

Case Report

Chernobyl's Aftermath: Multiple Manifestations of Basalioma in a Patient after Radioactive Contamination in 1986

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Simple Summary: We present a case of a 76-year-old patient with multiple cases of skin cancer in the past and now again two suspected skin lesions. The patient had been exposed to radioactive material during the Chernobyl GAU while building houses for the workers of the sarcophagus. Radioactivity is considered a risk factor, albeit rare, for the development of skin cancer. We subjected the patient to extensive diagnostics. The patient underwent a so-called PET-CT, which produces cross-sectional images by visualizing the distribution of a weakly radioactively labeled substance in the organism. After that, surgical removal of the two suspicious skin sites was performed. Analysis of the tissue sample revealed the suspected skin cancer at one site. This case demonstrates the value of PET-CT examination for visualizing the extent and possible spread of tumor. In addition, it can be shown that radioactivity must be considered as a rare cause of skin cancer.



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Abstract: Background: The Chernobyl nuclear disaster is still considered the worst nuclear accident in history. The particles were dispersed over the former USSR and large parts of Western Europe, leading to radioactive exposure to more than 10 million people. Radioactivity is a risk factor for the development of basal cell carcinoma (BCC), since radiation-induced mutations in both Sonic hedgehog (Shh) signaling pathway genes and *TP53* have been described. Methods: We present the case of a patient with a history of radiation exposure following the 1986 Chernobyl accident who presented to our outpatient clinic with recurrent basal cell carcinoma in the facial region. Case: The patient presented to our clinic with two facial lesions suspicious for BCC. Although there were no typical risk factors, 11 BCCs had previously been removed. The patient had been building shelters for the construction workers working on the sarcophagus around the destroyed reactor immediately after the 1986 accident. Staging using an 18F-FDG-PET/CT as well as ultrasound of the abdomen revealed no other tumor manifestations. Diagnostic excision of the two facial lesions was performed, and a histopathological workup revealed BCC at the right temporal region and acanthopapillomatosis with no sign of malignancy at the corner of the mouth. After presentation to the tumor board, complete resection of the BCC was initiated. Conclusions: This case demonstrates the value of early use of 18F-FDG-PET/CT in staging/restaging to visualize BCC location, local spread and potential metastases or secondary tumors and to aid in the decision for therapeutic management.

Keywords: basalioma; radiation; nuclear disaster; PET-CT

1. Introduction

We present the case of a 76-year-old Caucasian male with a history of multiple and two newly diagnosed basal cell carcinomas (BCC) after radioactive contamination during the Chernobyl disaster in 1986. It is, along with the Fukushima Daiichi nuclear disaster, the worst nuclear disaster in human history, with both rated a seven out of seven on the International Nuclear Event Scale. Two explosions during a planned safety test simulating a power outage led to a steam explosion from the vaporizing super-heated cooling water that ruptured the reactor core and destroyed the reactor building. The first explosion was followed by an open-air reactor core fire that released radioactive particles into the air [1] and contaminated large parts of the former USSR and large parts of Western Europe, Belarus and Russia. Over 10 million people have been exposed to low levels of radioactive material over the years, with the risk of exposure still ongoing in these areas [2].

Exposure to ionizing radiation is a commonly acknowledged risk factor for the development of BCC by causing DNA damage. An increased risk for the development of BCC has been described in atom bomb survivors [3], uranium miners and radiologists [4], interventional cardiologists [5] as well as children that underwent radiation for malignant tumors or tinea capitis [6]. The carcinogenic effect of ionizing radiation might be based on mutations in *PTCH* genes, leading to aberrant activation of sonic hedgehog (Shh) signaling. Furthermore, radiation-induced *TP53* mutations may also add to the pathogenesis of BCC. All these pathways modify the cellular response to DNA damage and finally may affect the initiation, promotion and progression of malignant skin lesions such as BCC [7].

2. Case Report

A 76-year-old Caucasian male was admitted to our outpatient department in July due to a newly diagnosed BCC on the left temporal side (R1 resection) and suspicion of a second synchronously appearing BCC in the right labial angle. The skin excision, which was performed by his dermatologist, showed irritable wound conditions (Figure 1), while the left labial angle showed a shiny, pearly skin nodule with central ulceration and small blood vessels running on the side of the raised skin area. It measured roughly 15×15 mm. The patient denied any other symptoms other than an occasional “tingling” sensation around the left labial angle. The patient denied any alcohol consumption, smoking or above-average exposure to UV rays. When taking the clinical history, the patient told us that he came into contact with the radioactive fallout in 1986 in his hometown Pripjat, Ukraine. The patient built houses in the area around the nuclear reactor after the disaster for the workers building the sarcophagus. He told us that almost all his co-workers died over the years due to different cancers. The same was true for most of his relatives that lived in the nearby area of Pripjat. The patient reported 11 previous cases of BCC over the last decade all over his body, including the left shoulder, right rib area and right lumbar area. Additional general diseases include arterial hypertension, hypothyroidism, as well as a history of adenocarcinoma of the ileocecal valve, apoplexy with known epilepsy, sigmoid diverticulitis and alcohol abuse.

We planned an inpatient stay to conduct an ^{18}F -FDG-PET/CT scan for further diagnostics and to rule out other malignant lesions, as well as a surgical biopsy of the labial angle under local anesthesia for histopathological analysis (Figure 2). Three different biopsies were taken from the top, bottom and middle of the lesion but showed no malignancy in histopathologic analysis, including reference histopathologic assessment at a university hospital. Furthermore, we had the patient checked for secondary carcinoma of the ear, nose and throat, which could be ruled out.



Figure 1. Irritable wound conditions after R1 resection of a histologically proven basal cell carcinoma.



Figure 2. Right labial angle after biopsy under local anesthesia.

According to the international guidelines, the indication for further imaging in BBC exists only in certain cases, such as suspected metastasis disease, perineural tumor growth or bone infiltration. In these cases, a CT or MRI scan can be performed [8,9].

The use of ^{18}F -FDG PET/CT in patients with advanced-stage disease or in patients after ionizing radiation exposure has, so far, not been fully explored due to its rarity. An increased metabolism of BCC lesions in head and neck tumors has been described before [10,11]. Our case demonstrates a hypermetabolic suspicious 16 mm lesion of the left labial angle with a maximal standardized uptake value (SUVmax) of 10.2 (Figure 3).

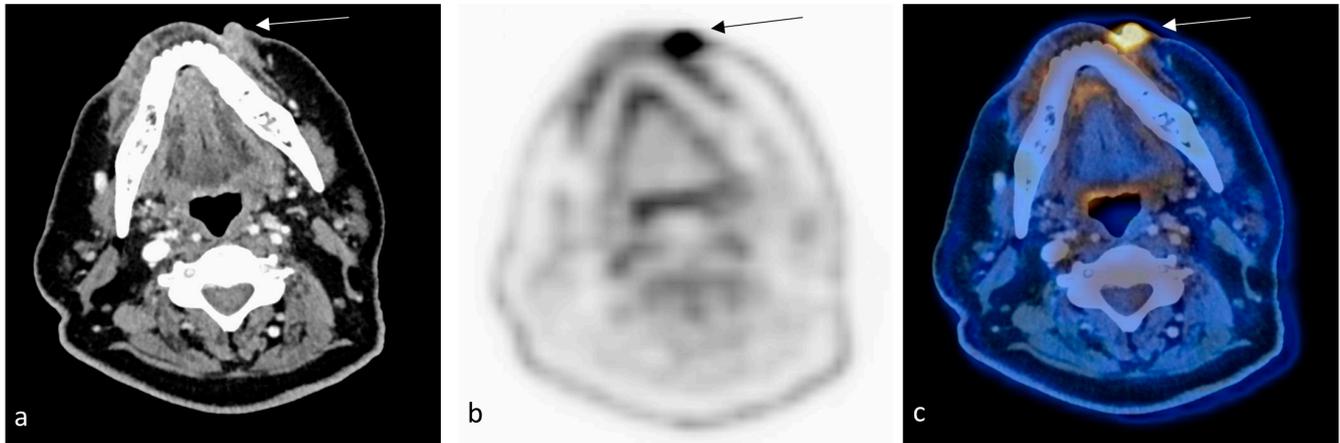


Figure 3. FDG-PET/CT scan shows hypermetabolic lesion of the left labial angle (arrow). (a) CT transversal. (b) PET transversal. (c) Fused PET/CT transversal.

At the primary resection site on the right temporal side, there is only a slightly increased metabolism above background (SUVmax 1.3), fit to postoperative changes or residual tumor at R1 resection. Moderately increased metabolism is seen in the hilar lymph nodes (SUVmax 6.3), which are classified as most likely inflammatory (Figure 4). No other suspicious skin or metastatic lesion was detected.

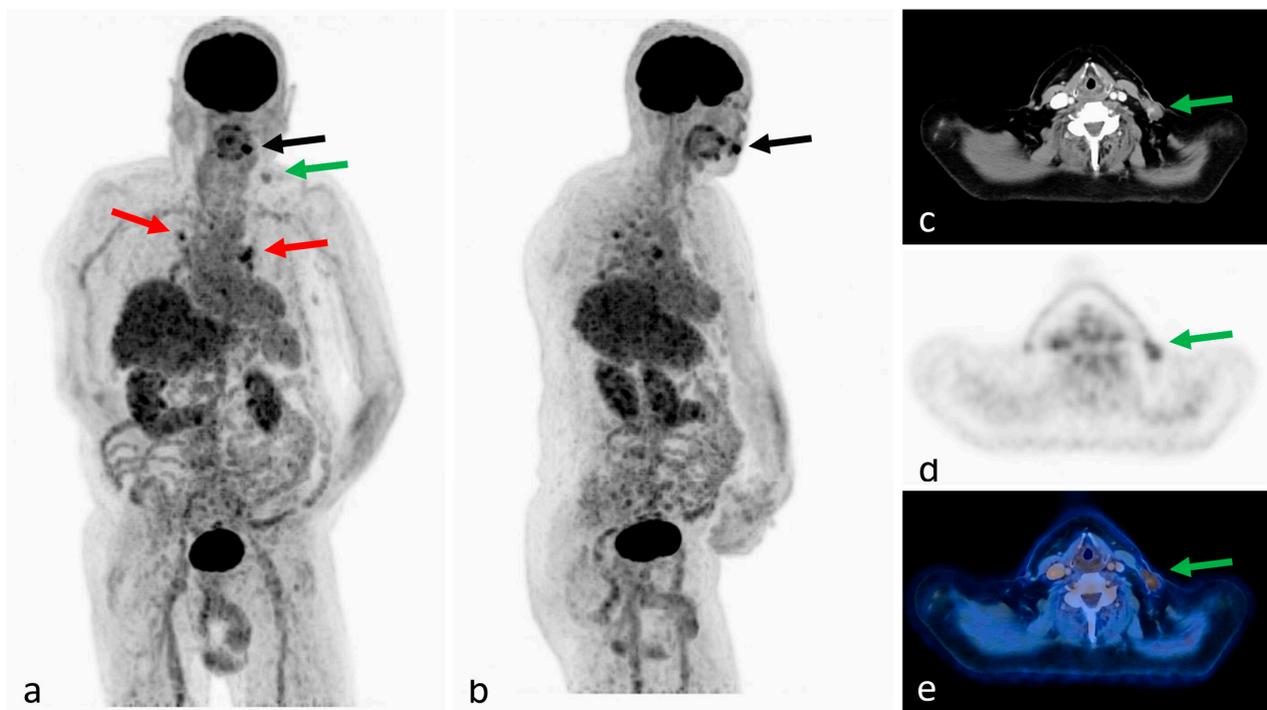


Figure 4. Suspicious lesion with increased metabolism of the left labial angle (SUVmax 10.2 black arrow), in a left cervical lymph node (SUVmax 3.2 green arrow) and in hilar lymph nodes (SUVmax 4.9 red arrows). (a) PET maximum-intensity projection (MIP) from anterior. (b) PET MIP oblique. (c) CT transversal. (d) PET transversal. (e) Fused PET/CT transversal.

The case was then presented at our interdisciplinary tumor conference to establish a therapeutic concept in accordance with the current national guidelines. Re-resection of the BCC was recommended. Further, a bronchoscopy with endobronchial ultrasound was recommended due to an uncertain lesion of the left lung as well as a fine-needle biopsy of a malignant-suspected lymph node on the left cervical side. We then set a date for another inpatient stay to fully resect the BCC of the left temporal side and to perform a re-biopsy of the lesion in the left labial angle due to it still being highly suspicious for malignancy in its clinical presentation and radiological findings in August 2021. Histologically, the complete resection specimen from the left temporal side showed infiltrative growth of atypical epithelial cells with peripheral palisading and basophilic stroma, consistent with nodular basal cell carcinoma (Figures 5 and 6).

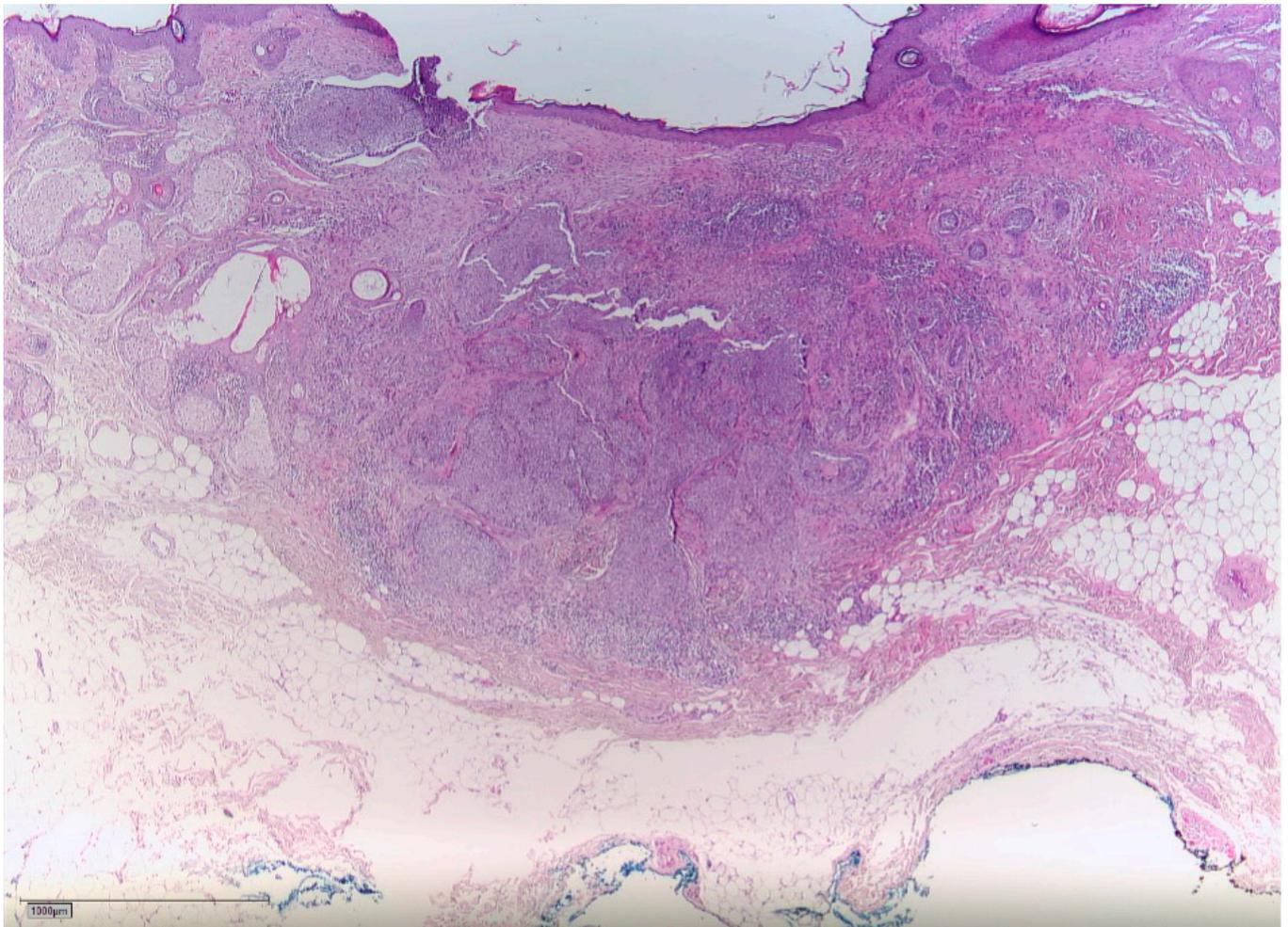


Figure 5. Histopathology of the temporal lesion (low magnification): Nodular growth of basaloid cells with chronic inflammation and focal ulceration (scale bar, 1000 μm).

The case was then presented at our interdisciplinary tumor conference once again. Since the BCC was completely resected and the biopsies of the mediastinal and cervical lymph nodes showed no evidence of malignancy, no further therapy was needed for the patient. We planned a third and final inpatient stay for plastic surgery to cover the skin defect of the left temporal side. The defect showed nearly complete reclosure through granulation so no further surgery was needed, and the patient was transferred to outpatient follow-up care.

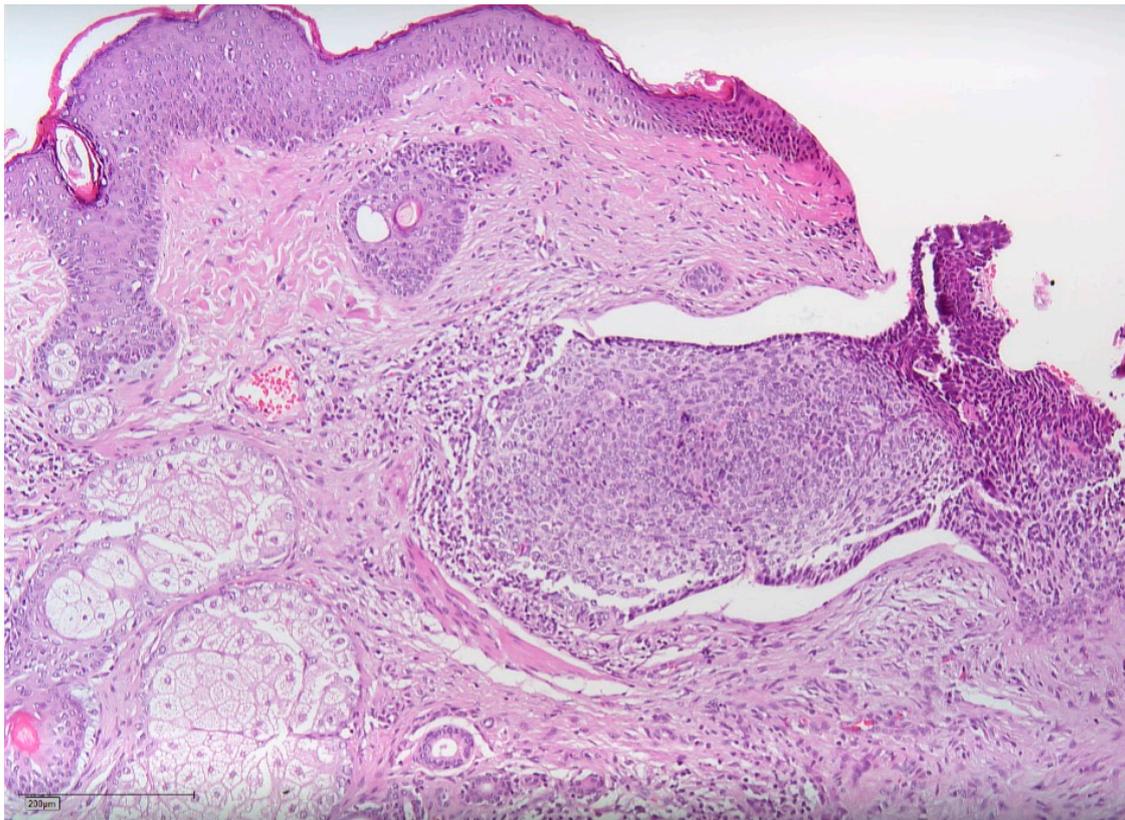


Figure 6. Histopathology of the temporal lesion (high magnification): Nodular growth of basaloid cells with chronic inflammation and retraction artefacts (scale bar, 200 μm).

3. Discussion

Ionizing radiation is now commonly accepted as a risk factor for the development of BCCs. Sugiyama et al. showed, in their long-life follow-up study, that the incidence of BCCs in the population of Hiroshima and Nagasaki was significantly increased when the patients with the highest exposure dose during the atomic bomb were considered [3]. In this study, it was also shown that the risk of developing malignant melanoma or squamous cell carcinoma remained unchanged despite exposure.

A similar phenomenon can be shown in bone marrow-transplanted patients who have to undergo whole-body irradiation for bone marrow depletion before transplantation as part of their therapy [12]. These patients do not show increased incidence of malignant melanoma or squamous cell carcinoma. The same applies to patients who were irradiated due to tinea capitis [6] or, for example, interventional cardiologists who are exposed to increased radiation in the course of their procedures [5].

However, there are also studies in the literature that show the opposite. For example, a study by Prysazhnyuk et al. [13] could not show an increased incidence of BCCs in the affected regions in Belarus, Russia and Ukraine that are still heavily contaminated with radioactivity today [14,15]. It was mainly the incidence of thyroid carcinomas that showed a sharp increase [16–18]. Therefore, so far, there are mainly only isolated case reports of patients with BCCs after contact with radiation in the context of the Chernobyl accident [19].

Despite contradictory studies, however, there are clear indications that radioactive radiation can be assumed to play a role in the development of BCCs. This can certainly be considered in the light of other possible predisposing factors, such as mutations in the PTCH gene [20], p53 mutations [7], chronic exposure to UV radiation [21], exposure to arsenic compounds [22] or autosomal dominant inherited tumor syndromes, such as

Gorlin-Goltz syndrome, basal cell nevus syndrome or nevoid basal cell carcinoma syndrome (NBCCS) [23].

In individual cases, therefore, an attempt can be made to establish a causality between exposure to radiation and the development of BCCs. For this purpose, cytogenetic changes from patient blood samples [24], as well as a whole-body counter, can be used to determine the incorporation of radioactive nuclides. In addition, altered gene expression patterns can be determined [25], and array-based comparative genomic hybridization can be performed for copy number aberration analysis of the available BCC samples [26]. It is also possible to investigate a potential exposure dose from skin contamination. However, these possibilities were not considered in this individual case because the patient unfortunately refused further diagnostic workup.

The limitation of this paper is that no definite link between the radiation and the development of the patient's multiple BCCs could be established because the patient refused further genetic workup. As a single case study, the findings cannot be generalized to a broader population, meaning that radiation exposure can only be considered as a rare differential diagnosis. This is also evident in the study of Chlebicka, in which, for 180 consecutive BCC cases, no case was causally associated with radiation [27].

4. Conclusions

Our case demonstrates the value of the early use of 18F-FDG-PET/CT in staging and restaging to visualize the BCC location, extent and potential metastases or second tumors and for further therapeutic management. Although no definite association of the BCCs with radiation could be established in this case, possible radiation exposure in the clinical situation can be considered as a rare differential diagnosis.

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