The autoradiographic study showed that irradiation of the duodenal wall by helium–neon laser causes a significant increase in [^{3}H]thymidine incorporation into the epitheliocytes of the crypts. In intact rats ILN for the duodenal crypts was 29.5 ± 1.0%. Irradiation of the duodenal wall for 5 min by white light caused an increase in [^{3}H]thymidine incorporation into enterocytes of the crypts (ILN was 35.9 ± 0.9%). Irradiation of the duodenal wall by a helium–neon laser for 1 min caused an increase in ILN of the crypts to 40.6 ± 1.0%. Irradiation by laser for 3 min did not cause an increase in ILN of the crypts (40.4 ± 0.7%). Irradiation for 5 min led to some decrease in [^{3}H]thymidine incorporation into the enterocytes: ILN was 38.5 ± 0.7% (Fig. 2).

Irradiation of the duodenal wall for 1-5 min by a helium–neon laser thus causes ultrastructural changes in the enterocytes and connective tissue cells which increase in severity with an increase in the total power of laser radiation, and it also causes an increase in proliferative activity of the crypt cells.

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PRESERVATION OF THE ISOLATED KIDNEY UNDER NORMOTHERMIC CONDITIONS BY PERFUSION WITH PERFLUOROTRIBUTYLAMINE EMULSION

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KEY WORDS: kidney; perfusion; perfluorotributylamine emulsion; protein–salt solution.

Two methods are used to preserve kidneys before transplantation: immersion, using a saline intracellular solution, and perfusion, with an extracellular solution. Preservation of the kidneys in these solutions is carried out at low temperature (2-7°C). In recent years reports have been published of perfusion preservation of kidneys under normothermic and hypothermic conditions both experimentally and clinically, with the use of perfluorocarbon emulsions [2, 3].

The object of this investigation was to study the state of the isolated kidneys of dogs during normothermic perfusion with perfluorotributylamine (PFTBA) emulsion, developed at the Central Research Institute of Hematology and Blood Transfusion, Ministry of Health of the USSR [1].

EXPERIMENTAL METHOD

Experiments were carried out on nine mongrel dogs weighing 10-15 kg. Under hexobarbital anesthesia both kidneys were removed from the animals, washed free from blood, and connected

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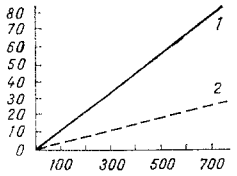

Fig. 1. Oxygen solubility in perfusion media at 37°C. Abscissa, partial pressure of oxygen in fluid (in mm Hg); ordinate, oxygen concentration in fluid (in μl O_2/ml); 1) 20 vols. PFE, 2) PSS.

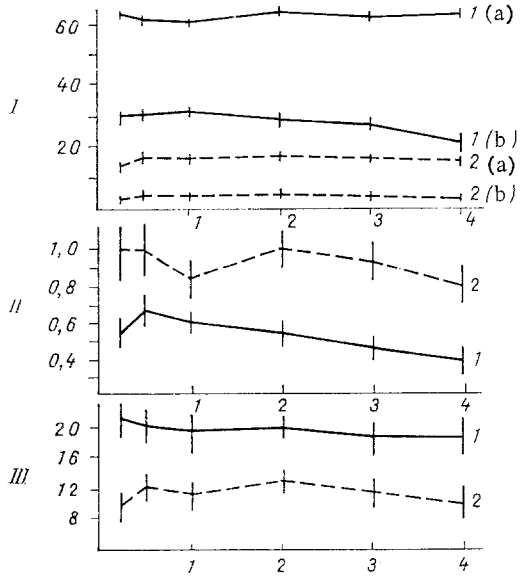

Fig. 2

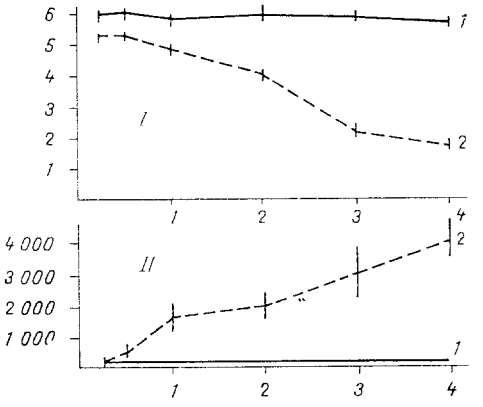

Fig. 3

Fig. 2. Oxygen concentration in arterial (a) and venous (b) perfusates, perfusion rate, and oxygen demand of kidney during perfusion. Abscissa, perfusion time (in h); ordinate: I) oxygen concentration (in μl O_2/ml), II) perfusion rate (in ml/min/g), III) oxygen demand (in μl O_2/min × 2). Remainder of legend as to Fig. 1.

Fig. 3. Dynamics of glucose concentration (I) and LDH activity (II) in perfusate during perfusion. Abscissa, perfusion time (in h); ordinate: I) glucose concentration in perfusate (in mM), II) LDH activity (in IU/liter). Remainder of legend as to Fig. 1.

to a perfusion system consisting of a chamber, pulse pump, and membrane oxygenator with heat exchanger. The basis for the perfusion medium was protein–salt solution (PSS), consisting of 5% albumin from normal blood donors in Hanks' solution. PFTBA, as the fluorocarbon with the most stable emulsion, was chosen as oxygen carrier. The final product consisted of a 20% emulsion of PFTBA (PFE) in PSS. For comparison, PSS without addition of PFE was used. To both PFE and PSS 5.5 mM glucose and 0.885 mM creatinine were added. Perfusion took place for 4 h at 37°C. During perfusion the following parameters were measured: the weight of the kidneys before and after perfusion, pH, pO_2, and pCO_2 in the perfusate, perfusion pressure, perfusion rate, lactate dehydrogenase (LDH) activity, glucose concentration (by the hexokinase method), the creatinine concentration, and the potassium concentration (by means of a flame

TABLE 1. Comparison of Function of Isolated Kidney during Normothermic Perfusion for 4 h with PSS and PFE (M ± m)

Parameters	PSS	PFE
Number of kidneys functioning during perfusion	5/8	10/10
Diuresis, ml/h	12,2±3,6	1,5±0,3*
CP_{cr}	1,68±0,27	5,95±0,35*
CP_K	1,0±0,12	6,48±1,33**
Glucose in urine, mmoles/liter	2,61±0,17	1,47±0,27*
LDH in urine, IU/liter	1010±62	41±6*

*Results differing significantly from corresponding results in experiments with PSS.
[**Not present in Russian original]

photometer). The coefficient of solubility of oxygen in PSS and PFE was determined by means of an oxygen analyzer (Lexington, USA). The oxygen content in the perfusate was calculated as a product of pO_2 and the coefficient of solubility, and the oxygen consumption of the kidney was calculated as the product of the arteriovenous oxygen difference and the volume velocity of perfusion. The results were subjected to statistical analysis. The significance of differences was determined by the t test.

EXPERIMENTAL RESULTS

Determination of the oxygen capacity of PSS and PFE showed that the coefficient of solubility of oxygen in PFE was almost three times higher than in PSS, namely 0.109 and 0.0302 μl O_2/ml·mm Hg, respectively (Fig. 1). Consequently, at pO_2 = 560 mm Hg (the mean value of oxygenation of the perfusate in the arterial system), oxygen solubility in PFE was 6.1 vol.%, but in PSS only 1.7 vol.%. The oxygen supply to the kidney cells by perfusion with PFE completely satisfied their demands, as shown by the high oxygen concentration in the outflowing (venous) perfusate. It was actually higher than in the arterial circulation during perfusion with PSS. The increased arteriovenous difference at the end of the experiments with PFE (Fig. 2, I) indicates an adequate reserve of oxygen capacity of this perfusate with an increase in the oxygen demand of the kidney. During perfusion with PSS the arterial venous difference remained virtually unchanged, but the oxygen concentration in the venous perfusate was very low. Consequently, despite the higher volume velocity of perfusion in the experiments with PSS (Fig. 2, II), explained by the increased viscosity of the PFE, the oxygen demand was significantly lower than in the experiments with PFE (Fig. 2, III). Evidently during perfusion with PSS, despite maximal oxygen extraction, an adequate oxygen supply to the renal parenchyma could not be ensured, whereas surplus perfusion satisfied the oxygen demand of the kidney. During perfusion of the kidneys for 4 h with PSS a progressive decrease in the oxygen concentration in the perfusate was observed (Fig. 3, I). Starting with the second hour there was also a parallel decrease in pH of the perfusate from 7.7 ± 0.18 to 7.55 ± 0.13. Oxidation of glucose during this period evidently took place mainly by the anaerobic pathway, thus confirming the inadequate oxygenation when PSS was used. Conversely, during perfusion with PFE virtually no oxygen was consumed. In the writers' opinion the oxidation substrate in this case consisted of fatty acids, an essential component of albumin solution from blood donors. Preservation of adequate aerobic metabolism of the kidneys when PFE was used as perfusate helped to maintain the cell membranes in a better state of preservation than during perfusion with PSS. For instance, virtually no outflow of LDH into the perfusate was observed in the experiments with PFE, whereas during perfusion with PSS it was considerable (Fig. 3, II). Edema of the kidney during perfusion with PFE amounted to 26.6 ± 2.5%, whereas when PSS was used it was 36.8 ± 6.9%. In our opinion, edema in the experiments with PFE was largely due to the fact that during perfusion a higher perfusion pressure had to be maintained because of the high viscosity of the emulsion.

Preservation of high activity of energy-dependent processes during perfusion of the kidneys with PFE was responsible for their greater functional capacity (Table 1). All ten kidneys perfused with PFE excreted urine during perfusion, whereas only five of the eight kidneys functioned on PSS. The concentrating power of the kidney, namely the ratio of the creatinine or potassium concentration in the urine to the corresponding concentration in the plasma, was

3.5 times higher for creatinine (CP_{cr}) and 6.5 times higher for potassium (CP_K) than during perfusion with PSS. Glucose reabsorption from the urine also was increased during perfusion with PFE. Just as in the perfusate, low LDH activity was observed in the urine during perfusion with PFE but high activity during perfusion with PSS.

Normothermic perfusion of the kidneys for 4 h with a 20% emulsion of PFTBA based on PSS thus enables the functional integrity of the kidneys to be maintained.

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USE OF SILATRANES COMBINED WITH VISHNEVSKII'S OINTMENT IN WOUND TREATMENT

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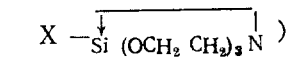
Some silatranes (organosilicon compounds with the general formula ) have been shown to possess the property of stimulating connective tissue repair [1, 2, 4, 5, 8]. However, for the practical use of silatranes a number of problems require solution, including that of the optimal therapeutic presentation [6]. The fact that all ointment (liniment) bases used for local application of therapeutic substances are not biologically inert [11] is an additional difficulty.

Vishnevskii's balsam liniment (ointment), containing tar, bismuth tribromphenate, and castor oil, has for a long time been found effective in surgical practice in the treatment of wounds. In the investigation described below Vishnevskii's ointment was tested as a carrier (liniment base) of silatranes.

EXPERIMENTAL METHOD

Two silatranes — 1-(ethoxy)silatrane and 1-(chloromethyl)silatrane — synthesized at the Irkutsk Institute of Organic Chemistry, Siberian Branch, Academy of Sciences of the USSR, were studied. Using Vishnevskii's ointment (VO) as the base, liniments of silatranes were made up in concentrations of 0.5 and 5%. For comparison, liniments in the same concentrations based on a mixture of lanolin and castor oil (LC) in the ratio of 1:3 were used. Two experimental models were created in experiments on laboratory rats: 1) a circular wound defect in the occipital region obtained by excision of a piece of skin 230 mm^2 in area, down to fascia. The liniments were applied daily and observations continued until the wound was fully healed. Regenerating skin was investigated by the usual histological methods; 2) a circular skin defect in the dorsal region with an implanted transparent plastic ring to prevent contraction and epithelization [7]. The liniments were applied daily and on the 7th day granulation tissue (GT) developing in the defect was removed, weighed, and examined histologically and biochemically [7]. The results were subjected to statistical analysis by the nonparametric [3] U test.

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