Degree of sub-harmonic components in infant cries and in down syndrome children and children with dysphonia

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Abstract

According to different studies of the infant cry, the sub-harmonic components or double series of fundamental frequency as a rule does not occur in the crying of healthy neonates. An acoustic analysis was made of three samples of cry signal (continuous signal or several short phonations), and six phonations of the vowel /a/ by pre-school children with dysphonia and by school children with Down syndrome. This was a cross-sectional study of children (nine boys) of different ages and with different disorders, including voice disorders such as dysphonia which occurred without any other medical impairments, and the genetic disorder of Down syndrome. Acoustic analysis was made using MDVP, Kay Elemetrics Computer software, a Real Time Frequency Analyser Type 2123 (Bruel and Kjaer), and the EZ Voice Program for Voice Analysis (Voice Tek Enterprises, USA). Four different parameters were measured: fundamental frequency, jitter, shimmer and degree of sub-harmonic components. Also, the focus of this study was to find and explain, sub-harmonic components or bi-phonation, as an indicator of voice or other pathology. Descriptive statistics of the acoustic data were obtained through Statistica for Windows, version 4.5.

Key words: infant cry, sub-harmonic components, jitter, shimmer, fundamental frequency, dysphonia, Down syndrome, acoustical analyses

1. Introduction

Wasz-Hockert et al. suggests that acoustic features of infant crying be correlated with confirmed medical diseases, as well as at-risk conditions [1]. Michelson and Sirvio [2] reported about cry characteristics in sick new-born infants and they compare them with healthy infants: latency period, duration of the cry signal, glide, continuous and interrupted cry, voiced, half-voiced or voiceless cry, maximum and minimum pitch of fundamental frequency, shifts, melody type, glottal roll, double harmonic break, bi-phonation, furcation and noise concentration.

According to the authors from voice field, children with Down syndrome show deviations from periodicity during phonation and speech like biphonation [3,4]. One of explanation of these results is in generally low muscular tonus in children with genetically syndromes. Aronson [5] said that voice disorder exist if are quality, pitch, intensity and flexibility differ than voices of people the same, age, sex and cultural environment. According to Deem, Manning, Knack, Matesich [6], and Wolfe, Fitch, Cornell [7], acoustical analysis of Fo frequency, intensity and oscillations during the vocal cords vibrations, give representative methods to differ normal than disordered voice.

2. Methods

An acoustic analysis was made of three samples of cry signal (continuous signal or several short phonations), and six phonations of the vowel /a/ by pre-school children with dysphonia and by school children with Down syndrome. This was a cross-sectional study of children (nine boys) of different ages and with different disorders, including voice disorders such as dysphonia which occurred without any other medical impairments, and the genetic disorder of Down syndrome.

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3. Results

Results of the acoustic analysis have shown a range of fundamental frequencies from 410 Hz to 600 Hz in the newborn infant cries, 279 Hz to 283 Hz in the dysphonia group and 180 Hz to 244 Hz in the Down syndrome group. Jitter and shimmer are abnormal in almost all samples and high degree of sub-harmonic components, as well as two fundamental peaks are visible on the acoustic pictures obtained

Table 1.
Inter - correlation between acoustic parameters (9 boys). Marked correlation is significant at p < .05000

	FOHZ	JITTER%	SHIMMDB	DSH%
FOHZ	1,00	,49	,72	-,10
JITTER%	,49	1,00	,36	,12
SHIMMDB	,72	,36	1,00	,12
DSH%	-,10	,12	,12	1,00

Legend:
FOHZ – fundamental frequency in Hz
JITTER% - jitter percent
SHIMMDB – shimmer in dB
DSH% - degree of sub-harmonic components percents

Table 1 shows significant correlation between SHIMMER and FOHZ. Higher value of shimmer indicates higher value of fundamental frequency. The Figure 1 presents MDVP Fo and peak to peak amplitude of the sick infant cry. The intensity oscillations (lower curve) follow rapid changes of Fo or glide (upper curve).

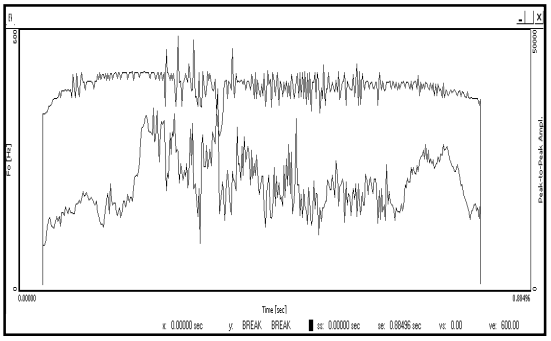

Fig. 1. Fo and peak to peak amplitude of the sick infant cry

Obtained results in Table 2 describe high values of Fo in a group with dysphonia; lower Fo than normal (in the group with Down syndrome) and normal Fo in the group of infant cries if the normative for the Fo is between 400 Hz to 600 Hz for healthy children [8].

Table 2.
Arithmetical means of four variables

	Mean dysph.	Mean cry	Mean Down
FOHZ	291,7667	464,9333	213,0667
JITTER%	,4533	1,9500	1,0367
SHIMMDB	,7900	1,4767	,8700
DSH%	15,8633	12,0367	17,7733

Abnormal shimmer is visible on all voice pictures of 9 boys made by EZ Voice and MDVP software. The higher value of shimmer is in the group of infants. The sick infant, one healthy infant, and a boy with Down syndrome (Figure 2) produced abnormal jitter.

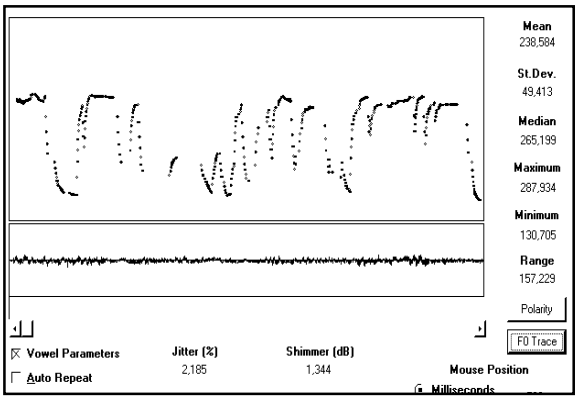

Fig. 2. Abnormal jitter and shimmer in group with Down syndrome

DSH parameter (sub-harmonic components) is disturbed in all samples. The most disturbed DSH is in the group with Down syndrome as well as MDV diagrams and RTFA pictures show (Figure 3, Down syndrome).

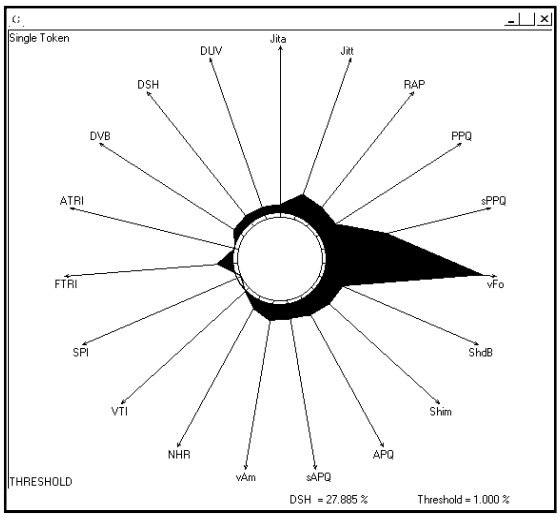

Fig. 3. Multi – dimensional voice diagram in group with Down syndrome

Findings of acoustical analyses in this research refer to high degree of sub-harmonic components in all samples. Three infant cries showed great perturbations despite 2 normal diagnosis of newborn children. Using the FFT algorithm (Multi-Speech, Model 3700, Ver. 2.2) high presence of sub-harmonic components is visible in each group of boys (*Figure 4).

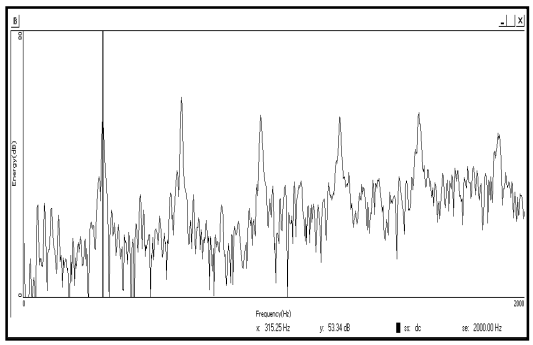

Fig. 4. Sub-harmonic components in group of boys with dysphonia

*Due to the limited space, only few figures and acoustic pictures are presented.

4. Conclusion

Changes in the melody type, bi-phonation, glide, abnormal pitch of the fundamental frequency, noise concentration and furcations are characteristics of sick infants [9]. Findings of acoustical analyses refer to high degree of sub-harmonic components in all samples. Obtained results show significant correlation between intensity oscillations and fundamental frequency changes. Group of authors [10, 11, 12], reported about high correlation between jitter and hoarseness or harsh voices about 0.51, 0.69 to 0.71.

MDV diagrams for each group of children show bigger short and long term frequency and amplitude perturbations in pre-school dysphonias, than in the other two groups. Greater changes of fundamental frequency follow greater shimmer or vice versa; especially in the cry signal of the sick infant. Bigger short and long term amplitude perturbations characterise cries of infants and significant presence of sub-harmonics components in the group with Down syndrome. There is evidence that the magnitude of voice perturbations in persons with normal voice characteristics is small or that the healthy vocal fold's form produces small periodic oscillations [13]. The first infant vocalisation could be indicator of pathological voices and this part of research has diagnostically character. Other obtained results in group with Down syndrome and dysphonia refer to therapeutically background as well.

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