

Risk of lens opacification in the exposed Techa River population

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Introduction

According to the literature discussing the changes in the bulb of the eye after different radiation accidents, the highest sensitivity to ionizing radiation has been shown by the lens. It should be noted that the threshold dose still remains a controversial point though radiation cataract is traditionally regarded as a non-stochastic radiation effect.

Objective

Analysis for eye disease incidence (cataract included) among residents of the Techa riverside villages exposed to chronic combined (internal and external) irradiation at low-dose rates

Information source: medical reports and out-patient cards of patients of clinic URCRM. Risk analysis of eye pathology incidence among patients of the URCRM clinic based on individual doses (TRDS-2000).

Study group

Number of exposed persons examined at the URCRM's inpatient department **6,343**

Period of follow-up **1950 – 2010**

Dose estimates (TRDS-2000), Gy
To soft tissue **0 – 0.46**

Methods for assessing the status of the organ of vision

- evaluation of visual acuity;
- examination of the anterior chamber;
- status of the refractory media and fundus oculi;
- measuring intraocular pressure;
- perimetry;
- duplex ultrasound and color doppler mapping.

Diagnostic methods and facilities for assessing the status of organ vision have been changed over the 50 years of follow-up.

Demographic characteristics of the study group (n = 6,343)

- o Gender:
 - women 3,566 (56%)
 - men 2,777 (44%)
- o Ethnicity:
 - Slavs 4,116 (65%)
 - Tartars and Bashkirs 2,227 (35%)
- o Residents of the Techa riverside villages in the period of maximum releases (i.e. 1950-1952)
- o Birth year range: 1864 - 1949

Radiation exposure

Discharges of liquid radioactive waste into the Techa River during the period 1949 through 1956 were the major source of radioactive contamination of the river and its adjacent territories. The residents of the villages along the Techa were exposed to both external irradiation from contaminated river sediments and flood plane soils, and internal irradiation due to ingestion of radionuclides with river water. All cohort consists of 29756 members.

Results

Over the period from 01.01.1950 to 31.12.2010, 1380 first-diagnosed cases of cataract were registered among cohort members. A peculiarity of the cohort consists in the fact that it only includes persons born before 1950, due to which the proportion of cohort members of younger ages is decreasing, i.e. it is an aging cohort. Over the past decade (up to 01.01.2011) 700 new cases of cataract were diagnosed. Before 1.01.2000, 680 cases were registered.

Including at

| | |
|--------------------|-------------|
| men | 226 (33.2%) |
| women | 456 (66.8%) |
| Slavs | 353 (51.9%) |
| Tatar and Bashkirs | 327 (48.1%) |

Person years, total 59.257

The mean age at diagnosis was 52.8 (±11.9) years for persons under 16 years of age at the start of exposure.

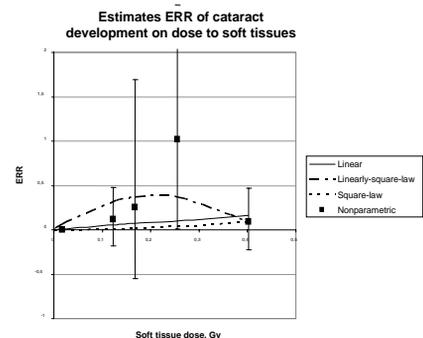
Among those who were over 16 at the onset of exposure time, the mean age for cataract development was 65.4 (±9.2) years.

Risk factors:

- Gender
- Ethnicity
- Attained age
- Age at the onset of exposure
- Calendar period
- Diseases previous a cataract: retinal angiosclerosis, ischemic heart disease, arterial hypertension, a cerebral atherosclerosis, adiposity
- Cumulative soft tissue dose

Cataract Excess Relative Risk (ERR) per 1 Gy was 0,40 (95%CI:-0,43;1,47).

Dose response relationship was studied using a linear ERR model with account for all other factors that could modify baseline incidence of cataracts.



Observed and Excess Cataract by Dose Category with Attributable Risks

| Dose groups, Gy | Mean dose, Gy | Person years | Cases | | Attributable fraction |
|-----------------|---------------|--------------|----------------|--------------|-----------------------|
| | | | Observed cases | Excess cases | |
| < 0.1 | 0.002 | 51,824 | 583 | 4,2 | 0.7% |
| 0.1 – 0.149 | 0.122 | 3,427 | 44 | 1,9 | 4.3% |
| 0.15 – 0.29 | 0.167 | 726 | 5 | 0,3 | 6.0% |
| 0.2-0.29 | 0.254 | 589 | 10 | 0,5 | 5.0% |
| >=0.3 | 0.402 | 2,689 | 38 | 5,7 | 15.0% |
| Total | 0.05 | 59,257 | 680 | 12,7 | 1.9% |

Factors influencing the baseline incidence of cataracts

- Incidence was 40% higher in women than in men ($p = 0.003$)
- Cataract incidence in Tatar-Bashkirs was 6% higher than in Slavs ($p = 0.42$).
- Risk of cataract increases if the following diseases precede the cataract: retinal angiosclerosis (the risk is increased by 1.7 times, $p < 0.001$); diabetes (the risk is increased by 1.3 times, $p = 0.04$); arterial hypertension (the risk is increased by 1.2 times, $p < 0.02$)

Conclusions

The cataract incidence in individuals chronically exposed in the Techa riverside villages:

- is prevailing in females compared to males
- increases with attained age, maximum number of cases was registered in persons older than 60 years.
- has increased risk in patients who have/had retinal angiosclerosis, diabetes and arterial hypertension.
- was not shown in our study to increase with the exposure dose; however, this could be explained by low cases of cataract in persons exposed in low and middle dose range. Further follow-up of the cataracts in the Techa River populations will allow more precise risk estimates in the future.