Role and mechanism of radiological protection cream in treating radiation dermatitis in rats

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Abstract

OBJECTIVE: To explore the role and mechanism of a radiation protection cream (Rp) in the treatment of radiation dermatitis, and to accumulate necessary technical information for a new drug report on Rp.

METHODS: High-performance liquid chromatography was used to establish the method of measuring the main effective ingredients of sovereign and adjuvant herbs of Rp drugs, and to formulate the draft quality standards of Rp. A total of 48 Sprague-Dawley male rats were randomly divided into the Model, Trolamine cream (Tc), Rp and Blank groups according to a random number table method. The skin of each rat’s buttocks was irradiated using an electron linear accelerator to establish an acute radiation dermatitis model. The histological changes were observed under light microscopy and electron microscopy during wound healing and the effect of Rp on rat fibroblast Ku70/80 gene expression was detected at the transcriptional level.

RESULTS: Pathological examination revealed that Rp protected the cellular and subcellular structures of skin after irradiation, promoting the proliferation and restoration of collagen fibers. Ku70/80 mRNA expression levels in the Rp and Tc groups were higher than that in the model group ($P<0.05$). Moreover, The majority of grade radiation dermatitis relative to the Model, Rp and Tc groups for reducing grade III and IV dermatitis efficiency were 85.7% and 69.2% ($P<0.05$), respectively. The efficacy of Rp group in treating radiation dermatitis was better than the Trolamine cream group by 16.5% ($P<0.05$).

CONCLUSION: Compared with Tc, Rp had certain advantages in the efficacy and performance to price ratio. Thus, Rp is considered an effective alternative formulation for the prevention and treatment of radiation dermatitis.

Key words: Radiological health; Skin cream; Radiation dermatitis; Pharmacology
INTRODUCTION

Radiation dermatitis is the most common complication of radiation oncology treatment. Radiation-induced skin reactions of erythema occur in approximately 87% of patients receiving radiotherapy, in which the incidence of moist desquamation is 10%-15%.¹ Moist desquamation also occurs at the end of radiotherapy in about 10% of breast cancer patients.² The prevention and treatment of radiation dermatitis has been a concern of radiotherapy professionals. Effective protection is a key tool in the treatment of radiation dermatitis. Trolamine cream is a commonly imported drug with good clinical efficacy, but is quite expensive. In clinical applications, Trolamine cream (Tc) does not exhibit significant therapeutic effects in patients with grade II lesions or skin blister-ulceration, skin touch pain, edema, and epithelial flaky moist exfoliation that constantly expand.

The main causes of radiation skin damage are X-, β-, and γ-rays. X- and γ-rays can penetrate through the skin to the subcutaneous tissue. They can even damage bones and sometimes generate long-term ulcers. β-rays (E-Line) cause local damage and external irradiation commonly leads to skin damage.³ The criteria of the radiation therapy oncology group (RTOG) are still being used to evaluate toxicity.⁴ These criteria are still considered the standard bases for evaluation of radiation-induced skin reactions. However, further research is needed to inform clinical practice. Simonen et al.¹⁸ spectrophotometrically measured damage due to low doses of radiation because it is difficult to detect small changes with the naked eye. Nuutinen et al.¹⁵ evaluated the degree of radiation injury by measuring the capacitance rate. Extensive necrosis and damage of the dermal layer connective tissue and collagen fibers can be observed under a light microscope. Under an electron microscope, mitochondria and various organelles show vacuolar degeneration, nuclei apoptosis, nuclear condensation and changes in collagen fibers. Radiation causes acute radiation-induced ulcer formation, and decreases the expression levels of several growth factors and their receptors, leading to the formation of granulation tissue, which affects the entire process of wound healing.³⁶ Radiation mainly kills tumor cells by causing DNA double-strand breaks. Studies found that Ku70/80 mRNA is involved in the regulation of DNA replication and that Ku deletion results in lower DNA replication in mammals.¹⁹ A previous study observed that irradiation significantly increased Ku70/Ku80 mRNA and protein expression levels in normal fibroblasts, in which Ku70/80 proteins are soluble protein fragments.¹¹ Ku can suppress the generation of apoptosis.¹² DNA fragments promote Ku and DNA connection and damage repair, thereby inhibiting apoptosis. In recent years, Ku has attracted attention in tumor prognosis and diagnosis.¹³-¹⁵ Previous studies demonstrated that the transcript level of Ku70/80 increased with the DNA damage activity.¹⁶-²² In the present study, we investigated the effect of Rp on Ku70/80 gene expression at the RNA level using real-time polymerase chain reaction (PCR) method and found that Rp can up-regulate Ku70/80 gene expression and promote the repair of cell DNA damage caused by radiation.

To date, numerous topical medicines are clinically used for the treatment of radiation dermatitis. These medicines include unilateral or compound Traditional Chinese Medicine (TCM), corticosteroids, vitamins, minerals, antibiotics and disinfectants. Radiation is a fiery toxin, causing muscle desquamation, hot itch, ulcers, blood heat-induced erythema, blood stasis-induced pigmentation, and burning-induced blood stagnation and meridian obstruction. Danggui (Radix Angelicae Sinensis), Baixianpi (Cortex Dictamni Radicis) and Zicao (Radic lithospermi) are used as sovereign herbs; Kushen (Radix Sophorae Flavescentis), Baizhi (Radix Angelicae Formosanae) and Gandan (Radix Glycyrrhizae) are used as adjuvant herbs; and Xuejie (Sanguis Draconis) blood and Bingpian (Borneolum Syntheticum) are used as assistant herbs. They are combined with a broad-spectrum antibiotic chloramphenicol powder from Western Medicine. Baixianpi (Cortex Dictamni Radicis) has a wide range of antibacterial and antifungal functions and can eliminate dampness. Zicao (Radic lithospermi) can cool blood and detoxify the blood, in which the lethal scattered blood heat has a unique effect on ionization burns. Danggui (Radix Angelicae Sinensis), Gandan (Radix Glycyrrhizae) and Baizhi (Radix Angelicae Formosanae) can nourish the blood, cause myogenic sores and detoxify fluid. Bingpian (Borneolum Syntheticum) can reduce fever, decrease swelling and prevent corrosion. It is also myogenic, eliminating itching and burning discomfort sensations. The broad-spectrum antibiotic chloramphenicol powder can enhance the antibacterial effect of prescription herbs. An effective and cost-effective method for preventing and treating dermatitis based on radiation dermatitis-grading criteria, individual differences in circumstances and a patient's economic status should be developed. In the present study, we used traditional herbal medicines that have been tested and their efficacies have been confirmed through clinical applications and animal experiments.

MATERIALS AND METHODS

Drug prescriptions

Danggui (Radix Angelicae Sinensis) 30 g, Baixianpi (Cortex Dictamni Radicis) 30 g, Gandan (Radix Glycyrrhizae) 15 g, Kushen (Radix Sophorae Flavescentis) 15 g, Baizhi (Radix Angelicae Formosanae) 15 g, Zicao (Radix lithospermi) 3 g, Xuejie (Sanguis Draconis) 3 g, and Bingpian (Borneolum Syntheticum) 3 g were used. Chloramphenicol powder (5 g) was added to strengthen the antibacterial effect of the herbs.

Drug preparation process

Radiological protection cream (Rp) group: sesame oil
dissolution method was used: Danggui (Radix Angelicae Sinensis), Baixianpi (Cortex Dictamni Radicis), Gancao (Radix Glycyrrhizae), Kushen (Radix Sophorae Flavescentis), Baizhi (Radix Angelicae Formosanae), Zicao (Radix lithospermi) were ground, sieved through a 10 gauge mesh and then soaked for 3 day in 500 mL sesame oil. The components were boiled in a pot until the Danggui (Radix Angelicae Sinensis) turned brown and then sieved through a 400 gauge mesh. Rp1 group used the decoction cooking method: the former six herbs were ground (10 gauge), soaked in 500 mL of water for 1-2 h, decocted three times and then sieved through a 400 gauge mesh. Rp2 group used the ethanol impregnation method: the former six herbs were ground (10 gauge), impregnated in 500 mL of ethanol for 3 day and then filtered to remove insoluble compounds.

Formulation quality control

TCM preparations are compounds with complex chemical compositions, thus making the qualitative and quantitative analyses of the herbs difficult. Although many studies25,26 focused on radiation dermatitis treatments of traditional unilateral or compound Chinese medicines, none of them investigated the herbs, their specific medicinal components and methods used to determine their content. However, content determination is an inherent quantitative criterion of the quality of TCM preparations. In the present study, the preparation was followed according to previous studies and the regulations of the People’s Republic of China Pharmacopoeia (2010 Edition),27 which provides Chinese and natural medicine extraction and purification guidelines ([Z] GPH2-1), to develop medicine determination indicators of the preparation group. Shikonin was used as the detection indicator for Zicao (Radix lithospermi).25 Fresh white alkali and fraxinellone were used as detection indicators for Baixianpi (Cortex Dictamni Radicis).26 Ferulic acid and polysaccharides were used as detection indicators for Danggui (Radix Angelicae Sinensis).25,30 Efficacy is the final discriminant basis.

Preparation determination

The preparation’s fraxinellone content was measured by high-performance liquid chromatography (HPLC): approximately 0.2 g of the drug was placed in a conical flask and 20 mL of 70% methanol was added, the flask was weighed, heated for 30 min to reflux, allowed to cool, weighed, shaken and then left standing. The supernatant was aspirated and filtered, and the filtrate was used for HPLC determination. Chromatographic conditions were as follows: column, AT-LICHROM C18 (4.6 mm × 250 mm); mobile phase, methanol-water (70:30); detection at wavelength of 240 nm; column temperature of 25°C; and flow rate at 0.5 mL/min.

Process: approximately 5 g of the drug was added to 15 mL of 90% ethanol, soaked at 35°C-45°C for 48 h, filtered, soaked again and then extracted three. The filtrate was combined with ethanol. The residue was added to 5 mL of methanol, filtered and then spotted. Optical density was detected, and fresh white alkali content was calculated using the national pharmacopoeia method.

The Shikonin content was determined by the national pharmacopoeia method. Approximately 5 g of Shikonin was extracted in a Soxhlet extractor using petroleum ether (30°C-60°C). The extract was cooled and leached three times with 0.2 mol/L NaOH aqueous solution (30, 20, then 10 mL) and washed with 10 mL water. The extracts and washings were combined and left for 2 h, then added to 0.5 mL/L H2SO4 (30 mL, solution changed from blue to red), shaken and left standing for 2 h. The precipitated crystals were filtered, washed with 10 mL of water thrice and then dried to a constant weight at 105°C. Precise weighing was performed to obtain the content of Shikonin in the formulation.

Ferulic acid preparation was determined by HPLC. Approximately 0.2 g of the drug was placed in a conical flask, added to 20 mL of 70% methanol, weighed, heated for 30 min to reflux, allowed to cool, weighed again, shaken and then allowed to stand. The supernatant was filtered, and the filtrate obtained was subjected to HPLC determination. Chromatographic conditions: column, AT-LICHROM C18 (4.6 mm × 250 mm); mobile phase, acetonitrile 0.085% phosphoric acid solution (5:83) flow rate, 1.0 mL/min; column temperature, 35°C; and detection wavelength, 316 nm.

Determination of polysaccharide preparations was according to the national pharmacopoeia. Approximately 5 g of the drug was heated in 85% ethanol under reflux twice. The temperature was kept at 80°C and checked eight times, water was extracted twice for 3 h and the concentration of alcohol precipitation was determined to be 60%. Glucose (0.0524 g) was dried at 105°C, and put in a 100 mL volumetric flask. Distilled water was then added to 100 mL (the mark) and the mixture was shaken. The concentration of 0.524 mg/mL glucose control solution was then obtained. Different amounts of reference solution (0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 and 7.0 mL) were placed in a 25 mL volumetric flask and then distilled water was added up to the mark. Approximately 2 mL each of the above solution was pipetted, added to 1 mL of 5% phenol and then the mixture was shaken. Subsequently, 7 mL of concentrated sulfuric acid was quickly added and the mixture was shaken for 2 min before boiling for 30 min. Next, the liquid was removed and placed in an iced water bath for 15 min of cooling. The absorbance of the extract was measured at 485 nm wavelength. The absorbances were plotted vs concentrations and a best-fit line was obtained using a regression equation. Approximately 2 mL of the test solution was weighed.
The total sugar content was determined from the standard curve method. The measured values were fitted into the regression equation to calculate for the polysaccharide content. Polysaccharide yield=the precipitate weight×polysaccharide content/sample volume×100.

**Animals**

A total of 48 Sprague-Dawley male rats [Certificate of quality No. SCXK (Lu) 20080002], weighing between 180 and 220 g, were divided into the model, Tc, Rp and blank groups, with a random number table method. The blank group are 6 rats, the rest are 14 only, be-cause after irradiation, the animals were sacrificed. The skin within the radiation field was obtained and set aside. This study was carried out in strict accordance with the recommendations in the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health, United States of America. The animal use protocol was reviewed and approved by the Institutional Animal Care and Use Committee of Jinan Central Hospital.

**Radiation injury**

Acute RTOG grading standards are as follows: grade 0: basic unchanged; grade I: blisters, light erythema, hair loss, dry desquamation and decreased sweating; grade II: skin touch pain, obvious erythema with flaky moist desquamation and moderate edema; grade III: confluent moist desquamation in addition to skin folds and severe edema; grade IV: ulcers, bleeding and necrosis.

**Pathological examination**

Skin lesions, epidermal and dermal tissues, dermal edema, capillaries, bleeding, neutropenia, and hair follicle structure were observed under a light microscope (NIKON D3100). Membrane integrity, mitochondria, endoplasmic reticulum structure, collagen fibers, and nucleus film structure were observed using a transmission electron microscope (JEM-1200EX electron Japan).

**Real-time PCR**

Real-time PCR data analysis used the $2^{-ΔΔCt}$ relative quantification analysis method. Both the target gene and the reference gene amplification efficiency were found to approach 100%. $ΔCt=Ct$ (target gene)−$Ct$ (reference gene), $ΔΔCt=ΔCt$ treatment group−$ΔCt$ blank control group, and $100×2^{-ΔΔCt}$ value was compared.

**Statistical analysis**

Data were processed using SPSS statistical software version 13.0 (SPSS, Chicago, IL, USA) and the results were presented as mean± standard deviation ($x±s$). Among groups using analysis of variance, $q$ test was used to compare the two groups. The inspection level was $α=0.05$.

**RESULTS**

**Pharmaceutical preparations**

Depending on the level of sovereign drug and patent medicine component (Table 1) and the clarity of the formulations, Rp was the compound chosen to form the Rp preparation of draft quality standards.

**Radiation injury**

In the model group, the rats developed severe symp-toms, including emerging flaky erythema with deep dis-coloration, obvious pressure sores, edema blister-ulcer-

<table>
<thead>
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<th>Name</th>
<th>Lithospermum</th>
<th>Angelicae</th>
<th>Dictamni</th>
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<tr>
<td></td>
<td>Shikonin</td>
<td>Ferulic acid</td>
<td>Angelica polysaccharide</td>
</tr>
<tr>
<td>Rp</td>
<td>181.86±2.78 ↑</td>
<td>22.70±1.34</td>
<td>0.78±0.05</td>
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<td>Rp1</td>
<td>51.96±1.96</td>
<td>27.24±1.55 ↑</td>
<td>1.18±0.11 ↑</td>
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<td>Rp2</td>
<td>155.88±2.24</td>
<td>21.58±1.05</td>
<td>0.80±0.07</td>
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</table>

Notes: Rp, Rp1, Rp2 were all compose of Danggui (Radix Angelicae Sinensis), Baizhianpi (Cortex Dictamni Radicis), Gancao (Radix Glycyrrhizae), Kushen (Radix Sophorae Flavescentis), Baizhi (Radix Angelicae Formosaneae), Zicao (Radix lithospermii). Rp group used sesame oil dissolution method; Rp1 group used the decoction cooking method; Rp2 group used the ethanol impregnation method. Rp: radiological protection cream.
ation, moist desquamation and ulceration necrosis 6-12 day after the experiment. Skin around the damaged area was dry and thickened. The rats were irritable and ate little. The symptoms in the Tc and Rp groups were less severe than those in the model group, with the emerging time between 5 and 17 days. Erythema and ulcers were smaller and light colored. Dry skin peeling was also observed, with a small number of cases showing increased erythema area, edema, moist desquamation and punctate ulcers. In addition, these rats showed normal activities and appetite (Table 2).

**Light microscopy**

The rats in the blank group had smooth epidermis, uniformly distributed spinous cells, normal hair follicles and no inflammatory cells. The rats in the model group showed obvious wound lesions, epidermal and superficial dermal necrosis, dermal edema, telangiectasia, bleeding and wide neutral granulocyte infiltration. The rats in the Tc and Rp groups showed injured but intact skin surfaces, visible fibroblast collagen fiber repair, hyperplasia and inflammatory cell infiltration (Figure 1).

**Electron microscopy**

The rats in the blank group had intact skin cell membranes, basement membranes of uniform density, clear collagen fibers in the dermis, complete fibroblast structure, flat sac-shaped rough endoplasmic networks and complete dermal capillaries. In the model group, rupture of the fibroblasts’ nuclear membrane, cell vacuolization, swelling, disorders and decreased collagen fibers were observed. In the Tc group, broken fibroblasts’ nuclear membrane, swollen endoplasmic reticulum, mitochondrial swelling and vacuolization, obliterated cristae and slightly increased collagen fiber were observed. In the Rp group, mitochondrial swelling in fiber cells, mild expansion of the endoplasmic reticulum, nucleus integrity and increased density of collagen fibers were observed (Figure 2).

**Real-time PCR**

Quantitative PCR amplification curves showed good fluorescence value curves. Ct values were close to each other, revealing that the PCR reaction system was stable, reproducible and reliable (Figure 3). Real-time PCR monitoring of the Rp and Tc groups showed that the Ku70/80 mRNA expression levels were higher than Model group \((P<0.05)\) (Table 3, Figure 4, 5).

**DISCUSSION**

We developed the Rp cream, a new combined Chinese and Western preparation using TCM theory and the principles of clinical efficacy of TCM compounds. The

<table>
<thead>
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<th>Group</th>
<th>n</th>
<th>Grade</th>
<th>V</th>
<th>I</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Blank</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Model</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>10 (4-16)</td>
</tr>
<tr>
<td>Rp</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>12 (6-14)</td>
</tr>
<tr>
<td>Tc</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>9 (7-16)</td>
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Notes: the blank group was not irradiated nor administered any treatment; the model group was daubed with distilled water, the Tc group was smeared with Trolamine cream and the Rp group was daubed with approximately 1 mm of radiological protection cream once a day. RTOG: radiation therapy oncology group; Tc: trolamine cream; Rp: radiological protection cream. The figures outside the brackets were the number of rats and the figures inside the brackets were the range of areas of radiation damage. V: value of radiation damage, was the sum of the product of the number of damaged rats \((n)\) and the grade of radiation damage \((G_i)\) \((V= \sum n*G_i)\), which indicated the level of radiation damage in one experiment group; I: index of radiation damage, the results of \(V\) divided by the total number of damaged rats \((N)\) \((I=V/N)\), which indicated the grade of radiation damage in one experiment group, Rp \(I<2.14<Tc \leq 2.31<model\leq 3.23\).
Zu GH et al. / Experimental Study

Rp cream showed greater efficacy in treating radiation dermatitis than Western radioprotective drugs (e.g. Trolamine cream). The majority of grade radiation dermatitis relative to the model, Rp and Tc groups for reducing grade III and IV dermatitis efficiency were 85.7% and 69.2% ($P<0.05$). The efficacy of Rp group in treating radiation dermatitis was better than the Trolamine cream group by 16.5% ($P<0.05$). Moreover, as show in Table 2, Rp $\quad \frac{14.0\pm1.3}{11.3\pm1.8} < Tc \quad \frac{5.6\pm1.3}{7.6\pm1.3} < \text{model} \quad \frac{11.3\pm1.8}{6.7\pm1.2}$, indicated that the index of radiation damage. In a clinical study using Rp, grade I and II skin reactions decreased by 53.8% compared with the national radioprotective drug, the duration reduced by 36%, the reaction area reduced by 25% ($P<0.05$) and no grade III or IV radioactive dermatitis occurred.  

**Figure 2** Histological changes under electron microscopy among different groups  
A, B ($\times 12000$): blank group, complete nucleus, extensive rough endoplasmic reticulum, collagen fibers arranged in neat rows, without exception; C ($\times 12000$), D ($\times 7500$): model group, shows a ruptured nuclear membrane, swollen cell, vacuoles, disorders of the collagen fibers; E, F ($\times 12000$): Rp group, E: shows a complete nucleus, swelling of mitochondria and mild expansion of the endoplasmic reticulum; F: increased collagen fibers and density; G, H ($\times 12000$): Tc group, shows upper left area of the nuclear membrane is ruptured, increased swelling of the endoplasmic reticulum, mitochondria swelling, vacuolization, cristae missing, visible autophagosomes and increased collagen fibers.

**Figure 3** Internal reference amplification curve in real-time PCR  
PCT: polymerase chain reaction.

**Table 3** Expression of Ku70/80 mRNA in experimental groups ($\bar{x} \pm s$)  

<table>
<thead>
<tr>
<th>Group</th>
<th>$n$</th>
<th>Ku70 mRNA</th>
<th>Ku80 mRNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>6</td>
<td>14.0±1.3</td>
<td>9.4±1.5</td>
</tr>
<tr>
<td>Model</td>
<td>13</td>
<td>5.6±1.3</td>
<td>3.2±0.8</td>
</tr>
<tr>
<td>Rp</td>
<td>14</td>
<td>11.3±1.8</td>
<td>7.6±1.3</td>
</tr>
<tr>
<td>Tc</td>
<td>13</td>
<td>10.8±1.7</td>
<td>6.7±1.2</td>
</tr>
</tbody>
</table>

Notes: the blank group was not administered irradiation; the model group was daubed with distilled water; the Tc was smeared with trolamine cream and the Rp group was daubed with approximately 1 mm of radiological protection cream once a day. Rp: radiological protection cream. Compared with the Model group, $P<0.05$.  

3400
3200
3000
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2600
2400
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2000
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1600
1400
1200
1000
800
600
400
200
0
-200
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

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Figure 4: Ku80 mRNA amplification curve in real-time PCR
PCR: polymerase chain reaction.

Figure 5: Ku70 mRNA amplification curve in real-time PCR
PCR: polymerase chain reaction.
Rp cream improved skin cell and subcellular structures after irradiation, including epithelial tissue repair, fibroblast collagen fiber repair and maintenance of its sub-structure, mitochondria and endoplasmic reticulum. Protecting the cell membrane, internal organelles and nuclear membrane prevent nuclear and organelle injuries. Compared with the Tc group, the Rp group showed a more significant restoration of collagen fibers. Real-time PCR results showed that the Ku70/80 mRNA expression levels were higher in the Rp and Tc groups than in the Model group (P<0.05), suggesting that Rp cream repairs skin damage and promotes wound healing, which are related to the up-regulation of Ku70/80 mRNA expression.

The Rp cream had both a preventive and therapeutic action on erythema, dry desquamation and in median and severe (grades III and IV) radioactive lesions, as observed through four sets of control experiments. Rp has certain advantages in efficacy and cost effectiveness compared with Tc. Moreover, the preparation is an effective alternative formulation in preventing and alleviating radiation dermatitis, especially grade II and III dermatitis. The clinical implementation of this preparation depends on the radiation dermatitis grade and types of lesions, individual differences, and the patient’s economic situation.

In animal experiments, Zhou et al. studied 3-month-old Wistar male rats [weighing (150±15) g] that underwent β- and γ-ray radiation-induced skin damage. Philips SL18-type linear accelerator 4 Mev β ray was used to irradiate rats’ buttocks to build a skin damage model with an irradiated area of 2 cm × 4 cm. Xue et al. used 60 Co γ-ray at a dose rate of 194 Gy/min and a radiation dose of 40 Gy to irradiate rats to build a radiation dermatitis model. Ni et al. adopted 6 Mev β-ray to irradiate the skin of rats’ buttocks, at a dose rate of 200 cGy / min, giving a radiation dose of 30 Gy, on an irradiation area of 2 cm × 4 cm. In the present study, we used 5.8 Mev electron line, with a total dose of 60 Gy on an irradiated area of 2 cm×4 cm. We also explored better normative experimental ray energy and dose modelling to achieve the effect without killing the animals.

Most clinical studies focused on grades I and II because grade III radiation dermatitis occurs less often and grade IV is quite rare. Szumacher et al. performed a phase II clinical study of 60 cases of breast cancer patients treated with radiotherapy and concomitant chemotherapy and skin application of Trolamine cream. In their study, the incidence of radiation-induced skin reactions was 15% in grade II, 83% in grade III, 2% in grade III, 0 in grade IV radiation dermatitis. Xu et al. also conducted a randomized study of 81 breast cancer patients with postoperative chest wall radiotherapy. The patients were randomly divided into a Tc group and a control group. The incidence of acute radiation dermatitis in the Tc group was 22% of grade I, 78% of grade II and 0 of grade III. In the control group, 7.5% in grade I, 70% in grade II and 22.5% in grade III (The difference between the groups was at P<0.001). In our experiment, 10 cases of grade III and 3 of grade IV radiation dermatitis emerged in the model group. The Rp and Tc groups only had grade II or grade III radiation dermatitis. The majority of grade radiation dermatitis relative to the model, Rp and Tc groups for reducing grade III and IV dermatitis efficiency were 85.7% and 69.2% (P<0.05), respectively. The efficacy of Rp group was better than the Tc group by 16.5% (P<0.05). Based on four sets of efficacy comparison on animal models, Rp was proven efficient in reducing grade III and IV radiation dermatitis of rats.

In future studies, the preparation purification and the sample size should be increased. The importance of scientific research methods to develop standardized clinical research design should also be strengthened to realize large-scale, multi-center and randomized controlled trials.

REFERENCES


