55$ ,  $p < 0.001$ ). OSAS, obstructive sleep apnea syndrome; AHI, apnea-hypopnea index.

the level of obstruction independently predicted the severity of OSAS, a conventional upper GI endoscopic examination could indicate a need for therapeutic intervention. According to the recommendation from AASM, therapeutic interventions should be considered for patients with severe sleep-disordered breathing, regardless of the presence of typical symptoms [5]. Although continuous positive airway pressure (CPAP) is considered to be effective independent of the site or cause of the upper airway obstruction, a significant proportion of patients have poor adherence to the therapy. In the present study, only 10 symptomatic patients with severe OSAS received subsequent CPAP therapy, suggesting a need for alternative therapeutic options such as surgery. A previous report highlighted the findings that the site and level of obstruction have a major impact

**Table 3.** Risk factors for predicting the presence of severe OSA

	Severe OSAS			
	univariate OR (95% CI)	<i>p</i> value	multivariate OR (95% CI)	<i>p</i> value
Age >60 years	0.80 (0.44–1.46)	0.46		
Gender, male	4.34 (2.04–9.21)	<0.001	2.89 (1.21–6.90)	0.02
BMI ≥25 kg/m <sup>2</sup>	5.20 (2.65–10.2)	<0.001	4.98 (2.23–11.2)	<0.001
Combined obstruction	2.43 (1.05–5.62)	0.04	0.71 (0.24–2.11)	0.54
Circumferential obstruction	0.43 (0.13–1.26)	0.12		
Severe obstruction	8.04 (4.09–15.8)	<0.001	7.79 (3.34–18.2)	<0.001
Snoring	4.72 (2.47–9.00)	<0.001	1.64 (0.73–3.68)	0.23

Patients with an AHI score ≥30 were diagnosed as having severe OSA. The presence of snoring was evaluated during upper gastrointestinal endoscopy under sedation.

*p* values were calculated using univariate and multivariate logistic regression analyses.

OSAS, obstructive sleep apnea syndrome; BMI, body mass index; AHI, apnea-hypopnea index.

on surgical outcomes [25]. Uvulopalatopharyngoplasty (UPPP), the most widely performed surgery for OSAS patients, was reportedly useful in patients with isolated palatal obstruction; however, severe supraglottic collapse predicts a poor response to this therapy [26]. Since endoscopic evaluation enables the dynamic visualization of upper airway obstructions, it could help to determine appropriate therapeutic strategies. To achieve favorable outcomes after an initial OSAS diagnosis, close collaboration among surgeons, GI endoscopists, and primary care clinicians will be needed.

Although the endoscopic evaluation of upper airway obstruction was shown to be a useful modality for the diagnosis of OSAS, the methodological differences from DISE conducted by otorhinolaryngologists should be considered. Regarding the patient's body position, we assessed upper airway obstructions while the patients was in a left lateral position, while DISE is usually performed in a supine position. Sleep-disordered breathing is known to occur more frequently in a supine position than in a lateral position [27]; therefore, the sensitivity might be lower in the present study. In addition, attention to the variety of sedation methods that can be used is needed. Unlike our study, propofol was often used in previous studies conducted in Western countries [9, 11, 15]. Because of the limited analgesic effect, the use of propofol as a single agent for GI endoscopy tends to be required in higher sedation levels [28]. Moreover, the insertion route can alter outcomes. Trans-nasal endoscopy may be more useful since the nasopharynx or upper part of the oropharynx can be evaluated. When interpreting the results

of awake trans-nasal endoscopy, it is worth remembering that lower pharyngeal obstruction is more common while the subject is asleep than awake, and DISE plays a significant role in laryngeal obstruction in OSAS patients [29, 30].

The present study had some limitations. Firstly, this was a retrospective study, therefore the selection bias could not be avoided. Additionally, the smaller sample size of control subjects is an important limitation of the study. Although subsequent PSG examination was recommended for all the subjects, the consultation rate for PSG examination was significantly lower in the control group. PSG examination is non-invasive but bothersome, which might have caused the healthy control subjects to hesitate to undergo subsequent PSG examination. Secondly, this evaluation was shown to be useful only in subjects who underwent GI endoscopy under sedation. Since endoscopic examination is usually performed without sedation, and sometimes trans-nasally, for cancer screening in Japan, its effectiveness is limited to some patients. Moreover, narcotic agents such as pethidine hydrochloride may not be suitable for use in routine clinical practice. Whether awake trans-nasal endoscopy can accurately predict the presence of OSAS would be interesting to investigate. Finally, the overall number of included patients was comparatively small, and only 2 Japanese institutions participated in this study. Since endoscopic evaluation is a subjective assessment, large-scale, multi-centered, prospective studies are needed to conclude the efficacy of upper GI endoscopic examination for the diagnosis of OSAS.



In conclusion, we demonstrated that a conventional upper GI endoscopic examination might be useful as a screening modality for OSAS. Additionally, we revealed a significant association between the severity of OSAS and the level of upper airway obstruction, which enable predicting the necessity of the therapeutic intervention. Since OSAS patients harbor a higher risk of morbidity and mortality from cardiovascular disease, early diagnosis and subsequent therapeutic intervention are impor-

tant. Our results indicated that endoscopists can contribute to the identification of potential OSAS patients, thereby improving their prognosis.

## Disclosure Statement

None of the authors have any potential conflicts of interest to declare.

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