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

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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

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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/m^2) 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).

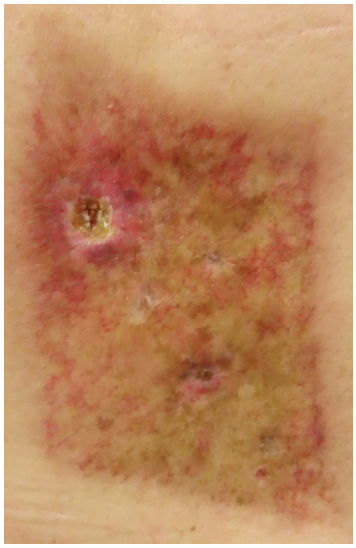

Figure 1 | An ulcerated, atrophic, and indurated plaque with dyspigmentation and telangiectasias on the left side of the patient's back.

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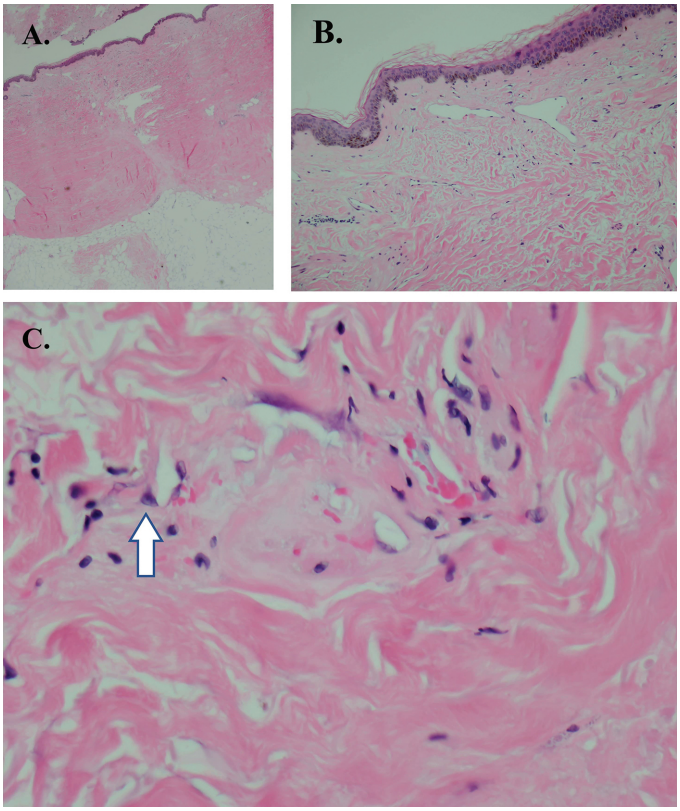

Figure 2 | Histology of the skin lesion; hematoxylin and eosin: (A) ×40, atrophic epidermis with dermal sclerosis and absent adnexal structures, minimal inflammation; (B) ×100, superficial dilated vessels with scattered bizarre fibroblasts; (C) ×400, bizarre fibroblasts with large hyperchromatic nuclei in the papillary dermis (arrow); vessels with a thickened wall.

Discussion

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.

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-

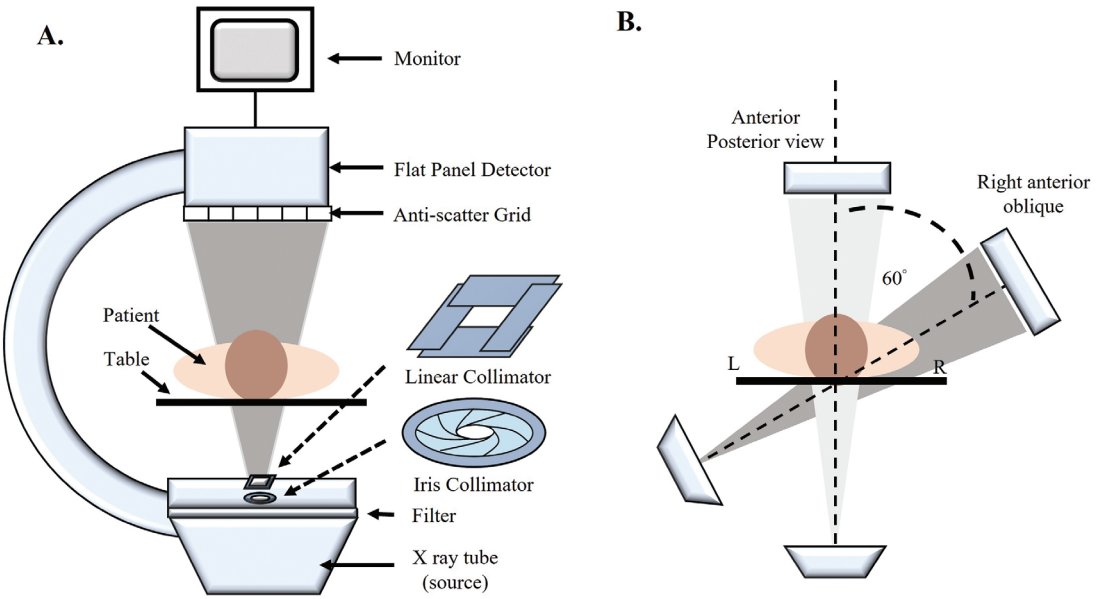

Figure 3 | (A) Diagram of a fluoroscopic system. The geometric shape of the skin lesion is related to the type of collimator, either a cylindrical or rectangular opening; (B) projection view: the skin on the left upper back receives a high radiation dose under prolonged use of a large right anterior oblique projection.

tinguishing distribution and pattern of the skin lesion. Predilection 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). Clinical presentations include permanent erythema, chronic ulceration, atrophy, telangiectasias, pigmentary alterations, destruction 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 perfusion, 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 prednisolone twice per day has therapeutic potential in FICRD with mild skin damage via inhibiting fibroblast activation and preventing further ulcer formation. However, for refractory ulceration and skin necrosis, medical therapy is often ineffective, and surgical 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 documentation are crucial. Whenever the dose exceeds the threshold level (2 Gy), the patient should be informed of possible skin reactions and medical follow-up should be considered.

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