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# Radiation Cataract after the Chernobyl Catastrophe – Specific Clinical Picture

## Радиационная катаракта после чернобыльской катастрофы – ее специфическая клиническая картина

**Abstract**

Radiation cataract as one of the first biological effect of radiation exposure, recognized as a direct consequence of the ionizing radiation influence.
Total is known about 224 cases of specific radiation cataracts after the Chernobyl catastrophe, 179 cases of specific radiation cataracts observed in dynamics.
Radiation cataract diagnosis was established by a council after careful ophthalmologic examination. Basic method – slit lamp biomicroscopy. Biomicrophotography of lens changes with video recording system and red reflex background photo, the Scheimpflug image analysis examined were applied. A specific clinical picture allows a clear distinction between radiation cataracts and involutionary and complicated cataracts of other genesis. Slit lamp biomicroscopy is the basic method of differential diagnosis of radiation cataracts.
**Keywords:** cataract, radiation cataract, ionizing radiation, biological effect of radiation exposure, differential diagnosis.

**Резюме**

Радиационная катаракта принадлежит к отдаленным эффектам ионизирующей радиации (ИР). Клиническая картина радиационной катаракты является достаточно специфической и может быть клинически отделена от многочисленных других видов помутнений хрусталика. До чернобыльской катастрофы изменения хрусталика при радиационном влиянии считались нестохастическим соматическим эффектом, однако катарактогенная доза для человека не была определена. Новые данные литературы свидетельствуют о появлении типичных помутнений хрусталика при действии в значительно меньших дозах ИР. Таким образом, вероятность регистрации радиационной катаракты в будущем при новых радиационных инцидентах значительно возрастает.
**Цель исследования.** Описать клиническую картину специфической радиационной катаракты, которая развилась у людей, пострадавших от катастрофы на ЧАЭС.



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**Материалы и методы.** В рамках различных исследований было обследовано 16 484 человека, облученных в результате чернобыльской катастрофы (учитывались участники ликвидации последствий аварии первых лет и эвакуированные из 30-километровой зоны). Диагноз радиационной катаракты устанавливал консилиум после тщательного офтальмологического обследования. Основной метод – биомикроскопия с помощью щелевой лампы. Применена биомикрофотография хрусталика и фотография на фоне красного рефлекса. Применялась техника получения Шаймпфлюг-изображения. Специфическая радиационная катаракта (составляет незначительную часть всех случаев катаракты) в этих группах наблюдалась в 226 случаях.
**Результаты и обсуждение.** Радиационная катаракта возникает после длительного латентного периода. Первый клинический признак ее – появление небольшого помутнения под задней капсулой хрусталика, полихроматическая изменчивость. По периферии хрусталика могут появиться точечные помутнения. Достоверный признак радиационной катаракты – появление скопления вакуолей, точечных помутнений между задней капсулой и корой хрусталика. Со временем, по мере прогрессирования катаракты, эти кластеры сливаются в небольшую непрозрачность возле заднего полюса, которая постепенно увеличивается в размерах, становится толще и плотнее.
Используется классификация радиационной катаракты, разработанная в Колумбийском университете. Катаракта первой стадии – зернистое помутнение, резко отделенное от окружающей среды, округлой или неправильной формы, напоминает пористую горную породу. По форме это мениск, сначала он может быть глубокий, затем плоско-выпуклый, затем двояковыпуклый.
Постепенно наблюдается увеличение плотности и объема помутнения. В одних случаях оно начинает напоминать тор, в других приобретает звездную форму. Вокруг него появляется граница с кластером точечных помутнений и вакуолей, которые образуют лучи или полосы, направленные к экватору, они впоследствии могут покрывать всю заднюю поверхность линзы.
Часто, особенно у молодых людей, заднее субкапсулярное помутнение стабилизируется и постепенно выталкивается новыми кристаллическими волокнами глубоко в хрусталик, в кору. В этом состоянии помутнение может сохраняться в течение всей последующей жизни. В других случаях помутнения прогрессируют, их расположение на оптические оси или рядом с ней вызывает относительно быстрое снижение остроты зрения. И только в третьей и особенно четвертой стадии радиационной катаракты уже труднее отличить ее от других задних субкапсулярных катаракт, а в пятой стадии – и от других катаракт.
**Заключение.** Радиационная катаракта имеет характерную клиническую картину, которая позволяет дифференцировать ее от другой патологии хрусталика. В диагностике этой патологии решающее значение имеют результаты биомикроскопии хрусталика.
**Ключевые слова:** катаракта, радиационная катаракта, ионизирующее излучение, биологический эффект радиационного облучения, дифференциальная диагностика.

## ■ INTRODUCTION

Radiation cataract as one of the first biological effect of radiation exposure, recognized as a direct consequence of the ionizing radiation influence [1, 2]. In 20th century it was believed that radiation cataract occurrence is possible only if irradiation dose is at least 2 Gy or more. Before the Chornobyl catastrophe, changes in the lens during radiation exposure were considered to be non-stochastic somatic effects [3, 4]. Results of the studies in recent years have contradicted these assumptions: a lot of literature data appeared the registration of typical lens opacities with significantly

lower doses [5–7]. The results of the accident at the atomic power station in Chornobyl significantly worsened about the widening [8–9]. Thus, the probability of its registration in the future, after the new radiation accidents, increases significantly.

But, since the basis of the diagnosis of radiation cataracts is its extremely specific clinical picture, in this paper we will focus on these issues. Therefore, in this report, we would like to describe the clinical features of radiation cataracts that were observed after the Chornobyl catastrophe.

## ■ THE AIM OF THE WORK

Describe a clinical picture of a specific radiation cataract, that developed in persons affected by the CHAES disaster.

## ■ MATERIALS AND METHODS

Within various studies, there were examined 16,484 persons, irradiated as a result of the Chornobyl disaster, among them 11 214 Chornobyl clean-up workers and 5270 persons, that were evacuated from zone of estrangement of Chornobyl nuclear payer plant. These groups of survivors of Chornobyl disaster numbers are smaller than residents of radiation contaminated areas [10, 11], their received larger doses of radiation [12, 13].

Radiation cataract diagnosis was established by a council after careful ophthalmologic examination. Basic method — slit lamp biomicroscopy. Biomicrophotography of lens changes with video recording system and red reflex background photo were applied. Same patients in the slitlamp camera system based on the Scheimpflug principle with image analysis examined (the Scheimpflug principle is a geometric rule that describes the orientation of the plane of focus of an optical system (such as a camera) when the lens plane is not parallel to the image plane).

Total in these cohorts known 226 cases of specific radiation cataracts (a small part of all cataracts) after the Chornobyl accident, 179 cases of specific radiation cataracts observed in dynamics.

To assess the stage of radiation cataracts, we used the classification of Columbia University [1]. According to that classification:

1 stage – discrete opacity which can take the form of a small spot readily discernible with retroilluminated light; aggregates of dots (>10) or vacuoles (>5), cortical spokes, granulated opacities;

2 stage – more extensive cortical changes collectively occupying 25% of the noted area of the lens;

3 stage – advanced changes. Light does not reach vitreous;

4 stage – premature cataract;

5 stage – mature cataract.

## ■ RESULTS AND DISCUSSION

The radiation cataract to occur after a long latency period. The first clinical sign of radiation cataract is the appearance of a small haze under a back capsule of a lens, polychromatic variability. At the periphery of the lens may appear point opacities.

With reliable sign of radiation cataract is the appearance of cluster of vacuoles, point opacities between posterior capsule and cortex of the lens.

Over time, with the progression of cataract, these clusters merge in small opacity near the posterior pole, which gradually increases in size, becomes thicker and becomes denser.

First, the cataract is a cellulose, sharply separated from the environment, round or irregular form of opacity, which is somewhat reminiscent of porous mountain rock. In form, it is a meniscus, at first it may be deep-bumped, then flat-bumped, then double-convex. In fig. 1 the stage I of radiation cataract in red reflex background photo presented, in fig. 2 the stage I of radiation cataract in Scheimpflug image presented.

Gradually there is an increase in the density and volume of opacity. In some cases, it begins to resemble a torus, while others acquire a stellar form. Around it there appears a border with a cluster of point opacities and vacuoles that form rays or bands directed toward the equator, and may subsequently cover the entire back surface of the lens.

The transition from the first to the second stage of radiation cataracts is presented in fig. 3. Often in the second stage, radiation cataract resembles a pancake with a translucent center (fig. 4).

Later, may appear a central opacity under an anterior capsule, consisting of a cluster of point opacities and vacuoles, and never reaches intensity such as opacity at the posterior pole (fig. 5).

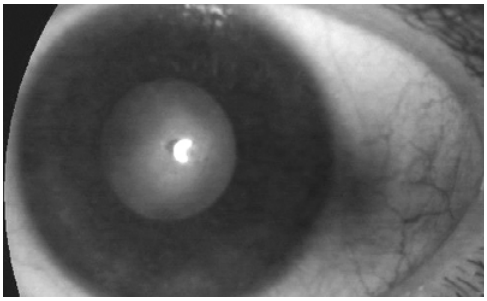

**Fig. 1. First stage of radiation cataract in red reflex background photo**

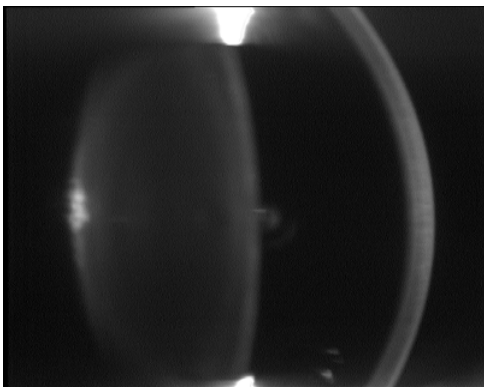

**Fig. 2. First stage of radiation cataract in in Scheimpflug image**

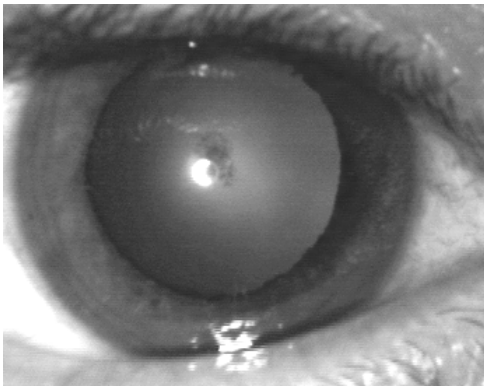

**Fig. 3. Transition from the first to the second stage of radiation cataracts, against the background of a red reflex**

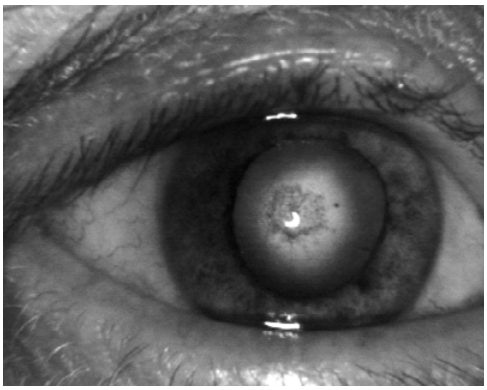

**Fig. 4. The second stage of radiation cataracts, against the background of a red reflex**

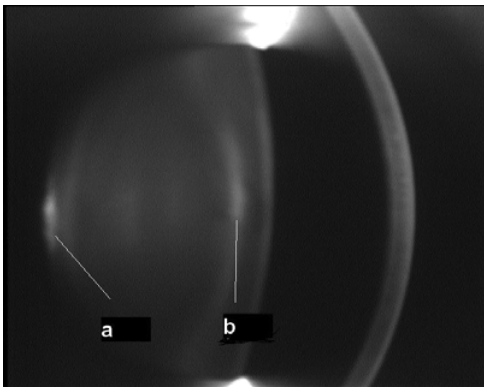


**Fig. 5. Posterior (a) and anterior (b) opacities, radiation cataract in Scheimpflug image**

Often, especially in young people, most of the damaged fibers move from the equator to the poles of the lens, the posterior subcapsular opacity stabilizes and is gradually pushed by new crystalline fibers deep into the lens, into the bark. In this state, turbidity can remain during the next life [9].

In other cases, clouding progresses, their location on or near the optical axis causes a relatively rapid decrease in visual acuity. It is important in cases where ophthalmoscopically there is no foveoly zone, immediately direct patients to operative treatment. The reason for this is the need for constant monitoring of the condition of the macular zone, the lesions of which in radiation-irradiated we reported [14, 15]. Late detection of macular lesions adversely affects the effectiveness of treatment of wet macular degeneration [16, 17].

In the third (fig. 6, 7) and especially the fourth stage of radiation cataracts it is difficult to distinguish it from other rear subcapsular cataracts.

The most difficult is the differential diagnosis of a complicated cataract, which arises in some chronic diseases of the eye – iridocyclitis, uveitis,

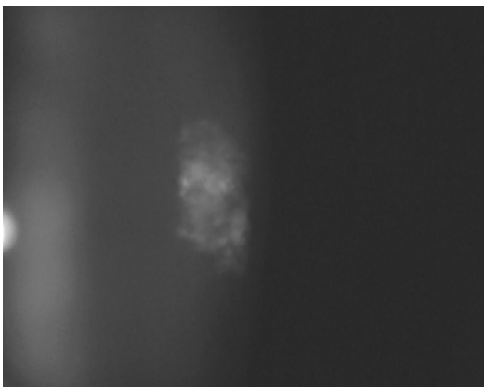

**Fig. 6. Transition from the second to the third stage of radiation cataracts, in the light of a slit lamp**

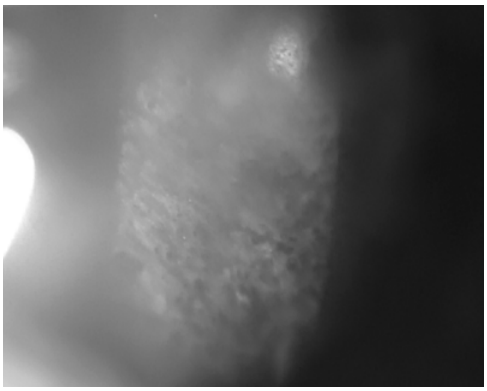

**Fig. 7. The third stage of radiation cataracts, in the light of a slit lamp**

pigmentary degeneration of the retina and others like that . The earliest biomicroscopic sign of complicated cataracts is the appearance under the back capsule in the region of the posterior pole of the lens of the polychrome variability. Then in the back of the cortical substance there is opacity, at first very soft, and over time they thicken, and the cloudy area in general becomes spongy, porous appearance. Then in the back of the cortical substance appear opacities, at first very soft, and over time they thicken, and the cloudy area in general becomes spongy, porous appearance.

Separate opacities are not severed apart from each other, but as if immersed in a diffuse mud. Opacities move in two directions: a) forward to the kernel and b) in the direction of the seams, thus is created a stellar form of opacity. Unlike radiation cataract with complicated cataract, there is no sharp distinction of differentiation of opacity from the other part of the lens.

It should be remembered about the possibility of simultaneous development of various types of acquired cataracts, the development of radiation cataracts or radiation and age cataracts simultaneously on the background of congenital cataract. Thus, at the same time, 2 or 3 diagnosis of cataracts of different etiology can be established when one eye is examined.

No determine the duration of the latent period were analyzed cases of radiation cataract detection during repeated examinations of patients with previously transparent lens. Continued observation revealed that the last reported case was detected 29 years after the officially confirmed radiation exposure. Consequently, the latent period of radiation cataract can exceed 29 years [18].

## ■ CONCLUSION

A specific clinical picture allows a clear distinction between radiation cataracts and involutionary and complicated cataracts of other genesis. Slit lamp biomicroscopy is the basic method of differential diagnosis of radiation cataracts.

**The authors declare no conflict of interests.**

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