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Research Article

Experimental Study of the Treatment of Burn Wound with Combination of Millimeter of Wave, Infrared Ray and Ultraviolet Ray

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Abstract

Aim: To evaluate the efficacy of a combination of millimeter of wave, infrared ray and ultraviolet ray in burn wound treatment.

Methods: 120 Sprague-Dawley rats, weight 200g-250g, male and female, were divided randomly into four groups: millimeter of wave treatment (A) group, infrared ray treatment (B) group, ultraviolet ray treatment (C) group and a combination with millimeter of wave, infrared ray and ultraviolet ray treatment (D) group. After 14 days treatment, the skin and the blood vessel turn, the wound healing, bacterial count, histology biopsy of healing wound, hydroxyproline content, cellular DNA content and cell cycle were observed.

Results: In D group, comparing with any other groups, after 14 days treatment the wound healed faster ($P < 0.05$). The hydroxyproline content increased; the analysis of cellular DNA content and cell cycle showed that the cellular proportion in S-phase was higher.

Conclusion: The combination of millimeter of wave, infrared ray and ultraviolet ray could promote remarkably the wound healing of deep partial thickness burn and seems to be more effective than either of them singly.

Keywords: Millimeter of Wave; Infrared Ray; Ultraviolet Ray; Burn wound; Experimental Study

Introduction

Physical therapy is an effective way for treatment of burn wound and features cheapness and well tolerance. In this study, we evaluate the therapeutic effect of the combination of millimeter of wave, infrared ray and ultraviolet ray in treatment of burn wound.

Method and Material

Animals

120 adult healthy Sprague Dawley rats, weight 200-250g, male and female, were provided by experimental animal center of medical college of Shantou University and divided randomly into four groups: millimeter of wave treatment (A) group, infrared ray treatment (B) group, ultraviolet ray treatment (C) group and a combination with millimeter of wave, infrared ray and ultraviolet ray treatment (D) group. 30 rats each group.

Scaled animal Model

Rats were burned by 90°C boiling water on back and both sides after being given intraperitoneal injection of 1% Pentobarbital Sodium. The burn wound surface was coated with a mixture of Hylococcus aureus, Pseudomonas Aeruginosa, Bacillus Pyocyaneus after 1 hour burn.

Therapy methods

Millimeter wave therapeutic instrument made in Shanghai was used in A group, Diameter of radiation head was 5~7 mm, Radiation power 10 MW/cm^2, 30 min/time, 2 times/d, Radiation intermission 12 h, 14 days as a course of treatment.

Infrared therapy apparatus made in Chongqin was used in B group, power was 250 W~500 W, radiation intensity 32 MW/cm^2, 30 min/time, 2 times/d, Radiation intermission 12 h, 14 days as a course of treatment.

Ultraviolet ray instrument made in Shanghai was used in C group, Ultraviolet wave was 253.7 nm, power 32W, 30 min/time, 2 times/d, Radiation intermission 12 h, 14 days as a course of treatment

In D group, the therapeutic order rats received was ultraviolet ray, infrared ray and millimeter of wave.

Clinical indexes

The epithelialization and vascularization of the surface of burn wound and burn healing condition were observed. After 14 days treatment the following experiments were done: (1) Histology

biopsy of healing wound; (2) bacterial count (3) Hydroxyproline content in unhealed burn tissue was measured using Meltem's method [1]; (4) Cell cycle was determined using flow cytometry.

Criteria of curative effects

- **Recovery:** No discharge, burn wound was covered by epithelium and fibrous tissue.
- **Improvement:** Secretion reduced, 60% burn wound was covered by epithelium and fibrous tissue.
- **Ineffectiveness:** Secretion increased, no epithelium and fibrous was found tissue on burn wound.

Statistical analysis

The obvious effective rate was analyzed using Ridit analysis. The data of Bacterial counts of subeschar tissue, Hydroxyproline level in unhealed burn tissue, Changes of cellular DNA in unhealed burn tissue were expressed as $X^2 \pm S$ and evaluated using student's t test.

Results

Condition of wound healing

Condition of wound healing was evaluated by visual inspection and computer digital image quadrature method after 14 days treatment. The therapeutic effects of D group was significantly higher than that of other three groups; No significant difference was found among A, B and C groups (RA = 0.7915, RB = 0.8785, RC = 0.756, p > 0.05).

Group	Sample	Cure	Improvement	No Effect	Cure rates%
A	30	5	17	8	16.67%
B	30	7	18	5	23.33%
C	30	6	16	8	20.00%
D	30	16	10	4	53.33%*

Table 1: Comparison of the therapeutic effects in 4 groups.

*P < 0.05

Histology biopsy of healing wound

No significant differences in histology biopsy of healing wound appeared among four groups. Epidermis and dermis were found in healed skin in four groups, accompanied by mild proliferation of the fibrocyte and slight inflammatory reaction [2].

Bacterial counts of subeschar tissue

No significant differences in bacterial count of subeschar tissue appeared among four groups (p > 0.05).

Group	Sample	Bacterial count
A group	25	$(1.57 \pm 0.05) \times 10^6$
B group	23	$(1.35 \pm 0.03) \times 10^6$
C group	24	$(1.46 \pm 0.04) \times 10^6$
D group	14	$(1.25 \pm 0.01) \times 10^6$

Table 2: Bacterial counts of subeschar tissue ($\bar{x} \pm s$).

P > 0.05

Hydroxyproline content in unhealed burn tissue

Hydroxyproline content in unhealed burn tissue of D group increased after 14 days treatment, No significant difference was found among A, B and C groups (Table 3).

Group	Sample	Hydroxyproline content
A group	25	13.57 ± 2.05
B group	23	14.28 ± 1.27
C group	24	13.24 ± 1.42
D group	14	21.36 ± 1.76*

Table 3: Hydroxyproline content in unhealed burn tissue ($\bar{x} \pm s$).

P > 0.05

Changes of cellular DNA in unhealed burn tissue

The cellular proportion in S-phase of D group was higher than that of A, B and C groups after 14 days treatment. No significant difference was found among A, B and C groups (Table 4).

Group	Sample	Change of cellular DNA		
		G0 - G1	S	G2--M
A group	25	64.45 ± 2.15	23.57 ± 2.05	6.52 ± 1.13
B group	23	58.59 ± 1.75	22.44 ± 1.08	6.02 ± 1.18
C group	24	61.56 ± 1.23	24.53 ± 1.12	6.43 ± 1.67
D group	14	62.56 ± 1.41	47.53 ± 1.33*	6.52 ± 1.24

Table 4: Changes of cellular DNA in unhealed burn tissue ($\bar{x} \pm s$).

P > 0.05

Discussion

Physical therapy is an effective method for the treatment of burn wound. It is confirmed ultraviolet ray has a bactericidal effect

by denaturing nucleic acid of bacteria and promotes wound healing by causing local vasodilatation which improves the blood perfusion of tissue and by promoting the secretion of cytokines, mitosis of fibrocyte and endothelium cell and collagen synthesis and secretion. The thermal effect of infrared ray can be favorable to wound healing by dilating arteriole and capillaries that improves blood perfusion in wound burn. Millimeter of wave can promote tissue repair by dilating capillaries that improves local blood perfusion [3]. Recently, ultraviolet ray and infrared ray are used in the treatment of wound burn. There are few reports about the treatment of burn wound using Millimeter of wave. At present, single of millimeter of wave, infrared ray and ultraviolet ray is applied in burn wound treatment; the aim of this study is to understand and evaluate the curative effect of the combination of millimeter of wave, infrared ray and ultraviolet ray on the treatment of burn wound.

The result of hydroxyproline content showed nucleated cells in unhealed burn tissue obviously increased on 14th day in D group. Meanwhile, the active proliferation and migration of new epithelium cell were observed; the analysis of cellular DNA in unhealed burn tissue showed the cellular proportion in S-phase was higher than that of A, B and C groups, it indicated that more splitting and proliferated cells appeared after the combination of millimeter of wave, infrared ray and ultraviolet ray, thus accelerated the healing of burn wound.

The experimental observation of the treatment of the deep IIdegree of burn using the combination of millimeter of wave, infrared ray and ultraviolet ray indicates the combination of millimeter of wave, infrared ray and ultraviolet ray can significantly accelerated the healing of the deep IIdegree of burn. The combination of millimeter of wave, infrared ray and ultraviolet ray is more effective than either of them singly. It may work by their superposition effect on the regeneration of the surviving epithelial cells at wound surface. Further study is required to understand how to utilize these three methods and prove that the combination of millimeter of wave, infrared ray and ultraviolet ray could be used to replace wound dressing change and tangential excision.

Conclusion

The combination of millimeter of wave, infrared ray and ultraviolet ray could promote remarkably the wound healing of deep partial thickness burn and seems to be more effective than either of them singly.

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