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Never came across radiation induced skin injuries- Why?

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It is extremely rare to come across an interventionist who has ever seen a patient with a radiation-induced skin injury (somewhat like a skin burn) from a fluoroscopic-guided interventional (FGI) procedure. It is equally difficult to find an interventionist who agrees that the procedures they perform can lead to skin injury to a patient. Interventional radiologists will normally say that this can happen in procedures performed by interventional cardiologists, and vice-versa.

One needs to examine why this is. Are skin injuries only a theoretical and rare possibility? If not, are they being missed? What happens to the injured patients?

In the early years of reporting of radiation-induced skin injuries in the early 1990's, when awareness of the possibility of FGI procedures leading to skin injury was poor, patients would typically go to their general practitioner, who would normally not have seen such an injury and would likely diagnose it as an insect bite, thermal burn or allergic reaction. If the injury was severe, the patient would be referred to a dermatologist who would also not usually be familiar with radiation-induced injuries. The dermatologist would try topical treatment, which would be ineffective, and ultimately refer the patient to the emergency department where, again, it would not be easy to reach a diagnosis. The injury takes a few weeks to appear after radiation exposure, depending upon the extent of exposure. This delay, coupled with a lack of awareness, makes it unlikely that the connection would be made with FGI. I have records of patients who used the internet to establish the link between FGI and their injury. Also, about 20 years ago, I recall a cardiac surgeon in my institute coming to me, stating that some of his patients had erythema on their backs and he

suspected faulty earthing of his operation table, or grounding pads used in the operation theatre, to be the cause. In the absence of awareness, one would not think that angiography done several weeks ago, before the patient came in for surgery, to be the cause. This may still be a typical scenario in many countries. Also there are reports of lawsuits filed against companies supplying these pads rather than thinking of radiation from fluoroscopy being the cause.

Miller et al. [2010] estimated the frequency of major radiation injuries to be between 1:10,000 and 1:100,000 procedures (based on 10 injuries reported every year in the USA from nearly 10 million interventions, taking a rounded figure). Therefore it is no wonder that many interventionists may not have come across these injuries. This, however, does not rule out the possibility of patients having injuries but not getting diagnosed.

Published reports of skin injuries have mostly been from the USA. It was arguably believed that body weight and obesity is the most important contributing factor. The observation of injuries from Thailand in not so thick patients (Fig. 1) indicated that while body cross section is an important contributing factor that hikes radiation exposure, it cannot be assumed to be the most important one. Even if the dose rate was lower for a patient with a thinner cross section, the machine setting was found to be the reason for such injuries. Fluoroscopists should get their machines checked by a medical physicist to ensure that the dose rate delivered by the angiography machine is in line with standards and what the machine is supposed to deliver. With lack of awareness possible at every level, one cannot assume that the service engineer is knowledgeable, and if they are satisfied, it may be the correct setting of radiation output from the machine.

SKIN INJURIES IN INTERVENTIONAL PROCEDURES



Figure 1. Skin injury in a patient with chronic total occlusion. a) 2 mths, b) 6 mths, c) 8 mths after last PCI, and d) after the flap surgery.

(Fig. 1. Skin injuries reported from Thailand. Reproduced from Rehani MM, Srimahachota S. Radiat Prot Dosimetry. 2011 Sep;147(1-2):8-12)

It is of utmost importance that the interventionist should be familiar with the dose figures displayed by the machine and keep a record of doses delivered to every patient. Unfortunately these dose figures are not indicative of peak skin dose and thus cannot directly indicate risk of skin injury. That creates greater need for the interventionist to be familiar with the generally displayed dose quantity, like cumulative air kerma (CAK) or skin dose, and know how to correlate these quantities with risk. For example, it may require 4-5Gy of CAK to deliver a peak skin dose of about 2Gy that can lead to mild or transient erythema. The higher the radiation doses, the higher the severity of the skin injury. Thus, interventionists must look at the dose values for patients with fluoroscopy times of more than 30 minutes. Fluoroscopy time may not be the most reliable factor but is indicative as radiation is also delivered through cine runs. Another dose quantity provided by

most machines is kerma (or dose) area product (KAP or DAP). This value is not a very good indicator of the risk of skin injury as it provides total energy imparted which can be related to stochastic risk, not really the risk to the localised part of the skin (deterministic effect).

It is important for interventionists to be familiar with radiation dose values, keep an eye on dose delivered, ask patients to be watchful if the dose figures exceed the specified trigger level, be mindful of radio-sensitivity of some patients, proactively call patients who have exceeded trigger values after approximately 30 days, to check for any skin reaction at the port of entry of radiation.

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Further reading

Miller DL, Balter S, Schueler BA, et al. Clinical radiation management for fluoroscopically guided interventional procedures. *Radiology*. 2010; 257(2): 321-332.

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Rehani MM, Ortiz-Lopez P. (Editorial) Radiation effects in fluoroscopically guided cardiac interventions-keeping them under control. *Int J Cardiol*. 2006; 109: 147-151.