THE BRITISH JOURNAL

OF

OPHTHALMOLOGY

SEPTEMBER, 1934

COMMUNICATIONS

IRRADIATION CATARACT

BY

J. G. MILNER

LONDON

Introduction

IT has been known for many years that the lens of the eye undergoes chemical and physical changes as a result of the passage through it of spectral rays. These changes become visible as cataract.

Cases of cataract due to exposure of the lens to infra-red rays have frequently been reported, and have occurred, industrially, in glass-workers, iron-workers, tin-workers, and chain-workers. The question was deliberated by the Cataract Commission in 1928, and the lens changes were attributed to heat rays.

Lens opacities following exposure of the eye to ultra-violet light are very rare, but cases have been reported.

Cataract following radium and deep X-ray therapy, if applied near the eye, has also been recorded, but has not received the attention it deserves. In recent years radium has been used much more extensively as a therapeutic agent, and deep X-rays are frequently employed in the treatment of pituitary tumours, or in neoplasms of the nose and accessory sinuses. In this deep X-ray therapy a large quantity of rays passes directly through the eyes.

This paper is devoted to a consideration of cataract caused by radium and X-rays. Infra-red and ultra-violet ray cataract will not be discussed.

History and Literature

X-ray cataract.—X-rays were discovered in 1895, and since then various investigators have produced lens changes in rabbits by exposing the eyes to these rays.

Clapp,[1] in a recent paper, gives a list of references of such experiments, and no further mention of them is necessary here, except to record that the site of the opacities was the posterior cortex of the lens, and that the latent period varied between 165 and 325 days in one series (Peters).

Recorded cases of X-ray cataract in man are uncommon. The first case reported in English literature was that of Paton,[2] in 1908. Paton's case was a woman, aged 32 years, who had lupus of the cheeks treated by X-ray therapy. Her sight began to fail nine months later, and two years after treatment the sight of one eye was very much affected.

In 1911 Stock[3] reported the case of a woman prematurely delivered of triplets as a result of X-rays; the lens of each foetus showed cortical changes.

Jess,[4] in 1929, recorded two cases. One had deep X-ray treatment for a nasopharyngeal tumour, and the other for a pituitary tumour. In both cases the cataract was post-cortical, and was discovered more than three years after treatment.

In 1931 Foster Moore[5] read a paper before the Ophthalmological Society, in which he described X-ray cataract occurring in a young man who was the subject of sycosis of the face and scalp. For this disease he had received, as treatment, a dosage of 12 Sabouraud units in five months. Two years later the sight began to fail. Both eyes were involved. Foster Moore stresses the site of the changes, which appeared in the lens substance, close to the posterior capsule. After removal of the lens by discission, the original pattern of the opacity was outlined on the posterior capsule. A drawing of this cataract is shown in Fig. 1.

In the discussion following this paper, Mayou said he had shown a case of exophthalmic goitre to the Society a few years previously, and this case had developed cataract following X-ray treatment for the goitre. Mayou also pointed out that in the early days of X-rays many operators had been exposed to the rays each day; some developed telangiectases on the skin, and others got cataract. Mayou suggested, as a cause of the cataract, that the cells lining the anterior lens capsule were killed by the rays. In the same discussion, Treacher Collins said that two years previously he had brought to a meeting of the Society Dr. Critchley,

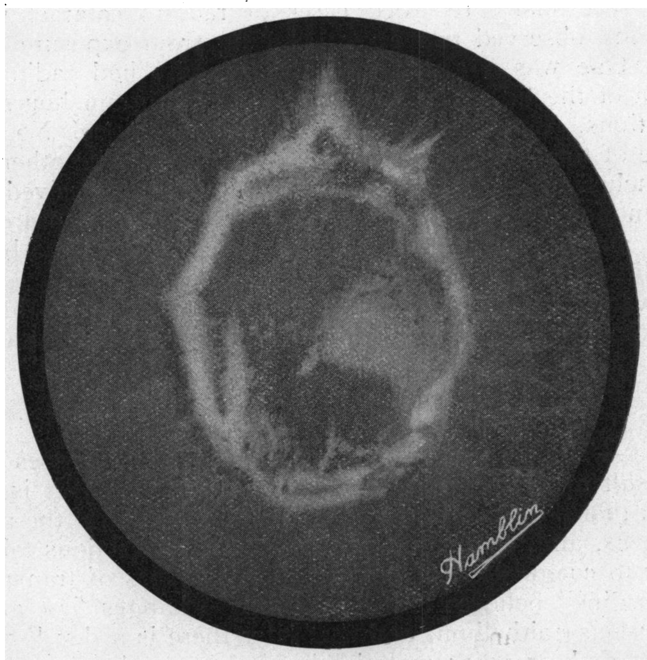

FIG. 1.

an X-ray worker. Dr. Critchley had developed post-polar cataract. Collins mentioned Erggelet,[6] who reported several such cataracts in X-ray workers.

Other observers have recorded cases, and for a full reference the reader should consult Clapp's paper.[7]

Radium cataract.—Experimenters have succeeded in producing cataract in rabbits by exposure to radium. In a series of investigations by Peters, quoted by Clapp,[8] the dose varied between 160 and 640 milligram hours, and the latent period between 90 and 260 days.

Some observers claimed to disperse lens opacities by radium treatment. Franklin and Cordes[9] treated 31 cases with incipient cataract by radium in amounts varying from 25 to 200 milligram hours; they claimed that 84·3 per cent. were improved. S. Withers,[10] in reviewing the indications for radiation therapy in ophthalmology, quotes Cohen and Levine who stated that in incipient cataract, lens opacities may diminish under the influence of radium. I think ophthalmologists are agreed that lens changes result from irreversible chemical changes, and I do not believe that radium, or any other agent, can have any permanent beneficial effect upon these chemical reactions.

There are many recorded cases of radium cataract in man. Robinson[11] observed two cases resulting from exposure to large doses. One was a girl, aged 6 years, who had radium for a sarcoma of the lid. The dose was 3,000 milligram hours in two applications. Three years after, the lens was opaque. No mention is made of the type of opacity which resulted. The other case is less conclusive. A middle-aged, diabetic woman received radium treatment for a rodent ulcer of the lid. Cataract appeared later, but the author admits that the lens changes may have been due to conditions resulting from diabetes.

Blegvad[12] reported four cases, and de Schweinitz[13] three. In one of the latter, the opacities were beneath the anterior capsule.

Morphology and Pathology

Cause.—The exact process whereby the lens undergoes changes as a result of irradiation has not been determined. It is agreed, I think, that the opacities are due to a disturbance of the nutrition of the lens, and, as a result of this, chemical reactions take place leading to coagulation of lens proteins and loss of transparency.

Desjardins[14] believes that degenerative changes first affect the anterior lens epithelium, and that later there is a development of vacuoles and granular material in the deeper layers. Mayou's view is similar.

Stallard[15] suggests that the defective nutrition of the lens is dependent upon damage of the capillaries of the ciliary body; there is vasodilatation and hyaline degeneration in neighbouring tissues, and the cells of Rouget in the capillary walls become paralysed.

I agree with Stallard's suggestion, and such changes in the capillaries of the ciliary processes are analogous to those taking place in the skin in the formation of telangiectases. Further, it may be pointed out that there is an individual variation in the effect of X-rays upon the skin. Some people are more likely to develop telangiectases than others, and there seems no reason why a corresponding individual variation of radio-sensitivity of the lens should not be assumed. This would help to explain differences in latent period, slight modifications in the structure of the opacities, and occasional cases of apparent immunity.

Situation and type of opacity.—There is no doubt that the site of election of this form of cataract is the posterior cortex, close to the posterior capsule. Both infra-red and ultra-violet cataracts occur in the same situation. In nearly all cases in the literature, and in all those that I have been able to collect, some of which I have watched from early stages, the posterior cortical region has been primarily affected.

To my mind the appearance of this sort of post-cortical cataract differs, quite definitely, in ophthalmoscopic picture, from that of a post-cortical cataract of other aetiology. For the purposes of description, it is convenient to divide the alterations taking place in the lens into four stages. This division is quite artificial, and stages 1 and 2 are usually seen together.

Stage 1.—The formation of vacuoles.

Stage 2.—The appearance of fine spots and feathery lines between and around the vacuoles. These spots and lines are rather cloudy of outline and difficult to distinguish individually. New vacuoles begin to extend further forward in the lens, and the posterior part of the opacity becomes more cloudy.

Stage 3.—The formation of a central posterior plaque, which is roughly circular in outline. The rim of this plaque is always slightly more dense in appearance than the remainder. The cloudy areas become thicker round the plaque, and the spots, lines, and vacuoles extend forwards and equatorially.

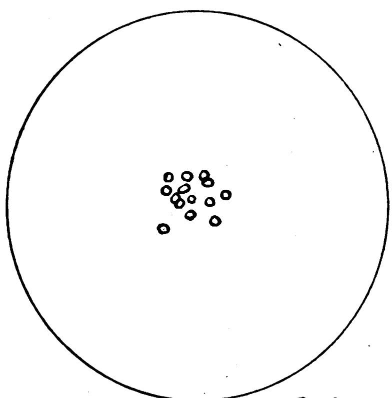

Fig. 2

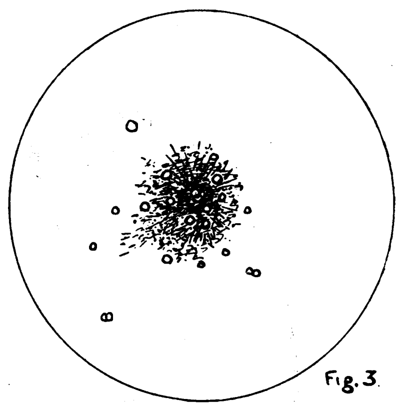

Fig. 3

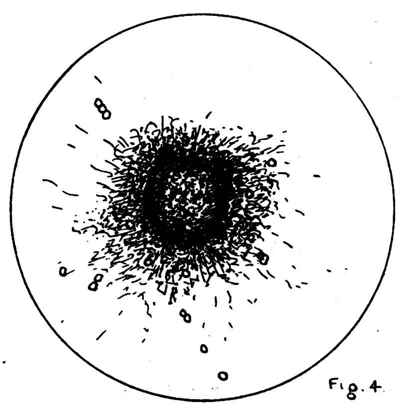

Fig. 4

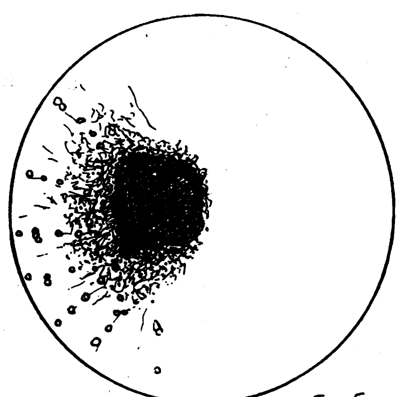

Fig. 5

Stage 4.—The whole lens becomes less transparent, and the distinctions of Stages 1, 2 and 3, less obvious. At this time ordinary senile cortical striae make their appearance in some cases.

I have endeavoured to show the changes, such as I have described, in the figures below.

Fig. 2 shows the first stage with a few post-cortical vacuoles. When examined with a slit-lamp, the vacuoles are found to be not quite circular. This feature was first noticed by Foster Moore.

Fig. 3 shows the spots and cloudy lines, and fresh vacuoles extending towards the equator. I have noticed vacuoles under the anterior capsule at this stage.

Fig. 4 gives an idea of the shape and form of the plaque. Around it the cloudy areas can be seen, and vacuoles and lines are visible coming forward.

Fig. 5 is included to show that the cataract is not always quite central. It also shows the vacuoles extending radially forwards. All the opacities in this case were confined to the inner side of the lens. This drawing was made from the left lens of case 16 of my series; Fig. 2 was from the right lens of the same patient.

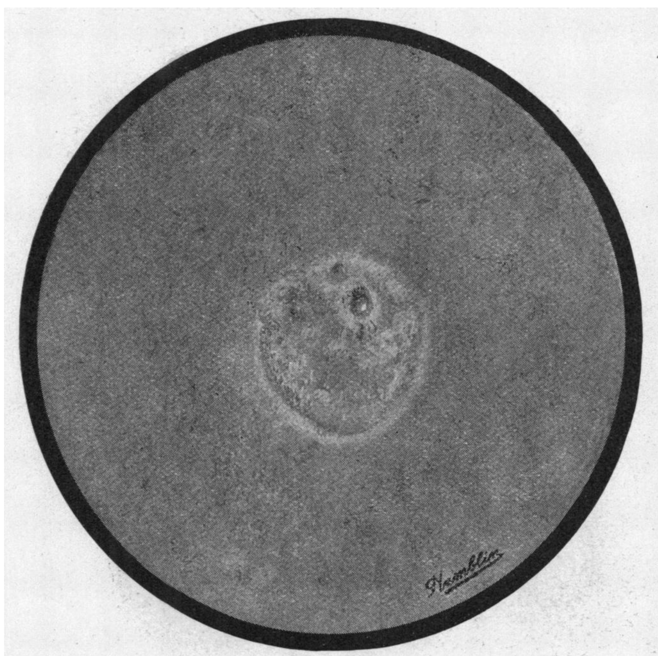

FIG. 6.

Slit-lamp appearance of plaque. Actually the plaque was highly refractile, and its crystalline structure well seen, but it is not shown in the figure.

On examination with a slit-lamp, the plaque is found to be highly refractile, and to contain large numbers of crystals. A slit-lamp drawing of a plaque is shown in Fig. 6, which is from the left eye of case 11.

The above description applies to the majority of irradiation cataracts. I am inclined to think that plaque formation is an

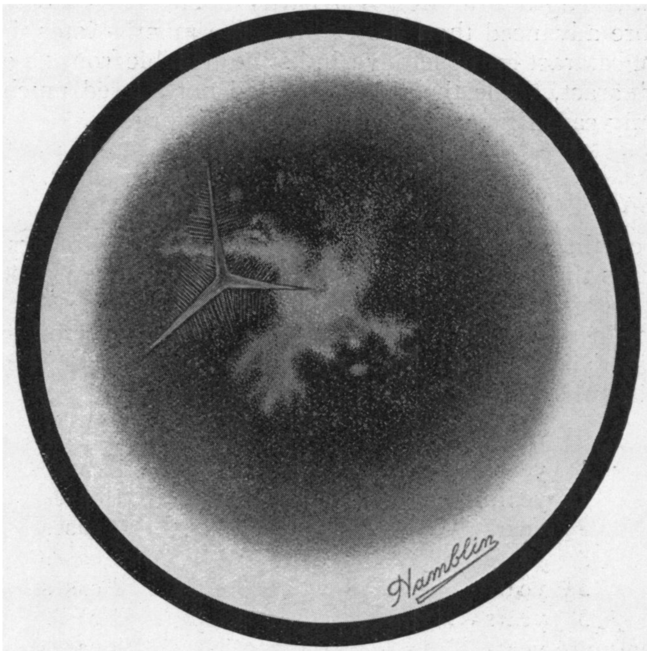

FIG. 7.

An atypical X-ray cataract. The posterior plaque is very irregular in outline, and is lacking a rim. Cloudy areas and vacuoles were present, but are not shown because they were further forward in the lens substance.

earlier phenomenon in X-ray cataract than in radium cataract, unless the dose of the latter is very large. Sometimes the more dense posterior area does not form a typical plaque; instead there is an indefinite pattern. This is shown in Fig. 7, which was an X-ray cataract (case 7). There were some vacuoles in this case, but they are not shown in the figure. The patient was 33 years of age.

Later stages consist in the formation of opaque patches in the anterior parts of the lens. Then the changes described above are masked. These later alterations may occur very rapidly. Case

3 is a good example. This was a woman, aged 52 years, who had a course of deep X-ray therapy from December, 1930 to January, 1931, and a second course from June, 1931 to July, 1931. She was suffering from a myeloma of the left maxilla. In May, 1932, Mr. Rupert Scott made the important note that the media were clear in each eye. I first saw the woman in May, 1933. She then had typical early irradiation cataracts (stage 2), and vision was Right 6/9, Left 6/9 partly. The left cataract was a little more advanced than the right. Five months later there was a mature cataract in the left eye, indistinguishable from an ordinary senile cataract, while the right lens had not altered much. This is the only case I have with such a rapid history.

Latent Period

One of the outstanding features in the study of irradiation cataract, is the length of time which expires between exposure to radiant energy and the formation of cataract.

Clapp, in the paper to which I have already referred, collected 38 cases of irradiation cataract from the literature. The latent period in this group was as follows:—

9½ months	1 case
1 year	1 case
1½ years	1 case
2½ years	2 cases
3 years	3 cases
3½ years	2 cases
5 years	3 cases
6 or more years	5 cases

In the remaining 20 cases the latent period was not stated. Thus, of 18 cases, 16, or 88 per cent., had a latent period of 18 months or longer.

In my series the latent period works out as follows:—

2 years	2 cases
2½ years	2 cases
3 years	2 cases
4 years	3 cases
5 or more years	4 cases

So that, of 13 cases, all had a latent period of at least two years. In some of these I was only able to judge the approximate latent period by finding out the date when the patient first noticed interference with vision. However, the point I wish to establish, is that there is a latent period of at least 18 months or two years between exposure and cataract formation, and that this period may be considerably longer. The longest record I have is 12 years (case 9).

Analysis of Cases

The total number of patients examined was 36. Several of these had very small applications of radium, but they were investigated with a view to the determination of what might be regarded as a safe dose.

Of my 36 cases, five received both X-ray and radium treatment, eight had X-rays alone, and the remaining 23 had radium alone. In considering the five cases which received both kinds of irradiation, I have regarded four of them as having only had X-rays, for the purposes of this investigation. I have done this because in each of the four, the radium was applied some distance away from the eye, and I do not believe it to have taken any part in the formation of lens opacities. Radium applied in the post-nasal space is too far removed to exert any influence upon the eye.

Therefore, I am regarding my cases as having been exposed to irradiation in the proportion of 12 to X-rays, one to X-rays and radium, and 23 to radium only.

X-rays.—Of the 12 cases, nine developed irradiation cataract. Of the other three, one had treatment as recently as April, 1932, and can, therefore, be considered to be in the latent period (case 1); another developed some lens changes, but as they were not typical I have regarded the case as negative (case 4); while the third case was definitely negative (case 5).

Thus, of 11 cases in which a positive result might be expected, nine, or 81 per cent., developed an irradiation cataract.

Radium.—23 cases were examined altogether, but they received, in the majority, very small doses. Three cases were definitely positive; three others had some post-cortical vacuoles, and 17 were negative. I have excluded the three doubtful cases, they were not convincing. They will be followed up later.

Consideration of Dosage

X-rays.—Before discussing the dosage, we must devote a few words to the method of application of X-rays.

The sort of case with which we shall find ourselves concerned, is, for example, a pituitary tumour, or a neoplasm of the nasal region. X-ray therapy in these cases is applied in a series of daily exposures. One exposure only is given each day, and the rays are focused upon the area to be treated. Each day the rays are "fired" from a different angle, so that the whole region

TABLE OF CASES.

Case Details.				Disease.	Treatment and Dose.	Year Treated.	Lens Change.
1.	J. D.	44	M.	Squamous carc. nose	Deep X-rays 1 course	18/4/32—30/4/32	Nil
2.	L. G.	58	F.	Post-nasal sarcoma	Deep X-rays 1 course	20/10/27—2/11/27	X-ray cataract, right and left
3.	L. B.	52	F.	Myeloma of maxilla	Deep X-rays 2 courses	29/12/30—10/1/31	X-ray cataract, left more advanced
4.	M. T.	48	F.	Carc. left antrum	Radium 1440 mgm. hrs. X-rays 1 course	February, 1929 13/10/31—27/10/31	Classed as negative (atypical)
5.	W. F.	60	M.	? N.G. orbit, right	Deep X-rays 1 course	15/6/28—29/6/28	Nil
6.	A. B.	43	F.	Sarcoma left frontal	Deep X-rays 1 course	20/9/29—2/10/29	X-ray cataract, right and left
7.	A. O.	33	F.	N.G. nose, right side	Deep X-rays a few applications Deep X-rays 1 course	November, 1929 July, 1930	 X-ray cataract, right and left
8.	A. M.	19	F.	Post-nasal tumour	Deep X-rays 1 course	18/10/29—6/11/29	X-ray cataract, right more advanced
9.	E. T.	46	F.	Lupus of nose	X-ray treatment	Treatment ended 1921	X-ray cataract, right
10.	W. S.	45	M.	Nasopharyngeal N.G.	Deep X-rays 1 course Radium 1512 mgm. hrs.	1923 August, 1924	Irradiation cataract, right
11.	E. T.	46	F.	Post-nasal sarcoma	Deep X-rays 1 course ½ course Radium 1296 mgm. hrs.	March, 1929 June, 1929 June, 1929	Irradiation cataract, right and left
12.	E. H.	7	M.	Glioma of retina	Radium 2700 mgm. hrs. Deep X-rays 1 course	1931 June, 1931	Irradiation cataract
13.	R. S.	67	M.	Epithelioma right cheek	Deep X-rays 1 course Radium 3432 mgm. hrs.	3/2/28—16/2/28 May and June, 1928	Irridiation cataract, right and left
14.	A. M.	80	F.	Rodent ulcer lid, left	Radium 2956 mch. hrs.	May, 1932	Opacities, atypical
15.	O. W.	36	F.	Angioma of retina	Radium 480 mch. hrs.	1932	Nil
16.	A. W.	56	M.	Rodent ulcer inner canthi, right and left	Radium 14380 mgm. hrs.	1926, 1927, 1928, 1930	Radium cataract left more advanced
17.	J. M.	67	M.	Rodent ulcer lid, left	Radium 624 mgm. hrs.	April, 1928	Radium cataract
18.	J. K.	53	M.	Rodent ulcer canthus	Radium 1188 mgm. hrs.	April, 1929	Radium cataract
19.	P. B.	60	M.	Melanoma limbus	Radium 41·6 mgm. hrs.	1929, 1932	Few vacuoles
20.	J. H.	11	F.	Spring catarrh	Radium 4·7 mgm. hrs.	1931, 1932	Nil

TABLE OF CASES—*continued*.

Case Details.				Disease.	Treatment and Dose.	Year Treated.	Lens Change.
21.	H. G.	64	M.	Epithelioma conj., left	Radium 50 mgm. hrs.	1929, 1930, 1931	Nil
22.	J. S.	9	M.	Spring catarrh	Radium 7·3 mgm. hrs.	1931, 1932, 1933	Nil
23.	M. S.	63	F.	Mooren's ulcer, left	Radium 8·3 mgm. hrs.	1930	Nil
24.	M. W.	60	F.	Rodent ulcer canthus	Radium 9 mgm. hrs.	1930	Nil
25.	T. W.	10	M.	Spring catarrh	Radium 10·5 mgm. hrs.	1930, 1931	Nil
26.	E. T.	58	M.	Rodent ulcer inner canthus, right	Radium 2488 mch. hrs. 259 mch. hrs.	1931 1932	Post-cortical vacuoles
27.	H. N.	76	M.	Rodent ulcer face	Radium 200 mgm. hrs.	1930, 1931, 1932	Nil
28	E. B.	57	M.	Rodent ulcer lid, right	Radium 36 mgm. hrs.	1932	Nil
29.	C. A.	62	M.	Rodent ulcer face, right	Radium 150 mgm. hrs.	1931, 1932	Nil
30.	M. C.	67	F.	Rodent ulcer canthus, left	Radium 1128 mgm. hrs.	1931	Nil
31.	M. R.	56	M.	Rodent ulcer canthus left	Radium 60 mgm. hrs.	September, 1932	Nil
32.	M. S.	66	F.	Rodent ulcer face	Radium 97 mgm. hrs.	1931	Nil
33.	A. O.	55	F.	Rodent ulcer lid, left	Radium 33 mgm. hrs.	June, 1932	Senile cataract
34.	J. K.	43	M.	Rodent ulcer face	Radium 35 mgm. hrs.	1931	Nil
35.	R. N.	3	M.	Naevus outer canthus	Radium 25 mgm. hrs.	1930	Nil
36.	N. P.	42	F.	Rodent ulcer lid, left	Radium 376 mgm. hrs.	1930	Nil

NOTES ON THE CASES.

Cases 1, 14, 15, 28, 31 and 33 are still within the latent period. They will be followed up. Cases 4, 14, 19 and 26, although showing post-cortical lens changes, have been classed as negative because they are atypical. Of them, I believe Case 26 will prove to be an irradiation cataract at a later date.

The three positive radium cataracts appeared in Cases 16, 17 and 18. Case 16 was treated by radium needles and seeds. There was a large area of disease involving the bridge of the nose. Cases 17 and 18 were treated by radium needles applied to the lids and left *in situ* for ten days. Case 17 developed telangiectases of the skin of the lids.

The average age of the positive cases in the above series is 45½ years. The eldest was 67, and the youngest 7 years old. Seven patients were females, and six males.

I have included in my list of irradiation cataracts, no case that I was not satisfied that I could exclude from the category of "senile cataract."

involved is subjected to irradiation from all directions. There are usually six points from which the rays are "fired," and each point is used twice. Thus a course of deep X-ray therapy means 12 exposures, and it lasts a fortnight.

To give an example, case 2 was a woman who had a sarcoma of the post-nasal space. She had a course of deep X-rays from October 20, 1927 to November 2, 1927. The applications were as follows:—

1.	Right lateral vertical.	4.	Right anterior oblique.
2.	Left anterior oblique.	5.	Right posterior oblique.
3.	Left posterior oblique.	6.	Left lateral vertical.

And then this was repeated.

In the above course of treatment, the rays pass directly through the eyes in the left and right anterior oblique positions; some rays reach the eyes from the lateral vertical positions; rays from the posterior positions probably do not affect the eyes at all. From this it is obvious that a considerable quantity of rays pass through each eye in one course of treatment. It should be mentioned that the left eye is screened when the right anterior oblique position is used, and *vice versa*.

In this series of cases, seven of the nine patients who developed cataract received only one course of deep X-rays. One of the others had a few extra applications only, while the other one had a full second course six months after the first. The patients who did not develop cataract each had one course.

It is quite clear that one course of deep X-ray therapy is sufficient to produce an irradiation cataract, in fact it is more than likely to do so.

Radium.—I examined 23 cases, but, as I have explained, most of these had very small doses, and the positive cases are too few to be of any statistical value.

Positive results were found in three patients. The amount of radium used in the treatment of each was:—

Case 16.	14,380 mgm. hrs.
Case 17.	624 mgm. hrs.
Case 18.	1,188 mgm. hrs.

Three cases were doubtful, that is to say lens opacities were present, but were not typical. These have been excluded.

There remain 17 cases in which the lens was clear (except case 33, in which there was senile cortical cataract), and the dosage varied from a maximum of 1,128 to a minimum of 4·7 milligram hours. I should mention that the patient who had 1,128 mgm. hrs. (case 30), was treated by radon seeds, some of which were applied at the border of the nose, and these probably had no effect on the eye, so that the maximum ineffective dose is very likely not so high as I have made it.

Fourteen of the 17 cases were treated by unscreened radiation, that is to say the active rays were of the beta type. The three cases in which cataract developed were exposed to gamma radiation.

I do not propose to say much more about radium cataract until I have been able to collect some more positive results, but one or two points arise from the study of my cases.

First, as small a dose as 624 mgm. hrs. was enough to produce a cataract in one case. Secondly, no case treated by beta radiation developed cataract, and thirdly, radon seeds are probably less likely to cause damage than radium needles. The strongest seed is not effective outside an area of 8 mm., so that if seeds are used more than a centimetre away from the lens the latter will not be affected.

The results of treatment of rodent ulcers in the region of the eye were very good in those cases that I saw at the Radium Institute. In these cases radium is used unscreened. This means that several short applications of radium are given, the effective rays being of the beta variety. When gamma rays are used, the application must be of much longer duration, and in this form of treatment screened radium is employed, the beta rays being screened off.

This seems to me to be very important in the consideration of the best method of treating, for example, a rodent ulcer of the lid. The surgeon should be guided by the knowledge that beta radiation is effective, and safe to the lens, and should use this form of radium therapy if it is practicable. If it is decided that beta radiation is not suitable, it would be wise to consider the possibility of surgical interference, especially if the only alternative is large doses of gamma radiation. Of course, if the growth is large and spreading, the curing of it is obviously more important than the prevention of cataract. But I believe we have been inclined to neglect the damaging effect of radium, in some cases, and have employed large doses of gamma radiation, with such sequelae as malformations of the lid, chronic conjunctivitis, etc., when just as good a result, without sequelae, could have been obtained by the use of smaller doses of beta radiation.

There remains for discussion case 12, which had both X-ray and radium treatment. It was a case of glioma of the retina treated by radium intra-ocularly, and it has been fully reported by Foster Moore, Stallard and Milner.[16] One course of deep X-ray therapy was also given, and it is not possible to say whether one method of radiation was more responsible than the other for the cataract which developed.

Protection

In view of the fact that one course of deep X-rays is sufficient to produce cataract, the problem of protecting the eyes during such treatment is a very important one. I have already mentioned that the eye on the side opposite to that from which the rays are coming is screened. But the eye on the same side is exposed to the full activity of the rays, and this occurs, as we have seen, to each eye twice. I am told that it is not possible to protect the ipsilateral eye, because, if it were screened, even by a very small filter, the barrage effect of the radiation would be interfered with, and treatment thus inefficient. Further, the eye is exposed to a "scatter" of rays, which means that some of them are deflected back from the orbital tissues. It is, however, to be hoped that a method of applying X-rays will be evolved, in which both eyes can be protected without interfering with the efficacy of treatment.

With regard to radium, the point is again stressed that beta radiation should be used when possible. If gamma radiation is used, protection does not seem to be feasible. It would entail wearing a sort of metal contact glass for about 10 days, and this would not be tolerated, apart from the difficulty of keeping it in place.

Conclusions

Exposure of the eyes to the effects of X-rays or radium is likely to result in the formation of cataract.

This cataract has a typical appearance, its characteristics being the formation of vacuoles, cloudy areas, and later a plaque. It also has a constant situation—the posterior cortex of the lens.

There is always a latent period between exposure and cataract formation, and this can be said to be at least two years. It may be many years.

One course of deep X-rays is sufficient to cause cataract. Too few cases of cataract due to radium have been seen to dogmatise, but it may be said (1) that beta rays, applied at short intervals for short periods, are effective in treatment, and harmless to the lens; (2) that gamma radiation is likely to produce cataract.

Protection of the eyes during treatment is impracticable, but efforts should be made to devise some method of screening the lens without jeopardizing the effect of the radiation.

Finally, I wish to record my thanks to Mr. R. Foster Moore for his very valuable help and advice, and for permission to reproduce Fig. 1; to Mr. Rupert Scott for allowing me to investigate three of his cases at St. Bartholomew's Hospital; to Dr. Durden

Smith for arranging for me to see several cases under his care at the Radium Institute, and for details of these; and to Mr. Ralph Phillips for referring cases from the Deep X-ray Department at St. Bartholomew's Hospital to me, and for his valuable technical advice.

REFERENCES

1. **Clapp.**—*Amer. Jl. of Ophthal.*, Vol. XV, No. 11, Nov., 1932.
2. **Paton**—*Trans. Ophthal. Soc. U.K.*. Vol. XXIX, p 37, 1909.
3. **Stock.**—*Klin. Monatsbl. f. Augenheilk.*, Vol. XLIX, p. 93, 1911.
4. **Jess.**—*Ann. d'Ocul.*, Vol. CLXVI, p. 165, 1929.
5. **Foster Moore.**—*Proc. Roy. Soc. Med.*, Vol. XXIV, p. 32, 1931.
6. **Erggelet.**—*Zeitschr. f. Augenheilk.*, Vol. LXIV, p. 161, 1928.
7. **Clapp.**—*Loc. cit.*
8. **Clapp.**—*Loc. cit.*
9. **Franklin and Cordes.**—*Amer. Jl. of Ophthal.*, Vol. III, p. 643, 1920.
10. **Withers.**—*Amer. Jl. of Ophthal.*, Vol. VII, p. 513, 1924.
11. **Robinson.**—*Arch. of Ophthal.*, Vol. LV, p. 335, 1926.
12. **Blegvad.**—*Acta Ophthal.*, Vol. IX, p. 32, 1931.
13. **de Schweinitz.**—*Bull. of O. O. R. L. Soc.*, Kansas City, Mo., Vol. II, No. 4, 1931.
14. **Desjardins.**—*Amer. Jl. of Roentgen.*, Vol. XXVI, p. 787, 1931.
15. **Stallard.**—*Proc. Roy. Soc. Med.*, Vol. XXVI, p. 59, 1933.
16. **Foster Moore, Stallard and Milner.**—*Brit. Jl. of Ophthal.*, Vol. XVI, p. 673, 1931.

SOME REMARKS ON PILOCARPINE

BY

J. A. VAN HEUVEN, M.D.

UTRECHT

OCCASIONALLY one meets a patient suffering from chronic glaucoma, who is treated with instillation of drops of pilocarpine and complains after this of a bad and diminishing vision. Now in these cases we nearly always deal with elderly people suffering frequently from incipient opacities of the lens. More or less subconsciously, I always considered these complaints to be caused by the narrowing of the pupil. About two years ago I saw shortly after each other two very intelligent patients suffering from chronic glaucoma, who both told me very definitely that their visual acuity was lowered a good deal for one to one and a half hours after the instillation of a 2 per cent. solution of pilocarpine.

Controlling this statement it appeared that indeed the vision was decreased from one-third to one-fourth of what it was before, about a quarter of an hour after the instillation of 2 per cent. pilocarpine solution in the conjunctival sac. It took one and a quarter to one and a half hours before it was normal again. In