FAILURE OF HAND GROWTH AFTER X-RAY THERAPY

By Y. S. Goh and T. H. Khor

SYNOPSIS

Late radiation damage to skin and bone, from superficial X-ray treatment for warts 18 years previously, is described in a 23 year old man. These effects are briefly described in relation to the dose received by the different tissues. Possible further complications in this patient by way of radiation-induced cancer are outlined.

INTRODUCTION

Chronic radiation damage to skin, bones and soft tissues has been well documented. Bone growth, particularly, may be retarded in children treated by roentgen radiation. The gravity of these sequelae militates against using such radiation in the treatment of benign conditions. We report here the damaging results of superficial X-ray treatment in a boy of five, treated for bilateral warts of the hands.

CASE REPORT

A.L.A. a male Chinese age 23 was seen in December, 1971 at the skin clinic, Middle Road Hospital with the complaint of "wrinkled" skin over both hands for many years. He was of normal build and in good general health.

The striking abnormality was in his wrists and hands—both hands were small in size and the distal forearms shortened (Figs. 1 and 2). The hands measured 13·4 cm. in length and 7·2 cm. in width. Such dimensions are those of a normal 9-13 year old Chinese male (Chang *et al*, 1968). The skin of the hands and wrists was dry and showed hyperpigmentation, hypopigmentation, alopecia, atrophy and numerous telangiectases. The web spaces exhibited many white fissures. There were no keratoses. The feet were normal in size.

The skin changes were consistent with chronic radiation damage, and he remembered having some "ray" treatment at the then General Hospital when he was a child. A search of the Radiology (Therapy) Department, Outram Road General Hospital records turned up his treatment card.

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This recorded that he was treated at the age of 5 years in 1953 for warts on both hands. Treatment was given on a superficial X-ray machine with the following beam characteristics—90KVP, 7mA, 2 mm. Al filter. A 25 cm. diameter applicator was used covering both hands. The dose delivered was 1,000 R over 15 days in 4 treatment sessions followed by a second course after a one month interval, of 1,750R over 25 days in 7 treatment sessions. Each fraction was 250R and the intervals between fractions for each of the two courses were 2, 3 and 6 days.

There was no record of follow-up.

INVESTIGATIONS

X-Rays (Fig. 3)

"*Forearms and Wrists:* Both radii and ulnae seem short, particularly the left ones, due to diminution in size and irregular development of their distal ends. The distal ulnae are more slender than usual and of uneven outline with some radiolucency extending over 2 cm. into their shafts. The distal radii are slightly expanded, with rather oblique articular surfaces, and there is some osteophytic lipping of the disto-medial aspect of the left radius. The metacarpals and phalanges seem smaller and shorter than usual. All bones of the wrists and hands appear rarefied.

Elbows: The head of the right radius shows a slight projection laterally.

Shoulders, Humeri and Feet: No lesions seen."

Skin Biopsy

A skin biopsy from the dorsum of the left hand showed a raised plaque covered by normal epidermis with a core of dense collagen and dilated capillaries. The adjacent epidermis was atrophic.

DISCUSSION

Since almost all roentgen therapy techniques involve skin irradiation, the effect of such radiation

on skin is well documented. Whilst the acute "weeping" reactions associated with cancericidal doses of superficial and deep X-rays are the result of epidermal changes, the late skin changes reflect the effect on the mesenchyme and blood vessels. The latter tissues are the more "critical" ones where long-term effects are concerned (Von Essen 1969, Moss 1969). Briefly the effects of skin irradiation leading to permanent changes are in the hair follicles (epilation), sweat glands (destruction), sebaceous glands (loss of secretions leading to a dry skin) and the dermis (fibrosis and subendothelial hyperplasia associated with telangicetases). These changes have all taken place in the case reported.

As the severity of damage is dose-dependent the dose delivered in this patient is of interest. The overall dose was 2,750R given in eleven all fractions of 250R each over 9 weeks. It is not possible to relate this to any single treatment schedule as treatment was in two courses with a consequent complex dose-time relation. The volume treated in this instance was quite large, a 25 cm. diameter applicator having been used. However, in this instance the size of each fraction (at 250R) is not excessive being sub-erythema. It has been shown that the degree of skin reactions is related to the size of each fraction too, in addition to dose-time and volume treated (Von Essen 1969, Traenkle et Muloy 1960). The severity of the patient's skin reaction is not in keeping with the order of dose given, possibly because calibration at the time of treatment was not competently performed. The indications are that output was considerably underestimated.

Bone changes from roentgen irradiation have also been well studied. Cartilage growth retardation has been recorded with doses in the order of 2,000R in 4 to 6 weeks (Moss, 1969), Rosenthal et Marvin 1957). In this patient the epiphyseal cartilages would have received the same dose as the surrounding soft tissues. The cortical bone however, having a higher Z value (atomic number) would present an entirely different dose picture. Blood vessels of the Haversian system and osteocytes lying in bony

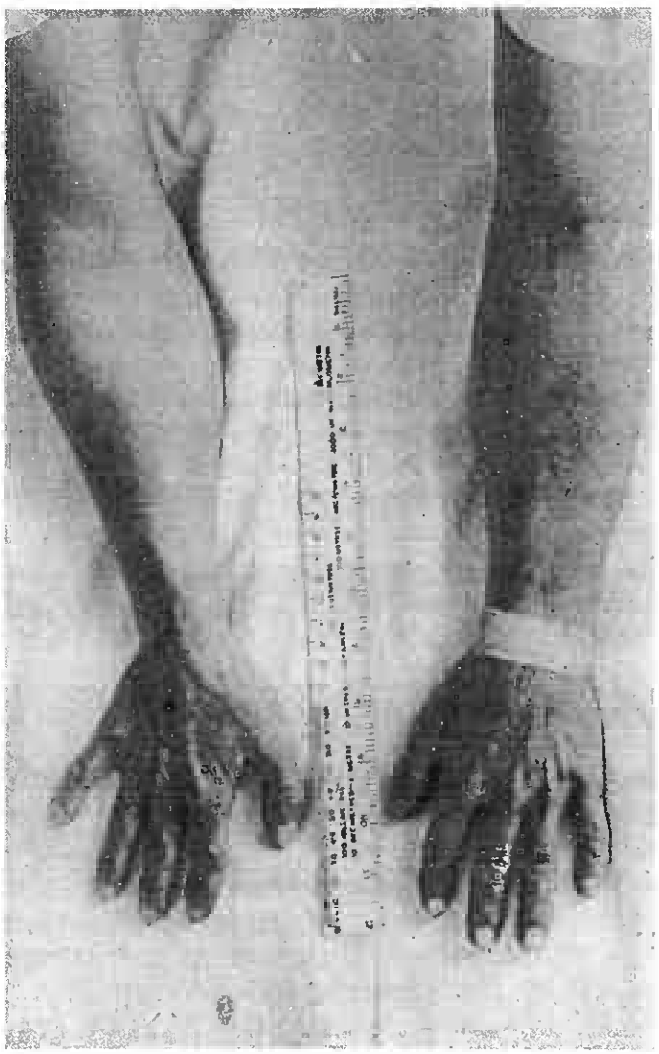

Fig. 1. Note the shortened hands and forearms. White fissures are also evident in the first interdigital space of the right hand. The adhesive tape is a dressing of the biopsy wound.

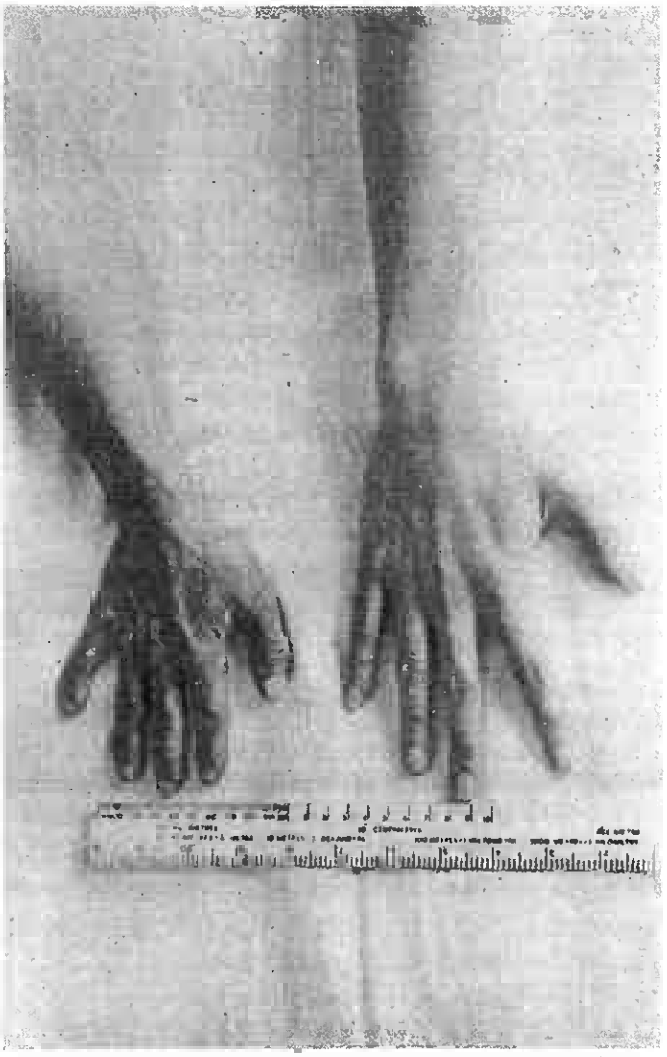

Fig. 2. The patient's right arm (left) compared with a normal subject's arm (right).

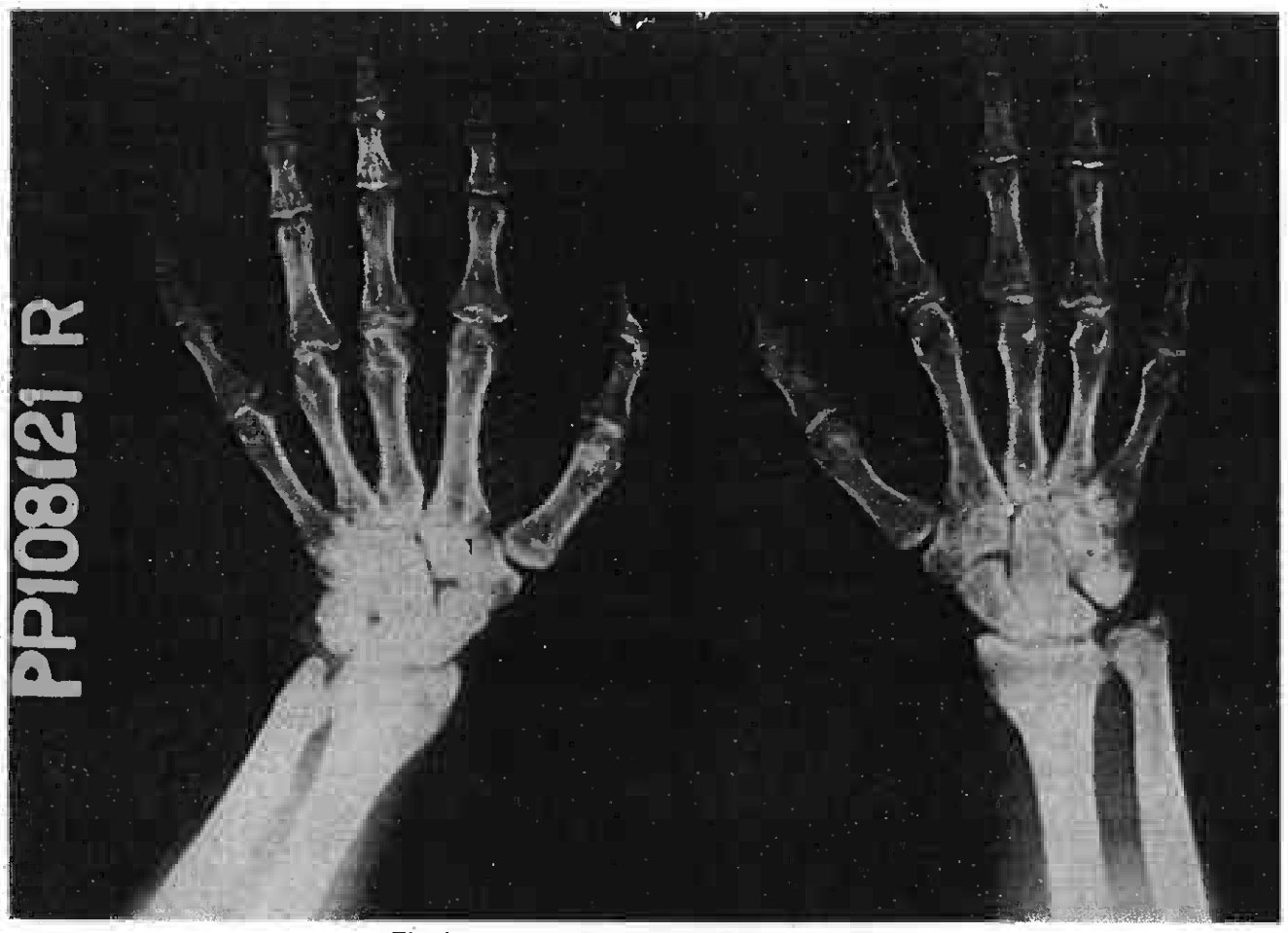

Fig. 3. X-ray of the hands and distal forearms.

spaces of less than 15 microns in diameter would receive 2 to 3 times the dose for homogenous soft tissue from the low-energy X-ray beam used (90KVP) (Johns et Cunningham 1968, Meredith et Massey 1972).

The arrest of bone growth seen in this patient is therefore to be expected from the treatment he received.

Treatment of benign conditions by roentgen rays has fallen into disfavour as the damaging effects on tissues have become widely known. Most modern textbooks of radiotherapy do not even mention the treatment of warts. However, Moss (1969) recommends treating only plantar warts and makes a point of minimising the depth of the lesion (by shaving), the volume to be treated and the dose to be given (maximum 1,500 rads single dose or 500 rads every other day for three doses). Treatment should not be repeated.

Although the changes documented in this patient are in themselves non-disabling, there still remains the risk of radiation-induced malignancy. The possibilities in this case are epitheliomata (squamous or basal), osteosarcoma and soft-tissue sarcoma. Witwer et Leucutia (1940) in reporting radiation-induced malignancies on skin theorized that lower energy X-rays (50KV to 130KV) gave rise to a higher incidence of such malignancies because of the more severe degree of atrophy they observed with this quality of X-rays. No details of doses were given in their series of 28 cases treated between 1922 to 1930 inclusive. Dosage was indicated subjectively e.g. second or third degree erythema. This patient would have had at least a second degree erythema so the risk of a subsequent malignancy is possible. The latent period recorded ranges from 2 years to 18 years. The majority of cases followed irradiation of benign conditions (acne vulgaris, keloid, callus, pruritis vulvae, seborrhoeic dermatitis, etc.) but none for warts (Witwer et Leucutia 1940).

The bone dose given (even for the epiphyseal cartilages) is within the range reported in the literature for radiation-induced bone sarcoma. Cruz *et al*, 1957 reported cases receiving doses ranging from 1,000R in one month to 5,289R over nine years. The "silent" interval between completion of irradiation to diagnosis of osteosarcoma was 4 years to 24 years. Sabanas *et al* (1956) gives much the same figures (dose 1,400 rads single dose to 10,000 rads in 39 months, latent interval 32 months to 30 years).

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ADDENDUM

We also wish to add that at the time of treatment in 1953 no qualified therapeutic radiologist was available in Singapore.

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