The Effect of I.R. Laser Irradiation on the Vasomotricity of the Lymphatic System

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Abstract. In this study the effect of i.r. laser irradiation on the vasomotricity of the lymphatic system was investigated. In order to examine this influence we carried out microscopic observations by means of a cold light source illuminating the everted skin of mice. The lymph vessel was visualized by an injection of a physiological dye (Patent Blue V) into the inguinal lymph node.

In a group of mice (N = 40) where no oedema was present before the irradiation, no dilatation of the lymph vessel was seen. However, in a second group (N = 40) where we produced an oedema by means of an intradermal injection of a physiological fluid we observed a remarkable vasodilatation of the vein, artery and lymph vessel.

INTRODUCTION

It is often observed clinically that i.r. laser treatment accelerates considerably the resolution of oedema (for example post-traumatic oedema). The oedema is drained quicker than in untreated conditions.

It is generally accepted that low power i.r. laser irradiation produces vasodilatation and consequently an anti-oedematous effect. However, there are few scientific studies to support this statement (1).

Fine and Klein (2) studied the effect of i.r. laser irradiation on the microcirculation of skin flaps in mice. Even with a low energy they found a vasoconstriction of the blood vessels during the first minutes. When they increased the energy applied, the blood flow stopped and an intravascular clot formation was seen. Capillary haemorrhage was observed. Furthermore, Goldman (3) described haemorrhaging and clotting of the blood after laser irradiation.

Helwig and Jones (4) irradiated the skin of pigs and observed blistering after 30 min. Beneath these blisters the capillaries were damaged and thrombi were seen. At the lateral side of the irradiated zone the capillaries were dilated.

The i.r. laser was also used to stop bleeding in cases of heparinized mice (2). The bleeding stopped after 5 min. The animals in the control group, who were not irradiated, bled to death.

It is evident that oedema resorption is dependent on the lymphatic system. Earlier theories that the blood circulation was the only transport system for the evacuation of the interstitial fluid on which physical means can have an influence are not correct. More and more scientists are convinced that the role of the lymphatic circulation is very important in this matter.

Oedematous fluid not only consists of water, which is easily resorbed and drained by the veins, but also has a very important protein content. Due to the large molecular weight of these proteins they can only be resorbed by the lymph system (5).

To examine this problem it was necessary to study the blood and lymph circulation in physiological and reproducible conditions in vivo.

To examine the microcirculation under these conditions we used the microscopy technique of Knisely (6) (i.e., transillumination microscopy in vivo). This technique was later adapted by Godart (7) to study the lymphatic system.

METHOD

We examined 80 female white mice (Suisse type) of weight 40 g divided into two groups (group 1: N = 40—no oedema was present; group 2: N = 40—oedema was present). For the anaesthesia we used a Urethane solution (25%) 4 ml of which was injected subcutaneously.

The fur was removed from the right side of the abdominal skin. The abdominal skin was opened by means of a dissection along the linea

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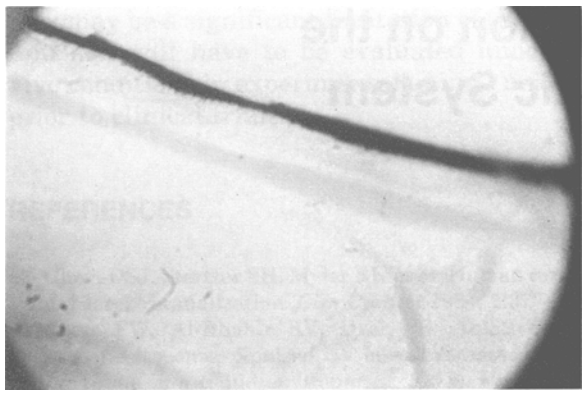

Fig. 1. Before treatment, magnification ×25. A = artery; V = vein; L = lymph vessel.

alba. In order to examine the internal side of the skin under the microscope we pinned the everted skin on to a cork surface.

In the second group of mice, we injected a physiological fluid intradermally distal to the area where we examined the lymph vessels. This intradermal injection had no influence on the vasomotricity of the lymph vessels. We also humidified the internal aspect of the skin with a physiological Ringer solution. To visualize the lymph vessels we injected an inguinal lymph node with a physiological dye (Patent Blue V).

A cold light source was used to illuminate the skin in order to avoid any action of temperature on the microcirculation (Intralux 50 W Volpi). The transmission of the cold light was by means of optic fibres, placed deep into the skin of the mice.

An operating microscope (OPMI 1 Zeiss) was used to visualize the vessels.

The mice were placed under the microscope and were irradiated with a pulsed i.r. laser at a distance of 2 cm for 4 min. Before the treatment started a photograph was taken as well as during and after the treatment. At the same time the whole procedure was videotaped. The laser used was a gallium arsenide pulsed laser with a pulsation duration of 200 ns, a peak power of 6.8 W and a mean power value of 8.8 mW. The energy density was 2.1 J cm^{-2}. The state of irradiance was 8.8 mW cm^{-2}. The frequency of the pulsations was 1000 Hz.

RESULTS

During the first part of this study (the group N = 40 where no oedema was present) we found that one laser irradiation of 4 min did not have an influence on the vasomotricity of the lymph vessels.

In our second group, where we produced an oedema (by intradermal injection of a physiological fluid) a remarkable vasodilatation of the vein, the artery and the lymph vessel was seen during and after one 4-min i.r. laser irradiation (Figs 1 and 2). These observations were found in all cases.

To be sure of the fact that it was the laser irradiation that caused the stimulation, we also examined the effect of a intradermal injection of physiological fluid on the vasomoticity of the lymph vessels; in a control group (N = 15) no vasodilatation was seen even after observation for a 2-h period.

DISCUSSION

It is clear that the effect of a powerful laser on the blood circulation results in a vasoconstric-

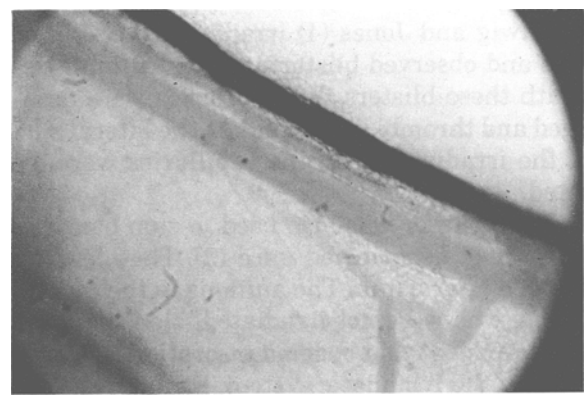

Fig. 2. After treatment, magnification ×25.

tion at the beginning of the irradiation (2) and later during the treatment there is complete cessation of circulation and even clotting in the capillaries (4, 8). Helwig and Jones (4) also reported an important vasodilatation at the edges of the wound. The intensity of the laser irradiation used here is of course much less. Miranda (1) found that when he irradiated the blood vessels with a low power i.r. laser a remarkable vasodilatation of the blood vessels was seen.

Concerning the influence of a low power laser irradiation no studies were found in the literature. The present study investigated this particular aspect. The results are in total agreement with the final aim of laser therapy in that the laser only seems to have an effect in pathological conditions (we only obtained a dilatation of the lymph vessels when an oedema was present).

The results obtained during this investigation help us to understand why good clinical laser therapy can be an effective treatment for oedema.

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