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RADIATION INJURIES RESULTING FROM THE IMPROPER
USE OF X-RAYS FOR DIAGNOSTIC PURPOSES

By Ye. I. Vasil'yeva

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RADIATION INJURIES RESULTING FROM THE IMPROPER
USE OF X-RAYS FOR DIAGNOSTIC PURPOSES

Following is the translation of an article by Ye. I. Vasil'yeva entitled "Luchevyye povrezhdeniya v resul'tate nepravil'nogo ispol'zovaniya luchey s diagnosticheskoy tsel'yu" (English version above) in Vestnik Rentgenologii i Radiologii (Herald of Roentgenology and Radiology), Vol. 35, No. 3, Moscow, 1960, pages 59-69.7

From the Therapeutic Department (Head - Doctor of Medical Sciences L. P. Provas) of the Central Scientific Research Institute of Medical Radiology (Dir. - Prof. M. N. Fobedinskiy) of the Ministry of Health USSR.

Of all the tissues which undergo pathological changes when exposed to X-rays, the skin was one of the first to be studied macro- and microscopically. Skin injuries, in the form of atrophy with concomitant changes in blood vessels and appendages, are often accompanied by third- and fourth-degree burns with the formation of protracted, unhealing, very painful and deep ulcers which in some cases initiate the development of an X-ray cancer.

During the past few years, owing to the development of our knowledge of the action of ionizing radiation, as well as of safety engineering and precise dosimetry, severe skin radiation injuries have occurred less and less frequently.

Cutaneous changes may originate as the result of a single large radiation dose, or from the cumulative effect of multiple small doses.

Cutaneous injuries occur not only in individuals who come into direct contact with ionizing radiation in the course of their work, but also in patients who have been subjected to X-ray examination and treatment with radioactive substances, when the rules of utilization of the X-ray devices are not adhered to (faulty calculation of possible exposure, omission of filter, inaccuracy of

device for measuring dose.

Acute radiation skin injuries have a protracted course and respond poorly to treatment.

We have observed four cases of acute X-ray injuries which originated as the result of the use of X-rays for diagnostic purposes:

Patient A., female. On 23 January 1953 a rearrangement of the fragments of a fractured basal phalanx of the first finger of the left hand was made, during which an X-ray screen on a mobile X-ray apparatus (UPPN-70-1, RU-760 type) was used by the physician for observation and control of the operation. Working with the physician was the surgical nurse on duty, who had received no training in X-ray techniques. The wrist of the woman physician, who wore no protective gloves, was exposed to X-rays for 40 minutes near the focus of the tube. Within an hour thereafter she experienced a marked muscular weakness, nausea, lack of appetite, headache, and later, vomiting. Within eight hours, pain was noted in the fingers of both of her hands and in the operated hand of the patient. During the night and on subsequent days the pain increased and spread along the forearm. On the fifth day there appeared slight erythema and considerable edema of the hands and forearm of the physician and the operated hand of the patient. On the tenth day the edema of the hand increased, the skin assumed a purple-red color; small petechia and later blisters filled with serous and subsequently purulent fluid appeared on the fingers. These phenomena were accompanied by acute pain. The blisters opened within a short time and in their place necrotic tissue appeared. Upon admission to the Clinic of the Institute, the physician reported acute pain, itching and burning in both hands, especially in the fingers and forearm. Day and night the pain was severe and was little alleviated by the administration of narcotics. The wrists remained edematous. On the back of the fingers of both hands the surface was dark red purulent, and ulcerous, covered in places with fibrin extending on to the palmar surface. The slightest touch of the wound increased the pain. The skin of the dorsal metacarpal surface was slightly edematous and pigmented. The nail matrices were edematous and cyanotic (Fig. 1.)

Thus, the physician had a cutaneous X-ray injury which as it progressed could be characterized as a fourth-degree burn.

In the patient who had undergone surgery, the manifestations of pain, itching and burning in the area of the affected hand were less pronounced. An X-ray ulcer was

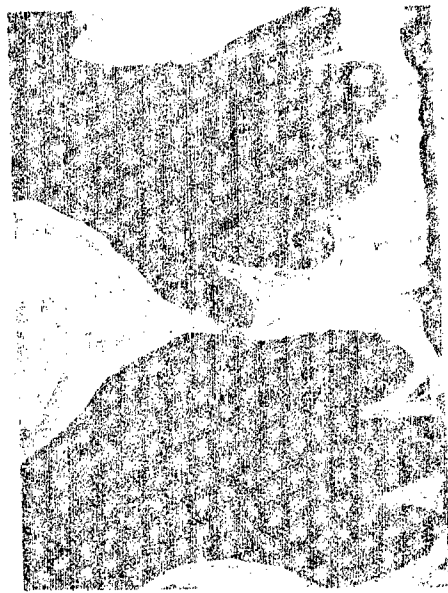


FIG. 1. Patient, P., X-ray
injury of both hands:
ulceration of the skin
of the dorsal surface
of fingers and areas
of the nail matrix.

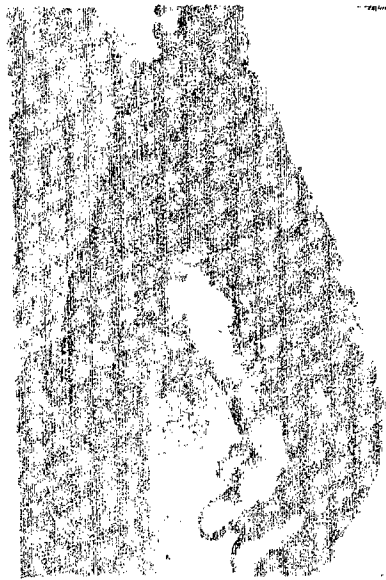


FIG. 2. Patient R., female.
X-ray injury of left
hand. The ulcer on
the dorsal surface of
the hand extends to
the palmar surface of
the forearm.

noted on the dorsal surface, extending to the palmar surface of the basal phalanx of the first finger and the first and second metacarpal bones of the left wrist. The ulcer was covered with a purulent film with hemorrhagic areas; there was no evidence of epithelialization. Around the ulcer on the skin and wrist there appeared pigmentation and desquamation. There was a considerable edema of the entire wrist (Fig. 2).

Thus, in the patient there was observed an analogous X-ray injury of the skin of the irradiated hand.

The third and fourth observations refer to employees of a Leningrad plant who had been subjected to soft X-ray radiation for a picture.

Engineer G., 25 years old, and X-ray laboratory technician A., 27 years old, each had two X-ray pictures taken of contusions of fingers of the right hand, on the URS-70 apparatus (designed for X-ray structural analysis of metals), under the following technical conditions: voltage 25 kv, current 14 ma, distance from tube to hand 15 cm, exposure two minutes. The total X-ray dose under these conditions for two pictures was 13,000 r.

Within two weeks after X-raying, there appeared in these patients marked redness on the dorsal surface of the hand and fingers, sensations of tension, edema, itching and acute pain. Shortly afterwards blisters appeared filled with serous fluid (in the area of the 2nd, 3rd and 4th fingers of the engineer; in the laboratory technician, in the area of the 2nd, 3rd and 4th metacarpal bones on the dorsal surface). In the case of the engineer the serous fluid was removed by means of a syringe; the laboratory technician's blisters were cut off with scissors.

Of these four patients, in the first two there was observed falling out of the hair on the head; in the other two depression, sluggishness, slight headache, poor sleep, palpitation, rise in temperature -- i. e., the manifestations of radiation sickness -- were noted. There were no noticeable changes in the organs of the thoracic and abdominal cavities.

Upon examination of the peripheral blood, only in patient P. was there observed a transitory increase of the number of leucocytes (to 13,000); in her blood a toxic granulosity of the neutrophils was also noted. In regard to other blood indicators there were no deviations from the norm during the three-month period of observation.

The treatment of the radiation injuries of the skin consisted of local application of stickleback oil in combination with penicillin and anaesthesia. Three patients were given cortisone intramuscularly (30 to 750 ml) for its

anti-inflammatory and stimulating effect on tissues.

One month after the treatment, the ulcerous surface in patients G. and A. had healed; at the seat of injury there remained atrophic, dry, thinned-out, and slightly cyanotic skin. The mobility of the joints was not impaired.

In patients P. and K., at the beginning of treatment the pain rapidly diminished and epithelization and granulation appeared. Within two months the ulcers in the areas of the 2nd, 3rd and, partly, the 4th fingers had healed and teleangiectasies had appeared on the irradiated skin. However, within four months there recurred acute pain and necrosis of the skin of the affected hands.

It is known that in radiation injuries atrophic and sclerotic processes develop which affect not only the skin but also the underlying tissues. Phenomena of arteriosclerosis with subsequent obliteration of cutaneous vessels contribute to atrophy of the skin and to the development of indurative edema, teleangiectasies and late necroses with formation of chronic ulcers. The first two patients will have to undergo surgical intervention (amputation of fingers).

In describing these cases of X-ray injuries, we wish to call to the attention of those who come in contact with ionizing radiation the necessity of careful and technically correct employment of X-rays for diagnostic purposes. Only physicians and X-ray technicians who have had special training in the field of X-ray technique have the right to engage in X-ray diagnosis.