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Effects of body mass index and adenotonsillar size on snoring sound intensity levels at highest power☆

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ABSTRACT

Objectives: Snoring during sleep is a major clinical symptom of adenoid and tonsil hypertrophy in paediatric patients. The aim of this study was to determine the effects of adenoid and tonsil size on snoring sound frequency and intensity in children.
Methods: Twenty-seven patients with adenotonsillar hypertrophy were included the study. Adenoid size was graded from 1+ to 4+ by rigid endoscopy. Patients were staged (I–III) according to body mass index (BMI) and tonsil and adenoid size. Snoring was recorded and analysed. The analysis focused on the highest power frequency (Fmax) and snoring sound intensity levels (SSILs).
Results: SSIL and Fmax values for Stage III were significantly higher than those for Stages I and II. BMI for Stage III was higher than for Stages I and II, and that for Stage II was higher than for Stage I. The BMI, SSIL, and Fmax values increased at each stage and tonsil/adenoid grade.
Conclusions: SSIL seems to be related to Adenoid and Tonsils size and BMI. As stage increased, both Fmax and SSILs increased proportionally. Also, Fmax values shifted to higher frequencies. Physicians and parents should be aware of snoring, and be informed that a higher frequency and intensity may be related to obesity and/or adenotonsillar hypertrophy. Snoring analysis may be a useful tool for detecting cases of Adenoid and Tonsils hypertrophy and/or upper airway obstruction during sleep.

1. Introduction

Obstructive sleep apnoea syndrome (OSAS) is caused by upper airway collapse during sleep when upper respiratory tract muscle tone decreases. Patients with upper airway narrowing are prone to developing OSAS. In the paediatric population, the most common OSAS cause is adenotonsillar hypertrophy [1].

In a study by Hwang et al. [2], adenoid and tonsil size were larger in the OSAS group than the control group, and there was a positive correlation between adenotonsillar hypertrophy and the apnoea–hypopnoea index (AHI). There was no significant difference between OSAS severity and adenoid and tonsil size. This finding was similar to previous results showing that adenoid and tonsil size did not predict apnoea. Brooks et al. [3] reported that adenoid and tonsil sizes did not predict apnoea, but a significant relationship existed between adenoid size and the duration of obstructive apnoea. Adenoid size contributed to low oxyhaemoglobin saturation, with a correlation coefficient (r) of 0.69.

The pathophysiological characteristics of adenoid hypertrophy in children probably involve a complex interaction between pharyngeal size and biomechanics [3]. Snoring is produced by soft tissue vibration in the pharynx, soft palate, and perhaps the uvula. This sound has distinct acoustic characteristics that are different from other breath sounds [4].

Snoring is a major symptom of adenotonsillar hypertrophy. Few investigators have reported a substantial correlation between snoring and adenotonsillar obstruction severity [5,6]. This study aimed to characterise the acoustic properties of snoring sounds using intensity and frequency parameters to investigate the relationship between these parameters and the degree of adenotonsillar hypertrophy.

2. Materials and methods

This study was carried out with permission from the ethics committee of Giresun State Hospital (Date: February 1, 2008,

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No: 1), and was conducted in accordance with the Helsinki Declaration [7]. Informed consent was obtained from parents. No funding support was required.

2.1. Patients

The subjects underwent physical examination. The nose was examined for nasal obstruction or septal deviation. Subjects with ≥2+ tonsillar hypertrophy were included in the study [8]. Adenoid size was determined endoscopically, and was graded from 1+ to 4+. Children with acute respiratory infections of two weeks duration, pulmonary and/or neurological diseases, or craniofacial abnormalities were excluded from the study.

Of the 27 habitual snorers, 6 (22%) were female and 21 (78%) were male. Patient age ranged from 4.00 to 13.00 years, with a median of 5.50 years in the Stage I group, 5.00 years in the Stage II group, and 5.00 years in the Stage III group (Table 1).

2.2. Methods

2.2.1. Questionnaire

Parents were asked to complete a self-administered questionnaire adapted from the American Thoracic Society questionnaire for children [9]. Snoring was evaluated with the following question: "Does your child ever snore?" (Answers: 1, never; 2, only with colds; 3, occasionally without a cold; and 4, often). Children who snored often were included in the study.

2.2.2. Body mass index (BMI)

Height (cm) and weight (kg) were measured using standard methods, and body mass index (BMI) was calculated and divided using standardised percentile curves [10].

2.2.3. Adenoid and tonsil size grading

Adenoid grading was performed using a 0-degree endoscope while the patient was in the supine position. Patients with 25, 50, 75, or 100% choanal obstruction were graded from 1+ to 4+, respectively. Tonsil size was graded on a point scale as follows: 0, no enlargement; 1, slight enlargement with the transverse air slit greater than half of the palatal airway diameter; 2, moderate enlargement with the air slit about half of the palatal airway diameter; 3, profound enlargement with the air slit less than half of the airway diameter; 4, total obstruction with tonsils touching each other at the midline [8].

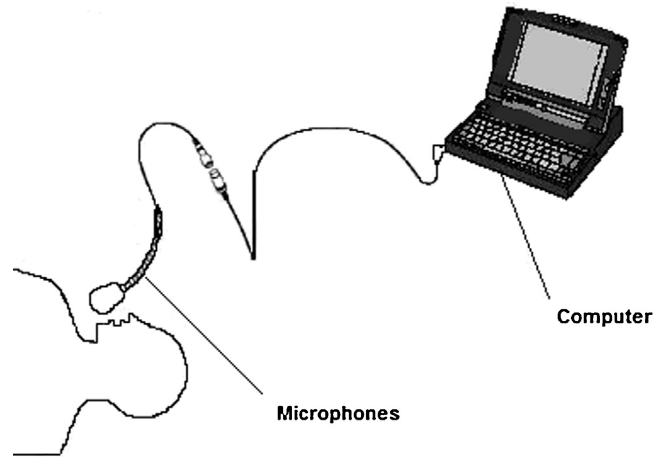

Fig. 1. The equipments for recording the snoring sound: Microphone placed over the subject's head. Snoring sound is recorded directly into the computer.

2.2.4. Staging

Staging was performed using BMI and adenoid and tonsillar sizes, as follows:

Stage 1: BMI <25, Tonsil size = Grade 2, and 1a: adenoidal size = 1, 2 or 1b: adenoidal size = 3, 4

Stage 2: BMI 25–29, Tonsil size = Grade 3, and 2a: adenoidal size = 1, 2 or 2b: adenoidal size = 3, 4

Stage 3: BMI ≥30, Tonsil size = Grade 4, and 3a: adenoidal size = 1, 2 or 3b: adenoidal size = 3, 4

2.2.5. Method for recording snoring sounds

The snoring sounds were recorded using microphones placed over the head of the subject with a headphone (Fig. 1). Sleep conditions were maintained in the hospital, and measurements were taken during day or night-time sleep. When patients began to snore, service nurses began a 5-min recording. Sounds were recorded directly into the computer as a wave file. We digitally

Table 1
Demographic features, tonsil and adenoid size, stage groups and BMI, SSIL and Fmax values of the children.[c]

		Groups according to the Stage values						P^a
		Stage I (n = 8)		Stage II (n = 10)		Stage III (n = 9)		
		Median	Min–Max	Median	Min–Max	Median	Min–Max	
Age	5.50	4.00–10.00	5.00	4.00–13.00	5.00	4.00–11.00	0.766	
		n	%	n	%	n	%	P^b
Gender	Male	7	87.5	7	70.0	7	77.8	P = 0.662
	Female	1	12.5	3	30.0	2	22.8	X2 = 0.824
	Total	8	100.0	10	100.0	9	100.0	
Size of the tonsils and adenoids		Median		Median		Median		
Tonsil grade		2.0		3.0		4.0		
Adenoid grade		2.0		2.5		3.0		

	Median	Min–Max	Median	Min–Max	Median	Min–Max	P^a
BMI (kg/m^2)	23.00	21.00–25.00	26.50	25.00–29.00	33.00	30.00–35.00	0.000
SSIL[c] (dB)	17.50	13.00–26.00	23.50	19.00–26.00	30.00	24.00–32.00	0.000
Fmax[c] (Hz)	704.50	692.00–712.00	842.50	832.00–854.00	982.00	970.00–974.00	0.000

[a] p-value shows the results of Kruskal–Wallis variance analysis.
[b] p-value shows the results of Chi-Square-test.
[c] Fmax, Highest power frequency; SSIL, Snoring sound intensity levels at the Fmax.