

Lessons Learnt Through the Follow-up of the Long-term Effects of Over-exposure to an ^{192}Ir Industrial Radiography Source in Bangladesh

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ABSTRACT

An industrial radiographer was accidentally over-exposed while taking the radiograph of weld-joints of gas pipe-lines in 1985 in Bangladesh. Symptoms of high radiation exposure occurred immediately after the accident and skin erythema developed leading to progressive tissue deterioration. The consequences of this over-exposure is being followed up to assess the long-term effects of ionizing radiation on the victim. Progressive tissue deteriorations have already led to multiple surgeries and successive amputations of the finger-tips so far. Lessons learned from this accident are also reported in this paper.

INTRODUCTION

An industrial radiographer was accidentally over-exposed to high dose of ionizing radiation from an ^{192}Ir source pellet during radiography of weld-joints in gas pipe-lines on June 10, 1985 in Bangladesh. Long-term effects of this over-exposure are being followed up. The findings have been published in Health Physics journal [1, 2, 3]. The source, housed in a portable exposure assembly, had an activity of about 1850 GBq. A guide-tube was used to control the transfer of the source from safe storage position to the exposure position and vice versa. For radiography, the tip of the guide tube was to be fixed to the weld-joint while the source was cranked to the exposure position. Following the elapse of the preset exposure time the source had to be cranked back to the safe storage position. This procedure was to be repeated for each radiographic exposure.

On the night of the incident the source had stayed in the 'On' position and did not possibly return to its safe storage position after the very first exposure. The radiographer, however, continued the work without knowledge of the hazard. After taking 18 such radiographic exposures he became tired and exhausted and felt malaise. So he stopped working and fell asleep. The following morning he was awakened by repeated callings. Observations indicated that the radiation source pellet was detached from its coupling and remained in the "On" position during the entire radiographic series.

FINDINGS

1. Radiation induced biological effects

a. Short-term biological effects

Biological effects such as mild vomiting, malaise, nausea and diarrhea occurred within a short period after the accident. Skin erythema, swelling and tenderness of the palmar surfaces and the tips of the thumbs, index fingers and middle fingers of the both hands accompanied by severe pain and inflammation developed within 7 days of the mishap. The inflammatory changes characterized

by redness and bullae spread over the affected fingers with severe pain and agony within a few days. The finger-tips developed abscesses with enormous pus formation and the affected finger nails fell off. He also developed toothache. At this stage a medical practitioner made some surgical dressings and prescribed antibiotics. During the first six months the most serious health disorder was local necroses of the skin and the deep layers of the palmar side of the affected fingers with sharply delineated injuries. The clinical findings were consistent with those reported elsewhere under similar accident conditions [4,5].

b. Long-term biological effect

Long-term follow-up of the effects of the accident on the victim is being carried out. The follow-up observations include among others studies of x-rays of affected limbs, blood analysis, tissue biopsies including histopathological studies and an evaluation of the skin condition of the overexposed limbs. The manifestation of disease syndromes and onset of other physical ailments are also being observed.

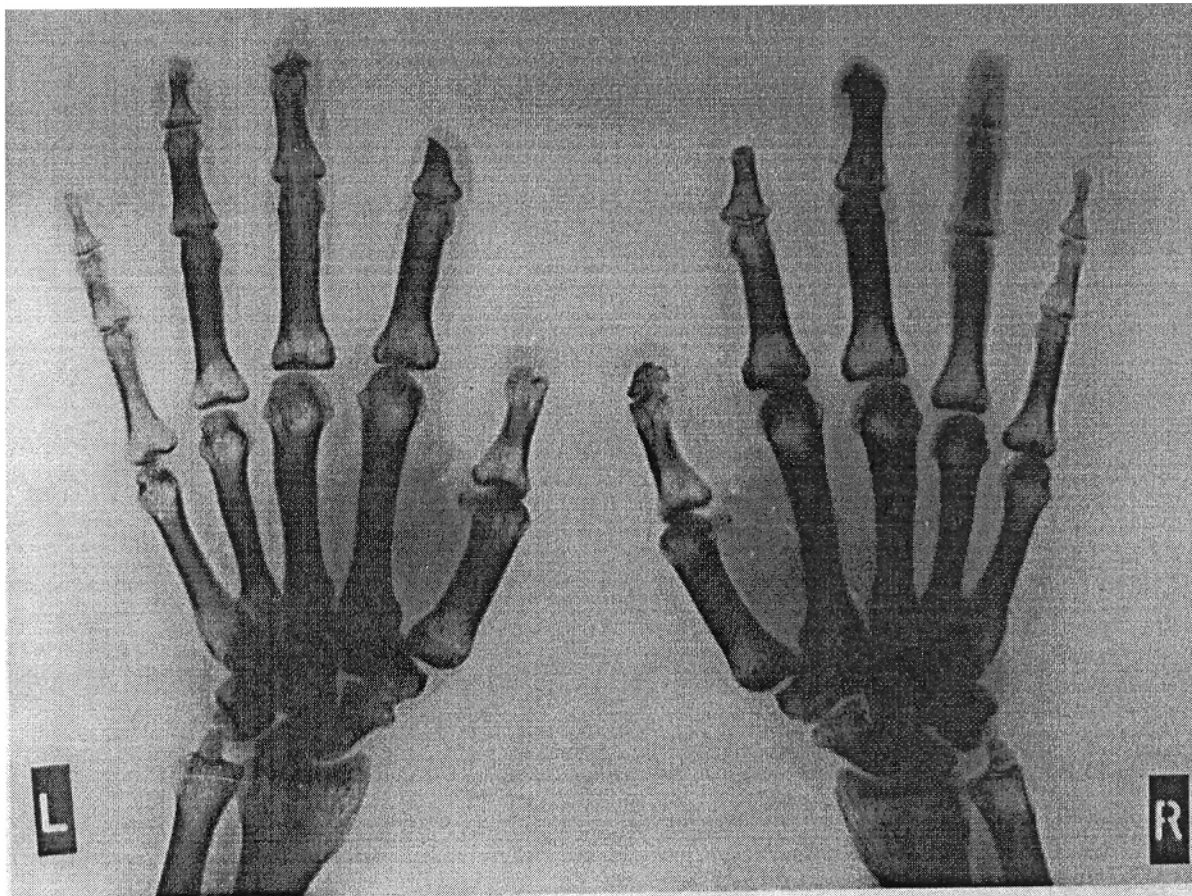


Fig.1: X-ray of the affected hands of the subject 5y after exposure to an estimated dose of 24 Gy to the fingertips and 2-3 Gy to the body. The fingertips have been subject to repeated surgeries to remove the progressively abscessed tissues. The bones at the fingertips appear to have grown brittle due to reduction of bone density.

The x-rays of palms and fingers taken from time to time reveal the following major changes:

- The terminal phalanges of the left thumb and the right and left index fingers are lost.

- The terminal phalanx of the left middle finger is partially lost.
- There is reduction in bone density particularly in the peripheral bones and in the left wrist joints. However joint spaces appear normal
- The tips of the affected fingers have already been lost and decaying away gradually.

c. Biopsy studies histopathological specimens

Skin changes: Microscopic examinations (X100) of the histopathological specimens of the skin showed hypokeratosis and hypoblastic stratum malpighi. The dermal collagen fibers were increased and were sparsely cellular with absence of adnexal structures. No evidence of malignancy was seen. Histomorphologic findings of the tissue were consistent with those associated with radiation injury.

- **Bone-marrow changes:** The biopsy test showed the myeloid: erythroid (M: E) ratio as 4: 1. The following is a summary of the cytomorphology of the marrow cells:
 - i. Erythropoiesis was active and normoblastic.
 - ii. Granulocytopoiesis was also active. The granulocyte maturational process appeared to be normal. There was no dysgranulocytopoiesis, and the blast cell populations were not elevated.
 - iii. Megakaryocytes were observed forming mature platelets as normal.
 - iv. No parasites or atypical cells were seen.
 - v. The cellular marrow was active.
- **Blood analysis:** There were no significant differences between the results of blood tests performed from time of time after 1.5 years of the mishap.

LATE SOMATIC EFFECTS AND PRESENT HEALTH STATUS

The most significant health disorder found is local necroses of the skin and deeper tissue layer not stabilizing even after a series of surgeries. The wounds at the finger-tips reappear within a year or two following repeated surgical removals of abscessed tissues through amputations. The finger-tip develop abscess with pus formation with pain worsening during the night. The affected fingertips have become prone to developing secondary infections whenever they come in contact with water or chemical agents or are subjected to mechanical irritations. Bones at the finger- tips have brittle. Following surgical removal each time the bones at the finger-tips again become brittle within a year or two.

The health condition of the victim has been deteriorating with passing of time. Cosmetic deterioration of the fingers and palms bother him producing prolonged depression accentuated by severe pain in the affected limbs from time to time. In addition infection has set in anew on the tips of two other finger-tips so far; unaffected with progressive tissue deterioration.

Serious trophic changes characterized by discolored skin. persist on the fingers. Motility of the fingers and ability to hold anything have significantly diminished by now.

LESSONS LEARNED FROM THE ACCIDENT

Studies on this accident revealed to us the effects of exposure to high dose of ionizing radiation on human being that cannot be obtained using humans experimentally. Results of irradiated animal studies are usually extrapolated to humans but such extrapolation is not totally reliable because of physiologic, metabolic and other dissimilarities. The long-term follow-up study of the consequences of this accidental overexposure complements the information obtained immediately after recovery from acute radiation exposure injury. It also provides useful lessons about treatment of the affected individual immediately after the incident and afterward. Continual monitoring helps to detect, the time of and the cause of on-set of disease syndromes in the victim.

Secondary infections develop in the affected limbs if they come in touch with anything or are subjected to mechanical stress. There are progressive tissue deteriorations due to frequent infections with the tips gradually decaying and falling away.

The radiographer was working alone and had no radiation monitoring device or personnel exposure monitor with him. So it is quite evident that any activity involving ionizing radiation must be carried out strictly following the radiation protection rules and regulations. None should handle any radiation source without proper radiation protection and safety training and the radiation worker must be provided with personnel and area monitoring capability. Besides, in industrial radiography work, personnel, protection would be better served if two or more are engaged in the operation because preoccupation of the radiographer in performing his work may disturb his strict adherence to good radiation protection and safety practices.

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