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Case presentation

Squamous-cell carcinoma *in situ*

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Abstract

We present a 30-year-old woman with atopic dermatitis and ichthyosis vulgaris and a one-year history of an erythematous, scaly plaque on the dorsal surface of her right hand, which developed three years after an accidental exposure to prolonged ultraviolet C (UVC) radiation in a laboratory accident. The plaque, which was initially treated as eczematous dermatitis, was eventually identified histopathologically as squamous-cell carcinoma *in situ*. Although causation is not definitive, this case is the first to describe development of non-melanoma skin cancer (NMSC) in an area of skin known to be acutely exposed to UVC radiation. As UVC radiation becomes a more frequently used anti-microbial technology, UVC radiation may become a more commonly identified risk factor in the development of NMSC.

Case synopsis

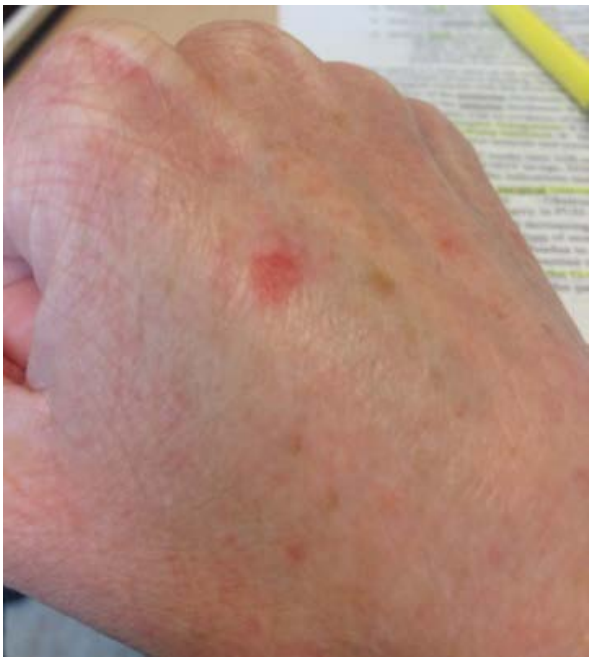
History: A 30-year-old woman with type I skin and a history of atopic dermatitis and ichthyosis vulgaris presented for the evaluation of a red, scaly plaque on her right hand that had developed over the course of one year. The lesion was neither pruritic nor painful and had not responded to several courses of high-potency, topical glucocorticoids. In addition to the primary lesion on her right hand, she more recently had developed multiple, erythematous, rough macules on her forehead and the dorsal aspects of the hands one month prior to presentation. She denied systemic symptoms. The patient had no personal history of skin cancer; her father had one basal-cell carcinoma and several actinic keratoses before age 60. She denied blistering sunburns or tanning bed use.

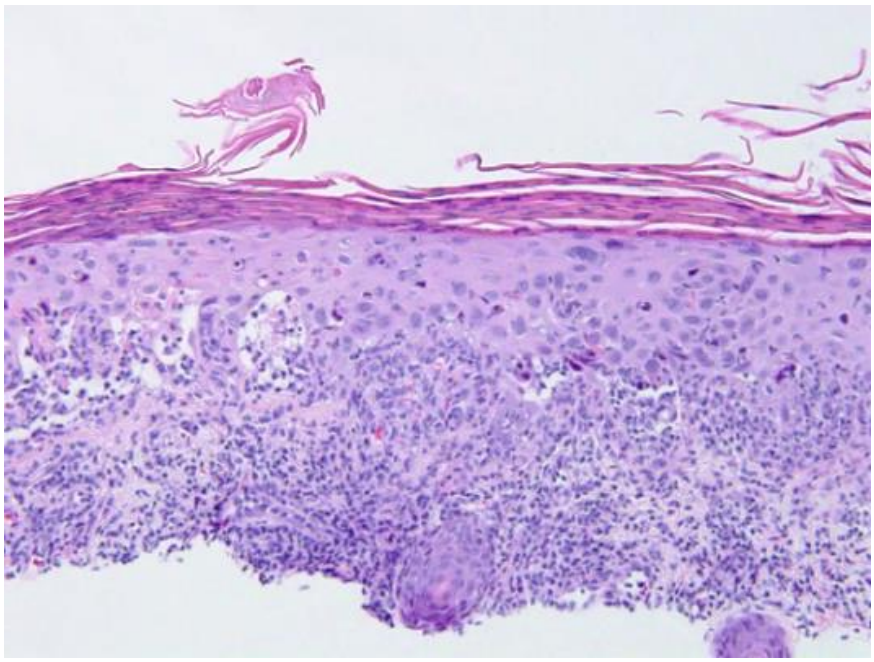
Three years prior to the development of the plaque on her left hand, the patient, who is a medical and graduate student in cell biology, was exposed to two hours of ultraviolet C (UVC) radiation (254 nm) during an accidental discharge of radiation from the germicidal lamp in the tissue culture hood in her laboratory. All of the fibroblast cells in her tissue culture died within 24 hours of exposure. While she worked in the tissue culture hood, she was wearing latex gloves and a laboratory coat. One day after exposure, she developed tender erythema of her wrists and arms; physicians at the student health center prescribed mupirocin and bandages. The erythema and tenderness resolved over subsequent weeks.

Physical examination: Over her forehead and dorsal aspects of the hands and wrists were scattered lentigines with a few intermixed erythematous macules. On the lateral portion of the dorsal aspect of the right hand, there was a thick, erythematous, scaly plaque, which was 1.5- cm in diameter.

Laboratory data: None

Histopathology: There is full-thickness keratinocytic atypia with suprabasilar mitotic figures and an underlying dense lymphocytic infiltrate.





Figures 1. Lentigines and erythematous macules Figure 2. Full thickness keratinocyte atypia and mitotic figures

Discussion

Diagnosis: Squamous-cell carcinoma *in situ*

Comment: Non-melanoma skin cancer (NMSC) is the most common form of cancer in the United States. Over 1.3 million cases of NMSC are diagnosed per year and 20% of these cases are squamous-cell carcinomas (SCC) [1]. SCC has a lifetime risk of 4 to 9% among Caucasian women in the United States [2]. In Caucasians over the age of 50, men account for 69.8% of SCC. However, in Caucasians age 10 to 49, women account for 49.8% of SCC [3]. Thus, young women are disproportionately affected by SCC. Higher rates of sunbathing and tanning bed use among women as well as increased levels of self-examination or surveillance by dermatologists among women may play a role in the higher frequency of diagnosis of SCC in younger women.

Although several population-based retrospective studies suggest that up to 3% of SCC is identified in young women [4], it is difficult not to associate this patient's antecedent exposure to UVC radiation with the development of SCC, owing to the distribution and time course of her acute and subsequent lesions. Her initial exposure resulted in painful erythema of the exposed areas (hands, arms, and forehead), which is a well-known acute sequela of UVC radiation exposure [5]. This acute erythema is the clinical manifestation of the cellular membrane damage and resultant apoptosis as well as DNA mutagenesis, which are known to occur within 22 hours of UVC radiation exposure [6].

Many risk factors for SCC are well documented in the literature; exposure to ultraviolet radiation, namely ultraviolet A and B, is the most common cause. Ultraviolet radiation causes DNA mutations, in particular mutations that result in the formation of thymidine dimers in the *p53* tumor suppressor gene. Keratinocytes with mutations in both alleles of *p53* are unable to undergo apoptosis, which results in clonal expansion of this line of abnormal keratinocytes. Clinically, this initial expansion manifests as actinic keratosis. Continued proliferation of these mutated keratinocytes leads to development of SCC [7]. Other risk factors for SCC include human papillomavirus infection, genodermatoses, chemical exposures to arsenic and hydrocarbons, chronic ulcers, and immunosuppression [8].

UVC radiation is not ordinarily cited as a contributory factor to development of NMSC because this particular segment of ultraviolet radiation is effectively filtered by the ozone layer; patient exposures are rare. However, countless articles exist in the literature that describe UVC radiation-induced DNA mutagenesis in cultured cells, microbes, and multicellular organisms, such as *C. elegans* [9]. For this specific ability to induce bactericidal DNA mutagenesis, UVC emitting lamps often are used in tissue culture hoods. When the hood is not in use, UVC radiation bathes the work area, which kills bacteria that could potentially contaminate and destroy delicate cell lines when the hood is in use.

There are no case reports in the literature that directly link UVC radiation to the development of NMSC, which is not surprising given the limited frequency of exposures and the difficulty proving causation of any one risk factor with subsequent development of carcinoma. Although there are some reports of medical students or laboratory workers exposed to UVC radiation who then develop immediate erythematous reactions, none of these patients was ultimately reported to have ongoing actinic damage or resultant skin cancer [10].

UVC radiation is frequently championed as an inexpensive and effective antimicrobial tool with widespread application in health care, which is well beyond its current use in tissue culture hoods. UVC radiation exposure is a commonly discussed method to reduce post-operative wound infections. Cardiothoracic operations performed directly under UVC radiation have been found to have lower rates of superficial and deep mediastinal post-operative infection [11]. Similar reductions in superficial infection rates have been shown with periodic exposure of ostomy sites to UVC radiation [12]. Additionally, UVC-emitting devices are emerging technologies for decontamination of patient rooms. Automated UVC emitters have been proven to decrease the microbial burden of vancomycin-resistant enterococci, methicillin-resistant *Staphylococcus aureus*, multiple drug resistant *Acinetobacter baumannii*, and *Clostridium difficile* spores [13,14].

This patient's treatment thus far has included Mohs micrographic surgery for the squamous-cell carcinoma *in situ* (SCCIS) on her right hand, but the eruption of many new likely actinic lesions (none yet biopsied) poses a treatment conundrum. She is considering field therapy, but, as a woman of childbearing age, she and her physicians are unsure that this is the ideal choice. Photodynamic therapy also is an option.

Although it is difficult to definitively correlate this patient's development of SCCIS with her antecedent accidental exposure to UVC radiation, UVC radiation is a known DNA mutagen, which accounts for its specific role as a germicidal technology. This case is the first to describe development of NMSC by a patient known to have acute UVC radiation exposure in the same skin distribution. If UVC radiation is to be more widely utilized in health care applications as the data suggests, the frequency of intentional and accidental exposures is bound to grow as is its role in the development of NMSC.

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