

Radiation dermatitis wet healing: a concept analysis



Review

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Abstract: **Objective:** To explore the concept of radiation dermatitis wet healing through a literature review and provide references for future treatment of patients with radiation skin injury.

Methods: Related articles selected from China National Knowledge Infrastructure (CNKI), Wanfang Database, PubMed, Web of Science, Medline, and EBSCO were analyzed with Rodger's concept analysis.

Results: We identified the application status of wet healing in domestic and foreign literature, defined explicit attributes of the procedure, and clarified concepts related to wet healing of radiation skin injury to provide a reference for the management of radiation dermatitis with wet healing.

Conclusions: Treatment of radiation dermatitis with wet healing is a unique procedure. Analyzing this concept can contribute to its development in the future and can offer a theoretical basis for treatment of patients with radiation skin injury.

Keywords: concept analysis • radiation skin injury • radiodermatitis • skin damage • wet healing

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1. Introduction

Radiodermatitis refers to acute and chronic skin damage caused by radiation applied to the skin. In head and neck cancer patients receiving radiation therapy, 80%–90% will develop radiation dermatitis, and 25% will have severe radiation injury.¹ It is reported that approximately 95% of patients treated with radiation therapy will eventually develop radiation dermatitis during or after treatment. Therefore, ascertainment of an effective means for the prevention and treatment of radiation-induced skin injury is of great practical significance.² Radiation skin damage can not only affect patients'

happiness index, impact their quality of life, and cause pain and discomfort but also reduce the dosage of drugs required and affect the efficacy of radiotherapy. Ascertainment of an effective means for the prevention and cure of radiation dermatitis is a problem that needs to be solved in the clinic. Wet healing theory has been widely used in various types of wound healing, but for clinical workers treating radiation skin lesions with more than 1 drug or with the dry processing method, wet healing in the application of radiation skin damage has no uniform standard. Thus, in this study, evidence-based, Rodger's

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evolutionary concept analysis will be conducted, defining the attributes, causes, and consequences of radiation dermatitis wet healing to provide a reference for the management of radiation skin injury.

2. Methods

Literature retrieval and screening: Keywords and free words were combined for retrieval using the following Chinese/English search words: “radiation skin injury,” “radiation dermatitis,” “wet healing,” and “wet healing theory.” Retrieval was performed in China National Knowledge Infrastructure (CNKI), Wanfang Database, PubMed, Web of Science, Medline, and EBSCO databases in both Chinese and English. This study adopts Rodgers’ evolutionary concept analysis.³ The search retrieved a total of 1027 English and 623 Chinese articles. The inclusion criteria were as follows: (1) the research topic was related to wet healing of radiation dermatitis; and (2) the study was published in Chinese or English. The exclusion criteria were as follows: (1) the research topic was not related to wet healing of radiation dermatitis; (2) the study was a duplicate; and (3) full-text literature could not be obtained. Two individuals screened the retrieved articles according to the established inclusion and exclusion criteria, and 26 articles were finally included (20 English articles and 6 Chinese articles).

The main steps of this study included the following: (1) identification of and nomenclature for the concept of radiation dermatitis wet healing; (2) identification of alternative treatments for radiation skin lesions; (3) collection and extraction of valuable data; (4) determination of radiation dermatitis attributes, causes, and effects through the analysis of the data; (5) identification and interpretation of concepts related to radiation dermatitis wet healing; and (6) establishment of a typical case of wet healing of radiation skin injury based on clinical cases.

3. Results

3.1. Development of the concept of wet healing and its application to radiation dermatitis

In 1962, British animal physiologist Jorge Winter studied pig tissue and found that covering wounds with a moist, permeable dressing could double the rate of epithelialization, which was termed the “wet healing environment theory.”⁴ It was demonstrated for the first time that epidermal cells can proliferate and migrate better in a moist environment created by the application of moist and permeable wound excipients. In 1963, Hinman and Maibach⁵ achieved the same results in humans.

Transparent semipermeable film dressings began to appear in early 1974, and Opsite, the first commercial sealing dressing, was produced by Smith & Nephew in the UK.⁶ The theory of wet wound healing was put forward, which challenged the traditional idea of wound healing.

In 2000, the U.S. Food and Drug Administration issued new industry guidelines for wound medical products that specifically emphasized keeping the wound moist as the standard wound treatment.⁷ Wet healing theory is widely used in pressure ulcers, wounds, and so on.⁸

Radiation dermatitis is a cutaneous reaction to ionizing radiation exposure that varies in the degree of reaction, such as dry, erythema, and moist desquamation.⁹ Radiodermatitis may cause a variety of symptoms, such as pain, discomfort, irritation, and itching. The severity of radiation skin reaction is graded on a continuum ranging from transient erythema and dry skin peeling to more severe moist desquamation and eventual ulceration. Radiation skin injury can affect daily activities and quality of life.

A moist environment can promote local circulation and perfusion, rapidly increase growth factor levels, stimulate local tissue regeneration, and accelerate wound healing. The skin dressing provides a moist healing environment for the wound, facilitates epithelial cell migration to the wound bed, promotes wound epithelialization, and protects the wound from contamination and friction. At present, wound protection, such as dressing, is undoubtedly the standard of care in wound management. Closed wounds heal 40% faster than unclosed wounds. This was thought to be due to the easier migration of epidermal cells in the moist environment created by the dressing.¹⁰ It is a relatively novel method to treat and prevent skin reactions caused by radiation by using a polymer barrier to form a solution, dressing, or film.

A study of radiation dermatitis wet healing showed that a moist environment promotes epithelialization and speeds up wound healing.¹¹ For patients with grade 2–3 radiation dermatitis and moist desquamation, we typically use soft, absorbent, silicone foam bandages. Bacterial repeat infections can be treated with local and/or systemic antibiotics.

Standard management of protective skin wound care, such as dressings, should be applied. ONS guidelines state that silver sulfadiazine should be used as the standard of care for the subsequent research questions regarding the use of dressings for radiation dermatitis.¹² After receiving radiation therapy, the ONS guidelines suggest semipermeable dressings in addition to the standard washing/skincare regimen.

Silicone dressings: Film-forming silicone gel (Strata XRT) can effectively reduce the degree of skin injury,

promote wound healing, and be used on skin with hair.¹³ One study found that after the application of prophylactic water membranes, there was a very reasonable cost-effectiveness and a significant reduction in radiation dermatitis. It is also effective in erythema, pigmentation, desquamation, and subjective symptoms, with fewer adverse reactions.¹⁴ A domestic study shows that wet compress therapy cannot prevent the occurrence of radiation dermatitis in patients with nasopharyngeal carcinoma receiving radiotherapy, but it can delay the occurrence, thus improving the tolerance of patients to radiotherapy.¹⁵

3.2. Properties of wet healing of radiation dermatitis

In nursing practice, the properties of wet healing of radiation dermatitis include the following aspects:

- (1) The healing process of radiation dermatitis: Healing of radiation dermatitis progresses through the typical stages of granulation formation, epithelial formation, and wound healing, and so the basic principles of general wound treatment can be adopted. A relatively moist wound bed is clearly conducive to healing, while excessive wetting is harmful and will lead to maceration.
- (2) The creation of a wet healing environment: Closed wounds heal 40% faster than unclosed wounds, in part because epidermal cells migrate more easily in the moist environment created by the dressing.¹⁶ Therefore, in promoting the healing of radiation dermatitis, the creation of a closed humid environment is conducive to recovery.
- (3) Wet healing methods: Wet healing has been widely applied in clinical practice. Research has shown that in a low-oxygen wet environment, the capillaries form faster, providing full nutritional support for the growth of cells, speeding up the formation of immune factors and growth factors, promoting the rapid skin migration of epidermal cells, and enhancing wound oxygen tension.¹⁷ During dressing changes, the low-oxygen, slightly acidic, and humid environment formed by the moisturizing dressing is closely attached to the skin around the wound and inhibits the growth of bacteria, reduces infection, promotes the growth of fibroblasts, and stimulates the formation of capillaries and the release and activation of endogenous collagenase to dissolve the necrotic tissue on the wound. Wound healing was accelerated by this debridement. In addition, the wet environment created by the moisturizing material can reduce the secondary injuries caused by dressing changes and relieve the pain of patients during dressing changes.
- (4) The choice of dressing

Hydrogels: Hydrogels are water- or glycerin-based dressings best indicated for dry wounds as they donate moisture to the wound bed.¹⁸ They are also useful on eschars, as they keep the eschar soft, allowing for a better environment to clear necrotic debris. They provide a nonadherent contact surface that has been shown to reduce pain, provide a cooling sensation, and prevent tensile or frictional trauma to the wound bed.

Hydrocolloid: Hydrocolloid dressings with water as a dispersion medium, which create a wet environment similar to human tissue and encourage strong water retention, can effectively reduce the incidence of local stiffness and inflammation and promote necrotic tissue autolysis. The dressing forms a bubble that coats the wound surface and can not only absorb the drainage but also prevent water gel.¹⁹

Films: Films are thin, semipermeable sheets of polyurethane that are efficient at allowing gas exchange and preventing bacterial colonization or wound contamination.¹³ They are useful for visualizing the wound as it heals, but the adhesive nature of the dressing can also retraumatize a wound upon removal. Films are ideal for superficial wounds but are not recommended for infected wounds because of their limited absorptive capacity.

Thermoplastic polyurethane (TPU): TPU is a sterile, semipermeable, transparent film that can significantly reduce radiation-induced erythema, pigmentation, and desquamation symptoms while also relieving subjective sensations such as itching, pain, burning, and limited movement.

Silicone dressings: Silicone gel (Strata XRT) can effectively reduce the degree of skin damage, promote wound healing, and be used on skin with hair.¹³

Silver-based dressings: Silver-based dressings may be just as effective as antibiotics. Silver dressings have been shown to speed up the healing process and improve pain caused by radiation dermatitis. In addition, due to its antibacterial properties, the use of silver leaf dressings is effective in reducing the incidence of severe skin reactions.²⁰

4. Antecedents and consequences of wet healing in radiation dermatitis

4.1. Antecedents

The pathogenesis of radiodermatitis involves a combination of direct radiation injury and a subsequent inflammatory response, affecting cellular elements in the epidermis, dermis, and vasculature.²¹ High-energy

X-rays during radiotherapy lead to direct and indirect ionizing events, transient free radicals, irreversible DNA double-strand breaks, and inflammatory responses, resulting in cell damage. Radiation affects all types of cells in the epidermis and dermis by damaging DNA.²² The free radicals produced by radiation directly or indirectly damage basal layer cells by ionizing radiation and hinder their division, proliferation, migration, and keratinization. Radiation can cause hyperplasia and swelling of endothelial cells of dermal and subcutaneous microvessels and small vessels, resulting in intima thickening, lumen stenosis and occlusion, microcirculation disorder, local skin ischemia, and hypoxia change. Radiation recruits inflammatory cells, causing them to release a flood of inflammatory factors, triggering cascade reactions, and eventually radiation skin reactions.

4.2. Consequences

As radiation therapy progresses, a patient may develop temporary erythema or dry desquamation on the local skin due to radiation damage (redness may occur and fade within hours after treatment). This can be accompanied by wet peeling and pain, severe ulcers, and necrosis, seriously affecting the patient's quality of life and treatment.²³

5. Related concepts

Late-effect or chronic radiation dermatitis: Delayed effects or chronic radiation dermatitis generally occur months to years after radiation exposure. The main manifestations are skin fibrosis, pigmentation, atrophy, and telangiectasia.²⁴

Radiation recall is an acute inflammatory response that is confined to a formerly irradiated area and is triggered by chemotherapy or other drugs. In patients who receive chemotherapy after radiotherapy, the incidence is estimated at 6%–9% and can occur weeks, months, or years after radiation therapy. The diagnosis is based on the reaction's appearance within the previous radiation therapy field.²⁵

6. Model case

The participant provided written informed consent prior to implementation of the program. A 67-year-old male patient with nasopharyngeal carcinoma was given an appropriate intensity of modulated radiotherapy with a total dose of 70 Gy (35 fractions of 2 Gy) after the relevant examination.

No special care was given, except conventional care during radiotherapy, until the symptoms of dry

radiation dermatitis appeared: dry skin and erythema. **Method and scope:** The hydrogel dressing was applied evenly to the skin within the radiation field, with a thickness of less than 3 mm. The dressing was applied 3 times a day and the skin of the radiation field was cleaned with normal saline before each application. Patients reported that after using the hydrogel dressing, itching and dryness were relieved. After 25 rounds of radiotherapy, the patient developed wet radiation dermatitis on the neck. The damaged skin was 5 cm long and 3 cm wide. The responsible nurse applied a hydrocolloid dressing to keep the local skin moist. The patient's pain score was reduced by 2–3 with the dressing, and local comfort improved. After standardized nursing, the patient's treatment was successfully completed, and he was discharged as scheduled.

7. Conclusions

Radiation skin injury types can be divided into acute radiation dermatitis and chronic radiation dermatitis according to the duration of injury.²⁰ Many topical medications and specialized wound dressings are used to prevent and control radiation-induced skin changes, but no single treatment has been consistently effective.²⁶ The application of wet healing theory in the treatment of radiation dermatitis has improved the symptoms and the quality of life of patients, making it a worthwhile practice to promote in clinical settings. However, most of the dressings are expensive, resulting in an economic burden on patients. Therefore, more universal wound dressings are expected to be developed for clinical application. In the absence of high-quality randomized controlled trials, wet healing of radiation dermatitis deserves more attention in the future.

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Ethical approval

Ethical issues are not involved in this paper.

Conflicts of interest

All contributing authors declare no conflicts of interest.

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