Characterization of the voice of children with mouth breathing caused by four different etiologies using perceptual and acoustic analyses

Caracterização da voz de crianças respiradoras bucais de quatro diferentes etiologias por meio das análises perceptivo-auditiva e acústica

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ABSTRACT

Objective: To describe vocal characteristics in children aged five to twelve years with mouth breathing caused by four etiologies: chronic rhinitis, hypertrophy, hypertrophy + chronic rhinitis and functional condition, using perceptual evaluation and acoustic analysis. **Methods:** Voice recordings of 120 mouth breathers judged by four speech pathologists using the software *Multi-Speech.* **Results:** The perceptual evaluation of the voice revealed high incidence of breathy and hoarse voices, especially in the rhinitis group. Most cases were moderate, with low pitch and normal loudness. Hyponasality was found in over 50% of sample, as expected, but we also found high occurrence of laryngeal resonance, especially in the rhinitis group. Mean fundamental frequency was 24.81Hz, SD = 15.02; jitter = 2.17; shimmer = 0.44, and HNR = 2.11. Values did not show statistically significant difference among the groups. **Conclusion:** Perceptual evaluation of the voice revealed that most mouth breathers presented hoarse and breathy voice, low pitch, normal loudness and hyponasal and laryngeal resonance. However, the acoustic analysis did not result in any significant condition.

Keywords: Voice; Speech acoustics; Mouth breathing/etiology; Voice disorders

RESUMO

Objetivo: Caracterizar a voz de crianças respiradoras bucais de cinco a 12 anos de quatro diferentes etiologias: rinite crônica hipertrófica, hipertrofia adenoamigdaliana, hipertrofia adenoamigdaliana associada à rinite e funcional/não-obstrutivo por meio da análise perceptivo-auditiva e acústica computadorizada. **Métodos:** Gravação da voz de 120 crianças respiradoras bucais (30 de cada grupo) analisadas perceptualmente por quatro fonoaudiólogas especialistas em voz e acusticamente por programa específico computadorizado. **Resultados:** Os tipos vocais mais freqüentes foram voz rouca e soprosa, com maior incidência de alteração vocal no grupo Rinite, o grau de alteração observado com maior ocorrência foi o grau moderado, com "pitch" grave e "loudness" normal. A ressonância hiponasal foi verificada em mais de 50% da amostra, como esperado; porém, observamos alta ocorrência de ressonância laríngea, principalmente no grupo rinite. A freqüência fundamental média foi 24,81Hz, o DP = 15,02; "jitter" = 2,17; "shimmer" = 0,44 e HNR = 2,11, sem diferença estatisticamente significante entre os grupos. **Conclusão:** As crianças respiradoras bucais têm alta ocorrência de disfonia, percebida na análise perceptivo-auditiva, caracterizada principalmente por voz rouca e soprosa, "pitch" grave, "loudness" normal e ressonância hiponasal e laríngea, porém sem alterações importantes na análise acústica computadorizada.

Descritores: Voz; Acústica da fala; Respiração bucal/etiologia; Distúrbios da voz

INTRODUCTION

Breathing is a priority function in life and is normally made through the nose to filter, warm and humidify the inhaled air. In general, the mouth is only used temporarily when there is extra effort or any other situation in which the air inspired through the nostrils is not enough. If exclusive nasal breathing is not

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possible and breathing through the mouth is permanently maintained, changing the normal dynamics of the process, an abnormal breathing type is defined, named mouth breathing. Mouth breathers are individuals who breathe through the mouth because of nasal obstruction or bad habit, and are subject to conditions that this respiratory mode may lead to. The most common causes of mouth breathing are: hypertrophy of palatine and/or pharyngeal tonsils, chronic rhinitis and bad habits that make mouth breathing involuntary and unconscious owing to its constant practice[1].

Mouth breathing due to tissue hypertrophy, rhinitis or habit may be frequently observed in the pediatric population and there is concern owing to changes in growth and craniofacial development that may take place in chronic presentation[1,2]. There are structural and functional consequences: the former can be craniofacial and dental changes, predominantly vertical craniofacial growth, increased gonion angle, high palate, maxillary underdevelopment, narrow nostrils, and occlusal affections with frequent protrusion of upper incisors. Changes related to speech and articulation organs are: hypotony, hypotrophy and hypofunction of facial, lip and cheek muscles, retracted or short upper lip and inverted lower lip or interposition of the lips, dry lips, hypertrophied gums with color modification and frequent bleeding, hypotonia, lowering and anteriorization of the tongue, and abnormal mouth proprioception. Other postural and body findings include thoracic deformities, flaccid and distended abdominal muscles, anteriorized head, shoulders roll forward, facial asymmetry, dark circles around the eyes, and tired look[2-6]. Functional consequences are related to mastication, swallowing, phonation and breathing itself. In mouth breathing, mastication may be impaired owing to reduction of force, mobility and coordination of the involved muscle movement. The children that breathe through the mouth normally have dental and occlusal impairment, which may interfere in the efficiency of mastication. Swallowing is normally affected by inefficient mastication and anomalous tongue movement, common in tonus and mobility changes caused by mouth breathing. In cases of tonsillar hypertrophy, children usually eat less, get tired easily, and have difficulty to eat solid foods or reject them owing to the narrowing caused by tonsil enlargement. Noisy swallowing, tongue thrust, exaggerated contraction of perioral muscles and forward head movement during swallowing can also be observed[1,2,5].

As to phonation, we may find imprecise speech, accumulation of saliva in the anterior region of the oral cavity, speech disorder, such as phonemic omissions, distortions and substitutions, in addition to lack of coordination between breathing and phonation, which depends on appropriate inspiration. In the clinical practice with mouth breathers, there is high occurrence of vocal quality affections, especially characterized by resonance deviations and associated hoarseness. Vocal affection may also result from lack of speech and breathing coordination, which makes the child increase stress while speaking, leading to poor vocal use. Moreover, oral mucosa dryness extended to the respiratory tract may be an irritating factor and interfere in the production of appropriate voice. Resonance deviations are frequently detected by upper airway obstruction, generating imbalance and vocal disorder[6-10] . There are studies that associate abnormal vocal quality in children and adults and respiratory allergy[7,9-10].

OBJECTIVE

The purpose of the present study was to characterize the voice of mouth breathers aged 5 to 12 years, with four different etiologies: chronic rhinitis, adenotonsillar hypertrophy, adenotonsillar hypertrophy associated with rhinitis, and functional/non-obstructive condition, using perceptual and computed acoustic analyses.

METHODS

We analyzed 120 vocal samples of children, 56 female and 64 male subjects, aged between 5 and 12 years, mouth breathers, with no vocal complaints or ongoing treatment for mouth breathing. They were submitted to otorhinolaryngological assessment and speech and vocal assessment. The ENT assessment comprised physical examination, rhinoscopy, oroscopy, otoscopy and flexible nasofibroscopy, determining the diagnosis of mouth breathing. Based on this assessment, children were divided into four groups of different etiologies: Group I - children with signs and symptoms of hypertrophic chronic rhinitis; Group II - children with palatine and/or pharyngeal tonsil hypertrophy; Group III - children with palatine and/or pharyngeal tonsil hypertrophy associated with chronic rhinitis; and Group IV - children whose ENT assessment did not reveal obstruction to the passage of airflow, but they had mouth breathing because of habit or functional characteristic.

The speech and voice assessment comprised a brief interview with the person responsible for the child, voice sample recording, perceptual analysis and

computerized acoustic analyses. The purpose of the interview was to make sure about the clinical conditions of the child and no use of drugs that could interfere in vocal production. Recordings were made in a sound-proof booth with a portable recorder Mini-Disc model MZ-R700, brand Sony, using a unidirectional microphone Mid Side Stereo, model ECM-909A, brand Sony, placed 10 to 15 cm away from the childs mouth and positioned in front, zero to thirty degrees of lateral amplitude from the childs oral cavity. The recorded material was transferred from mini-disc units to a computer hp pavilion zt 1130 using a stereo cable, edited in the software Sound Forge XP; an excerpt of automatic speech with number counting from 1 to 10 was used for perceptual analysis and sustained vowel /å/ was used for acoustic analysis. The perceptual analysis was made with automatic speech with number counting from 1 to 10 by a group of speech and voice therapists specialized in voice, who listened to the recordings at least twice and analyzed the following parameters: type of voice, severity, pitch - understood as auditory perception of vocal frequency (low/hoarse, high/thin or neutral/normal), loudness, which conveys the auditory sensation of vocal intensity (increased/loud, decreased/low or neutral/normal), and resonance, marking them in a specific chart, previously organized with the possible variations in each parameter. The computed acoustic analysis included the sustained production of vowel /å/ edited by the software Sound Forge, analyzed by Multi-Speech, in a computer hp pavilion zt 1130, through which the following parameters were analyzed: mean fundamental frequency, jitter and shimmer (which are interferences in frequency and vocal intensity) and HNR (harmonic-to-noise ratio). We calculated means, medians and standard deviations of numeric values of subjects of the 4 groups and statistically compared them using analysis of variance with ANOVA test. Parameters of type of voice, severity of affection, pitch, loudness, resonance, mean fundamental frequency, jitter, shimmer and HNR (harmonic-to-noise ratio) were compared between the four groups using Kruskal-Wallis statistical test. The same parameters were used to compare the pairs of groups using Mann-Whitney test. By applying Kolmogorov-Smirnov test, we analyzed the uniformity of distribution of values within each etiological group studied.

RESULTS

Table 1 shows the number of children in each group studied who presented a specific type of voice by consensus of the examiners. The variables that resulted in higher occurrence were breathy and hoarse types of voice, more frequent in the rhinitis group (group I). Table 2 shows the distribution of subjects relative to severity of dysphonia. The most frequent was moderate severity, with higher occurrence in the rhinitis group (group I), but with no statistically significant difference. Severe dysphonia was more frequently observed in the group of hypertrophy + rhinitis (Group III), with statistically significant difference. Table 3 shows the number and percentage of occurrence of low, high or normal pitch in the four groups, based on a minimum of 75% of votes given by the speech and voice therapists performing the perceptual analysis. The variable low pitch in the group of rhinitis (group I) showed

Table 1. Number and percentage distribution of individuals in the groups per type of voice

Group	Type of voice													
	Normal		Hoarse		Harsh		Breathy		T-strang		Hyponasal		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Rhinitis Group I	1	0,8	10	8,3	1	0,8	17	14,2	0	0	4	3,3	33	27,5
Hypert. Group II	0	0	12	10,0	0	0	11	9,2	1	0,8	5	4,2	39	32,5
H+R Group III	0	0	13	10,8	1	0,8	06	5,0	0	0	6	5,0	26	21,7
Func. Group IV	2	1,7	04	3,3	1	0,8	07	5,8	0	0	4	3,3	18	15,0
Total	3	2,5	39	32,5	3	2,5	41	34,2	1	0,8	19	15,8	106	88,3

Key: T-strang = Tense-strangled
N = Absolute number
% = Percentage of total number of individuals (120)
Hypert. = Hypertrophy
H+R = Hypertrophy+Rhinitis
Func. = Functional

Table 2. Number and percentage distribution of individuals in four groups per vocal alteration severity

Group	Alteration degree									
	Normal		Light		Moderate		Severe		Total	
	N	%	N	%	N	%	N	%	N	%
Rhinitis	1	0,8	4	3,3	10	8,3	0	0	15	12,5
Hypert.	0	0	4	3,3	08	6,7	0	0	12	10,0
H + R	0	0	3	2,5	05	4,2	2*	1,7	10	8,3
Func.	0	0	5	4,2	03	2,5	0	0	8	6,7
Total	1	0,8	16	13,3	26	21,7	2	1,7	45	37,5

Key: *Statistically significant difference between the groups Hypertrophy + Rhinitis and Functional (p = 0.008), observed in absolute number by means of Mann-Whitney test.

Table 3. Number and percentage distribution of individuals in four groups per pitch

Group	Pitch							
	Normal		Sound		High		Total	
	N	%	N	%	N	%	N	%
Rhinitis	2	1,7	14*	11,7	2	1,7	18	15,0
Hypert.	3	2,5	7	5,8	4	3,3	14	11,7
H+R	3	2,5	8	6,7	7	5,8	18	15,0
Func.	4	3,3	4	3,3	8	6,7	16	13,3
Total	12	10,0	33	27,5	21	17,5	66	55

Key: *Statistically significant difference for the Functional group; p = 0.004 (Mann-Whiyney test)

statistically significant difference as compared to the others in the Mann-Whitney test, with p = 0.004(*). Table 4 shows the distribution of children from the four groups in absolute numbers and in percentage regarding the variables normal, decreased and increased loudness. The variable normal loudness was observed in 61 children, receiving consistent responses in this parameter and representing 50.8% of the total sample. Table 5 shows the prevalent types of resonance in the studied groups. The variable of hyponasal resonance was observed in 63 subjects followed by laryngeal resonance in 34 of them. We used the statistical test of analysis of variance (ANOVA) and did not detect statistically significant differences between the values of mean, median and standard deviation of parameters for mean fundamental frequency, standard deviation, jitter, shimmer and HNR between the groups studied, considering as statistically significant a p < 0.050, as presented in Table 6.

Table 4. Number and percentage distribution of individuals in four groups per loudness

Group	Loudness							
	Normal		Diminished		Increased		Total	
	N	%	N	%	N	%	N	%
Rhinitis	14	11,7	4	3,3	2	1,7	20	16,7
Hypert.	17	14,2	4	3,3	2	1,7	23	19,2
H+R	14	11,7	4	3,3	5	4,2	23	19,2
Func.	16	13,3	0	0	7	5,8	23	19,2
Total	61	50,8	12	10,0	16	13,3	89	74,2

Table 5. Number and percentage distribution of individuals in four groups per resonance

Group	Resonance									
	Even		Hyponasal		Laryngeae		Pharyngeal		Total	
	N	%	N	%	N	%	N	%	N	%
Func.	1	0,8	13	10,8	6	5,0	1	0,8	21	17,5
H + R	1	0,8	18	15,0	8	6,7	4	3,3	31	25,8
Hypert.	1	0,8	16	13,3	9	7,5	2	1,7	28	23,3
Rhinitis	0	0,8	16	13,3	11	9,2	7	5,8	35	29,2
Total	4	3,3	63	52,5	34	28,3	14	11,7	115	95,8

Table 6. Distribution of means and P-values OF THE parameters - fundamental frequency, standard deviation, jitter, shimmer and hnr in each group

Group	Mean values of parameters				
	FD	DP	Sitter	Shimmer	HNR
Rhinitis	225,037	17,770	2,743	0,474	1,748
Hypert.	240,090	14,610	1,861	0,446	1,595
H+R	234,854	13,431	2,023	0,443	2,242
Func.	239,264	14,283	2,071	0,407	2,854
P	0,056	0,404	0,206	0,424	0,629

DISCUSSION

There are studies stating that mouth breathing may result in facial anatomical changes and mastication, swallowing and speech functional abnormalities, thus bringing different consequences to individuals[1-5]. Vocal alterations associated with mouth breathing have been studied[6-10]. In the present study, we described the vocal characteristics of mouth breathers. The perceptual analysis indicated that the most frequent type of voice in this population was breathy and hoarse voice, with higher prevalence in mouth breathers who had rhinitis. As to severity, severe cases were statistically significant in the group of mouth breathing of mixed etiology (obstruction + rhinitis), which shows that the association of factors affects the voice in a more serious manner. Low pitch became evident in the group with rhinitis, with statistically significant difference, which can be explained by the fact that allergy promoted changes in the respiratory tract mucosa and increased volume favored hoarse vocal production.

Most children presented normal loudness, reason why mouth breathing did not seem to affect this parameter. The resonance to be expected in mouth breathers is hyponasal, caused by reduction of nasal airflow. In fact, this was the predominant pattern for the mixed etiology group (obstruction + rhinitis). However, we were surprised by the occurrence of laryngeal resonance in the group of patients with rhinitis, showing that allergic patients produce stressed voice. Table 6 shows data concerning computerized acoustic analysis - none of the assessed aspects showed statistically significant variation among the groups and did not differ from the expected results in normal cases[11-13]. After assessing the voice of 120 children who were mouth breathers, divided into four different etiological groups, using perceptual and computerized acoustic analysis, we found that there was high occurrence of vocal alterations in all groups. Only 2.5% of sample was systematically classified as having normal voice. The main vocal characteristic with statistically significant difference was low pitch present in the rhinitis group. Loudness was within normal range for most of the children and they had hyponasal resonance. Acoustic parameters of fundamental frequency, standard deviation, jitter, shimmer and HNR were within the normal range and did not show statistically significant difference among the four groups of different etiologies. Even though we observed high occurrence of vocal affection in the perceptual analysis, computed acoustic parameters were within the normal range for the age group.

CONCLUSION

The perceptual vocal analysis of mouth breathing children demonstrated high occurrence of dysphonia

in this population, but the parameters in the computed acoustic analysis were within the normal range for the age group studied.

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