ELASTOSIS AND CUTANEOUS IRRADIATION INJURIES

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Elastosis is used in this paper to denote the histological appearance of the connective tissue in what has been variously termed senile elastosis, solar elastosis, elastotic degeneration of collagen,[1] basophil degeneration of collagen, and so on. Morphologically the abnormal fibres are not identical with elastic fibres, although they have an affinity for stains usually used for these fibres. They manifest the tinctorial reactions known to be given by elastic fibres, but they are also stained by many dyes which do not stain normal elastic fibres.[1] Evidence has been presented in the past to show that there are similarities, histological, histochemical, biochemical and physical, between elastotic material and elastic tissue, but dissimilarities have, at the same time, been shown to exist by the same authors.[1,3-5]

Elastosis is present when the normal elastic fibres of the

upper corium, extending to and including the pars papillaris, are replaced or overshadowed by a coarse mat of fibres 3 - 5 times thicker in diameter than normal. The fibres have no distinctive form or shape and often appear swollen, woolly and amorphous, due to the irregular manner in which they take up the usual elastic-tissue stains. They stain deeply but not metachromatically with toluidine blue and take up haematoxylin in routine staining.

Various workers have reported that there is an increase in the number of elastic fibres in the skin which has been damaged by X-rays,[6-8] and other authors have assumed that elastosis can be produced in the same way and that this elastosis in turn plays a part in the development of cancer.[1]

It was, however, clearly stated by Montgomery[9] that such changes, formerly attributed to radiodermatitis (and incidentally to lupus erythematosus), were seen only when these conditions affected skin exposed to sunlight; they were not seen when biopsy specimens were removed from areas protected from the sun's rays. In order to test the conflicting statements of Gillman *et al.*[1,2] and Montgomery,[9] skin, showing the results of X-ray damage, was examined from areas which had been exposed to sunlight for years, as well as from those areas normally covered.

In agreement with many other authors,[5,10-14] we have been accustomed, in White subjects, to seeing the histological picture of elastosis in numerous routine skin sections from areas normally exposed to the sun. The condition is in fact normal in middle-aged and elderly White people both in this country and in Australia.[15]

MATERIAL AND METHODS

Skin obtained at operation or by biopsy was kept in 10% formalin for 24 hours, imbedded in paraffin, sectioned, and stained by the following methods: haematoxylin and eosin, Verhoeff's and Weigert's elastic stains, acid orcein, Gomori's aldehyde-fuchsin, periodic acid-Schiff, Mallory's phosphotungstic acid-haematoxylin, toluidine blue at pH 4·5, and Fontana's silver stain for reticulum fibres. The counterstains used were van Gieson or Halmi green and orange.

FINDINGS

Case 1

A female, aged 71 years, had a rodent ulcer removed from the left side of her nose with carbon dioxide snow 14 years earlier. She frequently exposed her face to the sun. Later, a second rodent ulcer developed on her left cheek and she was given a course of 4 treatments (dose unknown) of X-ray therapy in 1945. In 1956 a small regrowth appeared at the site of the second rodent ulcer, and she was again treated with X-rays.

In 1959 she presented with a large area of X-ray atrophy on the left cheek with a central necrotic area. The whole of the affected skin was removed and portions well away from the central necrotic area were processed and examined (Fig. 1).

Histology. A coarse mat of fibres extends from the middle third of the corium to the base of the epidermis. They are thicker than normal and aggregated into irregular masses in contrast to the arrangement seen in healthy skin.[10] With toluidine blue they show pronounced basophilia but not metachromasia.

Comment. This marked elastosis is compatible with her age and habit of exposing her face to the sun. The X-ray therapy she received could not therefore be considered as a necessarily causal factor.

Case 2

A male, aged 19, fair, with a healthy skin. Eleven years earlier he had 3 X-ray treatments to the right knee for warts.

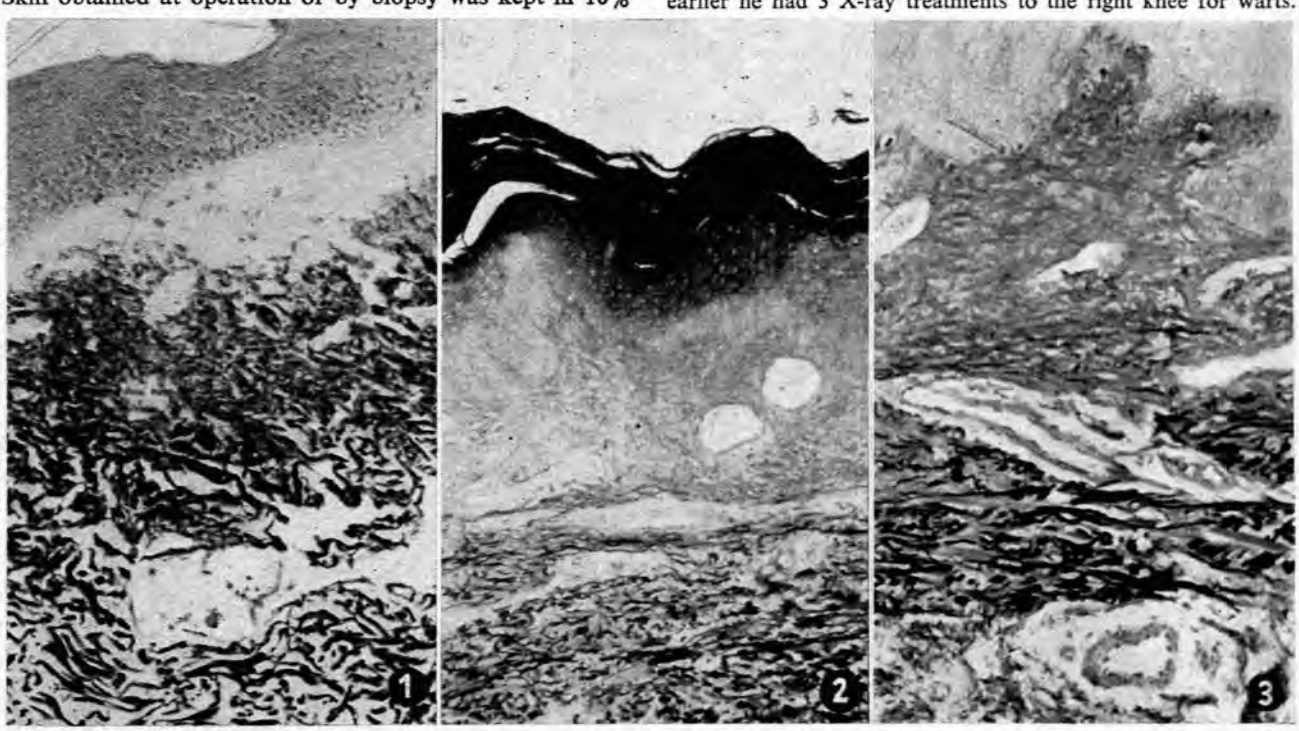

Fig. 1. Case 1. Elastotic degeneration (Verhoeff - Halmi green × 170).
Fig. 2. Case 2. Hyperkeratosis and telangiectasia. No elastosis (Verhoeff - Van Gieson × 85).
Fig. 3. Case 2. Normal elastic fibres in upper corium, but absent from papillae. No elastosis (Verhoeff - Van Gieson × 170).

On presentation there was atrophy of the skin with verrucose lesions and telangiectasia, the clinical appearance of chronic radiation sequelae. The relevant histological changes are seen in Figs. 2 and 3.

Histology. Hyperkeratosis and marked telangiectasia are the result of X-ray damage. Hair follicles and sebaceous and sweat glands are completely absent. The arteries in the middle and lower third of the dermis have thickened walls, and some of the blood vessels are thrombosed. Neither elastosis nor basophilia are present and there is even a loss of normal elastic tissue in the stratum papillare.

Comment. It is probable that, as a young healthy male, his knees were exposed to the elements, but at the age of 19 one would not expect elastotic degeneration to have appeared; he also received a dose of X-rays sufficient to cause atrophy of the skin and adnexa, telangiectasia, and damage to the arteries, yet the skin showed no elastosis.

Case 3

A female, aged 36 and blonde. Fifteen years earlier she had X-ray treatment to the butterfly area of the face for discoid lupus erythematosus. This resulted in a thickened, telangiectatic scar, which was removed for cosmetic reasons.

Histology. On the right side of Fig. 4 elastosis is seen; there is none on the left. X-ray damage, shown by telangiectasia, loss of adnexa, and vascular changes, is evident in many parts of the section. There are discrete areas of elastosis throughout, the non-elastotic areas being 0·5 - 1 mm. wide.

Comment. Our patient falls typically into the group which, according to Kissmeyer,[11] would show elastosis in skin from an exposed part, being fair, and in the fourth decade of life. In semi-serial sections it was noted that the non-elastotic areas lay in strips, and it was surmised that these represent creases in the skin, and would therefore be shaded from direct sunlight. Such protection would not be afforded against X-rays, and thus the non-elastotic areas had been equally subjected to X-ray damage.

Case 4

A female, aged 48. She had been treated some years previously with X-rays for a pelvic neoplasm. She presented with ulceration and postirradiation dermatitis of the lower abdomen and groins. Treatment was by removal and skin graft.

Histology. The skin shows typical X-ray damage with loss of hair follicles and sebaceous glands, and degenerated remnants of sweat glands. There are patchy thickening of the stratum corneum, areas of exudation and infection, and thrombosed blood vessels in the lower dermis and subcutis. Though abundant normal elastic fibres are present, there is no elastosis (Fig. 5). No basophilia is demonstrated with haematoxylin and eosin or with toluidine blue.

Comment. Here, in spite of extensive X-ray damage, the skin from a non-exposed area shows no elastosis.

Case 5

A female, aged 15 and blonde. Over several years X-ray therapy had been given to what had been described as pustular lesions of the trunk. The affected sites were 1 cm. in diameter, depressed, atrophic, and in most cases telangiectatic. A biopsy was taken from such an area on the buttock, i.e. from an area not normally exposed to light.

Histology. The adnexa are absent and the blood vessels show typical postirradiation damage. The elastic fibres are fragmented, often appearing as small cubes, but not increased in number. Individual fibres are of normal thickness.

Comment. The picture of elastotic degeneration was not seen.

DISCUSSION

That elastosis is caused by X-ray irradiation is not borne out by the literature apart from the statements of Gillman *et al.*[1,2] Accounts that may be misinterpreted include the following:

1. Wolbach,[6] in describing established X-ray dermatitis, mentions that there is a replacement of normal collagen by a peculiar dense hyaline collagen, rich in elastic fibres and poor in cells; he does not mention elastosis.

2. Teloh *et al.*,[7] examing 121 cases of dermatitis following X-ray, radium and radon, state: 'A confusing picture is seen depending on the chronicity and severity of the radiation damage. In an occasional case, the elastic fibres are normal in character and distribution. In severe injuries they are markedly decreased in number and occasionally entirely absent. In the majority of cases there is an apparent increase in number and heterogeneity in distribution of elastic fibres. The last picture is usually correlated with a moderately severe injury which may be in the acute or chronic stage. The elastic fibres are considerably altered

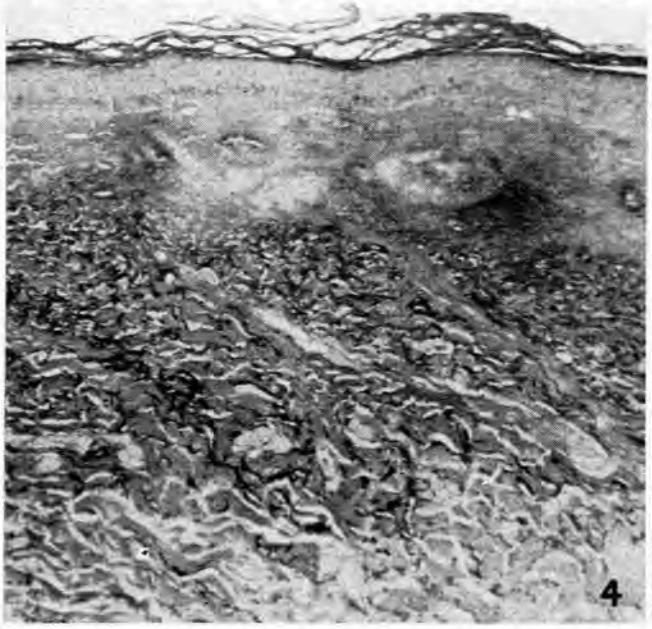

Fig. 4. Case 3. Marked elastosis at right side only (Verhoeff - Van Gieson × 85).

Fig. 5. Case 4. Apparent increase of elastic fibres. No elastosis (Weigert - Halmi green × 170).

in appearance due to fragmentation and splitting of the fibres, usually in the subepidermal region of the corium. These fibres are short, fragmented, thin, with frayed coiled ends, producing a thick maze of intertwining fibres. This is in marked contrast to the orderly arrangement of the normal elastic fibres of the corium. Whether the picture represents an actual increase in the elastic content of the corium is difficult to determine. The impression is, however, that the increase is more apparent than real and is due to marked fragmentation and splitting of fibres'. These findings corroborate those of Saunders and Montgomery[16] and do not suggest that the changes are those of elastosis. They are well illustrated in Fig. 5.

3. Warren,[17] states that within the first few days after irradiation the elastic fibres are swollen and more readily stained; later their degeneration may be complete, and their loss is responsible for much of the atrophy and loss of normal contour (of the skin).

A summary of our results (Table I) shows that in these few examples elastosis is present in the sun-exposed skin

TABLE I. THE RELATION OF PROLONGED SUN-EXPOSURE TO CUTANEOUS ELASTOSIS IN SKIN DAMAGED BY X-RAYS

Case	*Age*	*Sun-exposure*	*Elastosis*
1	71	+	+
2	19	+	—
3	36	+	+
4	48	—	—
5	15	—	—

of *adults* showing X-ray sequelae, to the same extent as we see it under the same conditions but without previous X-ray irradiation.

Elastosis was not seen in a *youth* whose sun-exposed skin had been damaged by X-rays, nor in 2 subjects who showed marked X-ray sequelae on areas not exposed to sunlight. It is concluded that the histological entity of elastotic degeneration of the skin is produced by solar, and not by X-ray, damage. Thus elastosis *per se* cannot be incriminated in the causation of skin cancer consequent on X-ray damage, as suggested by Gillman *et al.*[2]

SUMMARY

Histological examination of skin from 5 patients, who had had X-ray treatment, has shown that elastotic degeneration of skin can be correlated with prolonged exposure to sunlight, but not with severe damage from X-ray irradiation.

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REFERENCES

1. Gillman, T., Penn, S., Bronks, D. and Roux, M. (1955): A.M.A. Arch. Path., **59**, 733.
2. *Idem* (1955): Brit. J. Cancer, **9**, 272.
3. Burton, D., Hall, D. A., Keech, M. K., Reed, R., Saxl, H., Turbridge, R. E. and Wood, M. J. (1955): Nature (Lond.), **176**, 966.
4. Jarrett, A. (1958): Brit. J. Derm., **70**, 343.
5. Lansing, A. I. (1955): *Ciba Foundation, Colloquia on Ageing*, vol. I, p. 88. London: J. & A. Churchill.
6. Wolbach, S. B. (1925): Amer. J. Roentgenol., **13**, 139.
7. Teloh, H. A., Mason, M. L. and Wheelock, M. C. (1950): Surg. Gynec. Obset., **90**, 335.
8. Silverstone, S. M. (1942 - 1943): J. Mt. Sinai Hosp., **9**, 74.
9. Montgomery, H. *In* MacKee, G. M. and Cipollaro, A. C. (1946): *X-ray and Radium in the Treatment of Diseases of the Skin*, 4th ed. Philadelphia: Lea & Febiger.
10. Dick, J. C. (1947): J. Anat. (Lond.), **81**, 201.
11. Kissmeyer, A. and With, C. (1922): Brit. J. Derm., **34**, 175.
12. Ejiri, I. (1937): Jap. J. Dermat. & Urol., **41**, 8. (cited by Tunbridge *et. al. loc. cit.*[14])
13. Tattersall, R. N. and Seville, R. (1950): Quart. J. Med., **19**, 151.
14. Tunbridge, R. E., Tattersall, R. N., Hall, D. A., Astbury, W. T. and Reed, R. (1952): Clin. Sci., **11**, 315.
15. Mackie, B. S. and McGovern, V. J. (1958): A.M.A. Arch. Derm., **78**, 218.
16. Saunders, T. S. and Montgomery, H. (1938): J. Amer. Med. Assoc., **110**, 23.
17. Warren, S. (1943): A.M.A. Arch. Path., **35**, 304.