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# Cataracts as an adverse effect to the use of radiations

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## Abstract

Radiation therapy is the treatment based on ionizing radiation in order to kill cancer cells and reduce tumors, but it presents different adverse reactions at the place of exposure, in case of having received radiotherapy at the ocular level, the different ones will be affected structures, including the lens, this is an organ very sensitive to radiation, so it develops cataracts or opacities, the appearance of these opacities depends on the dose of RT administered, the area where the therapy is received, the scheme with which it is supplied, and other factors dependent on the patient.

**Keywords:** Cataracts; Radiotherapy; Eye; Radiation

## 1. Introduction

Currently there are many artifacts that have improved the quality of life of the population, just as in the field of health there have been many advances that improve life expectancy, diseases that were previously considered fatal, among them we can find the cancer that due to the invention of chemotherapy and radiotherapy today have a better prognosis [1].

Radiotherapy is a clinical specialty in charge of treatment based on ionizing radiation in order to destroy cancer cells and reduce tumors, being used for the first time for therapeutic purposes in 1899, they weaken the individual and secondary effects may appear at the ocular level or other systems [2].

In recent decades alterations at the ocular level have been documented, especially lens opacities in populations exposed to doses of ionizing radiation in this group, we can find in patients who have undergone CT tests, Radiological Technicians and Doctors, patients undergoing Radiotherapy, people exposed atomic bombs or nuclear accidents, astronauts. These documented opacities refer to an entity called cataracts [3].

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## 2. Methodology

This is a study aimed at a narrative review, it was carried out through the selection of original articles, a review of available research, written in English and / or Spanish, through recognized databases such as PubMed, scielo, science direct, Wiley, plos one. Regardless of its year of publication, using the search terms cataracts, crystalline, radiation, radiotherapy. No search criteria were established for a defined language; however, all articles containing the corresponding information and of great importance for conducting our review were selected.

## 3. Results

The lens is a biconvex and transparent structure, located in the posterior chamber of the eye, posterior to the iris, it is held by the ciliary body by the zonule. It is made up of enucleated cells and elongated fibers organized in concentric layers surrounded by a thin and transparent capsule, where exchanges are carried out by diffusion (Figure 1). [7-16] This structure performs relevant functions for ocular dynamics, it provides convergence power to the eye, to focus images on the macula, another of its functions is due to its bulging character when it is not stressed by the zonule, which gives way to the phenomenon of accommodation. The lens is a very sensitive organ and presents pathological alterations, among which we can highlight cataracts [4].

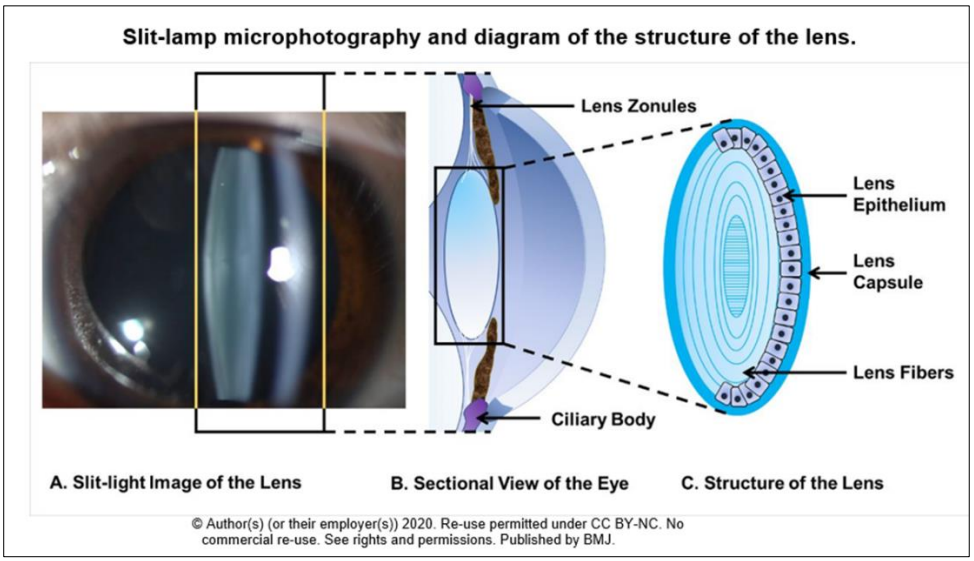


**Figure 1** Slit lamp photomicrograph and lens structure diagram. (A) Slit lamp photomicrograph of the eye after mydriasis. The biconvex shape of the lens is clearly visible. (B) The diagram of the sectional view of the square part in Panel A. (C) The cellular structure of the lens

Cataract is a partial or total clouding of one or more layers of the lens, which can cause reduced visual acuity and visual disturbances when it reaches a greater compromise. This pathology presents a clinical picture characterized by multiple functional signs and symptoms, which will vary depending on the location and density of the opacities [5].

The most classic warning sign is the deterioration of visual acuity, generally it develops slowly and progressively, particularly affecting distant vision, it is usual to find the patient manifesting a sensation of visual fog or veil. There are other symptoms such as photophobia that is defined as an exaggerated susceptibility to light, either during night driving of vehicles, the perception of light halos with a sensation of dazzling, generally in sunlight or while driving, myopia which is associated with an alteration of the refractive index of the affected lens [6].

In the different literatures it is described that there are predisposing factors to develop cataracts, such as age, exposure to sunlight, radiation exposures, alcohol and nicotine consumption, metabolic diseases such as diabetes and use of corticosteroids [7]. The etiology of lens opacities is not fully understood, it has been mentioned that it may be multifactorial. Among the different origins we find congenital, senile, metabolic, toxic cataracts, due to trauma, it has also been established that exposure to ionizing radiation is a cause [8].

Cataracts, as adverse effects of radiotherapy (RT), are justified as a lesion caused by RT in the epithelial cells of the germ zone of the lens, causing cell death accompanied by compensatory mitosis and cells with opacity in the posterior capsule, due to the location of the chlorine channels found in the epithelial cell membrane, therefore the mechanism of action is completely modified (Figure 2) [9].

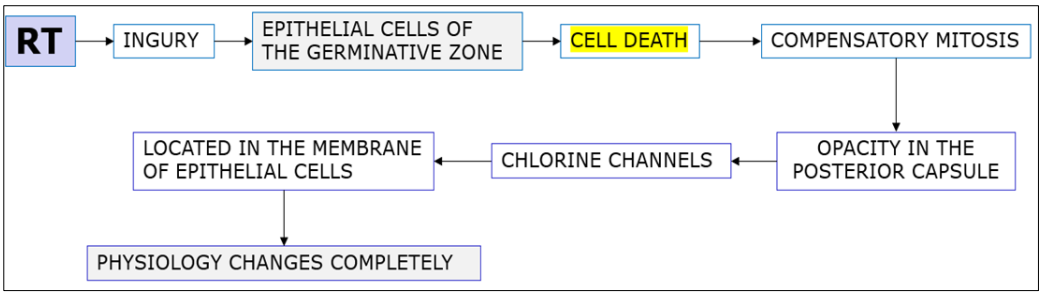


**Figure 2** Mechanism of injury of the crystalline

The incidence of cataracts is 40 and 50% of patients undergoing radiation treatment, it is generally associated with the portion of the lens that received radiation, even opacities develop when less than a quarter of said structure is irradiated, on the other hand establish incidence based on volume is complex because it is a very small structure, apart from ocular RT they are focused and very precise [10]. the severity of radiation-induced cataracts will depend on the dose delivered and its time onset is inversely proportional, that is, the higher the dose, the shorter the onset time [11]. The minimum tolerance dose (TD 5/5) is 10 GY, which indicates that the organ has a 5% probability of developing the disease and the maximum tolerance dose (TD 50/5) is of 18 Gy, this structure has a 50% probability of developing cataracts 5 years after RT [12]. Radiation dose fractionation plays an important role because it reduces the probability and delays the appearance of lens opacity [13,14].

The diagnosis of cataract is mainly clinical, an exhaustive physical examination should be done in patients with suspected cataracts, the physical examination begins with the evaluation of visual acuity, which may be impaired, and upon examination the pupils will be normoreactive, preserving both to photomotor stimulation as consensual [14]. A biomicroscopic examination should also be performed, which aims to determine the location and intensity of the opacification [15].

The management of cataracts is purely surgical because there is no pharmacological treatment for this, the standard treatment is the surgical extraction of the opacified lens and the implantation of an artificial intraocular lens (IOL) [16].

## 4. Discussion

The use of radiotherapy in the management of cancer raises concern for the medical community, due to the need to avoid the development of complications in healthy irradiated structures. The appearance of these can be early or late, depending on the dose. A study was carried out that followed up 40 patients in the context of a direct anterior beam orbital lymphoma, which showed the incidence of cataracts secondary to radiation depending on the doses (20-40 g and in 2 g fractions), the appearance of said disease occurred between three and nine years after RT, they also documented that in doses lower than 5 Gy, no opacity was observed, on the contrary, in patients who were administered doses greater than 16.5 Gy developed opacities. Other documents determined that the fractionation of the dose plays a key role in reducing the risk of cataracts, all this based on a study carried out on 277 people, where it was highlighted that 70% of the patients who did not divide the dose developed the disease, Compared with the patients who had the dose divided, only 18% had opacities.

## 5. Conclusion

Radiotherapy in recent years has positioned itself as one of the treatments of choice in neoplastic pathologies, due to its effectiveness. On the other hand, there is the fact that exposure to ionizing radiation triggers complications in many structures, being the case of the lens, which is a very sensitive organ to RT, since it develops long-term side effects which threaten vision, The most frequent alterations in said lens are opacities or cataracts, which causes a decrease in visual acuity.

The development of cataracts will depend on many factors such as age, metabolic diseases, uncontrolled exposure to ultraviolet rays, there are also factors inherent to the treatment such as the radiation dose, whether it is fractional or not, the percentage of the structure that irradiated. , among others.

Today there have been relevant advances and the application of protocols that aim to increase the percentage of patients treated successfully and at the same time reduce the risk of complications, however, it is recommended that after RT a strict follow-up with ophthalmology is carried out.

## Compliance with ethical standards

*Disclosure of conflict of interest*

The authors declare no conflicts of interest.

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