

Technical Papers

Atom Bomb Cataracts¹

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At the suggestion of the Committee on Ophthalmology of the National Research Council, a survey has been undertaken to determine what, if any, late ocular effects have resulted from the atom bombings in Japan. The undertaking was prompted in considerable measure by the recent discovery of cataracts in cyclotron workers. The survey is being currently carried out under the auspices of the Atomic Bomb Casualty Commission, and the present communication is a preliminary report on ten cases of cataracts which are believed to have been caused by the atomic bombs.

Nine of the patients were exposed at Hiroshima and one of the patients at Nagasaki. All were said to have had normal visual acuity prior to the bombing and for some time afterward. Seven were males and three were females. The ages at the time of the exposure were 13 to 55 years. All were within 550 to 950 meters of the hypocenter at the time of the explosion. Three were standing in the forward part of a streetcar next to each other, four were in wooden houses roofed with tile, one was crouching behind a wooden building, one was walking in the street, shielded by the plaster wall of a building, and one is not known to have had any shielding. Two had thermal burns of the profile type (that is, due to radiant heat); all had epilation of the head after a latent period of one to four weeks, with complete baldness lasting three to seven months. Six vomited on the day of the explosion, and eight had symptoms one to three weeks after the explosion consisting of fever and malaise, with vomiting and diarrhea in five and petechiae in five. One developed a sloughing lesion of the buccal mucosa and another a localized necrosis of the cheek with perforation. Whether these were due to radiation sickness or to the insanitary conditions prevailing at the time could not be determined. One of the three female patients has had amenorrhea since the exposure and the other two began their menses at ages 17 and 19, approximately three years after the exposure.

The only ocular complaint of the patients was failing vision. In one patient, the onset of subjective visual symptoms was said to have been as early as one month after the bombing, but the patient was in an apprehensive mental state at the time and it is by no means certain

that this initial complaint was owing to incipient cataracts. The latent period of visual symptoms was 6 months in one patient, 2½ years in one patient, and 2½ years in four patients. Three patients had no ocular complaints. The failure of vision was said to have been either gradual or stepwise and fluctuant in the seven patients, one of these patients having thought some improvement followed each loss. Three of the patients had been seen by Japanese ophthalmologists and recognized as having cataracts due to radiation: two by H. Ikui and one by K. Hirose.

The cataracts consisted of opacities in the axial zone of the posterior lenticular capsules over an area of 2 to 4 mm, with occasional punctate dots farther toward the periphery. The findings were approximately symmetrical in the two eyes. The central opaque disks had jagged but nevertheless relatively sharp edges. In the five patients in whom the changes were most marked, the peripheral portions of the opaque disks were denser than the central portions, forming doughnut-shaped opacities when examined with the ophthalmoscope. With the slit-lamp biomicroscope the opacities were of a lace-like texture, having a few polychromatic crystals and a few vacuoles. The opacities were confined to the posterior capsules, with no apparent extension into the underlying cortex, but the vacuoles were situated just in front of the capsules. In the two most advanced cases there was a distinct separation of the opacity centrally into two laminae from front to back, with a relatively clear interval between them. Toward the periphery of this central disk the two laminae fused to form the denser ring that had given rise to the doughnut-shaped opacities seen with the ophthalmoscope. In the less advanced cases, which did not show the doughnut configuration, the central portion showed an opacification of the whole thickness of the posterior capsule similar to the peripheral portion of the disk in the more advanced cases. Thus it appears that progression of these cataracts is accompanied by a separation of the central opacity by a clear interval and an extension of the unsplit opacity toward the periphery. The anterior capsule also showed a few punctate dots in seven of the patients and an occasional vacuole in three. The lens cortex and nucleus, however, was entirely clear in all cases.

The cataracts are considered to be similar to those which have previously been associated with exposure to x-rays and gamma rays (1). What part neutrons played in their pathogenesis is not evident. The patients were in a zone where neutrons and gamma rays were present, although information on the amounts of each is not accurately available. Most persons in this zone died either from thermal or mechanical injuries or from radiation sickness. That these persons survived and developed cataracts may be attributed simply to biologic variations; but it cannot be reasonably denied that

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whereas the cataracts resulted from exposure of the head region, the absence of lethal radiation disease may have been owing to a shielding of much of the rest of the body. Five of the patients had very little, if any, radiation sickness, and the symptoms in the others may not have been caused by the radiation. Yet all of them had profound epilation of the head, which was undoubtedly a radiation effect. It is possible that the three standing in front of the streetcar were protected in the lower halves of their bodies by the metallic baseboard below the car windows.

The frequency of atom bomb cataracts now, or to be expected in the future, cannot be stated at present, since practically all the cases of cataracts here cited were discovered through highly selective methods. However, it may be noteworthy that 1000 persons, believed to be a cross section of the survivors, who were within two kilometers of the hypocenter and in the open (including 16 persons within one kilometer), were examined and no case of radiation cataract was found. (Although all these persons were out of doors at the time of the explosion, the amount of shielding by buildings, posts, other persons, etc. could not be satisfactorily determined.) Among an additional 231 persons within one kilometer of the hypocenter, who were either in the open or in wooden buildings at the time of the explosion, there were found five cases of radiation cataracts (included in the ten mentioned above).

Reference

1. ROHRSCHEIDER, W. *Arch. Augenheilk.*, 1932, **106**, 221.

Cyclotron-induced Radiation Cataracts

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Although it is impossible now to make a complete or final report on the cyclotron-produced radiation cataracts, it seems desirable to publish a preliminary survey of the situation as it now appears. This survey should serve as another warning to research personnel and administrators in the field of high energy particles and it also should serve to indicate how large is the area of ignorance regarding radiation effects on higher organisms.

Early in December 1948 it became known that at least five nuclear physicists of average age 31 were afflicted with incipient cataracts. An *ad hoc* committee set up by the Division of Medical Sciences of the National Research Council arranged for questionnaires to be sent to all the high voltage laboratories of the country where comparable exposure risks might have been incurred, and a considerable body of preliminary data became available by this means.

Arrangements were made to bring together as many as possible of the afflicted men, along with a few other especially qualified and interested individuals, to discover

and compare if possible the common denominators of their experience and to make careful comparable medical examinations. A meeting was held in Washington, D. C., January 16 and 17, 1949, under the auspices of the Division of Medical Sciences, National Research Council, with the support of the U. S. Atomic Energy Commission. On January 18, eleven of these men were examined at the Wilmer Ophthalmological Institute, Johns Hopkins School of Medicine, by Drs. Alan Woods, Jonas Friedenwald, and Algernon Reese, who concurred in the following findings:

1. Ten of these patients showed opacities in the lenses.
2. The patients fell into three general groups as follows:

Group A (3 men): All showed severe changes in the posterior cortex of the lens, consisting of thick saucer or disk-like opacities, together with slight subcapsular or anterior cortical haze. The capsule and nucleus of the lens were clear, and there was no other pathology found in these eyes (except postoperative changes in one individual). In all vision was reduced.

Group B (4 men): Slight to moderate changes in the posterior cortex of the lens. These changes consisted in whitish opacities with a definite tendency to saucer or disk-like formation, in the milder cases accompanied by a golden reflex and occasionally by slight iridescence. Again there was occasionally slight haze in the anterior cortex, and a few vacuoles. The media and capsules were clear, and there was no other pathology in the eyes. In these men, vision was either normal or only slightly reduced.

Group C (3 men): Minimal, insignificant, and doubtfully relevant changes. The findings consisted in a thin lacy opacity in the posterior cortex and occasional punctate dots, and capsular iridescence. The thin lacy opacity, when observed, lay in the posterior cortex with a suggestion of disk formation, which made it a little suspicious. There was, however, considerable doubt in the minds of all three examiners whether these slight changes were definitely pathological. There were no other changes observed in these eyes.

3. All the observed changes followed the same general pattern, showing different degrees of severity. Furthermore, this common picture conforms to the general picture of roentgen-ray and radium cataracts. In the absence of other recognized causes, and with the common denominator of exposure to cyclotron irradiation, it appears logical to attribute these lens opacities to this cause.

Table 1 summarizes the experience of these men.

The men are listed in the table in the order of severity of symptoms. The first three men have what can be termed a severe handicap. The next four are afflicted to a degree which does not at present interfere markedly with daily life. The remaining three have a minimal affliction which does not cause appreciable handicap. It was noted, however, that the severe cases did not fully develop until about three years after the radiation was received. Hence, some of the men may in the future show a more severe pathological condition arising from radiation already received. Since there has been no evidence of damage to the retina, it would appear that there is a good prognosis for successful surgical intervention in the severe cases. Indeed, in the interval between January and July 1949, cataracts were successfully removed from two of the individuals concerned. Thus, it