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Cutaneous side effects of oncology treatments Part II. Radiation therapy

Besides chemotherapy, radiation therapy (RT) is another modality of treatment for malignant tumours. In the same manner as chemotherapy, RT is susceptible of inducing cutaneous side effects to the treated patients. Their severity will widely vary according to various factors related to the treatment, such as total dose, fractionation or not of the same and individual sensitivity of the patients. These side effects may be acute, occurring immediately after RT, or consequentiallate, occurring after some time of RT, even after cessation of the procedure, or chronic and in this case may last many years and even all over the life. The most frequent acute adverse events with RT are acute radiation dermatitis, radiation burns and radiation recall. The most common consequentiallate event is radiationinduced fibrosis, and among chronic side effects chronic radiation dermatitis is the most often observed. Besides preventive measures whose efficacy is limited, management and treatment are compulsory and must be wellknown by the dermatologists. These treatments will vary according to the nature of the side effect encountered, but also in function of its severity. This review is aimed to provide a better knowledge of the cutaneous adverse reactions in RT and help more adequately the affected patients who will seek help from their practitioner.

Key words

Radiation therapy, side effects, radiation dermatitis, radiation burns, radiation recall, radiationinduced fibrosis, prevention, treatment.

Introduction

Besides chemotherapeutical treatments, radiation therapy (RT), i. e. the use of ionizing radiation (IR) is the second important treatment modality in cancerology. Cutaneous side effects are a significant adverse effect of RT. Although rarely life-threatening, these adverse effects are of importance for the patient and must be treated adequately by both the radiotherapist and the dermatologist. Skin reactions to radiation are largely a function of technique, total dose, volume, and individual variations in treatment [1]. The improvements in technology and modalities of treatment in RT have considerably reduced the burden of cutaneous complications in RT. Cutaneous adverse events in RT are commonly graded as acute, consequential-late, or chronic [2]. Acute events occur within 90 days. Consequential-late side effects may be observed after this period and may sometimes become chronic and last over years [2].

Acute cutaneous side effects of RT

They include mainly acute radiation dermatitis, radiation burns and radiation recall.

Acute radiation dermatitis (ARD)

ARD is experienced to various degrees by great number of patients undergoing RT.

The incidence of these reactions and their severity are depending on the total radiation dose, the dose per fraction, the overall treatment time, beam type and energy and the surface area of the skin that is exposed to radiations [2]. It will also depend on the irradiation site: its incidence in patients treated with RT for locoregionally advanced head and neck cancer was reported as ranging between respectively 47 and 94 % (grade 0—2) and 3 to 46 % (grade ≥ 3) depending on the radiotherapy regimen used [3].

In Japanese patients treated with whole breast conventional therapy [4], the incidence was 94 % of grade 1—2 and 2 % of grade ≥ 3, whilst in another group of patients treated with whole breast hypofractionated therapy, the incidence was slightly lower: 82 % of grade 1—2 and 2 % of grade ≥ 3. In another study [5] comparing conventional radiotherapy (CRT) and intensity modulated radiation therapy (IMRT) in breast cancer, the latter treatment decreased the risk of occurrence of radiodermatitis (grade 2—3) from 52 % to 39 %. In the

RTOG 9003 study [6] the rates of acute grade skin toxicity were slightly higher with hyperfractionation (11%) and accelerated fractionation with concomitant boost (11%) compared with standard fractionation (7%). Interestingly, in children and adolescents receiving radiotherapy for the treatment of paediatric sarcomas [7], the results were online with those previously reported in adults: grade 1: 32%, grade 2: 45%, grade 3: 12% and grade 4: 2%. A significant association for increased grade of skin toxicity was observed between dose, volume of skin treated above 4000 Gy and use of a bolus. In a comparative study of the occurrence of radiation dermatitis, black patients reported more severe skin problems than Caucasians [8]. It is well admitted that the addition of chemotherapy to radiotherapy (chemoradiotherapy) increases the acute side-effect profile of treatment [9] particularly when combined with altered fractionation regimens. In a reported phase III study [10] in which the majority of patients received ≥ 60Gy with concomitant boost regimen, and 53% of patients also received chemotherapy, the mean rates of grade 2, 3 and 4 radiation dermatitis were 54, 20 and 4% respectively. The authors contrasted these data with the corresponding rate of 49, 8 and 0% observed all over arms of the RTOG 9003 study [6]. The severity of acute reactions has been shown both to lead to enhanced late effects and to impact adversely on cosmesis, especially in patients with infected irradiated skin [11]. Finally, correlation between the occurrence of radiation dermatitis and patient quality of life has been observed and the impact of this on the well-being of the patient should not be underestimated [10].

ARD generally occurs within a few weeks after starting radiotherapy, its onset varying depending on the radiation dose intensity and the normal tissue sensitivity of individuals.

As the cumulative dose of radiation increases, the transient erythema occurring at the beginning may evolve into a more persistent erythema to dry or even moist desquamation that reflects the damage to the basal cell layer and the sweat and sebaceous glands. The National Cancer Institute (NCI) toxicity grading of radiation dermatitis is well accepted and is as follows [12]:

- Grade 0: absence.
- Grade 1: Faint erythema or dry desquamation.
- Grade 2: Moderate to brisk erythema; patchy most desquamation, mostly confined to skin folds and creases; moderate oedema.
- Grade 3: Moist desquamation other than skin folds and creases; bleeding induced by minor trauma or abrasion.
- Grade 4: Skin necrosis or ulceration of full thickness dermis; spontaneous bleeding from involved site.
- Grade 5: Death.

The early modifications (grade 1) are reflecting the involvement of the basal layer of the epidermis, the decreased rate of proliferation of the epidermal cells and of surviving cells of the pilar matrix, and vascular damages [13]. However, the keratinocyte differentiation is mostly preserved. For such reason, a regeneration phase, with the replacement of epidermal cells resulting from a major increase in their proliferation, appears between the third and fifth week following the beginning of treatment. Further, the late modifications are mostly resulting from damages to dermal structures, especially vascular ones, and fibrosis is a major feature of this pattern. These lesions are irreversible, provoking frequently an aesthetic damage. They are sometimes severe, due to their extent, with a possible functional prejudice. Irradiation of the skin leads to a complex pattern of direct tissue injury and inflammatory cell recruitment, involving damages to the epidermal basal cells, endothelial cells and vascular components [3]. The sensitivity of Langerhans cells (LC) to radiation has long been established [14]. By humans, it was demonstrated that there is a decrease in the number of LC72 hours after three sessions with a unitary dose of 3Gy. On the other hand, a complete body irradiation before bone marrow graft reduces the cutaneous contingent of LC. The radioinduced destruction of LC and their precursors is dose dependent and these cells are relatively resistant to radiations [14]. Radiation-induced keratinocyte damage induces DNA injury repair via the activation of the p53 pathway and a simultaneous release of inflammatory cytokines as a consequence of the generation of free radicals [3]. The main cytokines involved in this reaction are Interleukin-1 (IL-1), Interleukin-6 (IL-6), Tumour Necrosis Factor-α (TNF-α) and Transforming Growth Factor-β (TGF-β) [15]. In severe radiation dermatitis there is a massive neutrophilic infiltration of the epidermis and profound apoptosis. This increase in the number of apoptotic keratinocytes was revealed by TUNEL labelling [16]. It was demonstrated in the same study, that keratinocyte apoptosis was partly dependent on ROS production after exposure to γ-rays, and that differential radiosensitivity of keratinocytes was linked to different oxidative stress responses.

At the same time, keratinocytes demonstrate increased expression of epidermal growth factor receptor (EGFR) possibly as a mechanism for counterbalancing the increased apoptosis, and repopulating irradiated areas [17].

Radiation burns

Radiation burns, although rare with current treatment modalities, can occur with high-dose exposure to x-rays during interventional radiology procedures or with RT [18]. There are marked differences between radiation and thermal burns in terms of physio-pathological mechanisms, clinical aspects and evolution [18]. Severe radiation burn is commonly seen after an accidental handling of radioisotope, the sternness of which depends on the activity of radioisotope and total exposure time [18]. Microvascular damage and an overall reduction in capillary density lead to progressive vascular insufficiency of the dermis. It leads to occurrence of unpredictable successive inflammatory waves leading to the extension, in surface and in depth, of the necrotic process. After an initial period marked by a clinical picture limited to a rash and itching, subsequent ulceration and necrosis develop, which may extend to the deep dermal and underlying muscle structures [19]. The patho-physiological process implies a cascade of inflammatory mediators and a continuous activation of target cells (endothelial cells and fibroblasts).

Radiation recall

Radiation recall is an acute inflammatory reaction confined to an area previously exposed to radiation after a chemotherapeutic agent or other medication. As stated in our previous paper, it may also frequently occur during chemotherapeutical treatments, without a need of concomitant irradiation. Clinically, radiation recall manifests with maculopapular eruptions, dry desquamation, pruritus, swelling and ulcerations. The incidence has been reported to occur in up to 6% of individuals undergoing RT, but reactions are drug-specific and can occur weeks to months after the original RT and subsequent chemotherapeutic administration [20].

Consequential late effects of RT

Rarely, acute radiation dermatitis fails to heal and consequential-late changes of RT may develop, which include chronic wounds and skin necrosis [2].

Radiation-induced fibrosis

Fibrosis of the dermis and keratosis of the epidermis are frequent late complications of irradiation, this being accidental or a consequence of radiotherapy [21]. Dose, fractionation and duration of irradiation are the major factors of fibrotic growth [22—25].

Hypofractionated irradiation was shown to induce a much higher rate of fibrosis than a conventional fractionation schedule (57% *vs.* 16%) [26]. Fibrosis was commonly observed after 7-month and 3-year follow-up with both simultaneous integrated boost and sequential boost [27]. Comparing accelerated partial breast irradiation (APBI) vs. conventional external beam radiotherapy, NTCP (Normal Tissue Complication Probability) values appear to bemuch higher in the latter [28]. Nevertheless, more recent studies demonstrate higher rates of occurrence of subcutaneous fibrosis after 15 months [29] (33%) and after 43 months [30] (44% vs. 9%). In two different studies [13, 32], 3.2% of patients developed breast fibrosis 24 months after Intraoperative Radiotherapy with Electrons (ELIOT) during breast conserving surgery, and this rate was shown to reach 33% after 48-months-survey. 25 months after IORT using low-energy X-rays 13.5% of patients developed fibrosis of the entire breast and 27% around the tumour bed. In addition, fibrosis may be related to pre-existing collagen diseases [34], concomitant or sequential administration of chemotherapy [35, 36], age [37] and the intrinsic radiosensitivity of the connective tissue, which generally varies from patient to patient [38]. It has to be noticed that after breast-conserving surgery, the concurrent use of chemotherapy with radiotherapy is significantly associated with an increased incidence of grade-2 fibrosis [39]. The incidence and prevalence of fibrosis is more common when compared to other radiation-induced morbidities [40]. Fibrosis being a late complication, the incidence seen at 5 years does not represent the full spectrum of injuries. Does that seem safe at 5 years can lead to serious complications later [40]. In another study, the length of time to expression of 90% of the ultimate frequency of moderate or severe complications was 3.2 years as regards skin fibrosis [41]. For subcutaneous fibrosis the time to reach a specific grade of reaction increases with the grade, thus being consistent with the clinical impression that fibrosis progresses in severity over time [41]. Late radiation damage in most tissues is characterized by loss of parenchymal cells and excessive formation of fibrous tissue [42]. Fibrosis is a complex tissue response whose predominant characteristics are massive deposition of extracellular matrix and excessive fibroblast proliferation. It is a dynamic process that involves constant tissue remodelling and long-term fibroblast activation.

Apart from the skin, fibrosis has been described in many tissues, such as lung, heart and liver [43]. Research has shown that radio-induced fibrosis is an endless scarring process, in which the myofibroblast, a particular type of fibroblast, plays an essential role [21].

The origin of fibroblast activation in fibrosis has now become a major issue in this field of research. In normal wound healing, fibroblasts are transient-

ly activated into myofibroblasts to proliferate and deposit the collagen matrix. Fibrosis can be considered as a wound where continuous signals for tissue repair are emitted. These continuous signals can lead to abnormal production of cytokines and growth factors, resulting in chronic, sustained long-term myofibroblast activation leading to fibrosis [21, 43]. Among the various growth factors TGF-β_1, which orchestrates chronic cell activation, is considered as a master switch for this fibrotic mechanism [44]. The patients with fibrosis may experience pain, skin retraction and induration, restricted arm and neck movement, lymphedema, and skin necrosis and ulcerations. Fibrosis in the skin and subcutaneous tissue is usually diagnosed by palpation and inspection.

Secondary Cutaneous Malignancies

Individuals treated with IR are also at risk for the long-term development of secondary cutaneous malignancies. Increased risk for skin cancers may last a lifetime following radiation, is dose-related, and increases over the patient's lifespan [45, 46]. Patients who are exposed to radiation at younger ages are at greater risk for the development of basal cell carcinoma (BCC) than those who are exposed as adults [45, 46]. BCCs that do present following RT are often more aggressive or unusual variants [2]. The link between cancer treatment with RT and the development of melanoma and other non-melanoma skin cancers later in life is less clear [45].

Chronic side effects of RT

Chronic radiation dermatitis (CRD)

CRD radiation is a true late-stage reaction that develops months to years after exposure to IR. The condition may develop in patients who only experienced minimal acute radiation dermatitis and so may develop in near-normal-appearing skin. Unlike acute radiation dermatitis, chronic radiation dermatitis is unlikely to self-repair and may remain indefinitely [2]. The defining features of the late-stage are fibrosis, atrophy, hypo- or hyperpigmentation changes and the development of cutaneous malignancies. The development of chronic radiation dermatitis, like in ARD, is intricately related to the cytokine TGF-β. Once the skin has had sufficient opportunity to «heal» from radiation-induced injury, long-lasting cellular dysfunction and stromal changes remain that impair cutaneous integrity [2].

Post-inflammatory dyspigmentation is common, and depending on the skin type of the patient and severity of the reaction may slowly resolve or worsen over time [2].

Prevention of side effects of RT

General Preventive measures

Prevention of radiation dermatitis is an important consideration in the pre- and post-RT period. General measures, such as maintaining proper skin hygiene by washing with lukewarm water and mild soaps, and the use of unscented, lanolin-free water-based moisturizers, decreases the risk for acute radiation dermatitis [48]. Avoiding metallic (such as magnesium in talc and aluminium in antiperspirants) and/or oil based topical products, wearing loose-fitting clothes, and avoiding sun exposure may help prevent post-RT complications. However, to date, there are few randomized controlled trials (RCTs) that assess preventive measures for acute radiation-induced skin toxicity. Topical moisturizers, gels, emulsions, or dressings can cause a bolus effect and so should not be applied shortly before radiation [49]. Careful positioning of the patient and appropriate placement of skin shields may decrease radiation-induced skin problems. Following RT sessions, exposure to ultraviolet light in treatment areas and temperature extremes should be avoided [2].

Topical corticosteroids

Topical corticosteroids have long been used for the prevention and treatment of RT-induced cutaneous side effects. However, the efficacy of topical corticosteroids in reducing the frequency and severity of radiation dermatitis was not demonstrated [2]. For instance, no statistically significant difference was found between mometasone furoate 0.1% cream and placebo [50]. The same occurs with 0.2% hydrocortisone valerate vs. placebo [51]. Others demonstrated decreased severity or frequency of acute radiation dermatitis in the topical steroid group [52]. Generally, application of low to medium potency steroid is recommended on the treatment field 1—2 times a day after each RT session to reduce the severity of ARD and decrease the severity of symptoms, including decreased itching, irritation, burning, and discomfort. It is not known whether corticosteroids may increase the incidence of infection, telangiectasia, or skin atrophy [2].

Miscellaneous

Oral Wobe-Mugus (a proteolytic enzyme mixture of 100 mg papain, 40 mg trypsin and 40 mg chymotrypsin) has been shown to decrease the risk for developing RT-induced cutaneous side effects by as much as 87% [53]. On the contrary, there is no supportive literature available to recommend the use of aloe vera, trolamine, sucralfate, or hyaluronic acid in the prevention of ARD.

Treatment of side effects of RT

Acute Radiation Dermatitis (ARD)

Obviously, the treatment will depend on the grade of ARD presented by the patient.

Patients with grade 1 ARD are usually treated with nonspecific treatment similar to the aforementioned general prevention measures. Dry desquamation can be treated with hydrophilic moisturizers, while pruritus and irritation can be treated with low to mid potency steroids [2]. In grade 2 and 3 patients, it will be important preventing secondaryinfection and dressing the areas of moist desquamation. Two types of dressings commonly used in moist desquamation are hydrogel and hydrocolloid dressings. Hydrogel dressings do not adhere to wounds and allow for ease of cleaning and reapplication. Hydrocolloid dressings are absorbent, self-adhering, and can be left in place for several days to simplify wound care [54]. These dressings have been shown to speed wound healing and improve patient comfort [55]. Another interesting alternative of treatment is topical superoxide dismutase (SOD). In a study designed to evaluate the efficacy of SOD applied topically in oncologic patients affected by acute radiation dermatitis, 57 patients were enrolled, who showed a dermatitis grade 2 or superior, and they were administered SOD ointment b.i.d., with follow-up for 12 weeks. At the end of radiotherapy, 77.1% of patients improved completely or partially, and at the end of the 12-week period 100% of patients were free of cutaneous toxicity. No acute toxicity relapses were reported. This study was demonstrating that the use of SOD topically was efficient in the treatment of radiation dermatitis [56]. In grade 4 patients, significant full-thickness skin necrosis and ulceration are observed. Treatment requires a multidisciplinary approach and discontinuation of RT. In addition, surgical debridement of necrotic tissues and the utilization of full-thickness skin grafts or pedicle flaps may be indicated. These high-grade cutaneous skin toxicity reactions can lead to late-consequential changes including fibrosis and non-healing ulcers, which have potential for malignant transformation. Moreover, waves of inflammation can occur with radiation burns leading to the need for successive surgical excisions, reconstruction, and potential need for amputation [57].

Radiation recall

Its clears spontaneously within hours to weeks of cessation of chemotherapeutic treatment. Its management uses to be symptomatic [58]. Systemic corticosteroids in conjunction with discontinuation of the drug will often produce dramatic improvement and may even allow for continuation of the RT [59].

Radiation-induced fibrosis

Radiation-induced fibrosis is one of the most difficult skin complications to treat [2]. A team approach with wound care, physical therapy, and pain management is needed to preserve quality of life [2]. Physical therapy may include active and passive range of motion exercises, which may help to improve range of motion and reduce contractures. Massage may also be beneficial [60]. Adequate pain control should be provided as pain from fibrosis can be significant. Pentoxifylline (PTX) may be used alone or in combination with tocopherol (vitamin E) to treat radiation-induced fibrosis as well as to prevent pulmonary fibrosis [61]. PTX is a methylxanthine derivative that is commonly used as an inhibitor of platelet aggregation, while vitamin E is a scavenger of reactive oxygen. PTX is thought to modulate the immune response by increasing polymorphonuclear leukocyte and monocyte phagocytic activity, antagonizing TNF-α and TNF-β [2], decreasing granulocyte–macrophage colony-stimulating factor and interferon gamma (IFN-γ), among other effects [61].

Combination with tocopherol may downregulate TGF-β expression and may even reverse alter the abnormal fibroblasts that perpetuate fibrosis [61]. Clinical trials have met with mixed results. In these studies, patients treated with PTX in combination with vitamin E demonstrated marginal improvement in their condition, but treatment had little to no benefit over placebo [62]. Duration of such treatment could be an important factor for its positive outcome: measurable superficial radiation-induced fibrosis (RIF) was assessed in patients treated by RT for breast cancer in a long-treatment (24 to 48 months) pentoxifylline-vitamin E (respectively 800 mg and 1'000 IU daily) group of 37 patients and in a short-treatment (6 to 12 months) in a group of seven patients [63]. This combination treatment was continuously effective and resulted in exponential RIF surface area regression (–49% at 6 months, —60% at 12 months, —63% at 18 months, and –68% at 24 and 36 months). The mean time to this effect was 24 months and was shorter (16 months) in more recent RIF (< 6 years since RT) than in older RIF (28 months). There is a risk of a rebound effect if treatment was too short. Long treatment (≥ 3 years) is recommended in patients with severe RIF.

For sure, treatment with topical superoxide dismutase (SOD) is a first line option. In 1994, investigators have shown the therapeutic effect of SOD in an excipient of PEG (PEG-SOD) administrated as an ointment twice a day for 3 months on radia-

tion-induced fibrosis [64]. After 6 months, results on radio fibrosis performed a 41% score reduction compared to pre-treatment score. The therapeutic efficiency was greater on the most recent fibrosis and there was a chronological order to the different recovery stages. After 6 weeks, pain was reduced or disappeared, and after 3 months fibrous texture broke up and softened. An effective reduction of the surface as well as pigmentation lightening would not usually occur until the 4th month. In 1996, a study conducted at Institut Curie in Paris [65] reported the treatment of 42 patients presenting with clinically evaluable cutaneous fibrosis after radiotherapy for breast carcinoma, the time elapsed between irradiation and treatment varying from 3 months to 40 years (mean delay + SD: 8.5 + + 8.4 ears). They were treated for three months by a SOD topical preparation, and sequential cutaneous punch biopsies were performed before and 3 months after completion of the treatment. The histochemical grading, using an objective spectrophotometric method, showed a decrease in fibrosis in 74% of treated patients. In 2004, 44 patients with clinical radiation-induced fibrosis following conservative treatment of breast cancer were evaluated for the local antifibrotic effect of an ointment with SOD applied b.i.d. for 90 days [66]. Topical SOD was found to be effective in reducing radiation-induced fibrosis by a lowering pain score in 90% of patients and a decrease of the fibrotic area size in half cases, after 6 months: mammography density suggested decreased fibrosis in one third of patients, whilst thermography showed that it was decreased in 80% of patients. Clinical changes persisted all along the study, and tolerance was quoted as excellent. 92% of patients reported a greater degree of local comfort. It was clearly demonstrated that SOD did not induce myofibroblast cell death, whereas it significantly reduced TGF-β_1 expression thus demonstrating that SOD might be proposed as a potent antagonist of this major fibrotic growth factor [67]. It was also suggested that SOD antifibrotic action occurred *in vitro* [68].

Treatment with IFN-γ in 5 patients over a 1-year period was shown to be useful in the treatment of cutaneous fibrosis [69].

Hyperbaric oxygen has been evaluated as a treatment for radiation-induced fibrosis; however, there is insufficient evidence to show efficacy at this time [70]. Treatment may result in less pain, swelling, redness, or lymphedema, but no effect on fibrosis has been found [2].

Chronic radiation dermatitis (CRD)

In CRD the care of ulcerations and wounds is nonspecific and follows general wound care guidelines. Wound dressings protect the injured skin from environmental damage and infection and also serve to contain wound secretions [2]. Moisture helps with re-epithelialization of tissue as well as removal of necrotic tissue and bacteria [2]. Hydrophilic and lipophilic creams and ointments may be used alone or with dressings to enhance barrier function. Similar to management of moist desquamation, hydrogel or hydrocolloid dressings may be utilized [61]. Chronic ulcers may require careful and selective debridement. Persistent eschars may be removed manually or treated with enzymatic debridement or autolytic dressings [2]. For infected or at-risk wounds, antibacterial agents should be considered and silver-based dressings may be effective for this purpose [2]. Chronic nonhealing ulcers and suspected lesions may need to be biopsied for histopathologic examination to exclude secondary skin cancers [2].

Telangiectasias

Treatments of telangiectasias resulting from chronic radiation dermatitis are limited.

Treatment with pulse dye laser has been shown in case series to be beneficial [71, 72].

Secondary skin cancers

Squamous cell carcinomas that arise in radiation fields exhibit aggressive behaviour and more frequently metastasize, so surgical excision is the preferred modality for management [2]. Radiation-induced keratoses are pre-malignant and may be treated with cryosurgery when localized or with mechanical destruction with peels, laser, or dermabrasion when diffuse [2]. Topical 5-fluorouracil, diclofenac, photodynamic therapy and imiquimod have also been used in the treatment of skin cancers and precancerous lesions [2].

Conclusion

Acute cutaneous reactions are common side effects of RT. Preventive measures are often elusive and treatment must be implemented, according to the grade of the lesions. Interruption of RT is sometimes necessary. Accurate wound management must be started promptly to decrease healing time and avoid infection. The treatment of chronic radiation dermatitis and radiation-induced fibrosis must also be adequate and permits some improvement.

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Шкірні побічні ефекти онкологічного лікування Частина II. Променева терапія

Променева терапія (ПТ) разом із хіміотерапією є способом лікування хворих зі злоякісними пухлинами. Так само, як і хіміотерапія, ПТ індукує виникнення побічних реакцій з боку шкіри, тяжкість яких значно варіюється, залежно від різних чинників, пов'язаних із лікуванням, таких як загальна доза, наявність чи відсутність фракціонування індивідуальної чутливості пацієнтів. Ці побічні реакції можуть бути гострими, що виникають відразу після проведення ПТ, пролонгованими, які розвиваються через деякий час після припинення процедури, або хронічними, і в цьому випадку можуть тривати багато років і навіть протягом усього життя. Найбільш часті гострі побічні реакції ПТ — гострий променевий дерматит, радіаційні опіки та місцеві запальні реакції в зонах опромінення. Найпоширенішою непрямою реакцією є індукований радіацією фіброз, а серед хронічних побічних ефектів найчастіше спостерігається хронічний променевий дерматит. Окрім профілактичних заходів, ефективність яких обмежена, менеджмент і лікування визнані обов'язковими й мають бути добре відомими дерматологам. Призначення цих процедур залежить від характеру та вираженості побічних реакцій. Цей огляд має на меті поглибити знання про побічні реакції з боку шкіри при ПТ та допомогти хворим, які звертаються по допомогу до фахівця.

Ключові слова: променева терапія, побічні ефекти, радіаційний дерматит, радіаційні опіки, місцеві запальні реакції в зонах опромінення, індукований радіацією фіброз, профілактика, лікування.

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Кожные побочные эффекты онкологического лечения Часть II. Лучевая терапия

Лучевая терапия (ЛТ) вместе с химиотерапией является способом лечения больных со злокачественными опухолями. Так же, как и химиотерапия, ЛТ индуцирует возникновение побочных реакций со стороны кожи, тяжесть которых может широко варьироваться в зависимости от различных факторов, связанных с лечением, таких как общая доза, наличие или отсутствие фракционирования индивидуальной чувствительности пациентов. Эти побочные реакции могут быть острыми, возникающими сразу после проведения ЛТ, пролонгированными, развивающимися через некоторое время после прекращения процедуры, или хроническими, и в этом случае могут длиться много лет и даже на протяжении всей жизни. Наиболее частые острые побочные реакции ЛТ — острый лучевой дерматит, радиационные ожоги и местные воспалительные реакции в зонах облучения. Одной из распространенных непрямых реакций является индуцированный радиацией фиброз, а среди хронических побочных эффектов чаще всего наблюдается хронический лучевой дерматит. Помимо профилактических мер, эффективность которых ограничена, менеджмент и лечение признаны обязательными, их должны хорошо знать дерматологи. Назначение данных процедур зависит от характера и выраженности побочных реакций. Данный обзор призван углубить знания о побочных реакциях со стороны кожи при ЛТ, чтобы помочь больным, обращающимся за помощью к специалисту.

Ключевые слова: лучевая терапия, побочные эффекты, радиационный дерматит, радиационные ожоги, местные воспалительные реакции в зонах облучения, индуцированный радиацией фиброз, профилактика, лечение.

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