EXPERIMENTAL METHODS FOR CLINICAL PRACTICE

The Use of Low-Power Laser Irradiation for Faster Vascularization of Tissue Transplants

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We studied the effect of low-power laser irradiation on vascularization and take of transplanted rabbit renal and pancreatic tissue in athymic nude mice. The mean size of the transplant and the number of blood vessels in it were higher in irradiated mice compared to nonirradiated controls. Moreover, the organ-specific structure of the transplants was preserved in irradiated mice, but not in the control group. These findings suggest that low-power laser irradiation can be used for promotion of vascularization and take of tissue transplants.

Key Words: *transplant; vascularization; graft survival; organ-specific structure; kidney; pancreas*

Vascularization of transplanted tissues is a slow process. For instance, vascularization of pancreatic islets takes 7-10 days [3]. The formation of new vessels starts from proliferation of endothelial cells in microvessel in the adjacent recipient tissue and their migration through the extracellular matrix into the transplant [1,5]. Nonvascularized transplants are poorly supplied with nutrients and oxygen. Hypoxia impairs survival of pancreatic islet cells [4]. Low-power laser irradiation stimulates proliferation and migration of recipient cells [2,6-8].

The aim of the present study was to evaluate the effect of low-power laser irradiation on the rate of vascularization and take of transplanted rabbit kidney and pancreas in athymic nude mice.

MATERIALS AND METHODS

Experiments were carried out on 6-week-old nude BALB/c mice. The kidney and pancreas from 2-day-old rabbit were promptly and thoroughly minced with scissors under sterile conditions, suspended 1:1 in MEM, and subcutaneously injected to mice (0.5 ml per mouse). Twenty-four mice received kidney cells and 12 mice received pancreatic cells. On days 1, 3, 5, 8, 10, and 12 after transplantation, the sites of transplantation were irradiated with an ODER He/Ne laser (633 nm, 3.5 J/cm^2). Six hours after the last laser exposure the transplants were removed, and fixed in 10% neutral formaldehyde; serial sections (7 nm) were stained with hematoxylin and eosin. The number of blood vessels in the transplant was evaluated by the number of vessels per section: vessels were counted in 10 field of vision in every 5th section at ×250.

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RESULTS

On day 33 after inoculation the mean size of renal transplants and the mean number of vessels in these transplants in irradiated mice were higher than in nonirradiated controls (Table 1). Blood vessels in irradiated transplants were also larger that in the control. The structure typical of the renal cortex (glomeruli, winding and straight tubules, collecting tubules) was

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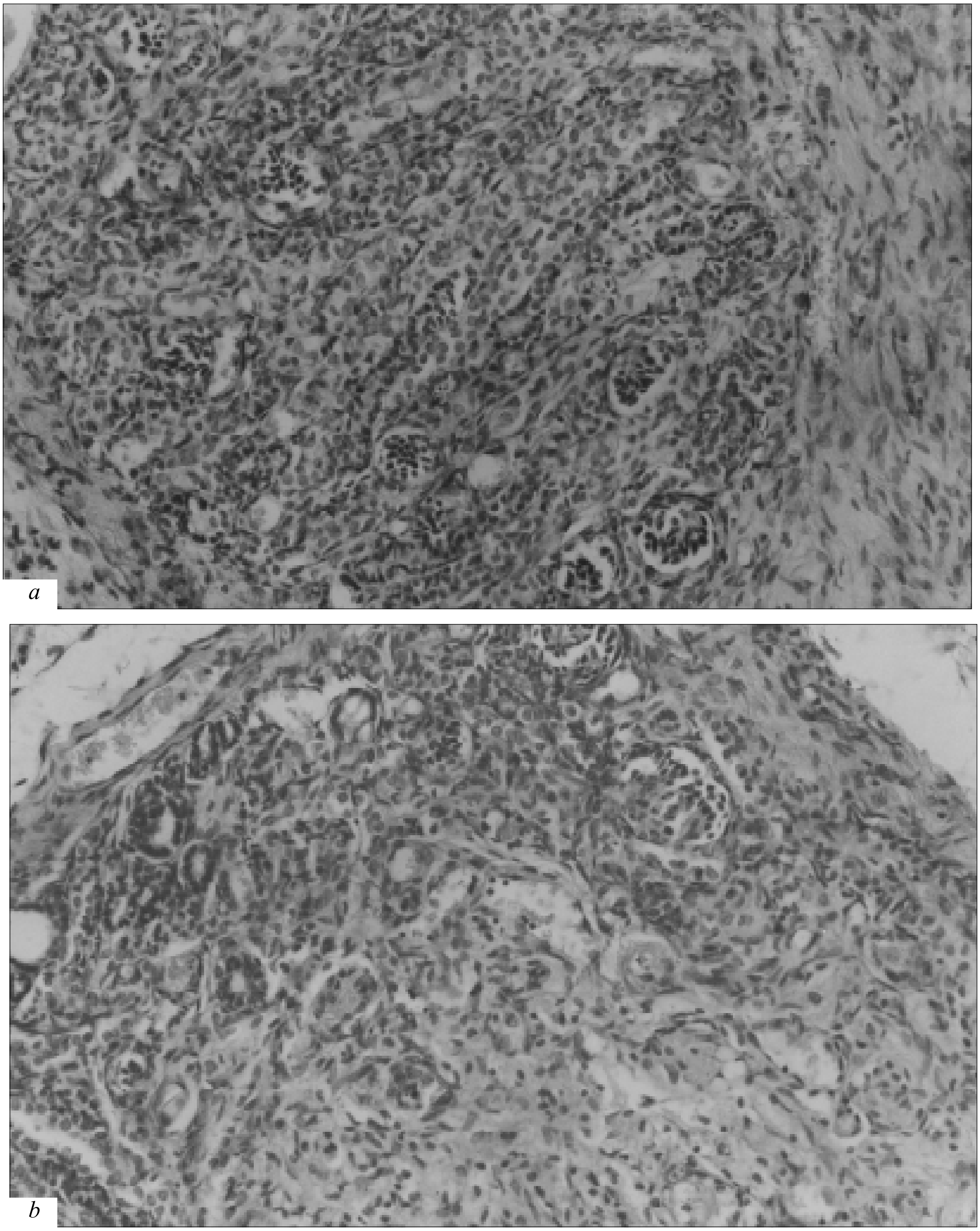

Fig. 1. Transplant of rabbit kidney after irradiation (*a*) and without irradiation (*b*). Hematoxylin and eosin staining, ×200.

TABLE 1. Effect of Low-Power Laser Irradiation on the Number of Blood Vessels in Transplants of Rabbit Renal and Pancreatic Tissue in Nude Mice ($M\pm m$)

Parameter	Kidney		Pancreas	
	without irradiation (n=12)	with irradiation (n=12)	without irradiation (n=6)	with irradiation (n=6)
Size of transplant, mm^2	34.8±7.2	52.0±7.5	15.3±1.6	27.3±2.9
Number of vessels	9.80±1.02	44.80±4.25	14.20±1.28	23.70±2.02

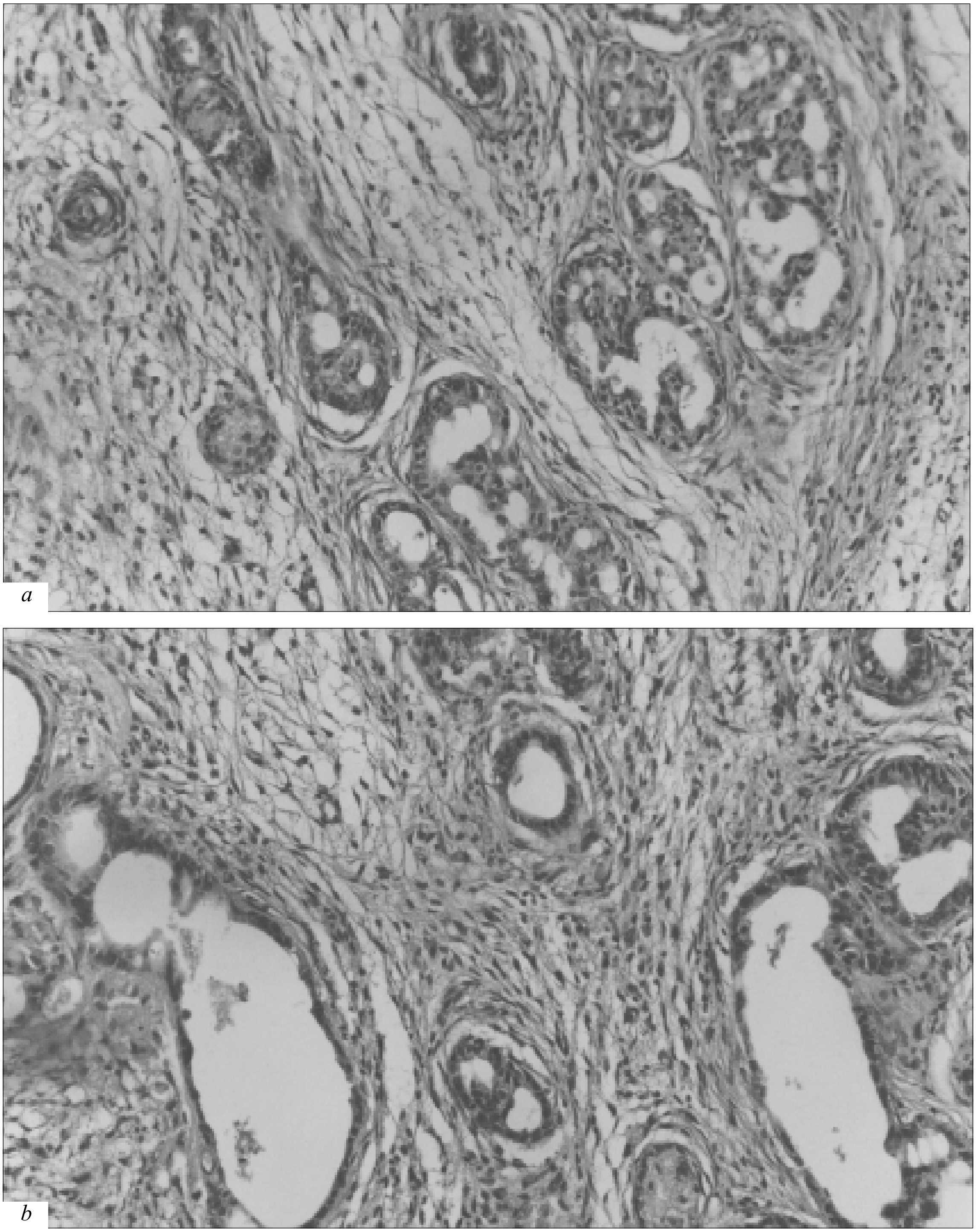

Fig. 2. Transplant of rabbit pancreas after irradiation (*a*) and without irradiation (*b*). Hematoxylin and eosin staining, ×200.

preserved in irradiated transplants (Fig. 1, *a*), while nonirradiated transplants lost their organ-specific structure (Fig. 1, *b*).

Similar regularities were found in pancreatic transplants: preserved structure of the acinar epithelium in irradiated transplants (Fig. 2, *a*), and atrophy of the acinar epithelium in controls (Fig. 2, *b*).

In the absence of immunological conflict, the success of tissue transplantation depends on vascularization process. This process is determined by the intensity of production of growth factors (fibroblast growth factor, endothelial cell growth factor tumor growth factor-β, interleukin-1, tumor necrosis factor, and other low-molecular weight substances) [1,5].

There are data on multiple effects of low-power laser irradiation on cells: it stimulates production of growth factors and cytokines and activates cell proliferation and migration [2,6-8]. However, the effects of irradiation on the formation of new vessels in tissue transplants were not studied. Our findings suggest that low-power laser irradiation can be used for promotion of vascularization and improvement of take of tissue transplants.

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