A TRANSPORT GLOBULIN, SERUM HORMONE BINDING GLOBULIN, AS A PREDICTING FACTOR OF VOICE CHANGE IN PUBERTY?

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ABSTRACT

In an earlier study we found that serum hormone binding globulin was the most significant predictive factor for pubertal voice change among andrenal hormonal factors in a puberty group of boys aged 13-16 years ($p<0.05$). In this study we have compared the results with the ones of a group of girls in puberty. The aim was to get a possible understanding of the central biological phenomenons for the regulation of voice in puberty in a better way. The voice parameters were phonetograms and fundamental frequency measured with 2000 electroglottographic circles in continous speech. They were compared with puberty stages, adrenal hormones and sex hormonal changes in boys and girls from 8-19 years of age.

INTRODUCTION

We know very little about the central regulating proteins for voice change in puberty. The transport mechanisms for sex hormones may be involved (1,2). We have tried to examine the serum hormone transport globulin to find out whether it can predict the voice change in puberty not only in boys but also in girls.
We know that this transport globulin does fall in both sexes at time of puberty and a better understanding of the globulin might illucidate the central regulation of voice at a whole. (3,4).
Children at a singing school were analysed with voice phenomena and normal pubertal development together with androgens and oestrogens. Thereafter a statistical analysis was carried out to confirm the function of the transport globulin.

MATERIAL AND METHOD

97 children, 47 girls and 48 boys with trained singing voices from 8-19 years of age in a singing school were included in the study with randomized selection of an equal group in each school class.
The voice parameters included fundamental frequency with a computer program based on analyzing 2000 consequtive electroglottographic circles (5) in a reading situation of a balanced text, IPA book, the northwind and the sun and phonetograms (6) with areas extracted in cm^2 on a standard paper. A coversion factor to dB x Herz was 1 cm^2=32 dB x Herz.
Blood examinations for androgens and oestrogens together with somatic examination were carried out on the same day in each child, before noon and 3-6 days after 1. menstruation day where menarche had taken place.
The measurings of androgens and oestrogens were made at The Hormone Dpt. of Statens Seruminstitut.
Logarithmic transformations of observations were required to obtain normal distribution. Data were investigated by one-way analysis of variance and correlation coefficients were calculated comparing all parameters. Multiple regression analysis of fundamental frequency in a reading situation and the lowest tone in the phonetograms with hormone values age and stage of puberty as independent values was carried out.

RESULTS

The change of the fundamental frequency with age is seen at fig. 1. - together with the tone range in semitones in the phonetograms from where also the lowest tones and the areas were extracted.
In table 1. the geometrical mean values for some voice parameters, puberty phenomena and measurings of hormones are seen devided in three age groups.
In table 2. coefficients in boys estimated from multiple regression of fundamental frequency depending on hormone values, age and stage of puberty after reduction of independent parameters are seen.
We have found a correlation coefficient for serum hormone binding globulin in girls in relation to menarche of -.93, which means that serum hormone binding globulin in this study has a predictive value for menarche. In table 3. the best sets of describing variables for the logarithm to fundamental frequency in running speech in girls are shown taking into account that relations are different before and after menarche.

DISCUSSION

We have made an analysis of voice (fundamantal frequency in continuous speech and phonetograms), pubertal stages and androgens together with oestrogens and found that the transport globulin, serum hormone transport globulin, was a significant predicting factor of change of fundamental frequency in puberty in boys in an puberty stage group 2-4 with a significant difference from zero by multiple regression of $p<0.05$. We have found the change of boys voices to happen at 14,5 years age at the same time as the serum hormone transport globulin is reduced.
In girls in puberty the change of fundamental frequency was not significantly related to the globulin, but serum hormone transport globulin showed a correlation coefficient of: r-0.93. to menarche. When the girls were devided in two groups before and after menarche, several parameters had significant relation to the change of fundamental frequency in running speech in puberty, before puberty: Hight, log (Elso4) $p<0.001$. and puberty stage $p<0.05$. - after menarche: log(variation of fundamental frequency in running speech) $p<0.001$., time after menarche: $p<0.01$. and age $p<0.05$.
Of course it has been difficult to set fundamental frequency in speech in relation to traditional pubertal biological changes. Taking time of beginning of menstruation onto account together with serum hormone binding globulin the fundamental frequency change in puberty possibly could be predicted in puberty. One advantage out of many might be to be able to predict to singing teachers in the famous boys choirs the time of sopraneos loosing hight, or changing timbre from child to adult.
Much information of biological central regulating factors of voice can be found in studies of puberty also because the psyco-social factors do not influence this time of life to the same extend as later on.

Fig. 1.

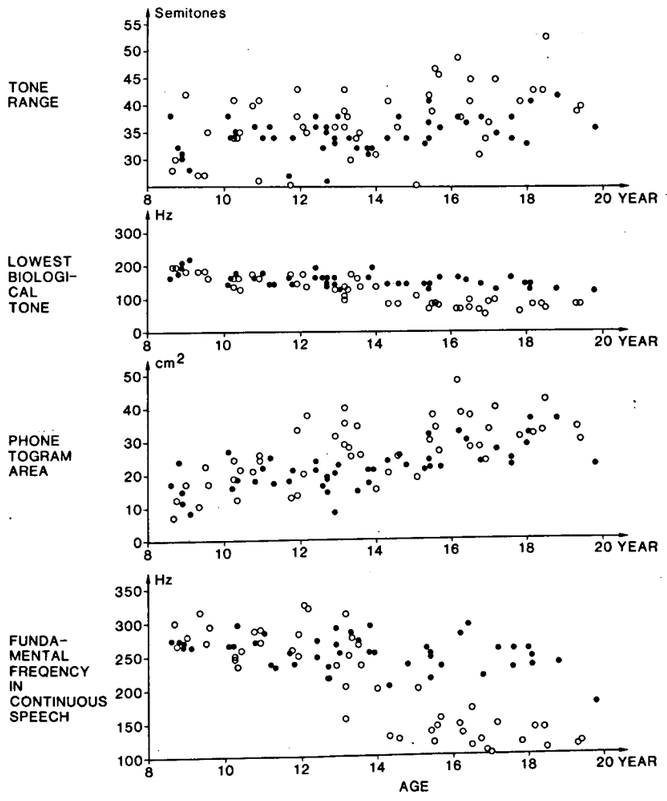

Table 1.

Geometric means of voice parameters, pediatrical measures and puberty hormone differences of 3 groups of ages, (boys and girls).

Age		8.6-12.9	13-15.9	16-19.8
Numbers of boys/girls		19/18	15/12	14/11
Fundamental frequency in speech (Hz)		273/256	184/248	125/241
Variation of fund. freq. (semitones).		3.7/3.2	4.8/4.2	5/5.2
Total tone transf. (semitones)		34.4/23	37.5/30	41.4/38
Lower tone (Hz)		158/166	104/156	72/145
Middle tone (Hz)		435/429	321/409	254/413
Phonetogram area (cm^2) (1 cm^2 = 32 dB x semitone)		19/17.3	28/21.8	34/28.3)
Hight (cm)		143/144.5	157/160	181/165
Weight (kg)		34.4/37.8	56.9/53.0	68.6/64.4
Pubic hair (stage)		1-3/1-4	1-5.5/2-5	5-6/4-6
Testis volume (mltr.)		2.3	13	20
Mamma development (stage)		1-4	2-5	5
SHBG	n mol/1	134/160	66/132.5	45/122.7
DHEAS	n mol/1	1400/3210	4100/3700	5900/7200
Delta 4 androsten dione	n mol/1	1.44/0.59	3.28/1.7	3.43/2.5
Total testosterone	n mol/1	0.54/0.50	10.5/0.76	18.9/0.94
Free testosterone	n mol/1	0.007/0.006	0.14/0.008	0.33/0.009
Dihydro testosterone	n mol/1	0.18/	1.21/	1.57/
Oestrone	p mol/1	/57	/104	/123
Oestradiol	p mol/1	/73	/135	/108
Oestrone sulphate	p mol/1	/732	/1924	/2343

Table 2.

Coefficients estimated from multiple regression of F_o depending on six hormone values, age and stage of puberty after reduction of independent parameters.

Number of boys	Stage of puberty	Geometrical mean values			Coefficient	
		$\bar{x}$ F_o Hz	age	$\bar{x}$ SHBG nmol	age	log SHBG
18	1	274	10,5	141	0.0002	0.010
11	2-4	219	13,5	91	-0.0016	0.501*
19	5-6	129	16,9	42	-0.0014	0.005
48	Total				-0.0033*	0.171*

Mean values of the remaining parameters according to grouping.
* Coefficient is signigficantly different from zero ($p<0.05$).

Table 3.

The best sets of describing variables for the logarithm of fundamental frequency in continuous speech (F_o) calculated for the whole group and for the two subgroups classified by menarche.

All girls*		Pre-menarche		Post-menarche	
	Variable P-value of t-test		Variable P-value of t-test		Variable P-value of t-test
Weight	0,066	Height	0,001	Age	0,033
Log (Tone range in speech)	0,042	Pubic hair (stage)	0,022	Time after menarche	0,008
Log (E_I)	0,054	Log (E_ISo_4)	0,001	Log (Tone range in speech)	0,001
Log (E_ISo_4)	0,043			Log (androst)	0,068
SE of estimation	0,034		0,0166		0,0288
SD of log F_o	0,037		0,0300		0,0409
F-test P-value	0,0443		0,0006		0,0036

Correlation coefficient SHBG, r-0.93 to menarche
* n=37 with all relevants measurings.

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