Thyroid Gland Status Among Population Living Around the Semipalatinsk Nuclear Test Site


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INTRODUCTION

From August 29, 1949 to 1989, 458 aboveground and underground nuclear and thermonuclear explosions of nuclear weapons conducted by the former Soviet Union at the Semipalatinsk Nuclear Test Site (SNTS). Regions of the Northeastern part of Kazakhstan were contaminated with high levels of radioactive fallout from atomic bomb tests, especially during 1949-1962. On various estimations, 1.2 million inhabitants were exposed. After the breakup of the former Soviet Union and with the ending of the cold war an international scientific community got a unique opportunity to study jointly health effects of radiation. Previously restricted and classified information is available now. A new and unique information can be obtained on the effects of radiation on humans, especially in terms of low level of radiation exposure and long-term consequences. It was determined by experts from recently declassified records, that mainly 22 aboveground and 1 underground officially registered tests, resulted in substantial exposures to inhabitants of this region and are thought to have been responsible for about 95% of the collective radiation dose from fallout to residents of areas adjoining the SNTS. Table 1 shows some features of those nuclear bomb tests. The results of some dose reconstruction indicate a dose range of 2 mSv to 5 Sv, with most local residents being exposed to effective doses below 0.1 Sv. However, there are no comprehensive data, describing dynamics of radioactive situation on territories adjacent to the SNTS from all atmospheric and surface nuclear explosions. It complicates reconstruction of effective and collective doses. Nevertheless the dose reconstruction issue is under process now and some preliminary progress already has been made. The thyroid gland is very sensitive to the carcinogenic effects of radiation. It is known, that the prevalence of thyroid nodules can be associated with radiation dose. Among exposed population the subsequent risk of thyroid cancer is highly dependent upon age at exposure. The present study was undertaken to restore the survey of thyroid abnormalities and to clarify the prevalence of thyroid nodules in regions adjacent to SNTS in consideration of possible health effects of fallout exposure.

MATERIALS/METHODS

Some features from three studies of thyroid gland status among population living around SNTS will be reported. The first study is a case review of pathological findings for 7,271 patients from three regions adjacent to the SNTS, who were surgically treated during 1966-1996 (Table 2); the second is a thyroid screening study of a cohort of 3000 village residents who were <20 years of age at the time of major fallout events (preliminary findings); the third is a complex molecular, morphological investigation and some approaches to rehabilitation of patients with thyroid abnormalities in this region.

RESULTS

Our first study revealed that there is a significant trend for the proportion of thyroid cancer to increase over time in the Semipalatinsk region of Kazakhstan 20-29 years after onset of testing in 1949, which might be related to radiation exposure. Table 3 shows a frequency distribution of 2653 thyroid abnormalities among surgical patients in the Semipalatinsk region of Kazakhstan. Our research among two main ethnic groups (native Kazakh and European extraction) detected that the initial level of thyroid abnormalities and thyroid cancer was higher among residents European extraction. The total number of surgical cases increased among both ethnic groups over the years, but the numbers of cases with Hashimoto’s thyroiditis and thyroid cancer increased dramatically among ethnic Kazakhs (Figure 1). Figure 2 shows some results of autopsy study among 544 cases from both exposed and control group who had died from different diseases during 1990-1993. The study data were taken from autopsy reports with 45 cases from study group with an exposure dose to thyroid gland from 5.0 to 8.0 Gy, 88 cases from study group with an exposure dose to the thyroid gland from 2.0 to 4.9 Gy and 411 cases from control group. The age of the patients varied from 40 to 50 years. It is documented that only thyroid nodule disease and thyroid cancer had essential excess among
patients from different exposed groups in comparison with a control group. It has been realized by special study of Kazakh Research Institute for Radiation Medicine and Ecology, that the concentration of thyroid stimulating hormone (TSH) in the blood of patients with thyroid nodule disease of exposed group with an exposure dose of thyroid gland 2.0-8.0 Gy significantly higher, than in a group of comparison.

Fallout contours from the most polluting nuclear explosions have been estimated by Kazakhstani, Russian and American scientists, and whole-body radiation dose values have been assigned to residents of various villages who were there during test period. Estimates of gamma radiation dose in the heavily-exposed cohort members vary by village, and range from 13 to 2200 mGy with a population-weighted average of 600 mSv; whereas the estimated average dose in the lightly-exposed villages is 20 mGy. Thyroid screening participants were invited (3000 inhabitants <20 years of age at the time of the major fallout events) with informed consent, from 6 exposed and 2 non-exposed villages of the Semipalatinsk region of Kazakhstan (Figure 3). Of those screened, 1320 were presumably exposed and 1678 presumably were not. Based on reconstructed estimates of external radiation exposure in both countries, radiation doses to local population were 10-100 times higher around the SNTS than among populations downwind of the Nevada Test Site. Thus, relationships observed between gamma dose and 131I in Utah, and other places downwind from the Nevada Test Site, may not apply here. Subjects were asked about residential history and childhood consumption of milk and milk products. In accordance with our preliminary findings nodular thyroid glands were found in 920 eligible patients, of whom 506 were recommended for fine-needle aspiration biopsy. 647 nodules were biopsied under ultrasound guided method. Spray-fixed slides were prepared for eventual Papanicolaou stainining. Nodule prevalence was 18% among men and 39% among women with a 3.5% per year positive gradient in prevalence overall by age at screening, and was significantly associated with estimated gamma radiation dose. We have revealed that thyroid nodules increased significantly with increasing estimated average gamma ray dose, among persons presumably exposed, but was nearly 3-fold higher among men (ERR$_{1Gy}$=4.4, p<.001) than among women (ERR$_{1Gy}$ =1.7,p=.002). Cytopathology review identified 27 cases of papillary carcinoma and 10 of follicular neoplasm in 10 cases. 3 cancers among males, 24 among females. The majority of FNA biopsies indicated benign nodular disease. Some patients with thyroid nodular disease and thyroid cancer were referred to surgical department of the Semipalatinsk city hospital. They have been treated successfully by surgery or by percutaneous injection of ethanol and medicines as indicated. Thyroid surgery revealed mainly an occult thyroid carcinoma with benign behavior and no lymph node metastasis. Postoperative histological findings confirmed cytopathological results. Some patients with thyroid nodules can be treated effectively without surgery by using percutaneous injection of erythrocyte pharmacocytes. Precise analysis of the surgical outcomes and postoperative thyroid gland function identified relatively high levels of thyroid function abnormalities after surgery and especially after extended surgical excision. Patients after thyroid surgery need a hormone replacement therapy for a long period of time. Indeed surgery remains the most effective treatment for thyroid cancer, but we need to decrease the need for unnecessary surgical excision. Usually clinical suspicion of thyroid cancer most frequently arises when a patient is found to have a solitary thyroid nodule. It was believed that there is a high incidence of cancer in this group, which was reported as about 10% in an unselected autopsy study. The exact incidence probably varies according to geographical distribution, selection of patients, previous exposure to ionizing radiation, pathological criteria for the diagnosis of malignancy and possibly many other factors. It should be considered that meticulous examination of the thyroid at necropsy discloses occult carcinoma in as many as 5.7% of persons with no known thyroid disease in the United States. It is imperative to keep these facts in mind when recommending an evaluation and treatment program for thyroid nodules and cancer. By far the majority of patients presenting with a solitary thyroid nodule have no clinical clues to the benign or malignant nature of the lesion. On the basis of analysis of our retrospective and prospective data in terms of thyroid cancer we concluded that the need for surgery should be reduced. Analysis of survival and a patients follow-up study revealed that in the Northeastern part of Kazakhstan a differentiated thyroid carcinoma is a relatively benign disorder. Conservatism in diagnostic and therapeutic modalities should be the rule. It should be noted that thyroid cancer remains of absorbing interest. Clearly we have much still to learn about this disease. There is a great need to demand the newer investigative techniques which can provide a clear diagnosis before operation needs to be planned. The outcomes of treatment was the most effective among patients with thyroid nodules, who received percutaneous injection of erythrocyte pharmacocytes in accordance with our method. It should be noted a noticeable trend to hormone level normalization among patients who has been treated by using erythrocyte pharmacocytes. The exact mechanism of that is still unclear and we need some more research to be done in this direction. Our study suggests to expand...
and advance thyroid research around SNTS, especially research at the molecular level, which has the greatest potential of giving right information about radiation related thyroid diseases and to improve the rehabilitation program of exposed population with thyroid abnormalities.

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REFERENCES


