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Perceptual and acoustic parameters of vocal nodules in children

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ABSTRACT

Vocal nodules constitute the major cause of dysphonia during childhood. Auditory-perceptual and acoustic vocal analyses have been used to differentiate vocal nodules from normal voice in children.
Purpose: To study the value of auditory-perceptual and acoustic vocal analyses in assessments of children with nodules.
Design: Diagnostic test study.
Patients and interventions: A comparative study was carried out including 100 children with videolaryngoscopic diagnosis of vocal nodules (nodule group-NG); and 100 children without vocal symptoms and with normal videolaryngoscopic exams (control group-CG). The age range of both groups was between 4 and 11 years. All children underwent auditory-perceptual vocal analyses (GRBASI scale); maximum phonation time and s/z ratio were calculated, and acoustic vocal analysis (MDVP software) were carried out.
Results: There was no difference in the values of maximum phonation time and s/z ratio between groups. Auditory-perceptual analysis indicated greater compromising of voice parameters for NG, compared to CG: G (79 versus 24), R (53 versus 3), B (67 versus 23) and S (35 versus 1). The values of acoustic parameters jitter, PPQ, shimmer, APQ, NHR and SPI were higher for NG for CG. The parameter f0 did not differ between groups.
Conclusion: Compromising of auditory-perceptual (G, R, B and S) and acoustic vocal parameters (jitter, PPQ, shimmer, APQ, NHR and SPI) was greater for children with nodules than for those of the control group, which makes them important methods for assessing child dysphonia.
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1. Introduction

Vocal nodules are the major causes of dysphonia during childhood and have been diagnosed in 40–60% videolaryngoscopic exams of dysphonic children. They prevail among boys until adolescence, peaking between 5 and 10 years of age [1–3]. Vocal abuse and incorrect use of the voice are the main predisposing factors [4,5]. Hyperactivity, impulsiveness and anxiety are psychoemotional features common to children with nodules [6].

Nodule formation starts with the traumatic collision between vocal folds, leading to damages to the epithelium and the lamina propria. Laryngeal hypercontraction causes increased pressure of capillaries of the lamina propria, which reaches values higher than 20 cm H_2O, resulting in transudate, inflammatory cell influx and subepithelial edema [7]. The basement membrane and the epithelium concomitantly thicken, while the fibronectin and the collagen in the lamina propria increase, making the lesion more rigid and fibrotic [8,9].

Vocal nodules are diagnosed by means of videolaryngoscopic exams, which are easily performed for adults (Fig. 1). For children, however, these exams are impaired due to their lack of collaboration and immaturity. Although the videolaryngoscopic exam is essential for the diagnosis of vocal nodules, the acoustic and auditory-perceptual vocal analyses have been employed as complementary assessment methods. Some authors have highlighted the importance of assessing the psychoacoustic parameters of GRBASI scale, i.e., roughness, strain and breathiness for bearers of vocal nodules [10,11]. Others have questioned the importance of breathiness since this parameter is naturally observed to a certain degree in the voice of children during phonation due to posterior glottic incompetence [12]. Such divergent opinions indicate the importance of using quantitative methods in vocal assessments, reducing thus the subjectivity degree. For this purpose, acoustic vocal analyses have shown valuable assessment tools.

The use of acoustic analyses has led to high jitter, shimmer and NHR values and lower f0 values for the voices of children with

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vocal nodules, differentiating them from normal voices [10,13]. Vocal analyses have also been employed in the follow-up of vocal rehabilitation treatment, for both adults and children [14].

There are some studies in the literature addressing auditory-perceptual and acoustic measures in children bearing vocal nodules; however, there is lack of careful and comprehensive investigation corroborating the results of those authors.

2. Objective

To study the perceptual and acoustic vocal parameters of vocal nodules in children.

3. Casuistry and interventions

The present study included 100 children aged from 4 to 11 years, with videolaryngoscopic diagnosis of vocal nodules (nodule group – NG), attended at the Voice Disorders Outpatient Clinics of the Discipline of Otolaryngology of Botucatu Medical School (UNESP) between 2011 and 2013. The results of perceptual auditory and vocal analysis were compared to those of a control group (CG), composed of 100 children without vocal symptoms and with normal videolaryngoscopic exams. Those control children had previously participated in an extensive epidemiologic study conducted by the same group of investigators [3]. They were attended at the same clinics and belonged to the same corresponding age range. Excluded were children with: hearing impairment; genetic syndrome and/or associated craniofacial malformation; history of prolonged intubation or cervical trauma; neurological diseases with compromised voice and speech; and dubious diagnosis of vocal nodules, or children that did not allow endoscopic assessment or acoustic or perceptual vocal analysis.

The parents of all children filled out a free and informed consent authorizing the exams, as well as a questionnaire of voice evaluation. Then, the children were subjected to videolaryngoscopy conducted by an otolaryngologist, who used the conjugate image capture system (multifunctional videosystem type XE-50, Eco V 50 W, Carl-Zeiss, Germany), flexible nasofibrolaryngoscope (3.3 mm; Ollimpus, Japan) or rigid laryngeal telescope (8 mm diameter, 70°, Asap, Germany) and conjugated microcamera (Asap, Germany).

Auditory-perceptual vocal assessments (maximum phonation time and GRBASI scale) were conducted by speech therapists who were experts in voice. The assessments were made during spontaneous speech, based on the counting of numbers from one to ten and sustained vowel emission /a/. Results were interpreted by two professionals who were experts in voice and their judgment should be similar. When there was no concordance, the records were analyzed by a third professional.

For computerized acoustic vocal assessments, the software Multi Dimensional Voice Program (MDVP, model 5105, Multi-Speech 3700, Kay Elemetrics Corporation, Germany) was employed; the definitive measurements were preceded by the training of children for understanding the test, and vocal samples were obtained during the sustained emission of vowel /a/, only removing 0.5 initial and final seconds and keeping comfortable height and frequency levels. The analyzed vocal parameters were: Fundamental Frequency (f0), Jitter Percentage (%), Pich Perturbation Quotient (PPQ), Shimmer Percentage (%), Amplitude Perturbation Quotient (APQ), Noise Harmonic Ratio (NHR), Soft Phonation Index (SPI).

The research project was approved by the Human Research Ethics Committee of Botucatu Medical School (UNESP, protocol CEP 3996-2011).

Statistical analysis for comparing the quantitative variables relative to both groups was done by using paired *t*-test when the variable had adherence to normal probability distribution; for the study between groups of the variables of GRBASI scale, Goodman test [15,16] was complemented with multiple comparisons between and within binomial or multinomial populations, considering 5% significance level.

4. Results

4.1. Sex and age range

Groups were homogeneously distributed according to age range and sex (Table 1).

4.2. Maximum phonation time

The maximum phonation time for phonemes /a/ and /z/ was discreetly shorter for children of the nodule group (Table 2).

4.3. Auditory-perceptual vocal analysis – GRBASI scale

Auditory-perceptual assessments identified some changes in the voices of children with nodules, differentiating them from normal voices. Most NG children had degree 1 of vocal change (G; *n*-63), which was recorded for only 24 children with normal voices. Degree 1 of roughness (R) was indentified for 42 NG children and for only 3 CG children. The degree of breathiness (B) for both groups was also significant and degree 1 of this parameter was identified for 54 NG children and 23 CG children. In addition, for 33 NG children, no degree of breathiness in the vocal emission was recorded. Strain (S) was slightly altered for 33 NG children and for only one control child. Asthenia (A) and instability (I) were not relevant between groups (Table 3).

4.4. Acoustic vocal analysis

f0 values did not differ between groups, but the values of all remaining acoustic parameters, i.e., jitter, PPQ, shimmer, APQ, NHR and SPI, were higher for NG children, compared to the control children (Table 4).

5. Discussion

The larynx of children undergoes a series of changes from birth to adulthood, and its growth is not only dimensional. The

Table 1
Distribution of children according to sex and age range.

Age range (years)	Nodule group		Control group	
	Male *N* (%)	Female *N* (%)	Male *N* (%)	Female *N* (%)
4–6	9 (15.25)	6 (14.63)	9 (15.25)	6 (14.63)
7–9	27 (45.76)	18 (43.90)	27 (45.76)	18 (43.90)
10–11	23 (38.99)	17 (41.47)	23 (38.98)	17 (41.47)
Total	59 (100.00)	41 (100.00)	59 (100.00)	41 (100.00)

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