Section 3. Medical science

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CREATION OF A NEW MODEL OF BURNS IN RATS WITH THE DETERMINATION OF THEIR DEGREE AND USE OF *APIS MELLIFERA* CARBOXYMETHYL CHITOSAN

Abstract. The article provides information about thermal skin burns and emerging pathophysiological changes in integumentary tissues. To study and treat these severe processes, need to burn the skin of animals. A new model of thermal skin injury in rats has been created. For the occurrence of a skin burn, a soldering gun with a flat rod PP REXANT ZD-715 12–0188 with a tip heating temperature of up to 400 °C was used. The degree of the burn was determined by histological examination of skin tissues under a microscope, which was IIIA and IIIB degrees. Positive results of using an ointment based on carboxymethyl chitosan (CMCHS) have been recorded.

Keywords: chitosan, carboxymethyl chitosan, modeling, burn injury, epithelialization.

Introduction

Burn injury is known as the most traumatic wound. In clinical practice, most burn patients experience severe pain during wound dressing, which necessitates the promptest effective treatment and the use of advanced drugs. When evaluating a burn wound care model, the use of animals is considered appropriate in studying the pathophysiology of burns, as well as in studying the effectiveness of treatment strategies due to the complexity and heterogeneous nature of burns [1].

Burn injury is a polypathophysiological phenomenon in which destructive injuries cause structural and functional disorders in many systems and organs of the human body. The use of animal models is considered to be an appropriate tool to study the pathophysiology of burns instead of experiment. This is due to the heterogeneous nature of burns and the similarity of animal skin with the characteristics of human skin. Over the past two decades, several models of thermal damage to the skin of animals have been developed to reproduce various degrees of burn injury, elucidate pathophysiological changes, and study effective therapeutic therapy [2].

The main part

The skin is the largest organ of the body and its destruction, especially caused by burns, can be life-threatening. Skin burns cause pathophysiological changes in the body, leading to severe forms of burn disease, in which several complications are manifested, such as escalation of infection and high mortality, as well as prolonged hospitalization of the patient [3]. With a large area of damage, burns can turn into a systemic problem affecting various organs [4].

The use of animal models of burns is critical for burn research, especially for studying the medicinal properties of new drugs since it is known that new treatment strategies should be initially tested at an experimental level before clinical application [5]. An experimental model is essential in the study of burns and their underlying mechanisms. Many animal models of burn injuries have been reported using mice, rats, rabbits, dogs, and pigs. They are widely used to study the pathology of a burn wound, the effect of systemic drug use, local therapy, and the effect of a burn injury on the entire body [6–8].

The use of animals as experimental models in various biological studies for transfer to human physiology was originally provoked by Bernard in 1865 [9]. Over time, the marked similarities in anatomy and physiology between humans and animals have further motivated many researchers to explore a wide range of mechanisms and treatments in animal models before using their findings to treat the thermal injury in humans. In burn research, there are several common methods of producing burn injuries in animal models, including hot water, hot metal instruments, electricity, and heated paraffin [10]. In these methods, the animal's back is shaved and heated material is applied to the skin to induce the desired surface area of the burn. Specific parameters such as heat and exposure are used differently in each burn model [11]. In addition, the integral design of an animal burn model experiment is also critical for the assessment of tissue burn.

Motamed et al. demonstrated a rat model of the third-degree burn to investigate the effectiveness of the amniotic membrane in combination with adipose-derived stem cell treatment. A burn wound was formed by extinguishing a hot rod (boiled in water) in the dorsal area for 30 seconds [12]. The authors of [13] literature developed a similar model using a brass block heated to 190 °C on the back of rats parallel to the midline for 20 seconds. This model was used to evaluate the treatment of severe burns with a medical dressing applied to the wound, as well as its inflammatory responses and healing mechanisms.

There is a known method of modeling a burn in an experiment in animals (mice, rats), which is carried out by immersing the animal's back in water heated to a temperature of 65–100 °C [14].

However, the method provides heating of not only the skin but also the skeletal muscles of the animal (this is because mice and rats have a weakly expressed layer of subcutaneous tissue) and causes early death of animals already in the first 2–3 days with a lesion area of 15–20% of the surface body. In addition, burns obtained in this way are accompanied by the development of wet skin necrosis, which also increases the severity of the injury. To reduce the severity of the injury and prolong the life of the animal, to monitor the course of reparative processes, the thermal insulation of deep tissues is resorted to by subcutaneous injection of 150–200 ml of air at the time of the burn, followed by its removal, which does not allow to fully transfer this model to the situation of burns emerging in humans [15].

In our study, we developed the following model for the development of a burn on the skin of a test animal. White outbred inbreeding experimental rats were selected, whose body weight is relatively the same. They were measured and divided into three groups. Group I – control rats, weighing 190–210 g. Group II – rats of 180–205 g, treated with an ointment drug applied to the surface of a burn wound.

The basis of the ointment preparation prepared was levomecol, to which powdered micro-dispersed CMCHS was added. CMCHS was synthesized from the dead bee Apis mellifera [16–17] and used to treat burn wounds. Group III, rats weighing 180––210g. were treated with monotherapy using levomecol ointment. In all groups, 10 rats of different sexes were selected. Only six rats from the first (control) group and all rats of the other groups were prepared for the process of inflicting burn injuries. The fur on the posterior dorsal part of the rats was sheared with medical scissors to obtain identical skin burns in all groups. Anesthesia was applied to rats located in a specialized box (by intramuscular injection of 0.1 ml of ketamine). Animals are fixed in the machine by four limbs. Subcutaneously, at the site of the alleged thermal injury, 20–30 ml of air was injected. The reason for introducing air under the skin is to save the lives of rats to protect the internal organs and underlying tissues from burns, for further morphological study of the burn wound and to study the effect of our drug.

Figure 1. Rats with IIIA and IIIB degree burns on the 2nd day

For thermal damage to the skin, a soldering gun with a flat rod PP REXANT ZD-715 12–0188 manufactured in Russia with a tip heating temperature of up to 400 °C was used. The exposure time of the heated tip on the rat skin was for 10 seconds. The contact of the flat tip of the soldering iron with the skin was set at an angle of 30 degrees relative to the plane of the animal's skin. The burn diameter was made in an area of 4.0 × 2.0 cm. When the burn process was over, within 15 minutes the rats began to recover from anesthesia and ointments were applied to the wound surface in the previously prescribed order. The next day after thermal trauma, i.e. on the second day, four rats from all groups were killed and given for histological examination (Fig. 1).

The degree of burn damage was determined by histological examination of skin tissue under a microscope. Pathological damage to the skin during the histological examination of tissues under a microscope showed that the rats had burns of IIIA and IIIB degrees with blackening and necrosis of the skin (Fig. 2).

Daily dressing of the wound was carried out according to the prescribed pattern 1 time a day with the application of medicinal ointments with a layer of 0.5–3 mm on the burn surface without bandaging.

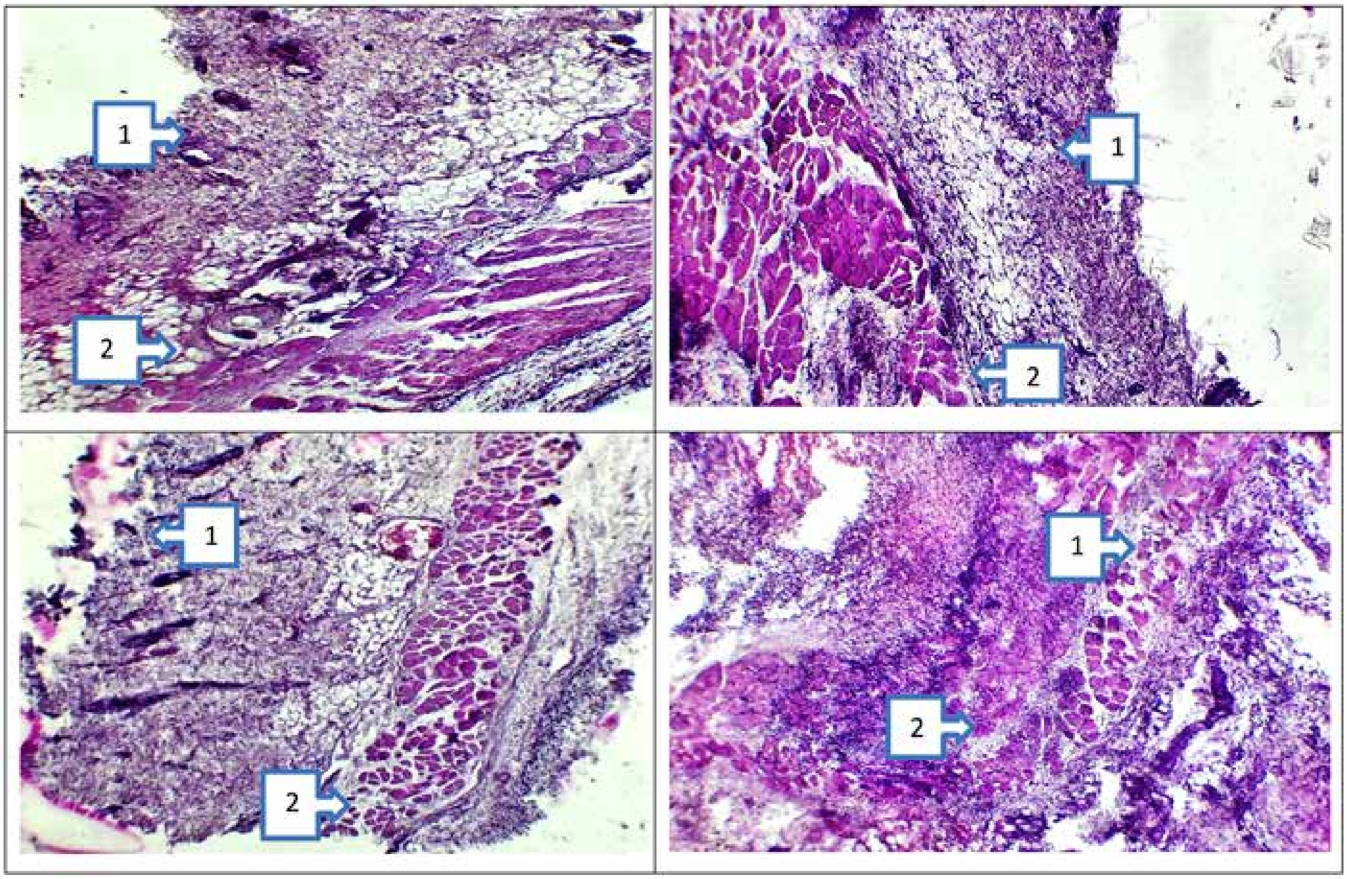

Figure 2. IIIA degree burns. Partial death of the skin (1), preservation of the deep layers of the dermis, and its derivatives (2)

Application of medicinal ointments and nutrition of rats (bread, cereal seeds, sunflower seeds) were carried out once a day at the same time interval.

The wound therapy was carried out for 22 days until complete healing, epithelialization of the burn wound in the 2nd group occurred on the 3rd week after the skin burn. In the group where monotherapy with levomecol was used (group 3), the epithelium of the wound healed within 24 days, and in the control group, the restoration of the skin occurred on the 30th day after thermal damage. The advantage of our simulation was the 100% viability of the rats. The rats remaining after sampling for histological examination survived until the burn process was completely cured.

Conclusion

Due to the proposed animal model, a better understanding of the morphological changes in thermally affected tissues during burns, the mechanism of formation of burns of varying degrees, and future research will be constantly improved with new treatment strategies that improve the quality of life of patients with burns.

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