Chronic radiation dermatitis induced by cardiac catheterization: a case report and literature review

Ting Ting Cheng¹, Hui-Ju Yang¹,²

¹Department of Dermatology, Changhua Christian Hospital, Changhua, Taiwan. ²Department of Post-Baccalaureate Medicine, College of Medicine, National Chung Hsing University, Taichung, Taiwan.

Abstract

Fluoroscopy-induced chronic radiation dermatitis (FICRD) is an uncommon but increasing complication that is challenging to diagnose due to its varied symptoms and delayed onset, usually from months to years after radiation exposure. For patients undergoing cardiac catheterization, high-risk factors for radiodermatitis include obesity, the presence of complex or chronic total occlusion lesions, the use of a fixed large beam angulation, and a procedure time of more than 2 hours. We present an individual with FICRD that had an indurated plaque on his back for 7 years to familiarize physicians with high-risk groups and early recognition of the disease.

Keywords: radiation dermatitis, cardiac catheterization, chronic total occlusion, fluoroscopy, indurated plaque

Introduction

The American College of Radiology has highlighted the following fluoroscopic procedures with a substantial radiation dose: transjugular intrahepatic portosystemic shunt creation, embolization of any lesion in any location, visceral angioplasty, percutaneous coronary intervention (PCI), and vertebral augmentation (1). Cutaneous injury may occur when the radiation dose exceeds 2 Gy, with transient erythema as the earliest sign (2). The lesion occurs at the site exposed to radiation, and the extent of skin injury depends on the dose delivered (3). Acute reactions encompassing erythema, epilation, and desquamation develop within days to weeks (2, 4). Chronic skin injuries have a longer time of onset (months to years), with clinical presentation of skin atrophy, ulcerations, and dermal necrosis due to higher doses (> 10 Gy), and they require extensive surgical repair (2, 4).

Case report

An obese (body mass index 42 kg/m²) 55-year-old man presented to our dermatology clinic with an itchy and painful skin lesion on the left side of his back that had persisted for 7 years. His medical history included hypertension, diabetic mellitus, dyslipidemia, and coronary artery disease. He denied excessive sun exposure, contact with substances, or any traumatic history.

On physical examination, the skin lesion was an erythematous atrophic plaque, about 8 cm long and 6 cm wide, rectangular, and sharply demarcated, with dyspigmentation, telangiectasias, and some superficial ulcerations (Fig. 1). There was no discharge or sign of infection. Morphea and chronic contact dermatitis were suspected; thus, a skin biopsy was performed, which revealed thinned epidermis, superficially dilated blood vessels, dermal sclerosis with minimal inflammation, and absent adnexal structures (Fig. 2).

Tracing his history, three catheterization procedures had been carried out between 2013 and 2014 at another hospital with a total fluoroscopy time of more than 4 hours. Drug-eluting stents were placed at 67% stenosis of the middle right coronary artery (RCA), 80% stenosis proximal to the middle left anterior descending artery, and chronic total occlusion (CTO) of the left circumflex artery (LCX). The patient mentioned that the physician tried a microcatheter and many kinds of guidewires for placing the stent through the distal LCX CTO lesion due to severe calcification, resulting in a procedure time of 3 hours. The total radiation dose exposure was unknown.

Erythema developed within a few weeks after the last PCI treatment and spontaneously resolved. Unfortunately, it recurred at the same place afterward and progressed. The skin lesion initially showed a poor response to topical corticosteroids with antibiotics. However, there was a resultant decrease in erythema and healing of the superficial ulceration after treatment with a hydrogel composed of sodium alginate, hyaluronic acid, and silver nanoparticles. Gabapentin was given for pain control. To sum up, the clinical and histopathologic findings were compatible with a diagnosis of fluoroscopy-induced chronic radiation dermatitis (FICRD).

Figure 1 | An ulcerated, atrophic, and indurated plaque with dyspigmentation and telangiectasias on the left side of the patient’s back.
FICRD is an increasing complication. Mélanie et al. (3) reported an 8.8% incidence of FICRD among patients undergoing high-risk procedures for skin injury, defined as a peak skin dose (PSD) > 3 Gy, reference point air kerma > 5 Gy, kerma area product > 500 Gy/cm², or fluoroscopy time > 60 minutes. Wei et al. (5) reported a 0.34% incidence of radiation ulcers among patients receiving either PCI or electrophysiologic ablation.

Discussion

Although fluoroscopic procedures are performed using X-ray beams with a low energy level (50 to 125 kilovolts), most of the energy is absorbed within a few centimeters of the skin’s surface, and the radiation beam is often directed toward a specific area for a period of time, making this area prone to injury (2). PSD, the maximum dose at any portion of a patient’s skin during a procedure, is associated with deterministic effects such as skin injury, hair loss, and cataracts (1). FICRD occurs after a single or cumulative threshold dose of 10 to 12 Gy (2, 4). Several studies have reported a large variation in mean PSD for PCI, ranging from 0.88 Gy to 1.79 Gy (6, 7). Decreasing PSD can reduce the risk of skin injury. Previous studies report methods that can reduce PSD, including shortening fluoroscopy time, minimizing the number of images obtained, placing the patient as far away from the X-ray tube as possible while minimizing object-to-image receptor distance, performing dose-saving pulsed fluoroscopy along with the use of last image hold, tight collimation, limited magnification, and varying the tube angle from time to time to change the irradiated skin area (1, 6).

Risk factors for FICRD can be classified into two categories. Technical factors include high radiation dose exposure, prolonged fluoroscopy duration, short intervals between radiation exposures, or a large angle of beam entry (1). Factors that are associated with an increased radiation dose include PCI of a chronic total occlusion lesion, a complex lesion (lesion Types B2 and C), and RCA and LCX lesions (6, 8). PCI of the RCA is often performed at a fixed large left anterior oblique angle and tends to use only one angulation (7). Lai et al. (8) reported a procedure time of ≥ 130 minutes as a predictor of a radiation-induced ulcer event in such cases. Host factors include obesity, the current application of chemotherapeutic agents, and preexisting underlying diseases such as connective tissue disease or defects in DNA repair genes (ataxia telangiectasia and xeroderma pigmentosum) (2). Our patient may have had a higher risk of developing FICRD due to obesity, which requires higher radiation doses to penetrate the excess adipose tissue, and a complex PCI with a procedure time of 3 hours. The indurated plaque on the left side of his back may be attributed to prolonged use of a right anterior oblique projection for the distal LCX CTO lesion (Fig. 3).

The diagnosis of FICRD is often made clinically, correlating with the patient’s history of fluoroscopic procedures with the dis-
tistinguishing distribution and pattern of the skin lesion. Predilec-
tion areas involving the bilateral axilla, scapula or subscapular
area, and midback are associated with the beam entry site (5).
Skin injuries are often presented with well-defined borders in
an unnatural shape such as a rectangular, square, or rounded,
corresponding to the shape of the collimators (Fig. 3) (5). Clini-
cal presentations include permanent erythema, chronic ulcera-
tion, atrophy, telangiectasias, pigmentary alterations, destruc-
tion of cutaneous appendages, and even dermal necrosis. It is
crucial to note that chronic radiodermatitis does not always have
an acute presentation at first (4). Histopathological findings are
not pathognomonic. Important histologic features that support
the diagnosis include ulceration, epidermal atrophy, prominent
superficial telangiectasia, dermal sclerosis, increased atypical
stellate fibroblasts, absence of lymphocyte infiltration, and loss
of adnexal structures (9). In this case, vascular occlusion with
fibrous wall thickening was noted, indicating insufficient perfu-
sion, which may have caused poor wound healing. Thus, since the
given history and clinical presentation were typical, a biopsy was
not routinely recommended because it could have exacerbated the
preexisting damaged skin, resulting in secondary ulceration (5).

To date, there is no standardized treatment guideline. Wei et al.
(10) proposed that a low-dose corticosteroid with oral 5 mg pred-
nisolone twice per day has therapeutic potential in FICRD with
mild skin damage via inhibiting fibroblast activation and prevent-
ing further ulcer formation. However, for refractory ulceration
and skin necrosis, medical therapy is often ineffective, and surgi-
cal excision with a local flap or skin graft reconstruction should
be considered. In our clinical experience, using hydrogel on the
superficial ulceration and emollient on the rest of the lesion was
effective. At the same time, pain control with gabapentin achieved
patient satisfaction.

Conclusions

This case report highlights the importance of thorough history-
taking with an emphasis on previous interventional procedures
when encountering sharp, demarcated, rectangular lesions on
characteristic locations such as the back and axilla. Patients with
obesity, complex or chronic total occlusion lesions, the use of
fixed large beam angulation, and a procedure time of more than
2 hours are at a high risk of fluoroscopy-induced radiodermatitis.
Pre-procedural dose planning and radiation dose parameter doc-
umentation are crucial. Whenever the dose exceeds the threshold
level (2 Gy), the patient should be informed of possible skin reac-
tions and medical follow-up should be considered.

References

management for fluoroscopically guided interventional procedures. Radiology.

interventional procedures: a review of radiation effects on patients’ skin and

3. Guesnier-Dopagne M, Boyer L, Pereira B, Guersen J, Motreff P, D’Incan M. Inci-
dence of chronic radiodermatitis after fluoroscopically guided interventions: a

4. Jaschke W, Schmutz M, Trianni A, Bartal G. Radiation-induced skin injuries to
patients: what the interventional radiologist needs to know. Cardiovasc Intervent

5. Wei KC, Yang KC, Mar GY, Chen LW, Wu CS, Lai CC, et al. STROBE-radiation ulcer:
an overlooked complication of fluoroscopic intervention: a cross-sectional study.

6. Fetterly KA, Lennon RJ, Bell MR, Holmes DR Jr, Rihal CS. Clinical determinants of
radiation dose in percutaneous coronary interventions: influence of patient size, procedure complexity, and performing physician. JACC Cardiovasc

6. Tanaka T, Matsubara K, Kobayashi S. Evaluation of peak skin dose during percu-
taneous coronary intervention procedures: relationship with fluoroscopic pulse

tion-induced skin ulceration in percutaneous coronary interventions of chronic

radiation ulcer: a case series study in comparison with morphea. J Dtsch Derma-

2021;100:135–46.