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Age Dynamics of Changes in Thyroid Volume

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Age dynamics of increase in thyroid volume (TV) was studied in healthy persons of both sex. TV was determined based on ultrasound measurements of three linear parameters: length (a), width (b) and thickness (c). TV was calculated with the formula: $TV = 2 \times (0.524 \times a \times b \times c)$. There were 5291 males and 6153 females, whose ages ranged from 3-31 years. Following parameters were studied: absolute increase of TV, growth rate and increase rate of TV, relative growth rate of TV. TV growth was found to be irregular in different age periods. Differences in TV growth between men and women as well as age periods of the most marked TV growth were ascertained. The obtained results allow to evaluate changes in TV in healthy persons most objectively.

Introduction

Sonography has found a wide clinical use as method for investigation of the thyroid gland. It is successfully applied for the measurement of thyroid size (1, 8, 9, 13), evaluation of thyroid structure to detect nodular or cystic diseases as well as differentiation between intra- and extrathyroid lesions (7, 10). Over the past few years, considerable information on thyroid size in children and adults at different ages were collected (4, 5, 11, 12). The experience in use of ultrasound for the measurement of thyroid size in mass screening examinations of the population was accumulated (2, 3). However, age dynamics of TV growth in childhood and adolescence are not completely clear. In the most publications, investigations were carried out either in separate age groups, or in small samples. At the same time, ultrasound morphometry enables a thorough in vivo analysis of peculiarities of thyroid growth at different ages.

The goal of this study was the analysis of dynamics of change in thyroid volume in the age interval from 3 to 31 years, elucidation of main periods of thyroid volume growth as well as comparison of characteristic of thyroid volume growth in males and females.

Materials and Methods

In 11 444 people (5 291 males and 6 153 females), age ranged from 3 to 31, thyroid volume was determined using real-time ultrasonography in the method proposed by Brun et al. (6). Investigations were conducted from May 1988 to May 1993. All persons lived in south-west districts of Kaluga region, in Russia, nobody of whom had any signs or symptoms of thyroid disturbances or thyroid diseases in medical history. The hormone levels of T_3 , T_4 , free T_4 and TSH in blood serum were within the normal range.

Ultrasonographies were performed using TOSHIBA (Japan) equipment: SSA-240 A and SAL-38 B with sector mechanical UST 7.5 MHz transducer covered by a WBK-51 balloon filled with water. Investigations were carried out by the common standard procedure. Linear sizes of thyroid lobes were measured. The volume of each lobe was calculated by the following formula:

$$V = a \times b \times c \times 0.524,$$

where a-length, b-width and c-thickness of the lobe. Thyroid volume was determined by simple summing volumes of right and left lobes.

Age dynamics of thyroid volume were analysed basing on indices which characterize dynamic series: absolute increase of thyroid volume, growth rate and increase rate of thyroid volume, relative growth rate of thyroid volume.

1. Absolute increase was equal to the difference between subsequent and previous members of series (of arithmetical means of thyroid volume). Absolute increase = $V_{i+1} - V_i$ ($i = 3, 4, \dots, 30$).

2. Growth rate was calculated by the ratio of each subsequent member of series to previous one taken as 100%. Growth rate = $V_{i+1}/V_i \times 100\%$

3. Increase rate was calculated by the ratio of absolute increase to previous member of series taken as 100%. Increase rate = $(V_{i+1} - V_i) / V_i \times 100\%$, where V_{i+1} and V_i are successive members of series.

4. Relative thyroid growth was calculated by the Mine's formula:

$$W = (V_{i+1} - V_i) / V_3 \times 100\%$$

where V_3 -constant index which is equal to thyroid volume (TV) at the age of 3 years, V_{i+1} and V_i -previous and subsequent members of series.

TABLE 1 INDICES OF DYNAMICS GROWTH OF THYROID VOLUME IN MALES

Age	Mean thyroid volume	Absolute increase in thyroid volume, ml	Growth rate of thyroid volume, %	Rate of increase in thyroid volume, %	Relative growth rate of thyroid volume, %
3	1.27				
4	2.39	1.12	188.19	88.19	88.19
5	2.81	0.42	117.57	17.57	33.07
6	3.26	0.45	116.01	16.01	35.43
7	3.18	0.55	116.87	16.87	43.31
8	4.08	0.27	107.09	7.09	21.26
9	4.63	0.55	113.48	13.48	43.31
10	5.05	0.42	109.07	9.07	33.07
11	5.78	0.73	114.46	14.46	57.48
12	6.23	0.45	107.79	7.79	35.43
13	7.29	1.06	117.01	17.01	83.46
14	8.55	1.26	117.28	17.28	99.21
15	9.69	1.14	113.33	13.33	89.76
16	11.27	1.58	116.31	16.31	124.41
17	12.30	1.03	109.14	9.14	81.10
18	11.36	-0.94	92.36	-7.64	-74.02
19	13.15	1.79	115.76	15.76	140.94
20	18.22	5.07	138.56	38.56	399.21
21	16.86	-1.36	92.54	-7.46	-107.09
22	15.39	-1.47	91.28	-8.72	-115.75
23	19.70	4.31	128.01	28.01	339.37
24	18.18	-1.52	92.28	-7.72	-119.69
25	17.44	-0.74	95.93	-4.07	-58.27
26	16.25	-1.19	93.18	-6.82	-93.70
27	16.83	0.58	103.57	3.57	45.67
28	16.80	-0.03	99.82	-0.18	-2.36
29	17.47	0.67	103.99	3.99	52.76
30	18.78	1.31	107.50	7.50	103.15
31	16.58	-2.20	88.29	-11.71	-173.23

TABLE 2 INDICES OF DYNAMICS GROWTH OF THYROID VOLUME IN FEMALES

Age	Mean thyroid volume	Absolute increase in thyroid volume, ml	Growth rate of thyroid volume, %	Rate of increase in thyroid volume, %	Relative growth rate of thyroid volume, %
3	1.62				
4	2.44	0.82	150.62	50.62	50.62
5	2.64	0.20	108.20	8.20	12.35
6	3.40	0.76	128.79	28.79	46.91
7	3.66	0.26	107.65	7.65	16.05
8	4.31	0.65	117.76	17.76	40.12
9	4.77	0.46	110.67	10.67	28.40
10	5.24	0.47	109.85	9.85	29.01
11	6.30	1.06	120.23	20.23	65.43
12	7.42	1.12	117.78	17.78	69.14
13	8.39	0.97	113.07	13.07	59.88
14	9.45	1.06	112.63	12.63	65.43
15	10.24	0.79	108.36	8.36	48.77
16	11.13	0.89	108.69	8.69	54.94
17	11.39	0.26	102.34	2.34	16.05
18	12.08	0.69	106.06	6.06	42.59
19	12.86	0.78	106.46	6.46	48.15
20	12.49	-0.37	97.12	-2.88	-22.84
21	12.83	0.34	102.72	2.72	20.99
22	12.60	-0.23	98.21	-1.79	-14.20
23	13.07	0.47	103.73	3.73	29.01
24	12.81	-0.26	98.01	-1.99	-16.05
25	15.32	2.51	119.59	19.59	154.94
26	15.36	0.04	100.26	0.26	2.47
27	13.93	-1.43	90.69	-9.31	-88.27
28	15.61	1.68	112.06	12.06	103.70
29	13.56	-2.05	86.87	-13.13	-126.54
30	14.33	0.77	105.68	5.68	47.53
31	14.34	0.01	100.07	0.07	0.62

Results and Discussion

As the result of examinations, TV in persons, 3-31 years of age, was established. All persons examined were divided into sex and age groups (age interval - 1 year). Mean TV (arithm. mean) was calculated in each age group. On the basis of mean thyroid volume, we calculated following values: absolute increase in thyroid volume, growth rate, increase rate, relative growth rate of thyroid volume (Tables 1 and 2).

Absolute increase of thyroid volume in boys, teen-agers and youths presented a variable value. The highest absolute increase of TV was noted in males aged from 13-20 years. Average annual absolute increase in TV during this period made up 1.5 ml. The highest absolute increase in TV occurred in females aged from 11-16 years. Average annual absolute increase in TV was 0.98 ml during this period.

Growth rate of TV in different age periods ranged from 92% up to 188% in males and from 87% up to 150% in females.

Fig. 1 and 2 show increase rates of TV both for males and females based on experimental data and those resulted from smoothed curve in the method of sliding mean.

The highest increase rate of TV was noted both in males and females up to 6 years of age and made up about 20%. Subsequently, a stable trend to reduction of increase rate of TV was observed. After the age of 23-24 years, it comes practically to zero.

From our standpoint, relative growth rate of TV is reflected by age changes in TV most precisely. Tables 1 and 2 present these values calculated based on experimental data. Fig. 3 and 4 show graphs based both on experimental data and those resulted from smoothed curve in the method of sliding mean. In males, 3-20 years of age, relative growth rate of TV increased continuously and ranged from 2% up to 12%. After the age of 21 years, relative growth rate is reduced. There are some periods of accelerated TV growth observed:

1st period-at the age of 3-6 years,

2nd period-at the age of 10-21 years,

At the age from 10-15 years, relative rate increases more

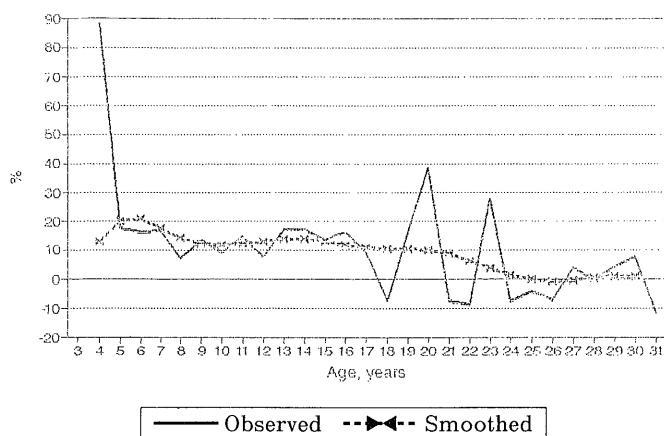


Fig. 1. Increase rate of thyroid volume in males

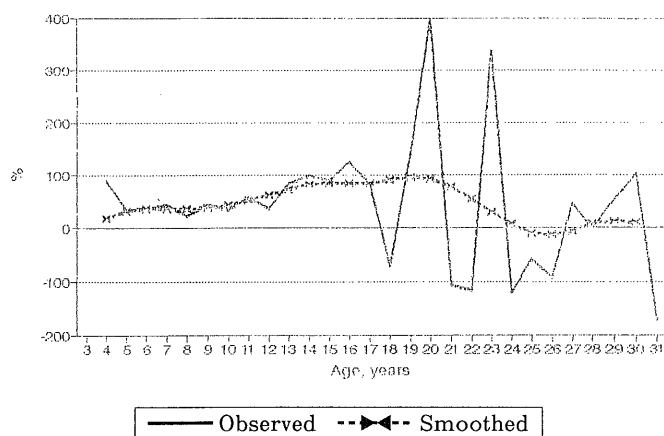


Fig. 3. Relative growth rate of thyroid volume in males

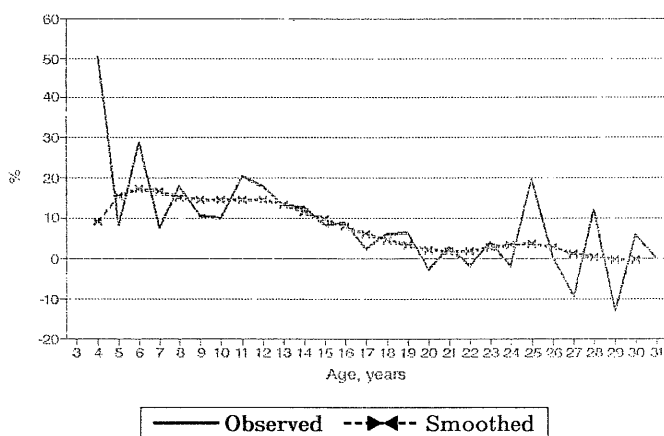


Fig. 2. Increase rate of thyroid volume in females

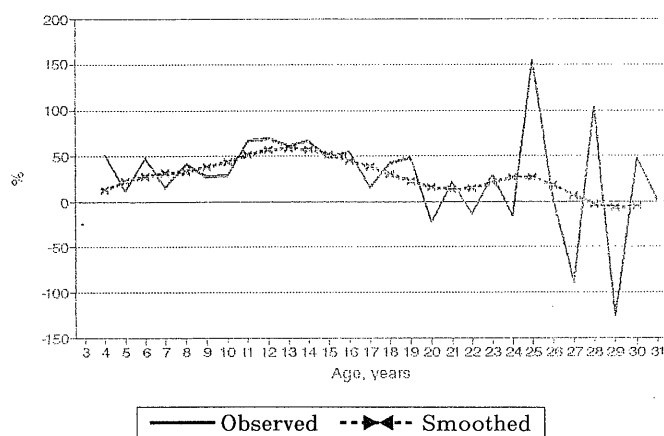


Fig. 4. Relative growth rate of thyroid volume in females

rapidly than in the age interval from 15-21 years.

In females, relative growth rate of TV was as follows : at the age from 3-13 years it increases, and the age from 13-21 years it slowly goes down. However, at the age of 21 years a trend to a slight acceleration of TV growth occurs because of the presence of a considerable number of pregnant women and nursing mothers. As illustrated in the graph, in age periods from 3 up to 6 years and from 9 up to 13 years, relative growth rate increased most rapidly.

Thus, the study of age dynamics of changes in TV in healthy males and females allowed to conclude that TV increases up to 23-24 years in males and up to 21 years in females. Afterwards, no dynamics of change in thyroid volume were noted.

In males, relative growth rate of TV increased up to 21 years, in females up to 13 years.

Maximum absolute increase in TV was noted in males at the age between 13 and 21 years, in females at the age between 11 and 16 years.

Two main age periods of TV growth were established :

1st period-from 3 up to 6 years both in males and females :

2nd period-from 9 up to 16 years in females and from 10 to 21 years in males.

The further comparative study is needed to confirm the effect of age on TV.

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