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Iodine influence on thyroid gland function

Iodine is an essential microelement necessary for the synthesis of the thyroid hormones, thyroxin and triiodothyronine. The thyroid gland has ability to act against iodine excess by the Wolff-Chaikoff mechanism, which inhibits iodine organification and prevents large amounts of thyroid hormone synthesis. Thyroid peroxidase mRNA, protein synthesis and thyroglobulin iodination are temporary inhibited for 48–72 hours. Recent data shows that the Wolff-Chaikoff mechanism is caused by a decrease in the number of sodium-iodide symporter (NIS) proteins, resulting in a reduce of thyroidal iodine transport. The sodium iodide symporter protein was first cloned by Dai et al. in 1996 (1). After that, the escape phenomenon occurs and prolonged hypothyroidism does not happen. However in fetus, newborns, patients after episodes of subacute or postpartum thyroiditis, persons with severe diseases like chronic obstructive pulmonary disease, mucoviscidosis and autoimmune thyroid diseases, escape from inhibition of excess iodine does not occur and hypothyroidism can be observed. Patients with underlying autoimmune thyroid disease such as Hashimoto's thyroiditis are particularly susceptible to develop iodine induced hypothyroidism. The mechanism of it is an inability to escape from the Wolff-Chaikoff inhibitory effect. This leads to inhibition of organic iodine and iodothyronines synthesis (2). Thyroid gland diseases depend on the level of iodine intake, because it is an important environmental factor of several disorders. At the iodine deficiency areas most commonly first simple goiter occurs, and then morphologic reconstruction starts and nodules appear. Development of nodular goiter arises from iodine deficit. The consequence of decreased thyroid hormone concentration is the stimulation TSH formation and other growth factors. High iodine intake seen in Japan, USA or Iceland inclines to hypothyroidism and Graves' disease (3, 4).

The most frequent neoplasm of the endocrine system are thyroid gland carcinomas, which comprise up to 1.5% of all human malignances. Most common of the thyroid gland carcinomas are the differentiated forms such as follicular and papillary. Medullary and anaplastic thyroid carcinomas are more occasional. Iodine intake is considered to have particular influence on thyroid morphology. Less aggressive papillary thyroid carcinomas are observed in populations with iodine prophylaxis. The ratio of papillary to follicular carcinoma rose after introduction of potassium iodide to table salt. This similar effect is observed among the population touched by the Chernobyl accident. Iodine is also mentioned as an environmental factor of other cancers. It has suspected influence on the development of breast, ovarian, endometrial and even stomach cancer, which is indicated by large epidemiological studies (5, 6).

Hashimoto thyroiditis is the most common thyroid gland inflammation. It can develop in 19% of elderly women. Hypothyroidism can be detected in 1% of the population, especially in areas of high iodine intake. Among children with Hashimoto thyroiditis, hypothyroidism can be found in 1.2%, especially in areas of excesive iodine intake. Most of the children over 10 years old with

hypothyroidism are affected with Hashimoto thyroiditis and recovery is spontaneous in 50% of them. In Europe, which is a region of iodine deficiency, Hashimoto thyroiditis is more rare than in Japan or USA (7).

The International Council for Control of Iodine Deficiency Disorders (ICCIDD), United Nations International Children's Emergency Fund (UNICEF) and World Health Organization (WHO) are organizations in charge of international investigations on iodine deficiency in Europe and all over the world. In the early 90's, only four European countries, Finland, Sweden, Norway and Island were free from iodine deficits. In 1992 Austria and Switzerland got rid of Iodine Deficiency Disorders (IDD). In 2002, the ICCIDD report showed that only 17 countries from 31 of Western and Central Europe still have problems with iodine supplementation and iodine deficiency disorders, though it can still be observed in those populations. This success was possible by iodine salt supplementation. However, the development of cardiovascular system diseases prevents the use of table salt. But adding potassium iodide to animal feeding stuffs, bread or even to fertilizers solves the problem of supplementation. ICCIDD, UNICEF and WHO started a successful fight against IDD many years ago. Disorders ranging from endemic goiter, hypothyroidism, inhibition of children's growth and brain development up to cretinism are considered as IDD. Also, it results in decreased fertility, increased deaths of newborns and fetuses and decreased socio-economic development. Degree of IDD severity is based on the level of ioduria, percentage of goiter, thyroid gland volume assessed by ultrasound examination, level of newborn thyrotropinaemia and serum thyreoglobulin concentration in children and adults. Classification of goiter endemias by severity is assessed through median urinary iodine excretion. In no-endemic areas, normal excretion of iodine in daily urine sample is more than 100 μg. Daily levels of urinary iodine excretion less than 20 μg are characteristic of severe iodine deficiency, 20–49 μg levels are moderate and 50–99 μg levels are for mild iodine deficiency in endemic areas. Iodine supplementation programs prevent IDD, endemic and autonomic nodular goiter occurrence. They also aid in progression of children brain and intelligence development as well as decreasing risks of follicular carcinomas. Supplementation modifies the treatment of Graves-Basedow disease by decreasing time of remission periods after thyreostatic therapy.

Rich iodine supply inhibit thyroid intake of this microelement, which needs higher dose of radioiodine therapy. High iodine intake also prevents iodine accumulation in thyroid gland in case of nuclear disaster. Iodine prophylaxis brings increased risk of autoimmunologic disease occurrence in patients with genetic predisposition and hyperthyrotoxicosis, in patients with autonomic nodular goiter, mostly short after introduction of better iodine supply. In many countries with iodine prophylaxis, there were no observed disorders of iodine excess, but beneficial influence of this procedure, for example less nodular goiter, mostly seen in elderly patients. The latest ICCIDD report says that iodine supply is presently safe and beneficial. Not increased hyperthyroidism, but elevated autoimmunologic markers can rise the possibility of occurrence of those diseases (8).

One needs to remember that iodine excess is also dangerous and harmful. The main sources of excess iodine are drugs and food including vitamins, amiodarone, mucolytic syrups, antiseptics, radiology contrast agents and seafood such as seaweeds (laminaria). The daily amount of iodine recommended by WHO is 150 μg also for pregnant and breast feeding women. In sea coast populations such as Japan, where seaweed is the main product also of bread and soups, the daily intake of iodine can be over 200 mg. Amiodarone, an antyarrhythmic drug as well often causes changes in levels of thyroid hormones due to inhibition of deiodinase activity. Patients undergoing chronic treatment with amiodarone can develop amiodarone-induced thyrotoxicosis (AIT), amiodarone-induced hypothyroidism (AIH) or amiodarone-related destructive thyroiditis. This drug contains about 200 mg iodine in one tablet and about 10% of iodine is denominated daily. The half-life of this drug is about

50 days, but the main metabolite, desethyloamiodarone can last up to 100 days (9). Iodine induced hyperthyroidism may occur in patients with iodine deficiency goiter, with euthyroid Graves' disease, after previous episodes of thyroid disturbances, with multinodular goiters, living in the areas of iodine lack and those with no previous thyroid disease. Iodine-induced hyperthyroidism incidence is quite low in iodine sufficient areas. In these areas the incidence of autoimunologic diseases occurs more often. Differences in Graves' disease remission periods also occur. The remission period in the areas of rich iodine supply, as Japan or the United States is shorter than in iodine deficient countries like in Europe. Treatment is different depending on the region. In Europe surgery is performed after the second remission, because it can take even several dozen years, but in Japan or USA just after the first remission. Also the response to antithyroid drugs is more rapid in patients with Graves' disease in iodine deficient areas. Iodine increases thyrotropin receptor antibodies, which are mainly responsible for iodine-induced thyroid dysfunction in patients with autoimmunologic diseases.

Opposite is seen in areas of iodine insufficiency, where hyperthyroidism is more frequent, particularly in the course of nodular goiter. Patients with previous episode of postpartum thyroiditis, Graves' disease, alfa-interferon therapy, amiodarone destructive thyroiditis or amiodaron-induced thyrotoxicosis more often develop thyroid function changes (10, 11, 12, 13, 14).

Radioiodine therapy brings risk of hypothyroidism shortly after treatment. Other complications possibly seen in practice are anaplastic thyroid gland cancer, or post radiation thyroiditis development. Hypothyroidism is seen in the first year after ^{131}J therapy in almost 50% patients, and average percentage of hypothyroidism per year is 5% in the first 5 years after therapy. Later then, just 1% of patients per year develop thyroid gland impairment. Regular serum concentration of TSH is indicated in all treated with ^{131}J (15).

The pregnancy is a condition characterized by change in the regulation of thyroid function. Production of thyroid hormones increases, depending upon iodine diet supply. Serum thyroxine-binding globulin levels increase, free hormone concentrations diminish. But in the first trimester the rise of chorionic gonadotropin results in the decreased basal TSH level and rise of free T4 and free T3. Iodine deficiency has repercussion on fetus and mother. It causes thyroid stimulation, hypothyroxinaemia and the development of goiter. Pregnant women daily iodine intake is recommended at the level of 150 μg. It is important that pregnant women should not use more table salt to supply iodine requirement, but additional vitamin tablets containing iodine supplements are indicated (16).

Iodine disequilibrium is dangerous for normal function not only of thyroid gland. Iodine deficit causes IDD. Iodine excess acts as an immunogenic factor, especially in patients with latent or overt thyroid gland pathology. Intake of this microelement should be adequate. Adults are recommended to supply 150 μg iodine daily. Europe is the earth region characterized as iodine deficient, but national programs under the auspices of ICCIDD, UNICEF and WHO have successfully eliminated IDD in most Western and Central European countries.

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SUMMARY

Iodine is a microelement necessary for the normal development and function of human being. Either iodine lack or excess is harmful and has side effects on thyroid gland function. The national supplementation programs are completely effective and decrease the number of iodine deficiency disorders (IDD) all over the world. However, the development of cardiovascular system diseases prevents the use of table salt. But adding potassium iodide to animal feeding stuffs, bread or even to fertilizers solves the problem of supplementation. ICCIDD, UNICEF and WHO started a successful fight against IDD many years ago. One needs to remember that iodine excess is also dangerous and harmful. Amiodarone, mucolitic agents, contrast media and antiseptics are some of the widely used agents in medicine that contain large amounts of iodine. These are administered in milligrams and grams, several times larger than the daily dose recommended by scientists. It can be the cause of both hypothyroidism and hyperthyroidism, particularly among the elderly, patients with genetic predisposition, latent thyroid gland pathology, nodular goiter and Graves' disease.

Wpływ jodu na funkcję gruczołu tarczowego

Jod stanowi niezbędny mikroelement do prawidłowego rozwoju i funkcjonowania organizmu człowieka. Zarówno niedobór jodu, jak i jego nadmiar prowadzą do zaburzeń oraz ujemnego wpływu na funkcjonowanie gruczołu tarczowego. ICCIDD, UNICEF i WHO rozpoczęły skuteczną walkę z IDD wiele lat temu. W licznych krajach na całym świecie wprowadzanie programów uzupełniania niedoborów tego pierwiastka w diecie na terenach endemicznych przyczyniło się do istotnego wyeliminowania chorób z niedoboru jodu. Prewencja chorób sercowo-naczyniowych ogranicza dzienne spożycie soli wzbogacanej w jodek potasu, ale rozwiązano ten problem dzięki programom uzupełniania jodem pasz dla zwierząt, chleba czy nawozów rolniczych. Nie należy zapominać także, że nadmiar jodu jest niebezpieczny dla organizmu, a szerokie zastosowanie środków medycznych z dużą jego zawartością, na przykład amiodaron, kontrastowe środki jodowe czy krople do oczu, dostarcza do organizmu miligramowe, a nawet gramowe ilości tego pierwiastka, przekraczając nawet kilkaset tysięcy razy dobową dawkę spożycia jodu rekomendowaną przez WHO. Może to stanowić przyczynę poważnych zaburzeń funkcji gruczołu tarczowego, zarówno pod postacią nadczynności, jak i niedoczynności, zwłaszcza wśród osób starszych, pacjentów z genetyczną predyspozycją, utajoną patologią tarczycy, wolem guzkowym tarczycy czy chorobą Gravesa-Basedowa.