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Influence of environmental pollution on the status of patients with endocrine ophthalmopathy in Kaunas

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Aims. To study ocular changes in patients with endocrine ophthalmopathy and to evaluate the possible harmful effect of pollution.

Materials and methods. 245 patients with endocrine ophthalmopathy on regular follow-up in 2004–2005 in the Ophthalmology Outpatient Department of the Kaunas Medical University Clinic were recruited for the study. A comprehensive examination of their ocular and thyroid status was performed. Patients were grouped according to their residence in the Kaunas city regions (Romainiai, Šilainiai, Vilijampolė, Žaliakalnis, Centras, Aleksotas, Dainava, Šančiai, Petrašiūnai, Panemunė). We evaluated the possible role of pollution in Kaunas regions on the development of ocular changes in patients with endocrine ophthalmopathy.

Results. We examined 245 Kaunas city residents with endocrine ophthalmopathy (mean age 53.4 ± 14.16 years). Thyroid hyperfunction was found in 104 patients (42.4%). The majority of patients were from Dainava (87, 35.5%), Žaliakalnis (48, 19.6%), Šilainiai (32, 13.1%) and Centras (12, 4.9%). The mean proptosis was 17.53 ± 2.32 mm. Exophthalmus was less than 20 mm in the majority (right eye (OD) 86.5%, left eye (OS) 84.1%) of patients. The average visual acuity of the right eye was 0.7 ± 0.35 and of the left eye 0.7 ± 0.36. Ocular signs were found in 203 (82.9%) patients.

Conclusions. Most of the patients with endocrine ophthalmopathy were aged 40–60 years, the majority being females with hyperthyrosis. Most of our patients were Dainava, Žaliakalnis, Šilainiai and Centras residents and lived near intensive traffic roads. Environmental pollution might have a possible harmful effect on the development of ocular changes in patients with endocrine ophthalmopathy.

Key words: endocrine ophthalmopathy, environmental pollution, ocular changes

INTRODUCTION

Endocrine ophthalmopathy is a disease that affects ocular muscles and microsoft eye tissue. The urban environment (atmosphere, soil and groundwater) is polluted by harmful substances from different sources. Environmental pollution has a harmful influence on predisposition to endocrine ophthalmopathy (Jankauskienė, 2003). Well known are the problems of pollution by point sources such as plants, refineries and petrol stations, diffuse pollution of urban soils. Typical sources of diffuse pollution are, for example, traffic-related emissions, heating processes in households, pollution by disposed building materials, uncontrolled deposited ashes, slag, and refuse. Presently, adequate urban soil management systems are not an established part of sustainable urban planning. There is a lack of knowledge about the spatial distribution and concentrations of harmful substances in urban soils. Obtaining such information faces the problem of heterogeneity of the anthropogenic components in ur-

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ban soils, pollution by point sources, and the diversity of urban land use types and its impact on soils (Meuser, 1996; Tyutyunnik et al., 1998). Urban soils are often polluted with harmful substances from a broad range of emission sources. Such sources include gaseous emissions by fossil fuel combustion, surface abrasion (e. g., traffic-induced abrasion of street surfaces or automobile tires), sewerage leakages, emissions of chemicals and metal-producing industries, or fertilizing. As soils accumulate, harmful substances can be used as a proxy for anthropogenic pollution and activities over time (Kristensson et al., 2000; Burneikis, Štreimikienė, 1999).

Environmental pollution by heavy metals has harmful effects on human health. A lot of scientists confirm harmful effects of heavy metals on the thyroid gland and eyes (Jankauskienė, 2003; Imbrasienė et al., 1997; Imbrasienė et al., 2004). Take lead poisoning, for example. If lead gets into the blood, the body will try to remove it. Since the metal atoms are too heavy compared with the body's immune forces, the removal may be impossible. Lead can initiate a chronic inflammatory response and remain in the body permanently. Studies show that lead poisoning reduces T4 in exposed workers. Statistical correlation of levels with environmental factors showed that lead (Pb) levels were most strongly correlated with the age of the house, with maternal exposure to heavy traffic for more than 5 years (Dabeka et al., 1986; Kurkjian et al., 2002).

The maximum values of lead are found in industrial areas and housing areas with buildings erected before 1920 (in those areas, average soil Pb concentration is higher compared to traffic areas). This might be the result of a higher Pb content in construction materials, emissions of coal-fired house heating, and of more intensive construction earth mixing and exchanging activities nearer to roads, which influences the Pb accumulation process in the soil.

Lower lead concentrations were found in soils from recreation areas and in soils of housing areas with buildings constructed after 1980. The low content of trace metals in newly constructed housing areas can be caused by mixed and exchanged soil matters, replacement of coal by less emission-producing heating methods such as oil, gas, electrical power or district heating, the growing awareness of society about the danger of harmful substances in the environment and the consequently developed risk management, and a short timespan for accumulation of deposited trace elements.

A scatter plot for zinc (Zn) and lead (Pb) content in the soils underlines this sequence of the grade of soil pollution in different land-use areas where 90% of all values are below high doses. Higher concentrations of lead and zinc occur mainly in traffic and industrial areas (Bartley et al., 1996; Dabeka et al., 1986).

Zinc acts as a stimulator and copper as a suppressor of the thyroid and immune systems. It appears that when copper becomes deficient, both the thyroid and the immune system will run out of control. If too much zinc is absorbed into the body, it is a possible cause of hyperthyroidism (Bartley et al., 1996; Kralik et al., 1996; Tsou et al., 1993).

Cadmium is one of the most potent and long-lasting toxic metals known. Cadmium has been demonstrated to damage thyroid cells and to decrease both T4 and T3. This damage can be viewed in *in vitro* studies of thyroid cells in a culture (Yoshizuka et al., 1991; Hutton, 1983). Increased intake of some heavy metals causes disorders of bioelement metabolism leading to their blood and organ decrease and higher elimination via the urine. There was a study to show that cadmium decreases blood levels of magnesium. In endocrine disease, there is evidence of cadmium toxicity and magnesium deficiency (Soldatović et al., 1998; Fujita, 1992; Disashi et al., 1996).

The aim of our research was to study ocular changes in patients with endocrine ophthalmopathy and to establish a relation between pollution in the Kaunas city districts and the frequency of endocrine ophthalmopathy.

MATERIALS AND METHODS

We examined 245 patients – residents of different Kaunas city districts. The diagnosis of endocrine disease was based on clinical and laboratory findings of diffused enlargement of thyroid gland, raised free thyroxin or triiodothyronine levels. In order to investigate the relation between pollution and ocular changes in patients with endocrine ophthalmopathy, we took cognizance of the Kaunas city pollution studies. On the authority of the Lithuanian Agriculture Institute Agrochemical Researches Laboratory studies (1993–1997; 1998–2000) and Vytautas Magnus University Environmental Science Department information collected in 1998–2000, the Kaunas city soils are most polluted with zinc (Zn), lead (Pb) and copper (Cu), and the ambient air is most polluted with NO_2 and with heavy metals.

RESULTS

The population-based cohort of Lithuanian patients with ophthalmopathy associated with autoimmune thyroid disease diagnosed in 2004 and 2005 comprised 245 patients of whom 219 (89.4%) were women ($P = 0.00001$; normal relative deviate test) and 26 (10.6%) were males. The distribution of incidence rates by twenty-year age groups included peak incidence rates in the age groups of 40 to 60 years in women and 60 to 80 years in men (Fig. 1). The mean age of patients was 53.4 ± 14.16 years. There was one patient (0.4%) in the age group under 20 years, 41 patients (16.7%) were 20–39 years old, 120 patients (49%) were aged 40–59 years, 75 patients (30.6%) were 60–79 years old and 8 patients (3.3%) were older than 80 years (Fig. 2). Nine patients (3.7%) with endocrine ophthalmopathy resided in Aleksotas, 12 patients (4.9%) in Centras, 87 patients (35.5%) in Dainava, 12 patients (4.9%) in Panemunė, 9 patients (3.7%) in

Petrašiūnai, one patient (0.4%) in Romainiai, 17 patients (6.9%) in Šančiai, 32 patients (13.1%) in Šilainiai, 18 patients (7.3%) in Vilijampolė and 48 patients (19.6%) in Žaliakalnis (Fig. 3). The majority of patients from Šančiai and Centras districts were older, lower educated and seldom consulted a doctor.

According to Vytautas Magnus University data, the most heavily polluted Kaunas districts are Centras and Žaliakalnis (zone of increased pollution takes in 36% of Centras and 30% of Žaliakalnis area). Medium polluted zones are Dainava (56% of area), Žaliakalnis (50%), Šilainiai (35%). The majority of patients residing in most polluted districts lived near traffic roads polluted with heavy metals and NO_2. Low-polluted districts are Aleksotas and Panemunė. Only 9 patients (3.7%) were from Aleksotas and 12 patients (4.9%) from Panemunė.

The diagnosis of endocrine disease was based on clinical and laboratory findings of a diffused enlargement of the thyroid gland and abnormal free thyroxin or triiodthyronine levels. Also, a comprehensive ophthalmic assessment including complete ophtalmological examination was performed. Grave's hyperthyroidism was found in 123 patients (50.0%), 83 participants (34.0%) had euthyroid endocrine ophthalmopathy, and 39 (16.0%) patients had a hypofunction of the thyroid gland (Fig. 4). The mean proptosis was 17.53 ± 2.32 mm, the mean proptosis of the right eye being 17.26 ± 2.24 mm and of the left eye 17.8 ± 2.39 mm. Exophthalmus was less than 20 mm in the majority (OD 86.5%, OS 84.1%) of patients. The average visual acuity of the right eye was 0.7 ± 0.35 and of the left eye 0.7 ± 0.36. Decreased visual acuity may depend on other ocular diseases. In our study, 31 patients (12.7%) had myopia and 45 patients (18.4%) had cataracts. Ocular signs were found in 203 (82.9%) patients. Orbital ultrasonography was performed in 11 cases (4.5%) and demonstrated enlargement of inferior rectus in 54.5% of medial rectus in 36.4%, superior rectus in 36.4% and lateral rectus in 45.5%.

DISCUSSION

The incidence of endocrine disease in adults has been reported to be 15–20 per 100000 per year (Barker et al., 1984). The researchers concluded that environmental pollution by chemicals (heavy metals) is an important factor in the development of endocrine ophthalmopathy (Nunery et al., 1993).

Endocrine ophthalmopathy behaves differently in different age and ethnic groups. Bartley et al. (1996) reported ophthalmic manifestations and complications in an adult series (the frequency of exophthalmus, restrictive extraocular myopathy and optic nerve dysfunction (Bartley et al., 1996). In our study, 62% (152 patients) had exophthalmus (>17 mm), 12.7% (31 patients) had myopia, and 18.4% (45 patients) had cataracts. We did not examine the family members of patients to document the family history of endocrine ophthalmopathy for further correlation. Villanueva et al. (2000) studied the family

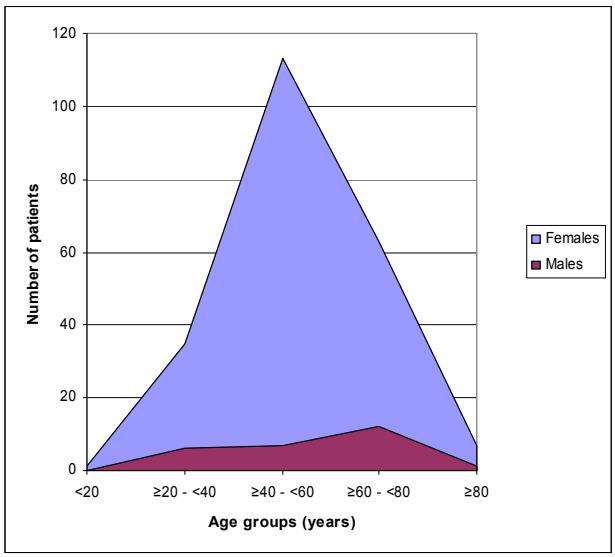

Fig. 1. Distribution of patients according to sex and age

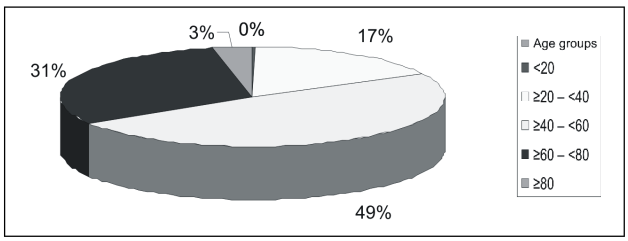

Fig. 2. Distribution of patients according to age

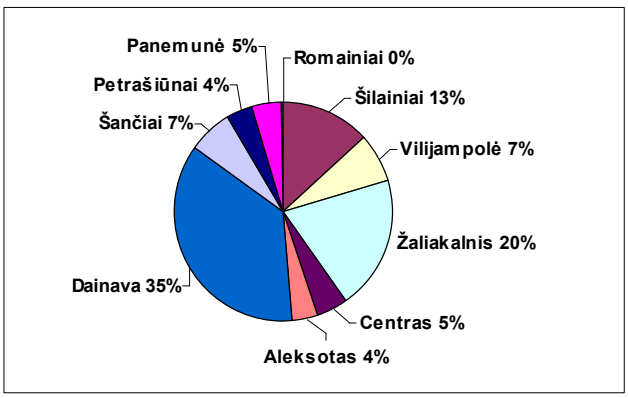

Fig. 3. Distribution of patients according to Kaunas city regions

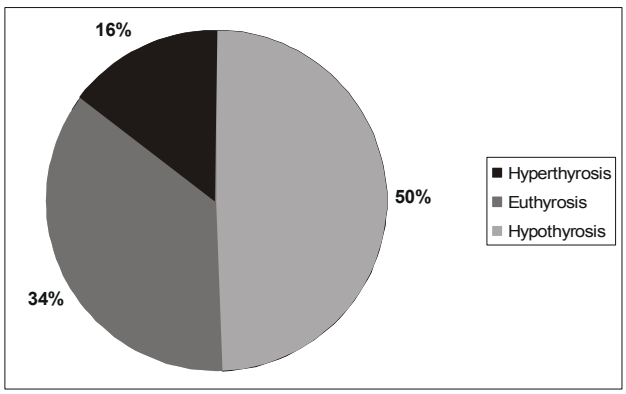

Fig. 4. Distribution of patients according to thyroid gland function

history, ethnically mixed patients with severe endocrine ophthalmopathy. Their data did not support a major role for familial factors in the development of severe endocrine ophthalmopathy. Various studies (Winsa et al., 1993) suggested that other factors rather than major genes were likely to predispose certain individuals to severe endocrine ophthalmopathy. Smoking and radioactive iodine treatment have been implicated in the manifestations of thyroid ophthalmopathy (Wong, Cheng, 2001; Tallstedt et al., 1993).

CONCLUSIONS

Most of our patients with endocrine ophthalmopathy were aged 40 to 60 years, were females and had hyperthyrosis. The majority of patients resided in Dainava, Žaliakalnis, Šilainiai and Centras districts and lived near intensive traffic roads, so we suppose that environmental pollution had a role in the development of ocular changes in patients with endocrine ophthalmopathy.

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APLINKOS UŽTERŠTUMO ĮTAKA ENDOKRININE OFTALMOPATIJA SERGANTIESIEMS KAUNO MIESTE

Santrauka

Tikslas. Įvertinti galimą įvairių Kauno miesto seniūnijų užterštumo įtaką endokrinine oftalmopatija sergančių ligonių akių pokyčiams ir išsivystymui.

Metodika. Ištyrėme 245 endokrinine oftalmopatija sergančius Kauno miesto gyventojus, kurie 2004–2005 m. lankėsi KMUK Akių ligų konsultaciniame-diagnostiniame skyriuje. Pacientams buvo atliktas išsamus oftalmologinis ištyrimas, įvertinta skydliaukės funkcija. Tiriamuosius suskirstėme į grupes pagal seniūnijas (Romainiai, Šilainiai, Vilijampolė, Žaliakalnis, Centras, Aleksotas, Dainava, Šančiai, Petrašiūnai, Panemunė) ir analizavome galimą minėtų seniūnijų užterštumo įtaką ligos išsivystymui.

Rezultatai. Ištyrėme 245 endokrinine oftalmopatija sergančius Kauno miesto gyventojus. Ligonių amžiaus vidurkis – 53,4 m. (±SN 14,16). Padidėjusi skydliaukės funkcija nustatyta 104 ligoniams (42,4%). Daugiausiai ligonių, sergančių endokrinine oftalmopatija, buvo iš Dainavos (87 ligoniai, 35,5%), Žaliakalnio (48 ligoniai, 19,6%), Šilainių (32 ligoniai, 13,1%) ir Centro (12 ligonių, 4,9%) seniūnijų. Išverstakumo vidurkis buvo 17,53 mm (±SN 2,32). Išverstakumas < 20 mm buvo nustatytas daugumai ligonių (dešinės akies (OD) – 86,5%, kairės akies (OS) – 84,1%). Regėjimo aštrumo vidurkis buvo OD – 0,7 (±SN 0,35), OS – 0,7 (±SN 0,36). Akių pokyčiai nustatyti 203 ligoniams (82,9%).

Išvados. Dauguma ligonių buvo 40–60 m. moterys, kurioms nustatyta padidėjusi skydliaukės funkcija. Dauguma mūsų tirtų ligonių, sergančių endokrinine oftalmopatija, buvo iš Dainavos, Žaliakalnio, Šilainių ir Centro seniūnijų. Dauguma šių ligonių gyveno prie intensyvaus transporto kelių, t. y. vietose, labiau užterštose sunkiaisiais metalais ir NO_2. Manome, kad aplinkos užterštumas galėjo turėti įtakos endokrinine oftalmopatija sergančių žmonių akių pokyčiams.

Raktažodžiai. endokrininė oftalmopatija, aplinkos tarša, akių pokyčiai