

Association of adenotonsillar hypertrophy and its treatment in childhood with risk of obstructive sleep apnea syndrome in adult Japanese male factory workers

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Abstract

Objectives: Obstructive sleep apnea syndrome (OSAS) affects patients' vital prognosis. Although adenotonsillar hypertrophy is linked to the pathogenesis of OSAS in children, the etiological role of childhood adenotonsillar hypertrophy in the later development of OSAS in the Japanese general population is unknown.

Methods: We evaluated 1121 male factory workers aged ≥ 20 years who underwent home portable monitoring for screening examinations of OSAS in Japan. The relative risk of developing OSAS among patients with a history of adenotonsillar hypertrophy in childhood and the relative risk reduction associated with treatment were estimated.

Results: We identified 85 men with OSAS (prevalence, 7.2%). The relative risk of OSAS in patients with untreated adenotonsillar hypertrophy was 2.92 (95% confidence interval [CI], 1.42–6.13). The relative risk reduction for treatment of adenotonsillar hypertrophy with OSAS was estimated as 78.3% (95% CI, 4.7–95.3) in men with a history of adenotonsillar hypertrophy and 11.9% (95% CI, 4.4–21.5) in the whole male population with and without a history of adenotonsillar hypertrophy.

Conclusions: The findings of this study suggest a large relative risk reduction of adult OSAS in patients who have undergone treatment of adenotonsillar hypertrophy in childhood.

Keywords: Obstructive sleep apnea, Adenotonsillar hypertrophy, Epidemiology, General population

Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by repetitive upper airway collapse during sleep. Patients with OSAS have a reduced cross-sectional area of the upper airway lumen because of excessive soft tissue bulk, abnormal craniofacial anatomy, or both.¹ OSAS is an important cause of medical morbidity associated with hypertension and cardiovascular and cerebrovascular disturbances,^{2,4} resulting in increased mortality.^{5,6} Advanced age, anatomical variations, alcohol consumption, sex, and obesity are important risk factors for the development of OSAS.^{5,7-10}

The most common cause of OSAS in children is adenotonsillar hypertrophy.^{11,12} Adenotonsillar hypertrophy in childhood might cause OSAS in adulthood. Additionally, treatment of adenotonsillar hypertrophy can cure OSAS in childhood and prevent the development of OSAS in adulthood.^{13,14} Although a previous study demonstrated the effect of a history of adenotonsillar hypertrophy on the development of OSAS in adulthood using clinical data,¹⁵ the role of a history of adenotonsillar hypertrophy in the later development of OSAS has not been examined in the general population.

In the present study, we evaluated the risk of OSAS in adulthood associated with untreated adenotonsillar hypertrophy in childhood in Japanese male factory workers. We also estimated the risk reduction of OSAS with treatment of adenotonsillar hypertrophy.

Methods

Subjects

We evaluated 1128 factory workers who underwent home portable monitoring for screening examinations of OSAS at Hitachi Appliances, Inc., from November 2001 to June 2005. All of the subjects were men who gave informed consent to the coauthors at a health examination. Four of the 1128 men were excluded because they were aged < 19 years, and 3 were excluded because of insufficient data. Therefore, 1121 men aged ≥ 20 years were analyzed. All subjects provided informed consent.

Portable Monitoring

Portable polysomnography (Pulsleep LS-100; Fukuda Denshi Co., Ltd., Tokyo, Japan), measurement of the blood oxygen level, and measurement of the pulse rate were performed by finger pulse oximetry. Respiratory airflow was monitored using a nasal cannula, and snoring was recorded. Certified physicians of the Japanese Sleep Society provided instructions for wearing sensors to all subjects, and the subjects fixed

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the pulse oximetry sensors and nasal cannulas at their home. Records of analyzable air flow and pulse oximetry within 3 hours were examined again. Data that remained unanalyzable after three repeated measurements during the above-mentioned recording were considered insufficient and excluded from the analysis. Registered polysomnographic technicians manually analyzed all respiratory events. A respiratory event was defined as a flow reduction of $\geq 40\%$ in combination with an oxygen desaturation of $\geq 4\%$. For each LS-100 recording, the portable monitoring respiratory disturbance index (RDI) was determined as the mean number of respiratory events per hour of time in bed.

Event Definition

A self-administered questionnaire was used to determine the Epworth Sleepiness Scale (ESS) score,¹⁶ medical history, and treatment or lack of treatment, including that for hypertrophy of the adenoids or/and tonsils. The diagnostic criteria in the second revision of the International Classification of Sleep Disorders were used to define OSAS (i.e., either an RDI of ≥ 5 events/h in combination with an ESS score of ≥ 11 or an RDI of ≥ 15 events/h indicated a positive OSAS diagnosis).¹ Patients with a history of adenotonsillar hypertrophy had hypertrophy of the adenoids or/and tonsils, and patients with a history of treatment for adenotonsillar hypertrophy had undergone adenotonsillectomy.

Data Analysis

Data were available for the RDI, ESS score, and history of hypertrophy of the adenoids or/and tonsils. Data were evaluated using the Statistical Package for the Social Sciences ver. 17.0 (SPSS Inc., Chicago, IL, USA). We observed the prevalence of OSAS in men with untreated and treated adenotonsillar hypertrophy and those without a history of adenotonsillar hypertrophy. The relative risk (RR) of OSAS was calculated by dividing the prevalence of OSAS in men with untreated and treated adenotonsillar hypertrophy by the prevalence of OSAS in men without a history of adenotonsillar hypertrophy. The risk reduction of OSAS for treatment of adenotonsillar hypertrophy among all men with a history of adenotonsillar hypertrophy (denoted as RE) was estimated as $E_{untreated} - E_{treated}$. $E_{untreated}$ was the expected number of cases of OSAS under the assumption that all men with a history of adenotonsillar hypertrophy were untreated. $E_{treated}$ was the expected number of cases of OSAS under the assumption that all men with a history of adenotonsillar hypertrophy were treated. $E_{untreated}$ and $E_{treated}$ were calculated by multiplying the number of all men with a history of adenotonsillar hypertrophy by the observed prevalence of OSAS in men with untreated and treated adenotonsillar hypertrophy, respectively. The RR reduction (RRR) of OSAS for treatment among all men with a history of adenotonsillar hypertrophy was estimated as $RE / E_{untreated}$. The RRR of OSAS for treatment among the whole male population with and without a history of adenotonsillar hypertrophy was estimated as $RE / (E_{untreated} + O_{without\ history})$, where $O_{without\ history}$ was the observed number of cases of OSAS among all men without a history of adenotonsillar hypertrophy. The 95% confidence intervals (CIs) of RR and RRR were approximately estimated using the variance formula for the ratio of proportions.¹⁷

Ethical Considerations

This study was approved in November 2010 by the Ethical Review Board for Epidemiological and Clinical Studies of the Fujita Health University School of Medicine, Aichi, Japan (No. 10-183).

Results

Among 1121 men analyzed, 85 were diagnosed with OSAS. The prevalence of OSAS was 7.2% in this study. Table 1 shows the history of adenotonsillar hypertrophy in childhood among all 1121 Japanese male factory workers according to age. Of the subjects with a history of adenotonsillar hypertrophy, 43 underwent treatment in childhood and 28 did not.

The RRs and 95% CIs of OSAS associated with a history of adenotonsillar hypertrophy in Japanese male factory workers are shown in Table 2. OSAS in adulthood was significantly associated with untreated adenotonsillar hypertrophy in childhood, but not with treated adenotonsillar hypertrophy in childhood. The RR of OSAS was 2.92 (95% CI, 1.42–6.13) for a history of untreated adenotonsillar hypertrophy and 0.63 (95% CI, 0.17–2.50) for a history of treated adenotonsillar hypertrophy.

The RRRs and 95% CIs of OSAS associated with treatment of adenotonsillar hypertrophy in Japanese male factory workers are shown in Table 3. The RRR for treatment of adenotonsillar hypertrophy with OSAS was estimated as 78.3% (95% CI, 4.7–95.3) in men with a history of adenotonsillar hypertrophy and 11.9% (95% CI, 4.4–21.5) in the whole male population with and without a history of adenotonsillar hypertrophy.

Table 1. Age distribution of subjects in the present study

Age (years)	n	(%)	History of adenotonsillar hypertrophy		
			No history	Untreated	Treated
Total	1121		1050	28	43
20–29	99	(8.8)	97	2	0
30–39	431	(38.4)	409	9	13
40–49	259	(23.1)	236	7	16
50–59	314	(28.0)	291	9	14
60–69	18	(1.6)	17	1	0

All subjects were men.

Table 2. Relative risks and 95% confidence intervals for OSAS associated with a history of adenotonsillar hypertrophy in Japanese male factory workers

History of adenotonsillar hypertrophy	Subjects	OSAS		RR (95% CI)	p value
	n	n	(%)		
No history	1050	77	(7.3)	1.00	
Treated	43	2	(4.7)	0.63 (0.17–2.50)	0.715
Untreated	28	6	(21.4)	2.92 (1.42–6.13)	0.016
Total	1121	85	(7.6)		

OSAS, obstructive sleep apnea syndrome; RR, relative risk; CI, confidence interval.

Table 3. Relative risk reduction and 95% confidence intervals for OSAS associated with treatment of adenotonsillar hypertrophy in Japanese male factory workers

History of adenotonsillar hypertrophy	Expected number of cases of OSAS (n)			Relative risk reduction (%)	
	Under assumption that all subjects with a history were untreated	Under assumption that all subjects with a history were treated	Difference	Estimated value	95% CI
No history	77.0	77.0			
History	15.2	3.3	11.9	78.3	4.7-95.3
Total	92.2	80.3	11.9	12.9	4.4-21.5

OSAS, obstructive sleep apnea syndrome; CI, confidence interval.

Discussion

We estimated that the RR of adulthood OSAS in association with untreated adenotonsillar hypertrophy in childhood was 2.92 among Japanese male factory workers. Several studies have shown an association between abnormal dentofacial morphology and the pathogenesis of OSAS in adults.^{14,18,19} The most common cause of OSAS in children is adenotonsillar hypertrophy.^{11,12} Adenotonsillar hypertrophy is a cause of mouth breathing secondary to impaired nasal breathing.²⁰ This condition leads to a posteriorly inclined mandible and hyoid bone because of the high intrapleural negative pressure that reaches the upper airway secondary to pharyngeal airway obstruction.²¹ An abnormal dentofacial morphology is frequently observed in adult patients with OSAS.^{18,19} A previous clinical study demonstrated that the risk of OSAS in men is 3.13 times higher in those with a history of untreated adenotonsillar hypertrophy versus no history of hypertrophy.¹⁷ This finding is supported by our results for the general male population.

In the present study, the RRR of OSAS for treatment of adenotonsillar hypertrophy was estimated as 78.3% in men with a history of adenotonsillar hypertrophy and 11.9% in the whole male population with and without a history of adenotonsillar hypertrophy. Treatment of adenotonsillar hypertrophy can cure OSAS in childhood. A previous study showed that treatment of adenotonsillar hypertrophy prevents the development of OSAS in adulthood.¹⁵ Our results suggest that the risk reduction of adult OSAS for treatment of adenotonsillar hypertrophy in childhood would be large in men with adenotonsillar hypertrophy. Additionally, treatment would have a large effect on decreasing OSAS in the whole male population with and without a history of adenotonsillar hypertrophy.

The prevalence of OSAS in men was 7.2% in the present study and ranged from 9.1% to 14.2% in previous population-based studies in Western countries.^{2,5} Our subjects were healthy workers, and 47.2% of them were aged <40 years. The prevalence of OSAS in the current study might have been underestimated because only healthy workers were evaluated.²² The RRR of OSAS for treatment of adenotonsillar hypertrophy in the whole male population, which was calculated using this prevalence of OSAS, might have been underestimated.

There are some limitations in the present study. The study was cross-sectional, and only men were included. We evaluated sleep-disordered breathing in these factory workers using a portable monitoring device (LS-100), which the subjects operated at home. The portable monitoring device recorded

respiratory events with an oxygen desaturation of $\geq 4\%$, from which the RDI was calculated, and manual correction was performed by authorized physicians of the Japanese Sleep Society after automatic analysis. This produced high agreement with the polysomnography results. A positive correlation was observed between the RDI determined using the LS-100 unit with manual analysis and the overnight polysomnography results ($r = 0.995$, $p < 0.0001$). In one study, the sensitivity and specificity of the RDI calculated by polysomnography (LS-100) for an apnea-hypopnea index of ≥ 5 , ≥ 15 , and ≥ 30 were 1.00 and 0.89, 0.93 and 1.00, and 0.90 and 1.00, respectively.²³ Information on the history and treatment of adenotonsillar hypertrophy was obtained using a self-administered questionnaire. The RRRs of OSAS for treatment of adenotonsillar hypertrophy were estimated using the above-described method (Data Analysis subsection), but were not observed directly. Our subjects included six and two men with OSAS who had a history of untreated and treated adenotonsillar hypertrophy, respectively. We did not adjust for other factors (e.g., age and body mass index) when estimating the RRs of OSAS for a history of untreated and treated adenotonsillar hypertrophy because of the small number of subjects with OSAS.¹⁵ Further studies involving more patients with OSAS and adjustments for potential covariates are necessary.

In conclusion, we evaluated the risk of development of adult OSAS in patients with untreated childhood adenotonsillar hypertrophy. Our findings suggest a large risk reduction in adult OSAS in association with treatment of adenotonsillar hypertrophy in childhood.

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Conflict of interest

The authors declare no competing interests for this study.

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