STUDIES ON THE INTERRELATIONS BETWEEN THE POLLUTION BY POLYCHLORINATED BIPHENYLS AND THYROID GLAND

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Objective. The aim was to obtain information about some fundamental interrelations between heavy pollution by polychlorinated biphenyls (PCB) as evaluated in terms of their blood level and the thyroid volume and function as evaluated by ultrasound and levels of hormones and anti-thyroperoxidase autoantibodies in blood.

Subjects and Methods. In the area of heavy environmental pollution by PCB (POLL) a total of 1008 adults were examined, while in the area with background pollution (BACK) the number of examined was 1038. In addition to several data obtained by questionnaires, the thyroid volume (ThV) was estimated by ultrasound (using the ellipsoid method) and several hormones (thyrotropin -TSH, total triiodothyronine – TT3, free thyroxine – FT4) and anti-thyroperoxidase autoantibodies (anti-TPO) were estimated in serum with the use of highly sensitive electrochemiluminiscent method. In this presentation also the data are used on the estimation of total PCB by congener specific assay using gas chromatography and mass spectrometry.

Results. ThV in all subjects from POLL was significantly higher (11.43±0.19 ml; mean±SEM) than that in BACK (8.98±0.11 ml – $P<0.001$). This was related to the level of PCB. Thus, in first decile of ThV in POLL the thyroid volume was 9.83±0.37 ml (range of PCB level was 336-961 ng/g lipids), while that in tenth decile was 11.19±0.56 ml (range of PCB level was 5,430-101,414 ng/g). However, it should be stressed that the actual PCB level was presumably less than that 20 years ago when the PCB manufacturing was terminated, while that in background area was presumably about the same. In addition, if all 2046 subjects were stratified according to PCB level, the frequency of large ThV (e.g. >15.0 ml) was three times higher in upper three deciles (e.g. 95/612 = 15.5 %) than in lower three deciles (e.g. 30/614 = 4.8 %).

The level of FT4 and TT3 in all subjects from POLL (e.g. 17.04±3.12 pmol/L and 2.04±0.37 nmol/L, resp.) was significantly higher than that in BACK (e.g. 15.99±2.58 pmol/L and 1.91±0.37 nmol/L, resp.). However, still more considerable differences appeared when evaluating the differences in discontinuous terms. Thus, the frequency of increased FT4 level (e.g. those >20.0 pmol/L) in POLL was 3.5 times higher than in BACK (e.g. 150/1008 = 14.9% vs. 41/1036 = 3.9 %). Similarly, increased levels of TT3 (e.g. those >2.5 nmol/L) in POLL were twice more frequent than in BACK (e.g. 107/1008 = 10.6 % vs. 55/1036 = 5.3 %; in both cases $P<0.005$). Although the frequency of increased TSH levels indicating subclinical or even overt hypothyroidism (e.g. >4.00 mU/L) was surprisingly high, there was no difference between POLL and BACK (e.g. 137/1008 = 13.6 % vs. 131/1036 = 12.6 %). In contrast, the frequency of decreased TSH levels indicating subclinical or overt hyperthyroidism (e.g. <0.50 mU/L) in POLL was significantly higher than in BACK (31/1008 = 3.1 % vs. 17/1036 = 1.6 %; $P<0.001$). Such trend towards thyroid hyperfunction was in agreement with increased FT4 and TT3 levels.

Frequency of anti-TPO in POLL was significantly higher than in BACK both in females (214/576 = 37.1 % vs. 166/636 = 26.2 %;$P<0.001$) and in males (129/433 = 29.8 % vs. 32/402 = 7.9 % ; $P<0.001$). In addition, in BACK the female/male ration of positive anti/TPO was 3.31/1.00 (which is approximately “normal”), while that in POLL was considerably less being 1.24/1.00.

Discussion. Although several significant differences in thyroid volume, hormone levels and positive autoantibody frequency were found which are in agreement with our previous surveys in those areas (e.g. 1994 and 1998), any definite plausible explanation on the mechanism of PCB effect could be offered. It should be considered that several hereditary factors influencing the sensitivity of individuals may play some role, e.g. in tuning of individual threshold level for toxic effects of PCB. Moreover, we are possibly facing a new steady state in the function of regulatory axis including hypothalamus, pituitary, thyroid and target tissues of thyroid hormones including their genomic effects. Such steady state apparently developed within several decades of PCB action. In addition, PCB do not belong to classical antithyroid substances (e.g. propylthiouracil and methimazol) which simply inhibit the biosynthesis of thyroid hormones resulting in increased pituitary thyrotropic function, but PCB rather show a number of toxic actions on each step of the above regulatory axis.

Conclusion. In large number of adult subjects examined in the area heavily polluted by polychlorinated biphenyls increased thyroid volume, increased levels of free thyroxine and total triiodothyronine, increased frequency of low thyrotropin levels and increased frequency of positive anti-thyroperoxidase autoantobodies were found as compared to the area with background pollution..