Thyroid Volume Measurement by Ultrasound in Schoolchildren from Mildly Iodine-deficient Area

Alma Toromanović*, Husref Tahirović

Department of Pediatrics, University Clinics Center Tuzla,
Trnovac bb, 75000 Tuzla, Bosnia and Herzegovina

* Corresponding author

Abstract

Thyroid size was estimated by ultrasound and physical examination in 480 schoolchildren (238 boys and 242 girls), 7-14 years old, living in Tuzla Canton. By physical examination goiter was found in 13.5% (n=65) of subjects. When compared with the upper limits of the reference thyroid volumes reported by WHO and ICCIDD, goiter by ultrasonography was found in 12.9% (n=62) of all subjects. All goitrous children had a diffuse goiter. The differences in mean thyroid volumes between groups with and without goiter detected by physical examination were significant in all age groups ($p<0.05$). The results of ultrasound examinations correlate well with palpatory findings and show higher values for the thyroid volume in children with goiter. It generally confirms the values of the findings by palpation, even in areas with mild iodine deficiency.

KEY WORDS: thyroid volume, iodine deficiency

Introduction

Determination of goiter prevalence and urinary iodine excretion in schoolchildren is recommended for assessing the extent and severity of iodine deficiency disorders in a region (1). For years, palpation was the single method available for defining thyroid volume. Although in moderately or severely iodine-deficient areas, thyroid palpation provides careful estimation of thyroid size, serious problems are encountered in areas with mild iodine deficiency, where most goiters are small. Thyroid ultrasound came to be considered the most reliable method for the estimation of thyroid volume (2,3). In epidemiological surveys, the use of this technique is strongly recommended to define the goiter endemia in areas of mild iodine deficiency. In the past, severe iodine deficiency, endemic goiter and cretinism were documented in restricted areas of Bosnia and Herzegovina. Salt production is present in Tuzla area since the medieval times and salt iodination was initiate in salt plant in Tuzla in 1934. Epidemiological surveys on goiter in Bosnia and Herzegovina were started systematically in the early 1950s. An investigation in 1953 has documented high goiter prevalence in endemic areas, varying from 34% to 60%. A law proscribing obligatory iodination of all salt for human and animal consumption, with 10 mg KI/kg of salt was proclaimed in 1953. On the basis of clinical observation of rather high prevalence of goiter among schoolchildren, the study, with the aim to evaluate the efficacy of compulsory iodine prophylaxis more than 40 years after its introduction, was carried out in all cantons in Bosnia and Herzegovina Federation in 1999(4). The results of the study show the persistence of mild iodine deficiency in Tuzla Canton on the basis of median urinary iodine excretion of 79.0 μg/L and goiter prevalence of 20.1% in schoolchildren. Thyroid size was estimated by physical examination. The aim of the present study was to measure thyroid volume and evaluate the prevalence of endemic goiter by ultrasound criteria in the schoolchildren population in mildly iodine-deficient area of Tuzla Canton.

Subjects and Methods

Thyroid size was assessed by ultrasound and by physical examination in 480 schoolchildren (238 boys and 242 girls) 7-14 years old, randomly selected, in Tuzla Canton. Tuzla Canton is one of the ten administrative territorial units of the Federation of Bosnia and Herzegovina, situated in North-Eastern Bosnia. Thyroid size was estimated by neck palpation, by the same examiner, and graded according to the World Health Organization (WHO)/International Council for the Control of Iodine Deficiency Disorders (ICCIDD) criteria (1) as follows: grade 0 - no palpable or visible goiter; grade 1 - a mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in the normal position, it moves upward in the neck as the subject swallows; grade 2: a swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated. Thyroid ultrasound was performed by the same examiner. Subjects were examined in supine position with the neck hyperextended. Thyroid volume was estimated using real-time sonography according to Brunn et al. (5) with Toshiba SSA-220A, using a 7.5 MHz linear transducer. Longitudinal and transverse scans were performed allowing the measurement of the depth (d), the width (w) and the length (l) of each lobe. The volume of the lobe was calculated using formula: V(ml)=0.479 x d x w x l (cm). The thyroid volume was the sum of the volumes of both lobes. The volume of the isthmus was not included. The criteria used for defining the upper limit of normal for thyroid volume (percentile 97) in children with a normal iodine intake were those proposed by WHO/ICCIDD (6).

Results

The mean thyroid volume as determined by ultrasonography was 5.5±2.8 ml. Although the mean thyroid volume was greater in girls (5.6±3.0) than in boys (5.3±2.5) the difference was not statistically significant ($p>0.05$). The results of the ultrasound examinations confirmed the fact that the right lobe (3.2±1.7) of the thyroid gland is larger, compared to the left lobe (2.2±1.2), and the difference is significant ($p<0.0001$). Mean and median thyroid volumes of all subjects according to age are shown in Table 1. The median thyroid volume increases from 2.7 ml at 7 years to 8.4 ml at 14 years. Significant positive correlation was observed between the thyroid volume and age ($r=0.97$, $p<0.0001$). Also, significant correlation was found between thyroid volume and body weight of children ($r=0.98$, $p<0.0001$), height ($r=0.98$, $p=0.0003$) and body surface ($r=0.99$, $p<0.0001$). When compared with the upper limits of the reference thyroid volumes, goiter by ultrasonography was found in 12.9% (n=62) of all subjects (n=480). All goitrous children had a diffuse goiter. By physical examination goiter was found in 13.5% (n=65) of subjects. Mean and median

AGE (YEARS)	NO. EXAMINED	THYROID VOLUMES (ML)		
		MEAN±SD	MEDIAN	RANGE
7	54	2.8 ± 0.9	2.7	1.4-5.1
8	65	3.8 ± 1.1	3.6	1.3-6.5
9	58	4.5 ± 2.9	4.1	2.2-17.5
10	55	4.5 ± 1.4	4.3	2.7-9.6
11	66	5.5 ± 2.0	5.0	3-13.4
12	60	6.2 ± 2.2	6.3	3-12.5
13	65	7.5 ± 2.6	6.8	4.6-15.3
14	57	8.6 ± 3.1	8.4	3.3-15.4

TABLE 1. Mean and median thyroid volumes of all age groups

thyroid volumes according to age in subjects with and without goiter by physical examination are shown in Table 2. The differences of mean thyroid volumes between groups with and without goiter detected by physical examination were significant in all age groups ($p<0.05$).

Discussion

Thyroid ultrasound is reliable, practical and objective method of determining thyroid size. The results of the ultrasound examinations confirmed the fact that the right lobe of the thyroid gland is larger, compared to the left lobe (7). Thyroid volume is well correlated with age and growth parameters, what was reported also in this survey (8,9). When the upper limits of reference thyroid volumes were taken into account (6), we found goiter prevalence of 12.9% in the studied population. This finding was in accordance with the prevalence of goiter (13.5%) obtained by physical examination. The volumes of thyroid gland in children where goiter was found by palpation and the volumes in children without goiter are compared and presented separately. The results of the ultrasound examinations correlate well with the palpatory findings and show higher values for the thyroid volume in children with goiter, which generally confirms the values of the findings by palpation. The recent studies (2,3) indicate that thyroid ultrasonography is more accurate than palpation in the assessment of goiter prevalence in the schoolchildren population living in mildly iodine-deficient areas. They have shown that palpation overestimates the actual size of thyroid, particularly in children. On the contrary, the data reported in this study indicate that physical examination is as precise as ultrasonography in the assessment of goiter prevalence in mildly iodine-deficient areas. This may be explained by the fact that this study was performed by the same investigator. Our findings for the volume of thyroid gland were

AGE (YEARS)	THYROID VOLUMES (ML)			
	GOITER (+)		GOITER (-)	
	MEAN±SD*	MEDIAN	MEAN±SD*	MEDIAN
7	4.2 ± 0.6	4.5	2.8 ± 0.9	2.7
8	5.3 ± 1.0	5.3	3.6 ± 1.1	3.5
9	9.4 ± 5.9	7.6	3.9 ± 1.5	3.9
10	6.3 ± 1.8	5.8	4.2 ± 1.1	3.9
11	7.1 ± 2.8	6.1	5.1 ± 1.6	4.7
12	8.4 ± 1.8	8.1	5.7 ± 1.8	5.7
13	11.5 ± 4.6	14.6	6.9 ± 1.5	6.7
14	12.4 ± 3.1	12.5	7.8 ± 2.7	7.2

TABLE 2. Thyroid volumes according to age in subjects with and without goiter by physical examination

*P<0.05

compared to the values of other authors. Our values are higher than the values of Gutekunst et Martin-Teichert (2) for Sweden, where there is no deficiency, are lower than the values of Semiz et al. (10) for goitrous area of mild to moderate degree from Turkey and are similar to the values of Aghini-Lombardi et al. (11) that refer to goitrous region in Italy

Conclusion

In conclusion, the ultrasound data indicate mild degree of iodine deficiency in Tuzla Canton. Although ultrasonography provides more precise measurement of thyroid volume compared with palpation, clinical examination in the assessment of goiter prevalence in mildly iodine-deficient areas should not be abandoned.

References

(1) World Health Organization and International Council for Control of Iodine Deficiency Disorders. Indicators for assessing iodine deficiency disorders and their control through salt iodination, WHO, Document WHO/NUT/94.6., Geneva, 1994;1-55.

(2) Gutekunst R., Martin-Teichert H. Requirements for goiter surveys and the determination of thyroid size. In: Delange F., Dunn J.T., Glinoer D., eds. Iodine deficiency in Europe. A Continuing Concern. New York: Plenum Press, 1993; 109-118.

(3) Vitti P., Martino E., Aghini-Lombardi F. et al. Thyroid volume measurement by ultrasound in children as a tool for the assessment of mild iodine deficiency. J. Clin. Endocrinol. Metab. 1994; 79:600-603.

(4) Tahirović H., Toromanović A., Hadžibegić N. et al. Assessment of current status of iodine prophylaxis in Bosnia and Herzegovina Federation. J. Pediatr. Endocrinol. Metab. 2001; 14:1139-1144.

(5) Brunn J., Blocjk U., Ruf J., Bos I., Kunze W.P., Scriba P.C. Volumetrie der schildrusenlappen mittels real-time-sonographi. Dtsch. Med. Wschr. 1981; 106: 1338-1340.

(6) Zimmermann M.B., Molinari L., Spehl M., Weidinger-Toth J., Podobas J., Hess S., Delange F. Updated provisional WHO/ICCIDD reference values for sonographic thyroid volume in iodine-replete school-age children. IDD. Newsl. 2001; 17: 12.

(7) Tajtakova M., Hančinova D., Tajtak J., Malinovsky E., Varga J., Langer P. Goiter prevalence and thyroid volume by ultrasonographic volumetry in two groups of schoolchildren and adolescents from east Slovakia. Endocrinol. Experimentalis. 1989; 23: 85-96.

(8) Oberhofer R., Ober A., Seeber A., Amor H. Struma-Epidemiologie in Sudtirol. Dtsch. Med. Wschr. 1992; 117:1508-1512.

(9) Vulpoi C., Zbranca E., Preda C., Ungureanu C., Constantinescu G., Toma C., Bredetean O., Cojocaru M. Thyroid volume in children. J. Endocrinol. Invest. 1997; 20 (5): 42.

(10) Semiz S., Senol U., Bircan O., Gumuslu S., Akcurin S., Bircan I. Thyroid gland volume and urinary iodine excretion in children 6-11 years old in en endemic area. J. Pediatr. Endocrinol. Metab. 2000;13(3): 245-251.

(11) Aghini-Lombardi F., Antonangeli L., Pinchera A., Leoli F., Rago T., Bartolomeri A.M., Vitti P. Effect of iodized salt on thyroid volume of children living in an area previously characterized by moderate iodine deficiency. J. Clin. Endocrinol. Metab. 1997; 82: 1136-1139.