Index of epithelization rate of thermal burns in laboratory animals when application of the "acerbin" preparation

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Abstract. Thermal burns in animals represent an urgent problem for veterinary medicine, since the anti-burn drugs available on the world pharmacological market are not always adapted for use on animals and are approved for use in veterinary medicine. In this regard, the aim of the work was to use the wound healing spray "Acerbin" for medical purposes in the treatment of thermal burns and to evaluate its therapeutic efficacy by the rate of epithelialization of burn defects in the skin in laboratory animals. The work was carried out at the Department of Surgery and Therapy of the Kursk State Agricultural Academy, on laboratory white mice in the amount of 60 individuals, in which thermal burns were simulated in the croup and treated with applications of the Acerbin spray. To assess the rate of growth of epithelialization, planimetric measurements of the area of burns were carried out before treatment on the 3rd, 5th, 7th, 10th and 14th days of treatment, as well as the corresponding mathematical calculations of the rate of reduction of burn defects. According to the research results, it was found that when applying the Acerbin spray, the burn rate index on the 3rd day was 0.25 ± 0.06; on the 5th day - 0.58 ± 0.03; on the 7th day - 0.74 ± 0.01; on the 10th day - 0.86 ± 0.02; on the 14th day - 0.95 ± 0.01. Thus, at the end of the therapeutic period, the index of the epithelialization rate of thermal burns approached the most physiologically justified numerical expression equal to "1.0", which allows it to be recommended for use in veterinary medicine as the preparation of choice for the treatment of thermal burns of the skin in animals.

1 Introduction

At present, about 600 thousand cases of burns, both in animals and in humans, are annually registered in Russia, which accounts for 50 to 60% of all diagnosed traumatic injuries. Thermal burns in animals most often occur when they are kept in the domestic conditions of apartment buildings when the body surface comes into contact with an open flame or electric heating devices. They cause charring of the coat and damage to the deep layers of the skin. Further damage causes significant damage to the conformation characteristics of companion pets. At the same time, thermal burns are difficult to treat, contribute to the development of multiple organ failure and, as a consequence, high mortality, which ranges

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from 65 to 95%, depending on the severity and stage of the course. First, the available arsenal of veterinary anti-burn drugs is often not species-specific. Secondly, many veterinary anti-burn drugs are not able to have a wound-healing effect on damaged tissues in a short time and require long-term and repeated use. Thirdly, veterinary anti-burn pharmacological preparations ineffectively eliminate the phenomena of local intoxication, which affects the rate of epithelialization of damaged tissues.

Therefore, the problem of treating thermal burns remains the most urgent problem for medical and veterinary science and practice. Currently, a sufficient number of anti-burn drugs adapted for use in medical practice in the treatment of humans are presented on the world pharmacological market. However, for veterinary purposes, the same pharmacological market does not fully satisfy the needs of practicing veterinary specialists who are faced with the problem of treating thermal burns in animals. Multiple organ failure arising against the background of thermal damage not only contributes to the high mortality rate of combustive patients, but also slows down the regeneration processes. Due to the peculiarities of cardiac activity in the damaged tissues, the percentage of oxygenation decreases. In connection with the violation of the hepatetic and nephro-urological function of the corresponding internal organs, an imbalance of acid-base balance occurs in the tissues subjected to thermal action, which causes a slowdown in the processes of granulation and epithelialization.

In this regard, the relevance of the search and development of new innovative anti-burn pharmacological preparations adapted for use in veterinary medicine for the treatment of burnt animals increases.

2 Materials and methods

To solve the problem of developing new anti-burn agents adapted for use in veterinary medicine, it was considered necessary to test the wound healing spray "Acerbin" for medical purposes in the treatment of thermal burns in animals and evaluate its therapeutic efficacy in terms of the rate of epithelialization of burn defects. The drug, according to the current instructions, has a keratolytic, aseptic and wound-healing effect. It contains DL-malic acid, benzoic acid, salicylic acid, propylene glycol, purified water and is a solution for external use.

DL-malic acid in its pharmacological effect stimulates metabolism, normalizes cell metabolism, improves local and general blood circulation, strengthens the immune system and enhances the protective properties of the body as a whole. It has anti-inflammatory, anti-edema properties.

Benzoic acid is a monosyllabic carboxylic substance by its cyclic nature, it is a natural compound. In appearance, it is a white powder from elongated granules or crystals with a characteristic luster. Benzoic acid exhibits anti-inflammatory and antifungal effects, consisting in preventing the multiplication of lactic acid fermentation bacteria and yeast, as well as in suppressing the activity of enzymes of pathogenic microbial agents. These antiseptic and antibacterial properties of benzoic acid are widely used in the pharmaceutical industry for the production of antifungal drugs in the form of solutions, sprays or ointments.

Salicylic acid is clinically a dibasic acid, has keratolytic, antiseptic, anti-inflammatory, antifungal effects. The above pharmacological properties are confirmed by numerous studies that have revealed many factors of a positive effect on the state of the epidermis, namely, salicylic acid is well absorbed by the skin, dries it out, cleanses the skin pores from impurities, normalizes blood circulation, helps to reduce the inflammatory process, relieves irritation symptoms, eliminates itching, stimulates the regeneration of damaged tissues. Thus, due to its keratolytic, antiseptic, local healing properties, salicylic acid is widely used in the fight against dermatitis, seborrhea, psoriasis, keratosis, burns.

Propylene glycol is a clear viscous liquid with a density lower than that of ethylene glycol and glycerin, but higher than that of ethanol. Possessing hygroscopic properties, i.e. the ability to absorb and absorb water from surfaces and air, drying them, propylene glycol is widely used as filler in medicines for external use, as a bactericidal agent, as a base in the manufacture of creams, ointments, lotions, sprays, as well as soaps and toothpastes.

The work on approbation of the wound healing spray "Acerbin" for medical purposes in the treatment of thermal burns in animals was carried out at the Department of Surgery and Therapy of the Kursk State Agricultural Academy. To solve the formulated scientific and practical problem, thermal burns were simulated on 60 white laboratory mice. Simulation of burns was carried out in accordance with the "European Convention for the Protection of Vertebrate Animals Used for Experiments or Other Scientific Purposes", namely, all laboratory animals were deeply sedated by injections of the pharmacological preparation "Xila" at a dose of 0.1 ml per animal. In sedated experimental models, an operative field was prepared on the dorsal surface in the region of the croup in compliance with the rules of asepsis and antiseptics according to standard methods: they cut the hair with a razor, and treated the skin twice with an alcohol solution of iodine with an exposure of 2 minutes. Later, the third degree burn defects were clinically and experimentally simulated, namely, the tip of the working part of a red-hot electric soldering iron was applied to the previously prepared surgical field with an exposure of 5 seconds. After simulating a thermal burn, laboratory animals were taken out of the state of deep sedation by injections of sulfocamphocaine and the spray "Acerbin" was applied on the 3rd, 5th, 7th, 10th and 14th days. In the course of the experiment, planimetric studies were carried out before treatment and during the application of the “Acerbin” spray. Planimetric studies included: making cellophalograms of the affected skin on the 3rd, 5th, 7th, 10th, and 14th days, respectively. The contours of cellophalograms at the appropriate time of registration were transferred to graph paper and the area of thermal burns was obtained at the time of measurement by the number of whole squares included in the contours (mm^2), that is, Sn. Further planimetric studies included the calculation of ΔS (1) - the rate of epithelialization of the burn wound and Yt (2) - the value of relative healing according to the following formulas:

$$\Delta S = \frac{(S - Sn) * 100}{S * t} \quad (1)$$

where S - the size of the wound area during the previous measurement; Sn - size of the wound area at the moment; t - number of days between the first and subsequent measurements.

$$Yt = \frac{S_0 - S_t}{S_0} \quad (2)$$

where S_0 - initial wound area; St - wound area on day t.

Based on the obtained planimetric data on the area of burn defects and the rate and epithelization index calculated according to the above formulas, there were made conclusions about the possibility of using the medical spray "Acerbin" in the treatment of thermal burns in animals.

3 Literature Review

Thermal burn is damage to integuments and deep-lying tissues caused by high temperatures [1, p. 198]. Burns patients present as one of the most challenging situations in both human and veterinary medicine [2, p. 232]. Thermal burns of small pets can occur as a result of exposure to flame, boiling water, steam or hot air, hot metal objects in the domestic conditions of maintenance of apartment buildings and private farmsteads [3, p. 1].

According to statistics from The British Small Animal Veterinary Association, among all surgical pathologies in small pets, burns are about 20% [4, p. 4]. According to the classification of Alden H., Harken, Ernst, burns are divided, depending on the cause that caused them, into thermal, chemical and radiation [3, p. 1]. Burns, even superficial, and all the more deep, quickly become life-threatening for the animal, since in addition to local changes they cause general disturbances in the body. At the same time, at the site of the burn defect, local coagulation tissue necrosis occurs, the strongest intoxication of the body of toxicological and microbial origin, a significant violation of the regional and peripheral blood flow, which complicates the healing process of defects. Healing of skin lesions causes inflammation of the tissues damaged by the burn, edema, hypertrophic and ugly scars [5, p. 475]. The initial assessment should include the evaluation of the general physical condition, systemic compromise, amount of body surface affected, plus degree of local injury [6, p. 17]. Thus, the choice of topical agent or type of coating to be used in the treatment of burns should be based on an assessment of the characteristics of the lesion and the evidence presented in the literature [7, p. 1]. These products should have characteristics such as antimicrobial or bacteriostatic activity, absence of toxicity and hypersensitivity, compliance, shortening of healing time, and cost / benefit ratio. However, many of the methods used to heal burn injuries are controversial. In this regard, there is an urgent need to develop new innovative means of adequate and highly effective pharmacotherapy [8, p. 5].

4 Results

The research results showed that initially the area of the simulated burns was 42.30±3.20 mm^2 ($p \leq 0.05$). On the 3rd day of application, the burns had an area equal to 31.12±2.72 mm^2 ($p \leq 0.05$), that is, they decreased by 8.35±2.12 mm^2 ($p \leq 0.05$). On the 5th day of the spray application, burn defects decreased additionally by 8.54±0.87 mm^2 ($p \leq 0.05$); an average wound area in the group was 17.50±1.70 mm^2 ($p \leq 0.05$). After a week of appropriate treatment, the size of thermal burns on average in the group of supervised laboratory animals decreased to 10.60±0.73 mm^2 ($p \leq 0.05$), that is, by 6.61±0.24 mm^2 ($p \leq 0.05$). On the 10th day, the area of clinically - experimentally simulated thermal burns was 5.40±0.67 mm^2 ($p \leq 0.05$) and was less than on the 7th day of treatment by 4.98±0.44 mm^2 ($p \leq 0.05$). At the end of the clinical trial of the medical spray "Acerbin" in veterinary medicine for the treatment of thermal burns, it was found that on the 14th day their area was 2.14±0.03 mm^2 ($p \leq 0.05$) and was less than the 10th day by 4.41±0.25 mm^2 ($p \leq 0.05$).

5 Discussions

Analysis of the dynamics of healing of thermal burns in laboratory animals when applying the spray "Acerbin" showed that in the first three days of application to burn defects, their area decreased by 26.24% ($p \leq 0.05$), and the epithelialization rate index was 0.25±0.06 ($p \leq 0.05$). Subsequently, by the 5th day of supervision, thermal burns decreased by an additional 43.91% ($p \leq 0.05$) from the dimensions of the previous planimetric measurements carried out on the 3rd day of the experiment, and the epithelialization index increased to 0.58±0.03 ($p \leq 0.05$). On the 7th day, burns decreased by 39.43% ($p \leq 0.05$) relative to the size recorded on the 5th day of observations, and on the 10th day by 49.05% ($p \leq 0.05$) in comparison with the results of planimetric accounting of the 7th day of the experiment, that is, the epithelization index at the given time of registration was 0.74±0.01 ($p \leq 0.05$) and 0.86±0.02 ($p \leq 0.05$), respectively. On the 14th day, the burn epithelization index was 0.95±0.01 ($p \leq 0.05$), and the area of burns decreased by 60.37% ($p \leq 0.05$) relative to the

measurement results on the 10th day of clinical observations. Thus, the results obtained testified to the positive effect of the “Acerbin” spray for medical purposes on the healing of third degree thermal burns of the skin in animals, since the epithelialization index by the 14th day approached the numerical value of “1.0”, which is physiologically justified.

6 Conclusions

Scientific and applied research has shown that when applying the spray "Acerbin" the index of epithelialization of burns on the 3rd day is equal to 0.25±0.06 ($p \leq 0.05$), on the 5th day - 0.58±0.03 ($p \leq 0.05$), on the 7th day - 0.74±0.01 ($p \leq 0.05$), on the 10th day - 0.86±0.02 ($p \leq 0.05$), on the 14th day - 0.95±0.01 ($p \leq 0.05$), that is, at the time of completion of treatment it was the maximum close to the physiologically justified numerical expression in "1.0".

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