Radiation Therapy in Diseases of the Eye

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Recent advances in engineering, new discoveries in nuclear physics and the development of more appropriate clinical techniques have resulted in considerable progress in radiation therapy of diseases of the eye, as also a gratifying trend toward more frequent consultation between ophthalmologist and radiologist. The purpose of this paper is to review the physical principles upon which current radiation therapy of diseases of the eye is based, to discuss some of the effects of radiation on the normal tissues of the eye and eyelid, and to report on the clinical experience of treating diseases of the eye at the University of California Hospital.

Physical and Technical Considerations

With various qualities and types of radiation, such as beta rays, low and high energy x-rays, and gamma rays, some degree of selectivity can be achieved in irradiating diseased tissue while protecting normal tissue as much as possible. In the case of superficial lesions, for example, low energy radiation may be applied directly to the involved area, depth of the dose being limited by the range of the particles or photons. Similarly, in radiation to the anterior ocular segment, special equipment directs the x-rays tangentially to the globe, thereby protecting the lens. Conversely, if it is desired to irradiate deeper tissues and at the same time protect the superficial tissues from unduly large amounts of radiation, more penetrating forms of radiation may be applied over a number of fields to converge on the target.

The modern armamentarium includes various sources of beta rays and many forms of x-ray generators. Among the former are the naturally occurring elements of radium,\(^9\) radon,\(^{10, 14, 25}\) and radium D and E,\(^4\) as well as the artificially radioactive elements, strontium,\(^7\) ruthenium,\(^7\) and phosphorus.\(^6\) Beta radiation is absorbed in from 1 to 5 mm. of tissue; and with energy up to 2 mev. (million electron volts), the dose decreases inversely to the square of the depth of penetration. Hence, the superficial layers of any tissue will receive a high dose, while at 2 and 4 mm. the dose will be one-fourth and one-sixteenth as great, respectively.

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- Because of the wide variety of x-rays now available, selectivity is possible and important in treatment of diseases of the eye. By the use of short-range radiation, newly developed eye shields and the insulation of the eyelid itself, and by careful angulation of the beam, the desired irradiation can be given where it is needed without injury to surrounding tissues. The authors have found the 50 kv x-ray unit to be the most reliable and adaptable for most circumstances.

The skin of the eyelid reacts to irradiation more sensitively than other tissues. The cornea reacts with keratitis and sometimes intractable ulceration. The iris, uveal tract and retina are less seriously affected.

At the University of California Hospital irradiation has been found satisfactory for treatment of corneal ulcer, keratitis, pterygium, certain types of conjunctivitis, episcleritis, corneal vascularization, iritis, uveitis, and hemangioma. Irradiation may be of great benefit in absolute glaucoma with pain and blindness. Of 42 patients with carcinoma of the eyelid treated between 1935 and 1946, 27 had no recurrence in five years, 5 had recurrence, 7 died of other causes and follow-up was incomplete on 3. Good cosmetic result was usually achieved. No recurrence has been observed in 22 patients treated since 1946. Irradiation has been used with success in other kinds of cancer of the eye structures.

Among the x-ray generators in current use are the superficial therapy units, such as the Phillips 50 kv, the Chauoul 60 kv, the Grenz ray apparatus (Bucky), the newer units equipped with beryllium window tubes, and the higher energy units providing x-rays of a wide range of quality, the half-value layers ranging from 1 mm. of aluminum to 4.5 mm. of copper.\(^1\) 6, 10, 20, 22, 27 Supervoltage equipment has little place in the treatment of eye diseases per se, but is often useful in the management of the deeper seated retrobulbar lesions.

Special Techniques: In treating lesions of the eyelid, or certain structures of the eye, it is imperative to confine the radiation to the diseased tissues. Lead shields, 2 mm. thick, coated with paraffin, and
shaped to the contour of the eye, are suitable; conventional plastic contact lenses coated with lead 1 mm. thick are also satisfactory. Drew and Jones measured the dose to the lens under this protection, using a special tissue-equivalent phantom. The qualities of x-rays studied ranged from 0.1 to 0.7 mm. copper half-value layer. A field of 6x8 cm. was used with the eye shield placed in the center, simulating subpalpebral insertion of the shield. The dose at the significant site (lens) was found to be approximately 5 to 7 per cent of the dose to the unprotected surface. When the shield was placed over the eyelid the dose was increased from 8 to 11 per cent. In the absence of scatter, the direct x-ray transmission through the shield was between 0.5 and 1 per cent. Therefore, the dose of radiation to the sensitive regions of the eye would be due almost entirely to scatter. Drew and Jones concluded that the subpalpebral method of insertion of the shield is the most effective method of protecting the globe.

Walton recently described a technique of limiting the x-rays to the superficial tissues of the anterior segment of the eye by the use of a special applicator which directs the beam tangentially to the anterior surface of the eye. The mounting is so arranged and shielded that the lower surface of the applicator tube lies in the same plane as the central axis of the x-ray beam, thus cutting off the lower half of the field and providing an upper portion with a sharply defined lower edge. The accuracy of the alignment is checked through a periscope cone. The fall-off in dosage across the cornea from the temporal to the nasal side obeys the inverse square law closely.

When so small an amount of tissue is irradiated the effect of scatter on the dose can be disregarded. Walton found that for the average cornea 12 mm. in diameter the fall-off was less than 10 per cent, and no scatter to the tissues beyond the plane of the limbus was detectable. He also described a method designed to give a maximum dose on the retina while avoiding the lens. A modification of the frequently used 90° angle technique, it consists of directing the x-ray beam to the globe from the temporal and nasal side at a 45° angle to the sagittal plane. The dose received by most of the retina is approximately 150 per cent of the surface dose except in nasal and temporal portions, where the radiation is received from only one beam and is about 95 per cent of the surface dose. The point of maximum dose is on the vitreous, where supposedly it does no harm. If this technique is properly carried out, the lens receives neither direct nor appreciable scattered radiation.

Martin and Reese described still another method of delivering large doses of radiation to the posterior aspect of the globe in the treatment of bilateral retinoblastoma. This procedure is used when one eye has been enucleated, a condition which, incidentally, facilitates beam direction. Circular portals about 2.5 cm. in diameter are used, fitted with special cylinders to assure accuracy of beam alignment. (It was felt that larger portals would be highly injurious to the cornea, lens, and conjunctiva.) Two portals have been designated: (1) a temporal portal lateral to the outer canthus, and (2) a nasal portal on the opposite side of the bridge of the nose, the beam being pointed contralaterally and slightly backward.

| TABLE 1.—Depth dose data for superficial therapy |
|------------------------|----------|----------|----------------|----------------|----------------|
| Physical Factors       | Filter   | In Air   | At Surface    | To Cornea (0.1 cm.) | To Iris (0.3 cm.) | To Mid-lens (0.5 cm.) | To Vitreous Body (1.0 cm.) | To Peripheral Retina (2.0 cm.) | To Central Retina and Optic Nerve (2.5 cm.) |
| 50 kv, 2 ma,           | 0        | 100      | 104           | 90               | 65             | 52             | 32             | 13             | 9             |
| 4.04 cm. tstd,         | 1 mm. Al | 100      | 108           | 95               | 79             | 69             | 47             | 26             | 18            |
| 1.0 cm. diam. field*:  | 2.5 mm. Al | 100   | 109           | 98               | 85             | 74             | 53             | 31             | 23            |
| 50 kv, 2 ma,           | 0        | 100      | 107           | 92               | 68             | 53             | 34             | 14             | 10            |
| 4.04 cm. tstd,         | 1 mm. Al | 100      | 110           | 99               | 82             | 72             | 50             | 26             | 20            |
| 2.4 cm. diam. field*:  | 2.5 mm. Al | 100 | 112           | 103             | 87             | 78             | 57             | 34             | 25            |
| 50 kv, 2 ma,           | 0        | 100      | 104           | 81               | 54             | 41             | 21             | 6              | 4             |
| 2.0 cm. tstd,          | 1 mm. Al | 100      | 107           | 95               | 70             | 59             | 34             | 12             | 9             |
| 1.0 cm. diam. field*:  | 2.5 mm. Al | 100 | 108           | 99               | 78             | 68             | 39             | 16             | 10            |
| 50 kv, 2 ma,           | 0        | 100      | 106           | 86               | 64             | 49             | 23             | 8              | 5             |
| 2.0 cm. tstd,          | 1 mm. Al | 100      | 109           | 90               | 71             | 52             | 36             | 15             | 10            |
| 2.4 cm. diam. field*:  | 2.5 mm. Al | 100 | 111           | 94               | 73             | 62             | 40             | 18             | 13            |
| 100 kv, 10 ma,         | 100%     | 41%      | 9.1%          | 1.2%            |                |                |                |                |                |
| 30 cm. tstd,           | 1 mm. Al | 100      | 106           | 104             | 94             | 86             | 68             | 48             | 42            |
| 2.4 cm. diam. field‡:  | 1 mm. Al | 100      | 106           | 104             | 94             | 86             | 68             | 48             | 42            |

*Philips Metalix Corporation Contact Therapy Apparatus Technical Data.
‡See Reference 7.
Table 1 indicates how the variation in technical factors affects the dosage to parts of the eye. More detail is given in Table 1 for the 50 kv unit because the authors have found this unit to be the most reliable and adaptable for most circumstances. However, theoretical advantages have been claimed for other units and applicators in the treatment of superficial ocular lesions, and no doubt they may be superior in special circumstances. Figure 1 illustrates the dimensions referred to in Table 1, while Chart 1 shows comparative depth dose data for four different qualities of radiation.

**EFFECTS OF RADIATION ON THE NORMAL STRUCTURES OF THE EYE**

The biological effects of radiation on the eye have been reviewed in detail by Warren, Desjardins, Cogan, Hunt, Reese, and others. Also, recent experimental work by Poppe, Von Sallmann, Hughes and Iliff has added to the knowledge obtained from clinical observations.

Reese described a sequence of stages of reaction in various ocular structures following extremely large doses of radiation: "Superficial punctate keratitis, panus formation over the lower third of the cornea, extension of the keratinized half of the lid margin over the gray line toward the conjunctiva, xerosis of the conjunctiva and cornea, and, finally, entropion of the lid margin, symblepharon and contraction of the palpebral aperture."

**Eyelids:** The skin of the eyelid reacts in the same way as that of the rest of the body except that it is more sensitive, probably because of the thinness of epidermis. When treatment is given in daily fractions over three weeks or more, as in the case of cancer therapy, erythema increases as treatment progresses. Moist epidermitis may develop if the dose is sufficiently high, but usually heals within six to eight weeks after treatment, with complete epithelization. Residual atrophy of the skin often develops. This depends on the total dose delivered. With small doses, there is temporary loss of the cilia, but with large doses, such as are used to treat cancer, this effect is usually permanent. Atrophy of the tarsus has been reported as causing widening of the palpebral aperture. Another effect which has been noted is disappearance of the firm elastic tissue along the lid margin that makes it soft and pliable. Later effects are depigmentation, which is more frequent, and patchy pigmentation and telangiectasia, occurring occasionally.

**Conjunctiva:** Conjunctival tissue, like most mucous membrane, is quite sensitive to radiation. The degree of reaction depends on the total dose as well as the time over which it is given. At times the reaction consists of mild edema, hyperemia, and epiphora. Occasionally, following intense treatment, there is pronounced conjunctivitis accompanied by photophobia and lacrimation.

**Cornea:** The cornea is relatively insensitive to small doses. However, with larger doses a definite corneal reaction is to be expected, essentially that of superficial keratitis. With x-rays of conventional energy range, doses from 4,000 to 6,000 r cause keratitis to develop in several weeks, the time depending on the fractionation rate. The lesion may be limited to superficial epithelial keratitis, but the deeper layers are often involved, and an intractable ulcer may result. Even when frank ulceration does not develop, the keratitis may persist for months, with severe photophobia and epiphora. Frequently xerosis follows, presumably owing to radiation atrophy of the lacrimal and mucous glands.

**Iris:** Proliferation and migration of the pigment-containing epithelium of the iris have been observed...
by Reese, who noted an increase in the number of clump cells, an appearance of pigment dust over the surface of the iris, and an appearance of pigment deposits on the posterior surface of the cornea. He further observed an atrophy of the pigment-containing epithelium of the iris, permitting the light to pass readily through it. However, the iris and the uveal tract are not greatly affected by usual therapeutic doses.

Retina: Cogan stated that x-rays have relatively little effect on the retina. He quoted Hoffmann as stating that thickening of the arteries and chromatolysis of the ganglionic cells have resulted from roentgen radiation, and further stated that retinal changes occur more frequently than described. He cited a case in which occlusion of the central retinal vein was noted six months after the administration of 4,000 r. Retinal plication has been observed after extensive radiation.

**Therapeutic Considerations**

Nonmalignant Lesions of the Eye and Its Adnexa: Many inflammatory lesions reportedly are benefited by radiation; the literature is voluminous (extensively reviewed by Desjardins and others). In the authors' experience, however, only a few conditions respond sufficiently well to justify the use of radiation. Radiation should be used only when it is the best treatment available, and late complications should be avoided by keeping the dose as low as is compatible with a satisfactory result.

As previously mentioned, there are many ways in which ionizing radiation may be administered. In recent experience the authors have found x-rays generated by 50 or 100 kv satisfactory for most purposes. Radon bulb ophthalmic applicators and radioactive strontium applicators have not been used at the University of California Hospital.

The findings here reported cover cases treated at the University of California Hospital from 1935 to 1952. Recently certain forms of conjunctivitis have been cured with compound F, and such diseases as episcleritis and recurrent catarrhal infiltration of the cornea have been reported as responding well to topical cortisone. Further evaluation will be necessary to prove whether these agents are more efficacious than x-rays.

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* Friedell has advocated the use of the Sr ophthalmic applicator in a number of conditions, all treatments being given by direct contact in a dose of 325 r in one minute approximately once a week to a total of approximately 1200 r for most lesions (superficial tumors of the lids and conjunctiva, vernal conjunctivitis, anterior segment tuberculous, vascularization of cornea, and corneal ulcers). In a personal communication, Friedell pointed out that the present dosage schedule is considerably higher. He stated that he delivered from 600 rps to 1200 rps per treatment at weekly intervals, for total doses as high as 6000 rps to 8000 rps wherever necessary. Also, he pointed out that there are differences as great as 50 per cent in the ratings of different applicators.

Corneal Ulcer: Most patients were referred because of failure to heal or respond to a variety of treatments. From 1942 to 1952, ten patients were treated.

The lesions were first reported from a month to four months prior to x-ray therapy. In most instances treatment was given with 100 kv x-rays (HL 1.04 mm. Al); 30 r to 50 r (air) every 5 to 7 days for 3 to 4 treatments. The total dose in most cases was 200 r (tissue dose) in two to four weeks. The results were satisfactory in seven of the ten patients, healing the ulcer and relieving pain.

Episcleritis: Only one patient was treated. The lesion had existed for about four years, with frequent intermittent episodes of acute pain. With 100 kv x-rays (HL 2.4 mm. Al), 3 treatments were given in 15 days, a total of 300 r (tissue dose). There was marked improvement with almost complete subsidence of the lesion. Five months later an exacerbation occasioned a second course of treatment (300 r tissue dose); to date there has been no recurrence.

Keratoconjunctivitis: Between 1947 and 1949 three patients were treated. One of these patients was to have a corneal transplant and, because of existing inflammation, was given preoperative treatment. With 100 kv x-rays (HL 2.4 mm. Al), a total of 750 r (tissue dose) was given through the closed eyelid in 6 treatments over 15 days. The condition improved, and no flare-up was noted following operation.

In the second case (bullous keratitis, keratocystitis, and secondary glaucoma), the patient was also treated with 100 kv x-rays (HL 1.04 mm. Al). A total of 200 r (tissue dose) was given in 12 days, in 4 treatments. Immediate subjective improvement was noted, but later results are not known since the patient did not return for follow-up examination.

In the third case (keratoconjunctivitis with corneal infiltration and ulceration), 100 kv x-rays (HL 2.4 mm. Al) were used. The left eye received a total of 100 r (tissue dose) and the right eye, 30 r (tissue dose). The lesions were reported improved except for slight residual scarring.

Pterygium: It has been the authors' policy to use radiation therapy only for pterygia of the fleshy, vascular type, for those which recurred after operation, and those in which progression was noted. In the past five years, six patients have been treated. The lesions were all located medially and were found to have been present from two months to ten years. Treatment was given with the 50 kv unit. The usual total dose to tissue was approximately 500 r given in 5 treatments in about 9 days. The results generally were satisfactory; i.e., either the progress of the pterygium was arrested, or regression took place. In one patient recurrence was noted after two years.
Corneal Vascularization: From 1946 to 1951, nine patients were treated. In most of these, the vascularization followed corneal transplants necessitated by acid burn, corneal curetage for precancerous melanosis, atopic keratoconjunctivitis, corneal opacities, or scarring following smallpox. The interval between operation and x-ray treatment varied from eight to 56 days, although most patients were treated within two to three weeks after operation. In most instances, 50 kv x-rays were used. The total doses varied from 500 r (tissue dose), given in 5 treatments in 10 days, to 1,500 r (tissue dose), in 12 treatments in 15 days. Six patients were improved; i.e., either the vessels were obliterated or the spread inhibited.

Vascularization in the Region of the Anterior Chamber: Three patients with this condition have been treated since 1945. In two, vascularization followed operation for a cataract, while in the third the cause was unknown. The 100 kv x-rays were used in one case, while the 200 kv x-rays were used in the other two. From 1,000 to 1,600 r (tissue dose) were given in 9 to 14 days. The treatment resulted in obliteration of the blood vessels.

Epithelization in the Anterior Chamber (following cataract extraction): From 1944 to 1948, five patients were treated. Either 50 kv, 100 kv, or 200 kv x-rays were used, and the number of treatments ranged from 4 to 15; the number of days over which treatment was given varied from 7 to 18. An average total tissue dose of 1,000 r was administered. The results were poor.

Uveitis, Iritis, Iridocyclitis: Between 1942 and 1950, 12 patients were treated who had these conditions. Three were treated with 50 kv x-rays and 8 with the 100 kv x-rays (HVL from 1.04 to 3.4 mm. Al); the total tissue dose varied from 40 r to 600 r; the number of treatments varied from 1 to 5; and the total time varied from 1 to 21 days. Eight were definitely improved. In general, it is recommended that 30 r to 50 r be given at weekly intervals for a total of 3 or 4 treatments.

Cavernous Hemangioma of the Eyelid: Six lesions were treated between 1945 and 1951. Five cases involved the upper eyelid, one involved the inner canthus. Five patients were three to six months of age, and one was six years old. In two cases, 100 kv x-rays were used (HVL 2.4 and 3.4 mm. Al); in two, 50 kv x-rays; in one, radium plaque, and in one radioactive phosphorus (on blotting paper). The more penetrating radiation was used on the deeply seated lesions. A wax-coated lead shield was used to protect the eyeball when indicated. The total tissue dose was less than 500 r in all cases but one in which, for an extensive lesion, 750 r (tissue dose) was necessary. Usually one or two treatments sufficed, but in some instances, additional therapy was required. In all cases regression of the lesion was observed.

Hemangioendothelioma: The patient was a male infant aged 7 months. The lesion involved the lateral third of the left upper lid and had previously been treated by partial excision. With 50 kv x-rays a total of 3,600 r (tissue dose) was given in 10 days. The lesion subsequently disappeared. There was faint residual pigmentation but no deformity of the lid. Three years later, there was still epilation of the lateral half of the lid but no recurrence of the lesion.

Coats's Disease (Exudative Retinitis): A 13-year-old boy had a lesion of three months' duration. There was partial blindness with retinal detachment and also new vessel formation and chorioretinitis. With 100 kv x-rays (HVL 7.0 mm. Al) 16 treatments were given in 28 days, a total of 800 r (tissue dose). The result was poor, and three months later the eye was enucleated.

Von Hippel's Disease (Angiomatosis of Retina): One patient was a girl aged 15 years. The disease was bilateral. In 1941, 1,000 kv x-rays were used to apply 2,200 r to the lesion in 17 days; a second course of 2,200 r was given two years later with the 200 kv x-ray. In 1943 it was noted that sight was lost in the right eye (detached retina), but the left eye was intact. Follow-up at intervals of two and twelve years showed the vision and fundus changes in the left eye to be the same.

The second patient, a boy aged 7, was seen in 1946. The lesion was of 9 months' duration. With 200 kv x-rays (HVL 1 mm. Cu) 700 r were delivered to the retina in 4 days. One year later, 350 r were given in 7 days. The patient did not return for further observation.

Retinitis and Retinitis Proliferans: Six patients with this disease were treated from 1948 to 1951. The clinical findings were partial or total loss of vision with retinal or vitreous hemorrhage and occasionally retinal proliferation. In four patients the disease was associated with diabetes mellitus. Two hundred kv x-rays (HVL 1.0 mm. Cu) were used in all but one case; 1,000 r to 2,000 r were applied to the retina in 14 to 28 days. The long-term results were poor, although there was temporary improvement in four instances.

Absolute Glaucoma: Of the 15 patients treated, most were blind and in severe pain. The conditions leading to glaucoma included central retinal vein thrombosis, secondary glaucoma following cataract removal, cataract, iritis, retinal detachment, and diabetic retinopathy; in several cases the causative condition was unknown.

The treatment was given with techniques in which the half-value layers ranged from 0.5 to 1.0 mm. in copper. A dose of approximately 1,000 r in air or
800 r to the tissues was given in 14 to 21 days. The pain was alleviated in 6 patients. In 3, there was only slight improvement. No improvement was noted in three cases, while in the others treatment was incomplete or follow-up inadequate.

Other Nonmalignant Lesions Reported Amenable to Radiation Therapy (not treated at University of California Hospital): Successful treatment has been reported in blepharitis, chalazion, conjunctivitis (follicular, Parinaud's, trachoma or granular conjunctivitis), Mooren's ulcer, pinguecula, corneal opacities (new scars), traumatic injuries (recurrent abrasions and erosions), and acne rosacea keratitis.

MALIGNANT LESIONS OF EYELIDS AND THE GLOBE

Carcinoma of the Eyelid: It is now fairly well established that in malignant epithelial tumors of the eyelid, radiation therapy is one of the treatments of choice. In most instances the lesion can be controlled with good cosmetic result. In cases treated by the authors, results were similar to those reported in recent, more inclusive reviews on the subject by Hunt,12 del Regato,24 and Stetson and Schulz.26

Treatment was given to 40 males and 24 females whose ages ranged from 20 to 89 years. Table 2 shows age and sex distribution in the series. The duration of disease prior to therapy is given in Table 3. As carcinoma of the eyelid develops slowly, evaluation of results is difficult.

Incidence of various kinds of lesions and the apparent sites of origin are noted in Table 4.

The authors endeavor to obtain biopsies of all lesions to be treated. In 26 cases, however, no biopsy was done because of objection by the referring physician (possible cosmetic defect) and also objection on the part of the patient.

Forty-five patients were treated with 100 kv x-rays (HVL 2.4 to 3.4 mm. Al) at a distance of 20 to 30 cm. from the skin. Doses to the tissues of 4,000 r to 6,000 r were given in a period of 7 to 21 days. The eye itself was protected in the conventional manner with a wax-coated lead shield. It appears that the most cosmetically satisfactory result is obtained by distributing the dose over a period of 18 to 22 days.

Seventeen patients were treated with 50 kv x-rays through an added aluminum filter of 1 to 2.5 mm. at a distance of 20 mm. or 40 mm. The dose to the tissues in these cases ranged from 5,000 r to 7,000 r and was given in 11 to 21 days. Two patients in whom carcinoma of the lid had already invaded the orbit were treated with 200 kv x-rays (HVL 1.0 mm. Cu). One of them died of the tumor (the only instance of this kind in the series).

Of the 42 patients treated between 1935 and 1946, 27 had no recurrence in the five years following treatment. Seven died of other causes before five years and 5 had recurrence within that time. Follow-up was incomplete on 3. Since 1946, 22 additional patients have been treated, and no recurrence has been observed to date.

The most frequent late reactions to radiation therapy consisted of slight atrophy and depigmentation of the skin of the eyelid. In a few patients mild telangiectasia or increased pigmentation was encountered. The lid defect (minimal in most cases) was usually proportional to the size of the tumor or the amount of tissue removed at biopsy. Although epilation of the eyelashes was reported in 8 cases, it is certain that this must have occurred more frequently. Slight ectropion developed in three patients. Complications observed in one instance each were corneal opacity, cataract, obliteration of the lacrimal duct, and adhesions of the lids to the cornea.

Methods of treatment of carcinoma of the eyelid used in the past ten years at the University of Cali-
California Hospital are listed in Table 5. Since 1942 statistics have been maintained from the cases abstracted in the University of California General Tumor Registry, but as the number of cases in each category is still small, an analysis of the results is not yet justified.

Retinoblastoma: The first of three patients, a girl 15 months old, was seen in 1939. The tumor was first noted in the right eye when she was 6 months old and the eye was then enucleated. A similar lesion was found in the left eye when she was aged 14 months, and x-ray therapy was instituted.

Treatment was administered through anterior, lateral, and oblique fields; doses in air were 2,600 r, 2,700 r, and 450 r respectively in 37 days. An early reaction was severe epidermitis with marked conjunctivitis and keratitis. At this time an upper respiratory infection occurred with purulent nasal discharge, and the eye became secondarily involved. The cornea became perforated 8 months after treatment. The late reaction consisted of keratitis, blepharoconjunctivitis, scarring, telangiectasia, and shrinking of the globe, resulting in complete symblepharon and total blindness. However, in 1951, 12 years later, the patient was still alive.

The second patient was a girl aged 2½ years. X-ray therapy to the right orbit was given (after enucleation) with the 200 kv x-rays (HVL 1.0 mm. Cu) for a total dose to the tissues of 2,000 r through lateral and anterior ports in 26 days. Follow-up notes indicate that the lesion was controlled on the right, but that a tumor involving the left eye was later treated elsewhere.

The third patient, a female aged 27 years, received treatment to the left orbit (after enucleation) at another institution. She was treated at the University of California Hospital for a metastatic lesion in the frontal bone. With 200 kv x-rays, a total dose to the tissue of 3,200 r was given in 24 days, and temporary arrest was effected.

A more extensive account of radiation treatment of retinoblastoma has been published by Martin and Reese.17

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<th>Bas-Sq.</th>
<th>Squam.</th>
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<td>Curettage and desiccation</td>
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Carcinoma of the Cornea: A male patient, aged 76 years, was treated in 1947 with 5,000 r of 50 kv x-rays in 23 treatments in 29 days. The lesion disappeared. The patient died four months later of other causes.

450 Sutter Street (Hogan).

GLOSSARY

half-value layer (HVL): The thickness of any particular material necessary to reduce the intensity of an x-ray or gamma ray beam to one-half its original value; the figure is usually given as a measure of the intensity of the ray.

kilovolt (kv): One thousand volts.

ma: Milliamperes.

mev: Million electron volts.

roentgen equivalent physical (rep): The amount of ionizing radiation which will result in the absorption in tissue of 83 ergs per gram.

target-skin distance (tsd): The distance between the focal spot of the target of the x-ray tube and the patient's skin at the point of entry of the x-ray beam, usually measured in centimeters.

REFERENCES


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Scientific Program for Doctors on Hawaiian Trip

The Hawaiian Medical Association has announced a scientific program for physicians who will take part in the American Medical Association's 13-day Hawaiian Holiday Tour which will follow the annual A.M.A. convention in San Francisco next June 21 to 25.

The party will leave San Francisco aboard Pan American Airways Strato-Clippers and United Air Lines Stratocruisers at 11:45 on the night of Friday, June 25—the closing day of the convention—and arrive in Honolulu early the next morning. The party will stay at the Royal Hawaiian Hotel on Waikiki Beach.

The return trip, scheduled at 4 p.m. on July 3, will be made on the luxurious Matson liner, SS. Lurline, which will dock in Los Angeles on July 8.

All of the reservations are being handled for the A.M.A. by William M. Moloney, general agent, Room 711, 105 West Adams Street, Chicago.

—A.M.A. Secretary's Letter