

ASSESSING THE EFFICACY OF LASER IRRADIATION AND PHOTODYNAMIC THERAPY IN DIABETIC FEMORAL PHLEGMON: AN EXPERIMENTAL PERSPECTIVE

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Resume: The article presents the findings of experimental research on the induction of purulent wounds in laboratory rats and evaluates the effectiveness of both traditional and novel healing methods. For this purpose, the authors conducted experimental morphological studies on 54 "Wistar" laboratory rats at the experimental department of the Academician V.V. Vakhidov Republican Specialized Scientific and Practical Medical Center. A diabetic phlegmon model was employed to simulate the purulent-necrotic process in the rat thigh, using photodynamic therapy and laser irradiation. The studies demonstrated that local laser exposure combined with photodynamic therapy accelerated the reduction of inflammatory infiltration, led to the complete cessation of purulent-necrotic discharge, facilitated wound cleansing, and activated regeneration processes.

Keywords: experimental model, diabetic phlegmon, autopsy of the purulent-necrotic process, photosensitization, laser irradiation. the aim of the study is to improve the results of treatment of purulent lesions of the extremities in patients.

Relevance

Experimental animal models are among the most effective tools for studying the pathophysiology of various diseases. One of the simplest methods to induce diabetes mellitus and hyperglycemia in animals involves partial or complete removal of the pancreas. Additionally, chemical agents are often used to create a diabetes mellitus model by selectively damaging pancreatic beta cells, leading to the development of the disease [2,9]. Several diabetogenic substances, such as streptozotocin, alloxan, pirinuron, dithizone, and dialuric acid, are employed to replicate the model [1,6].

For the local treatment of extensive and chronic non-healing wounds, numerous methods and wound dressings have been developed. However, the variety of these approaches indicates that there is currently no universally effective method for treating extensive and chronic wounds in diabetes mellitus (DM), underscoring the need for new therapeutic strategies [3,5,10]. Wound healing in DM is often prolonged, complex, and costly, with an uncertain therapeutic prognosis. Standard treatment methods frequently fall short in achieving wound closure and preventing amputations, making the search for innovative therapeutic approaches a pressing issue [4,7,8,9].

Despite advancements and the implementation of new technologies aimed at minimizing intra- and postoperative complications, there remains a notable gap in the literature regarding the development of new treatments for purulent wounds in diabetes mellitus using experimental models.

The aim of the study: to develop a method for the treatment of purulent-necrotic lesions of the soft tissues of the thigh in conditions of diabetes mellitus and to evaluate its effectiveness in experimental morphological studies.

Material and methods

Experimental studies were performed in the laboratory of experimental surgery of the State Institution "RSNPMC named after Academician V. Vakhidov" on white mongrel rats of both sexes weighing 230-280 gr. (table.1). Operations were performed under general anesthesia in accordance with the requirements for humane treatment of experimental animals (Strasbourg, 1986). The animals were kept in a vivarium equipped with supply and exhaust ventilation, a temperature regime of 21-22 ° C, in separate cages of 2 individuals. Nutrition was carried out with a balanced composition of carbohydrates, proteins, fats and vitamins.

Table 1

Distribution of animals by series of experimental studies

| Series. | Groups. | 1 days | 7 days. | 14 days. | 30 days | Total. |
|----------|--|--------|---------|----------|---------|--------|
| 1 series | 1 group without treatment | 3 | 3 | 3 | - | 9 |
| | 2 group treatment | 3 | 3 | 3 | - | 9 |
| 2 series | 1 group phlegmon in diabetes without treatment | 3 | 3 | 3 | 3 | 12 |
| | 2 group - phlegmon with DM traditional. treatment | 3 | 3 | 3 | 3 | 12 |
| 3 series | A new method for the treatment of phlegmon in diabetes | 3 | 3 | 3 | 3 | 12 |
| Total | | 15 | 15 | 15 | 9 | 54 |

Series of experiments:

1 series: formation of a phlegmon model in the thigh area in rats.

2 series: study of the features of the course of experimental phlegmon in rats in control and against the background of diabetes mellitus.

3 series: development of a new method for the treatment of phlegmon with comparative studies of the results of treatment of diabetic phlegmon in rats in a traditional and new way.

To conduct objective studies, before forming an experimental model of soft tissue phlegmon in rats, a model of the development of diabetes mellitus was initially reproduced. For this purpose, a method of forming an experimental model of SD was used, proposed by a team of authors of the State Institution "RSNPMC named after Academician V.Vakhidov". The drug Alloxan was used as a pharmacological agent. Method and dosage of alloxan administration according to the proposed method: administration of alloxan tetrahydrate intraperitoneal solution at a dose of 170 mgr. per 1 kg of body weight. Alloxan was administered after daily fasting.

The first signs of diabetes manifested themselves in the form of a sharp increase in water consumption up to 120 ml, a sharp loss in weight, hair loss. In biochemical studies, whole blood and serum were used. Several phases of changes in blood glucose were observed: the first phase – hyperglycemic, reaching a maximum during the first hours; the second – hypoglycemic, which mainly manifested itself during the first day, the third phase – the phase of persistent hyperglycemia (Table 2).

Table 2

Dynamics of glucose in the blood of experimental animals

| Indicator | Control value for rats | Days of the experiment | | | | | | |
|-----------|------------------------|------------------------|-----------|-----------|----------|----------|----------|---------|
| | | 1st | 3rd | 5th | 7th | 14th | 30th | 45th |
| Glucose | 2,3±0,2 | 3,7±0,05 | 10,7±0,04 | 10,2±0,12 | 9,4±0,02 | 9,7±0,05 | 9,4±0,04 | 10±0,07 |

A model of the formation of a purulent-necrotic process in the thigh region in rats

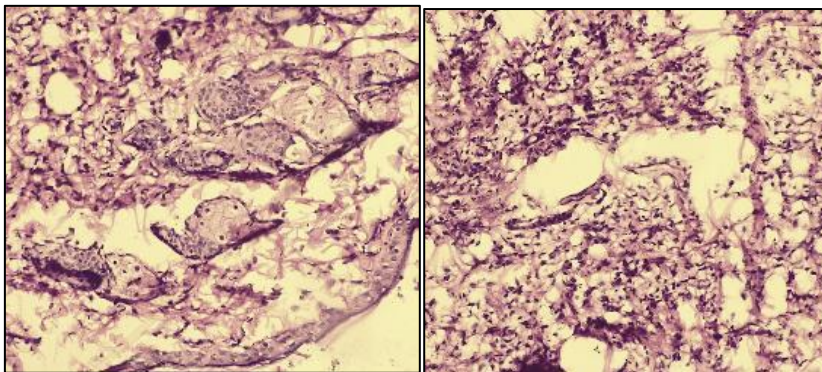
The formation of the phlegmon of the lower limb was carried out according to the following method. Under general anesthesia with sevoflurane vapors, an incision was made in the area of the b/3 thigh of the lower limb. Using the mosquito tool, a bed was formed distally in the subcutaneous space, where a gauze strip moistened with a solution of a bacterial mixture obtained from the lumen of the colon was placed. Dilution at the rate of 100 mg. of feces per 20 ml of saline solution. The skin wound is sutured with a nodular suture.

In the postoperative period, the animals received painkillers for 1 day in dissolved drinking water: Ipobrufen tablets at the rate of 500 mg. per 100 ml of water. In the following terms, anesthesia was not carried out.

During 3 days of observation, the animals remained active, moved freely around the cage, took food and water. In the area of the left thigh, starting from 2 days after the operation, the volume of the thigh began to increase. During palpation, soreness and fluctuation were noted due to the formation of a purulent cavity in the subcutaneous tissue.

Result and discussion

Morphological studies of the biopsy material showed that on day 3, partially necrotic epidermis, abundant round-cell infiltration (macrophages, lymphocytes) were detected in this zone, neutrophilic leukocytes, serous exudate and hemorrhages in the hypodermis are often found. The blood vessels are dilated and full-blooded. Diffuse leukocyte infiltration in the dermis and subcutaneous tissue, which push apart the connective tissue fibers and surround the sebaceous and sweat glands (Pic. 1).



Pic. .1. 3 days. Purulent-necrotic lesion of soft tissues in the area of the left thigh. Stained with hematoxylin and eosin. Ok10hOb40.

On 3-4 days after the formation of an abscess in the area of the left thigh, a breakthrough of purulent discharge from the area of the sutured skin wound was observed in rats (Pic. 2-3-4).



Pic. 2. Purulent discharge from the phlegmon of the thigh area



Pic.3. Purulent wound of subcutaneous tissue

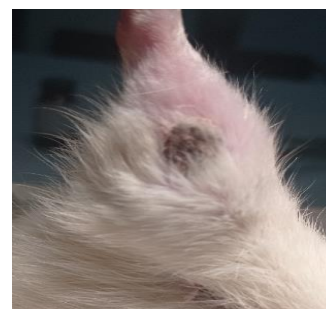


Pic. 4. Purulent-necrotic process in the thigh area

Later, during 7-9 days after the operation, spontaneous healing of the purulent-necrotic process occurred with the exit of a foreign body from the wound in the form of a gauze strip (Pic.5). The wound healed by secondary tension for 10-11 days after surgery (Pic.6).



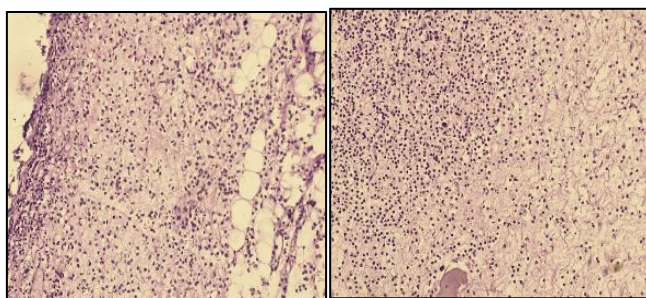
Pic. 5. Wound healing process after opening and sanitation of the hip abscess



Pic. 6. Healing of a purulent hip wound in a control (healthy) group of animals

Formation of a purulent-necrotic process in the thigh area in rats against the background of diabetes mellitus. In the group of animals that were modeled diabetes mellitus by the administration of alloxan, a persistent increase in blood sugar levels occurred on 7-10 days. During this period, a purulent process was formed in the control group of rats in the area of the left thigh in the previously described way. After the operation, animal management was carried out in a standard way. On the 2nd and 3rd days after the operation, against the background of a slight increase in the volume of the limb and the formation of an abscess, a fatal outcome occurred in 3 animals. According to laboratory tests and autopsy, the progressive deterioration of the animals' condition was associated with an increase in septic condition and organ failure.

Microscopically, during these periods, the destruction of the dermis and hyperplasia of the epidermis were noted. There was pronounced edema, hemorrhages and diffuse infiltration of polymorphonuclear leukocytes in the subcutaneous tissue. Blood vessels are dilated and unevenly full-blooded (Pic. 7).



Pic. 7. 3 days. A purulent-necrotic lesion of soft tissues was formed in the area of the left thigh. Stained with hematoxylin and eosin. Ok10xOb40

The rest of the animals had a sluggish purulent process with the formation of necrotic tissues in the subcutaneous tissue and skin. Subsequently, the rats independently gnawed out necrotic tissues with the extraction of the gauze strip left in the wound. Independent healing of a purulent wound occurred only in 1 of the control animals on the 14th day after surgery..

Comparative studies of the results of treatment of diabetic phlegmon in rats in a traditional and new way

In the third series of experiments, comparative studies of the effectiveness of a new method of treating purulent-necrotic wounds of subcutaneous tissue against the background of experimental alloxan diabetes mellitus were carried out.

Against the background of the formation of a purulent process in the thigh area, surgical intervention was performed on 4-5 days after the operation.

The results of traditional treatment. In the control group of animals, the purulent wound was dissected under general anesthesia with sevoflurane vapor with sanitation, necrectomy and treatment with 3% hydrogen peroxide solution. Then the wound remained open and observation was carried out.

The next day after the opening of the abscess, the wound was covered with a purulent-necrotic plaque. There were no signs of granulation and wound cleansing.

On the 3rd day after the opening of the abscess, necrosis of the skin took place along the edges of the surgical wound, the latter gaped, without signs of a reduction in the area. The bottom of the wound was covered with a purulent-necrotic plaque (Pic. 8). On the 7th day after the operation, the wound was covered with a dense crust, after removal of which a meager amount of purulent discharge with necrotic tissues arrives. Granulating tissue appears in some places of the wound (Pic. 9).



Pic. 8. Control. Purulent-necrotic process in the hip area on the background of diabetes mellitus.



Pic. 9. Control. Necrosis of the skin on the 7th day after the formation of an abscess and traditional treatment on the background of diabetes

On the 11th day after the opening and rehabilitation of the wound in rats with diabetes mellitus, the wound is again covered with a dense crust that does not separate from the edges and bottom of the wound. When pressing, there is no discharge and fluctuation. There is a reduction in the area of the wound.

Results of treatment in an experimental group of animals. In the experimental group of rats, a new method of treatment was performed at the same time:

A method of surgical treatment of purulent-necrotic processes and phlegmon of the lower extremities against the background of diabetes mellitus: dissection of tissues and sanitation of purulent congestion, excision of necrotic tissues with the leaving of two-light transparent drainage tubes in pockets and cavities, characterized in that after removal of drains, the open wound is closed with a sterile polyethylene self-adhesive film (film for bandages), then, in the postoperative period, drip washing of the wound cavity is carried out through the installed drainage with a 0.1% solution of methylene blue for 1 hour under a pressure of at least 500 mm of water.st. at a rate of 60 drops per minute and 30 minutes after the start of washing through a film fixed over the wound, the wound area is irradiated with an Vostok-2 laser device in a defocused continuous mode, in the range of 630-660 nm, with a power of 120 MW, for 1 minute for each 2.5-3.0 cm², while this procedure is performed 3-4 times a day for 3-5 days, and after the acute purulent inflammation subsides 2 times a day for 2-3 days and then 1 time a day for another 2-3 days.

CONCLUSIONS

1. Morphological studies during the formation of a purulent-necrotic process in the thigh area in rats on day 3 showed that necrotic epidermis, infiltration, serous exudate and hemorrhages in the hypodermis were detected in the affected area, while against the background of diabetes mellitus, microscopically marked destruction of the dermis, pronounced edema, hemorrhage, and also diffuse infiltration by polymorphonuclear leukocytes.

2. Experimental morphological studies conducted on the model of purulent-necrotic soft tissue lesions in conditions of diabetes mellitus have shown that the use of local laser exposure and photodynamic effect in the treatment of these destructive processes accelerate the regression of inflammatory infiltration of all layers of the dermis and subcutaneous fat, shortening the period until the complete cessation of purulent-necrotic discharge and cleansing the wound from fibrinous overlays, reduction of local tissue edema and activation of regeneration processes.

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