

# Medical management of severe local radiation injury after acute x-ray exposure

Andrey Bushmanov<sup>\*1</sup>, Natalia Nadezhina and Andrey Kretov

*Center of Occupational diseases of the Burnasian Federal Medical Biophysical Center of the Federal Medical Biological Agency of Russia, Marshala Novikova street, 23, 123098, Moscow, Russia*

**Abstract.** Medical management during acute period in a case of severe local radiation injury after acute x-ray exposure includes 3 stages. During the first stage patient got conservative treatment according to the common pathogenetic mechanisms of LRI (disaggregating therapy, stimulation of regeneration, disintoxication therapy, antibiotic therapy, pain relief therapy, Local anti-burn therapy - specific non-adhesive bandage with antiseptic and anti-burn medicaments); estimation of severity, deepness and area of injury by clinical picture and dates of instrumental methods of examining; defining necessity and volume of surgical treatment; preparing arrangements for surgical treatment. This stage ends with forming of demarcation line of a very hard severity of a Local Radiation Injury. The second stage includes necrectomy of the area of a very hard severity with microsurgical plastic by revascularized flap and autodermoplastic. The third stage - adaptation of revascularized flap and total epithelization of injured area.

**KEYWORDS:** *x-ray exposure, local radiation injury, medical management.*

**1. Introduction.** Local radiation injuries (LRI) are result of local or extra- nonuniform exposure. Actuality of this kind of radiation trauma is based on increasing of the rate of LRI in comparison to the total rate of radiation injuries. The rate of LRI in Russia during 1950-1960 was 21,3%, during 1971-1981 was 61,3%, and the rate at the end of 2004 was 72%. During last nine years (1998-2006) scientists of the Center of Occupational diseases of the Burnasian Federal Medical Biophysical Center of the Federal Medical Biological Agency investigated 34 incidents of an overdose: FMBA of Russia – 9 incidents, other industry branches of Russian Federation – 23 incidents. Results: 72 persons were involved, 25 persons got radiation injuries – 2 Acute Radiation Syndrome (ARS), 17 LRI, 6 ARS with LRI.

First place judging by the rate takes LRI of palms, about 80%. Normally this kind of LRI is a result of contact between palm and a source of ionizing radiation for defectoscopy or radiotherapy. In this case palm, fingers and forearm are general areas of injuries. LRI from “strong” x-ray exposure, electrons and gamma-neutron exposure are very similar concerning the severity of clinical picture.

Second place takes LRI of palms from “soft” x-ray exposure. Cases of “soft” beta-exposures are very similar concerning the clinical picture. Injuries of rare area of fingers, palms and forearms are typical for this kind of LRI. Involved persons are usually personal of different factories.

Clinical picture of LRI includes some phases:

- first reaction
- latent period
- acute period
- period of outcome
- period of late consequences

LRI is distinguished by the severity grade:

- light severe
- middle severe

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\* Presenting author, E-mail: radclin@yandex.ru

- hard severe
- very hard severe

Criteria for this classification are skin changes, clinical phase lasting, kind of exposure and dose distribution.

**2. General part.** Medical management during acute period in case of severe local radiation injury after acute x-ray exposure includes 3 stages.

During the first stage patient got conservative treatment according to the common pathogenetic mechanisms of LRI (disaggregating therapy, stimulation of regeneration, disintoxication therapy, antibiotic therapy, pain relief therapy, Local anti-burn therapy - specific non-adhesive bandage with antiseptic and anti-burn medicaments); estimation of severity, deepness and area of injury by clinical picture and dates of instrumental methods of examining; defining necessity and volume of surgical treatment; preparing arrangements for surgical treatment. This stage ends with forming of demarcation line of very hard severity of Local Radiation Injury.

The second stage includes necrectomy of the area of a very hard severity with microsurgical plastic by revascularized flap and autodermoplastic.

The third stage - adaptation of revascularized flap and total epithelization of injured area.

This clinical example shows stages of medical management:

Patient Ch., 24 years old (maintenance engineer of X-ray spectrograph, employee of integrated iron-and-steel factory, which is not the object of nuclear industry), during repairing process of X-ray spectrograph got x-ray exposure of both manus and right forearm. In 20 seconds he cleaned dust by his both arms. He staid in immediate proximity to x-ray during 30 minutes. The patient found out that the x-ray tube was turned on at the end of the repairing process. He denied that he had any pain or discomfort in manus during the repairing process.

Patient had typical clinical picture of severe local radiation injury after acute x-ray exposure: lack of latent period for right hand (about 6 hours) and 2 weeks of latent period for left hand, fast appearing – after 6 hours – of edema and hyperemia of right manus, early forming of vesicles – 2 days after exposure – and forming of erosive and ulcerous areas under vesicles of right manus, starting of forming of necrosis area – 15 days after exposure – at rare area of the right manus, late appearing – 17 days after exposure – vesicles of left manus.

Status localis (the patient was hospitalized in the Center of Occupational diseases of the Federal Medical Biophysical Center of the FMBA of Russia):

Right manus – edema, rear area, lower-third section of forearm, proximal and middle phalanges of II-IV fingers were covered by erosive and ulcerous areas. There was a dense, black colored area of necrosis at base of II-IV fingers of the right manus. Some small regions of peripheral epithelization were also present. The right manus was mostly inactive due to edema and dense necrosis. The process of necrosis continued.

Left manus – total epithelization with small areas of peeling and depigmentation.

On the basis of the received data we have the following situation:

- Anamnesis: manipulations of both hands in the area of x-ray exposure;
- Typical clinical picture (lack of latent period for right hand and 2 weeks of latent period for the left hand; fast appearing – after 6 hours – of edema and hyperemia of right manus; early forming of vesicles – 2 days after exposure – and forming of erosive and ulcerous areas under vesicles of right manus; starting of forming of necrosis area – 15 days after exposure – at rear area of right manus; late appearing – 17 days after exposure – vesicles of left manus) tells us about very high severity and high severity of LRI in right manus and forearm, and medium severity of LRI in left manus.

We defined the diagnosis as following: Acute local radiation injury (LRI) of the right manus and forearm – high severity and very high severity (III-IV), and in left manus – medium severity (II) after x-ray exposure.

Also, to define severity and area of local radiation injury of the both manus, the following procedures were carried out:

- Magnetic nuclear resonance tomography of both manus with contrast: granulations at base of III-IV fingers of right manus, reactive changes of muscles, suspicion of necrosis of distal phalange of the I finger of the right manus.
- Computer tomography of both manus: signs of necrosis were not found.
- Radioisotopic study of both hands: inflammatory changes on skin of right hand, muscles and bones from manus to elbow.
- Ultrasonic scanning of vessels on the both hands: left hand was without disorders, right hand had a magistral blood flow, without diastolic component.
- Electromyography: muscles conditions without disorders.

During acute period Patient got conservative treatment according common pathogenetic mechanisms of LRI.

On 85-th day after exposure by conservative therapy we got total epithelization of left manus, partial peripheral epithelization of right manus and formed demarcation line of very hard severity of LRI.

Taking into account a severe LRI of soft tissues, inefficiency of conservative therapy in similar injures and good conditions of soft tissues of the right palm at 85 days after exposure a plastic microsurgical operation was made: necrectomy on the rear area of the right manus with single-stage microsurgical plastic of defect by fascia of musculus serratus and perforated autodermoplastic.

On 134-th day after exposure fascia of musculus serratus got total adaptation with 65% of epithelization. In connection with partial necrosis of autodermal flap (35%) iterative autografting was made.

Result of surgical operations at right hand was total epithelization of injured area (157 days after exposure). Course of rehabilitation was started (physiotherapy with local applying of special medicaments for stimulation regeneration and resorption of scars, massage of manus and curative gymnastics ).

Hospitalization ended at 171-st day after exposure, results of treatment:

- total epithelization of left hand, there are small areas of hypopigmentation, good condition of skin;
- total epithelization of right hand, good condition of transplanting flap, there are areas of hyper- and hypopigmentation, teleangioectasia, artificial webbing of III-IV fingers;
- functional activity of left hand recovered completely;
- functional activity of right hand recovered partial: activity of manus joints is limited, process of taking of small things is limited also, speed of writing decreased.

Outcomes of acute period are epithelization of expoused area or absence of it, with or without developing scary and atrophic changes.

Period of late consequences is characterized by developing several changes of injured area:

- scary and atrophic changes of skin, subcutaneous fat, muscles;
- radiation fibrosis of skin;
- teleangioectasia;
- disturbance of pigmentation (hyper- and hypopigmentation);
- late radiation ulcers;
- osteoporosis;

If exposed area includes joint, we can see contraction of this joint.

Severity of MLP is one of the general factors of determination of outcomes and period of late consequences. Hereby light severity in 80% of cases ends by epithelization, 20% - epithelization with local skin atrophy and has no any consequences in late period. Middle severity outcomes are characterized by 80% epithelization with skin atrophy and 20% - skin atrophy with teleangioectasia and disturbance of pigmentation, during period of late consequences 10% of cases have late radiation ulcers. In case of hard severe injure all patients have scary and atrophic changes, and only 50% of cases end by epithelization, 82% of patients have late radiation ulcers in late period. Outcomes of very hard severe injures are characterized by absence of epithelization and all patient have development of late radiation ulcers in late period.