

Atrophy of Germinal Epithelium of the Rabbit's Testis Induced by Roentgen Rays.

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In an attempt to produce atrophy of the germinal epithelium of the rabbit's testis, a series of adult animals were subjected to roentgen irradiation of the scrotal region. It was hoped, at the same time, to preserve, if possible, the functional integrity of the glandular cells of the testis.

This report describes the technic which was found adequate to induce complete and uniform degeneration of the entire spermatogenic series without appreciably suppressing the hormonal activity of the testis for such periods of time as the animals were observed.

Material and Method. Altogether 24 male rabbits of an albino breed, from 6-13 months of age, were treated with roentgen rays. Both testes were irradiated at the same time through the anterior scrotal wall. The adjacent parts of the body were protected with lead rubber sheets.

The X-ray machine employed was of a type producing a half wave current through 2 valve rectifiers. It was equipped with an oil immersed tube unit possessing an inherent filtration equivalent to approximately 1 mm of aluminum. The tube was operated on a current of 3 ma at a peak voltage of 140 kv. The target skin distance was 18 cm. A filter of 1 mm of aluminum was interposed, making a total filtration equivalent to approximately 2 mm of aluminum. With this setting, the machine delivered 126 r per minute when fields not over 100 sq cm were exposed. The erythema skin dose (E.S.D.) was 517 r.

Each animal was given 6 treatments at intervals of 3 days. The time of exposure was 3 minutes at each treatment. This made a total of 2,268 r (4.4 E.S.D.) for each animal over a period of 15 days.

The rabbits were examined once a week, and the period of observation extended from 2 to 6 months after the first treatment. Six animals were killed for histological study of the testes, 2-3 months after the first irradiation. Three of these had been subjected to both vasectomy and irradiation, while the other 3 had received only irradiation. The changes observed, however, were common to all animals.

Results. The first effect of the rays was shown by the testes becoming flabby in consistency. This change was detected as early as 9 days after the first treatment in 1 animal, 13 days in another, 16-18 in 7, and 21-24 days in the remainder.

A gradual and progressive decrease in size of the testes was next observed. In the course of about a month subsequent to the change in consistency, or 6-7 weeks after the first irradiation, the testes were reduced to about half their original size, or less. Thereafter, no further reduction in size was detected.

None of the animals showed any gross alteration in the size of the penis or of the scrotum, in a period of 6 months. The psycho-sexual behavior of the animals was not affected by treatment.

Untoward Reactions. A transient and moderate edema developed in the scrotum of one animal and in the prepuce of another, presumably as a result of the irradiations. Other reactions were not encountered. The general condition of the animals remained good.

Organ Weights. The testes showed a reduction in weight to less than one-half of the values obtained in another series of animals not irradiated.¹ The secondary sex organs, however, showed no appreciable decrease in weight. As a matter of fact, the seminal vesicles showed a tendency to increase in weight (Table I).

Histological Study. Histological examination of the testes revealed no difference between those animals that received X-rays alone and those that underwent vasectomy in addition to the roentgen irradiations. The specimens were obtained from 30 to 86 days after the first irradiation. The first specimen was obtained at biopsy. The sections were stained with hematoxylin and eosin.

Within 30 days of the first irradiation, or 15 days after the last, there was a marked atrophy of the germinal epithelium, and the seminiferous tubules had decreased in size (Fig. 1). However, one could still find a few spermatogonia. A 58-day specimen showed

TABLE I.
Weights of Sex Organs of Normal, Orchidectomized, and Irradiated Rabbits.

Group	Testes		Seminal vesicles		Bulbourethral gland	
	N	Mean $\pm$ σ_m mg/kg	N	Mean $\pm$ σ_m mg/kg	N	Mean $\pm$ σ_m mg/kg
Normal	17	1002.4 $\pm$ 84.0	18	526.9 $\pm$ 64.7	17	189.5 $\pm$ 22.5
Orchidectomized	—	—	8	128.7 $\pm$ 11.7	8	66.2 $\pm$ 10.2
Irradiated	5	437.7 $\pm$ 59.7	6	697.0 $\pm$ 39.0	5	157.9 $\pm$ 6.0

N = Number of animals.

¹ Frazier, C. N., and Hu, C. K., *Endocrinol.*, 1941, **28**, 283.

practically complete disappearance of the germinal cells, leaving behind a single layer of Sertoli cells. There appeared to be a few atypical spermatogonia. Specimens of 78-86 days showed, in addition to the changes stated above, a varying degree of fibrosis (Fig. 2). This process involved the interstitial tissue as well as the remnants of the tubules. All the changes were remarkably uniform throughout the sections examined.

In some instances, there appeared to be a relative increase in the amount of interstitial tissue together with an increase in the number of Leydig cells. This seemed to be due to the marked decrease in the size of the seminiferous tubules, and the resulting condensation of the remaining interstitial tissues.

Discussion. Using the technic described we obtained a rather prompt, uniform and clear-cut destruction of the germinal epithelium of the seminiferous tubules in the adult rabbit, a species of animal known to be relatively resistant to roentgen rays. We share

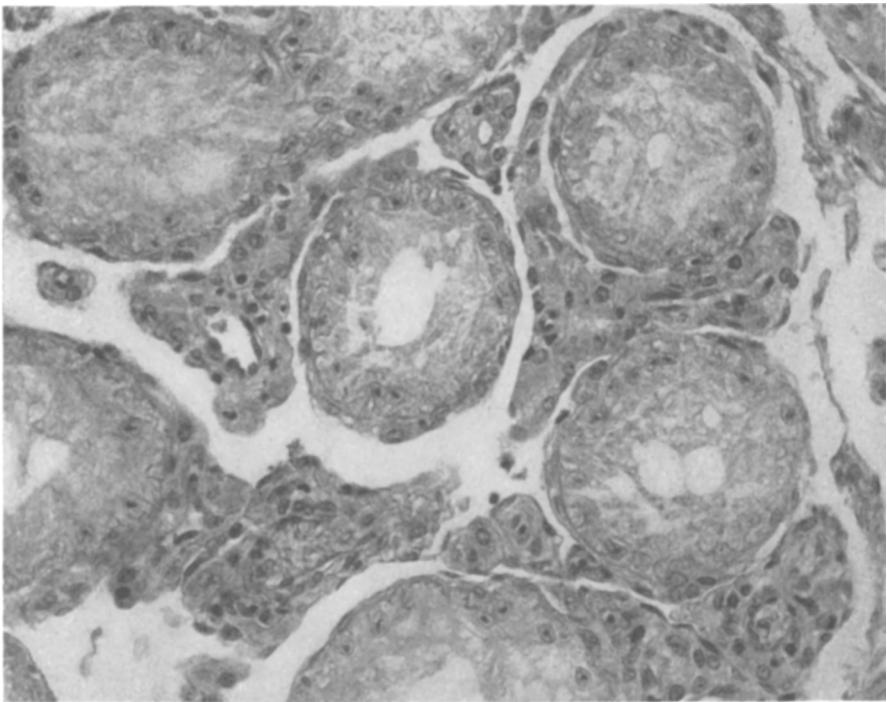


FIG. 1.

Section of testis 30 days after the first roentgen irradiation, showing marked atrophy of germinal epithelium. Only Sertoli cells remain in the tubules. $\times 295$.

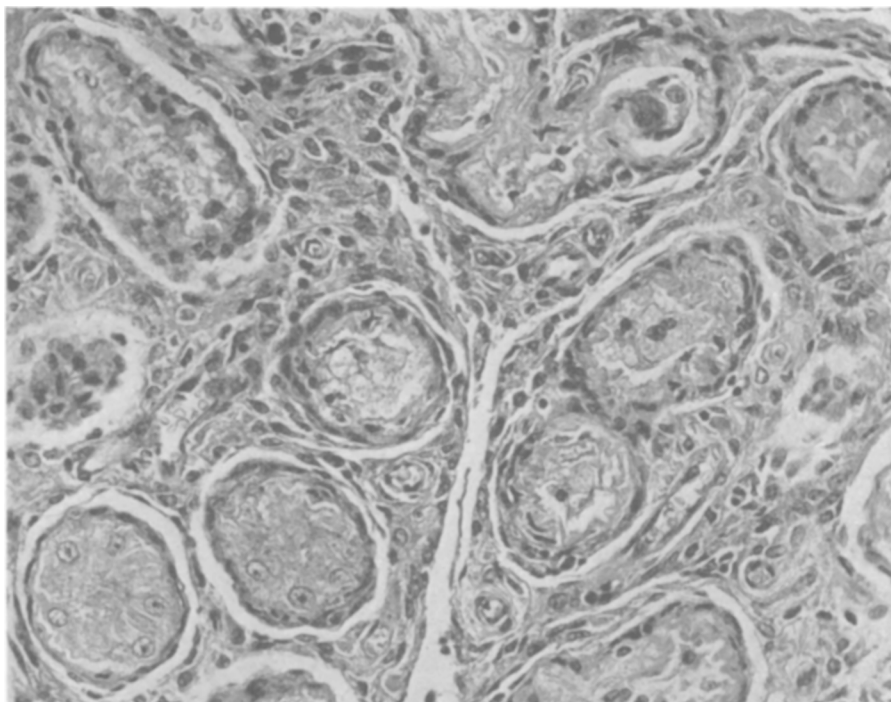


FIG. 2.

Section of testis removed 80 days after the first roentgen irradiation, without vasectomy. Note the general fibrotic appearance, complete atrophy of the germinal epithelium and reduction in size of the seminiferous tubules. $\times 295$.

the opinion with Ferroux, Regaud and Samssonow,² who have successfully used a similar technic, that the effects of the X-rays seem to be permanent.

No changes in the interstitial tissue of any physiological significance were demonstrated. The animals retained their sexual power in spite of the loss in fertility. Furthermore, the penis, scrotum and the secondary sex organs did not show atrophic changes within the period of observation.

The structural relationship of the sexual organs to the function of the testis was shown in 8 adult rabbits subjected to castration. In these there occurred a shrinkage of the scrotal sacs and complete atrophy of the glans penis within 3 months following removal of both testes. There was also a considerable decrease in weight of the secondary sex organs (Table I).

The histological changes observed in the animals subjected to

² Ferroux, R., Regaud, Cl., et Samssonow, C., *Compt. rend. Soc. de biol.*, 1938, 128, 173.

both vasectomy and irradiation were practically the same as those found in animals receiving only irradiation. Furthermore, in another series of animals in which the influence of vasectomy was studied, the degeneration in the germinal epithelium was neither as uniform nor as complete as that resulting from the roentgen rays alone.

The data on hand seem to indicate that the roentgen rays have a selective action on the germinal epithelium of the testis.

Summary. Testes of adult rabbits subjected to a series of exposures to X-rays aggregating 2,268 r (4.4 E.S.D.) over a period of 15 days showed complete atrophy of the germinal epithelium. The secretory function of the testes, as judged by the maintenance of the normal size of the penis and scrotal sacs, and by the normal psycho-sexual behavior of the animals, was not affected as long as 6 months following irradiation.

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Immunity and Experimental Relapsing Fever in the Chinese Hamster (*Cricetulus griseus*).

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While the problem of immunity in relapsing fever of man and of laboratory animals has been extensively investigated, no definite conclusion has been reached owing to the contradictory findings. However, it is generally agreed that immunity following an attack of relapsing fever is of short duration but occasionally a long-lasting immunity may occur which has usually been attributed to the persistence of residual infection, notably in the brain.¹⁻⁴ In connection with our studies on the course and chemotherapy of experimental relapsing-fever infection by a California strain in Chinese hamsters,⁵ opportunity arose for a careful examination of certain phases of immunity in this infection with special attention to its relation to

¹ Hindle, E., *A System of Bacteriology*, London, His Majesty's Stationery Office, 1931, **8**, 146.

² Hindle, E., *Trop. Dis. Bull.*, 1935, **32**, 309.

³ Coleman, G. E., *J. Infect. Dis.*, 1934, **54**, 1.

⁴ Beck, M. D., *J. Infect. Dis.*, 1937, **60**, 64.

⁵ In press.