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SHORT COMMUNICATION

OCULAR HYPERTONIA AND CRYSTALLINE LENS OPACITIES IN HEALTHCARE WORKERS EXPOSED TO IONISING RADIATION

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Some activities performed by healthcare workers may still involve total or partial exposure to ionising radiation exceeding the limit values. In addition to the appearance of crystalline lens opacities which may lead to rays-cataract, recent studies have indicated possible induction of ocular hypertonia in occupationally exposed subjects. The aim of this study was to establish the actual prevalence of ocular hypertonia and crystalline lens opacities in a group of healthcare workers exposed to ionising radiation. The collected data failed to show significant risk of ocular hypertonia and suggested that crystalline lens opacity was not an important indicator of exposure. Notwithstanding, preventive and periodic (every 5 years) ophthalmologic control may prove helpful for medicolegal purposes. Namely, such control would record congenital crystalline lens opacities in many individuals and would thus rule out unjustified claims of occupational disease due to exposure to ionising radiation. Additionally, ophthalmologic control should focus on different and probably more important ocular risks for the radiologists such as the ocular fatigue resulting from a prolonged use of a video display terminal or other diagnostic screens or electrodiaphanoscopes.

Key words:
cataract, eye, glaucoma

Eyes have long been the target of the dose-dependent activity of ionising radiation. This particularly refers to the appearance of opacity in the crystalline lens as the most sensitive part of the ocular system and may go as far as the development of cataract. The cataract in subjects exposed to radiotherapy involving the irradiation of the eyes may be accompanied by ocular hypertonia (1). Recent studies have pointed out the high risk of ocular hypertonia in occupationally exposed subjects (2, 3). French legislation related to radioprotection still holds permanent ocular hypertonia and glaucoma as a possible reasons for refusal of admission to work involving potential exposure

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to ionising radiation. (4). The pathogenesis of the damage points at the effect of irradiation on the iris from the loss of pigmentation in the iris to the accumulation of the pigment in the irideocorneal angle which may then obstruct the outflow of the aqueous humour and lead to hypertonia and eventually glaucoma.

Particularly with respect to the crystalline lens, ophthalmologic control has formed a general approach that we have defined as »classical« within the frame of sanitary surveillance aimed at radioprotection.

Technical progress in radiation protection has considerably reduced the risk of exposure to ionising radiation over the past 20 years and has pushed further down the permissible exposure limits. The threshold dose for the appearance of non-stochastic effects on the crystalline lens following acute and chronic exposure to ionising radiation has been well defined (see Table 1) (5, 6).

The comparison of doses absorbed at work involving the risk of exposure to ionising radiation with the accepted threshold doses affecting the crystalline lens may make the preventive and periodic ophthalmologic control look obsolete.

Table 1 *Threshold of dose for the appearance of non-stochastic effetcs on the crystalline lens*

	Threshold of dose		
Target organ and effect	**Equivalent dose following acute exposure (Sv)**	**Equivalent dose following chronic exposure (Sv)**	**Annual doses following chronic exposure (Sv)**
Crystalline lens: opacity and microopacity	0.5 – 2.0	5	>0.1
Vision deficit (cataract)	5.0	>8	>0.15

Ophthalmologic control as a part of radioprotection activity frequently reveals the presence of lens opacity, or even more often of microopacity. There are various classifications and evaluations of opacity and microopacity of the crystalline lens (7). At times a subject who showed no anomalies on the first control shows them on the second control performed by other ophthalmologist even within so short an interval as two years. A completely opposite case of unexpected disappearance of opacity between two medical checks is also possible. An evident appearance of opacity or microopacity of the crystalline lens within a two-year period may considerably perplex a person with the risk of exposure to ionising radiation. In the majority of similar cases the appearance of opacities of the lens cannot and must not have any influence on decisions about the suitability for a job which includes exposure to ionising radiation.

Notwithstanding the well defined dose threshold for the appearance of adverse effects on the crystalline lens, the damage is often reported to the Italian National Insurance Institute (INAIL) and regarded as a consequence of occupational exposure to ionising radiation. INAIL often recognises such alterations of the lens as occupational diseases, including the unilateral cataract. In such cases a physician in charge should be held responsible for an inefficient surveillance of damage and its gradations caused by ionising radiation.

The aim of our research was to estimate the actual risk of ocular hypertonia and the prevalence of crystalline lens opacity in a group of healthy subjects whose work involves the risk of occupational exposure to ionising radiation and, ultimately, to see how justifiable ophthalmologic controls really are in the health surveillance protocol.

SUBJECTS AND METHODS

The investigation was carried out by examining the results of ophthalmologic control of 132 individuals in S. Orsola – Malpighi Hospital. The study excluded subjects affected by diabetes mellitus, subjects with the family history of glaucoma, subjects affected by arterial hypertension, and subjects having undergone or undergoing cortisone-based treatment.

The examined group included subjects who were classified, before the D.Lgs. 230/98, as occupationally exposed workers of A and B category.

The 132 tested subjects, 75 males and 57 females, included 38 doctors (24 radiologists, 4 radiotherapists, 1 physician of nuclear medicine, 1 orthopaedist, 6 anaesthetists, 1 gastroenterologist, and 1 cardiologist), 55 radiology technicians, 15 professional nurses, 3 auxiliaries, 1 specialised auxiliary, 1 assistant operator, 9 health physicists, and 9 technicians of health physics.

The average age of the examined group was of 41.6 years, whereas the average working age at a workplace involving risk of exposure to ionising radiation was 13.6 years. The exposure to ionising radiation was evaluated on the basis of analysis of the total dose gathered in the study. The average actual dose was 16.4 mSv.

The ophthalmologic control, conducted as a part of the regular radioprotection programme, included testing of conjunctivae, of the ocular tone by use of applanation tonometry according to Goldman, and of the crystalline lens after mydriasis.

RESULTS

The value of 18 mmHg (2, 3, 8) was taken as a threshold value of ocular hypertonia. The evaluation of the average ocular tone relied on the highest tone value of both

Table 2 *Results of the investigation*

Subjects and wards	Average age	Average working age (years)	Average dose gathered (mSv)	Average ocular tone	Crystalline opacities
All subjects (132)	41.6 (d.s. 8.4)	13.6 (d.s. 7.6)	16.4 (d.s. 42.2)	14.9 (d.s. 1.5)	8
Nuclear medicine (13)	43.0 (d .s. 9.7)	14.8 (d.s. 6.8)	9.5 (d.s. 12.1)	15.3 (d.s. 0.8)	1
Cardiodiagnostic (2)	41.5 (d.s. 12.0)	10.5 (d.s. 0.7)	99.0* (d.s. 140)	14.5 (d.s. 0.7)	0
Radiation therapy (6)	43.0 (d.s. 8.9)	13.1 (d.s. 7.5)	10.5 (d. s. 11.3)	14.7 (d. s. 2.2)	0
Radiology and other wards (111)	41.3 (d.s. 8.2)	13.5 (d.s. 7.8)	16.0 (d.s. 42.3)	14.9 (d.s. 1.5)	7

*one subject was recorded a dose of 198 mSv

eyes for each tested subject. The control recorded all opacities including microopacities of the crystalline lens. However, it was not possible to use a single classification of the microopacities. Table 2 summarises the results of the investigation.

DISCUSSION AND CONCLUSIONS

The incidence of ocular hypertonia in general population aged 30–40 and 70–80 is 1.2% and 10%, respectively. Glaucoma incidence is 0.2–0.5% in general population aged 50–55 and 2% for age over 70 (2). The opacity of the crystalline lens has a prevalence of 5% for ages 40–49 (9).

Contrary to the results obtained previously (3), this study does not confirm the existence of a significant risk of ocular hypertonia in workers occupationally exposed to ionising radiation. In other words, the real levels of occupational exposure to ionising radiation do not have a determining effect on crystalline lens opacity. However, one can not deny the fact that the opacity of the crystalline lens and particularly the rudiments of a real cataract, even if unilateral, found in subjects occupationally exposed to ionising radiation are often associated with that exposure and therefore recognised by the Insurance Institute as occupational disease. Such identification often unjustly implicates lack of both technical and medical preventive measures and is likely to wrongfully damage the employer through insurance coverage.

We believe that it is advisable to maintain ophthalmologic controls within the sanitary protocol on radioprotection for precaution and periodical verification. It is therefore obvious that such control must seek to identify microopacity of the lens. It seems essential to ask an ophthalmologist for a detailed description of possible microopacity, which would evidence probable congenital or acquired origin.

This is why it would be useful to set definitions and a classification of the lens opacities that would be used unequivocally in ophthalmologic control within a radioprotection programme. A five-year interval between controls seems acceptable. A shorter interval may apply for an opacity or microopacity noted earlier, but of uncertain origin and development. Another reason for a shorter interval between controls would be a rare case of direct exposure of the eyes. Our results suggest that it is not necessary to keep up periodical controls of the ocular tone as it does not appear to be affected by occupational exposure to ionising radiation. On the other hand, ophthalmologic controls may focus on other ocular-visual risks associated with the increasing use of imaging techniques which cause greater strain of the eyes.

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Sažetak

OČNA HIPERTONIJA I ZAMUĆENJA LEĆE U ZDRAVSTVENIH RADNIKA IZLOŽENIH IONIZIRAJUĆEM ZRAČENJU

Neke od djelatnosti zdravstvenih radnika još uključuju rizik od potpune ili djelomične izloženosti ionizirajućem zračenju u razinama koje nadilaze granične vrijednosti. Osim različitih stupnjeva od zamućenja leće do katarakte, nova su istraživanja upozorila na mogućnost pojave očne hipertonije i zamućenja leće u profesionalno izloženih osoba. Cilj je ovoga istraživanja bio utvrditi pravu incidenciju očne hipertonije i zamućenja leće u zdravstvenih radnika koji su povremeno izloženi ionizirajućem zračenju. Rezultati pokazuju da nema značajnoga rizika od očne hipertonije u toj populaciji te upućuju na to da zamućenje leće nije značajan pokazatelj izloženosti ionizirajućem zračenju. Bez obzira na to, periodični i preventivni oftalmološki pregledi (svakih pet godina) mogli bi se pokazati korisnima u medicinskom i pravnom pogledu. Naime, ovakva bi kontrola mogla registrirati urođena zamućenja leće u mnogih pojedinaca, što bi isključilo mogućnost neopravdanih zahtjeva za odštetu za profesionalnu bolest zbog izloženosti ionizirajućem zračenju. Osim toga, oftalmološki bi pregledi trebali uzeti u obzir i druge, možda i važnije rizike za zdravlje oka u radiologa kao što je umor oka zbog dugotrajnog naprezanja pri uporabi videoterminala ili ostalih ekrana, odnosno elektrodijafanoskopa.

Ključne riječi:
glaukom, katarakta, oko

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