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Effect of 810 nm Near-Infrared Laser on Revascularization of Ischemic Flaps in Rats

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Abstract

Objective: To investigate the effect of 810 nm near-infrared (NIR) laser on the revascularization of ischemic flaps. ***Background:*** It has long been proved that photobiomodulation therapy (PBMT) improves the blood supply of flaps. NIR laser improves the treatment of hypodermis-located lesions and of flap survival, but basic research on the use of 810 nm NIR laser for ischemic flap revascularization is still lacking. ***Materials and methods:*** We prepared two symmetrical long random-pattern flaps on the backs of 60 rats. Each flap was 6 cm long, 1 cm wide, and 1 cm to the middle line. The flaps were divided into an irradiated flap group and an internal control group. The irradiated flaps underwent postoperative 810 nm laser therapy with the energy density of 11.30 J/cm^2 daily. The control flaps were covered by stainless steel to avoid laser irradiation. We observed the viability of the flaps. The flaps underwent Hematoxylin and Eosin (H&E) staining for the observation of histomorphology, immunohistochemical staining of factor VIII for the capillary count, α-smooth muscle actin for the small arterial count, and vascular endothelial growth factor for the integrated optical density (OD) of the positive stained color. ***Results:*** The irradiated flaps showed significantly better flap survival than the control flaps. H&E staining showed that the irradiated flaps had clear tissue structure and little inflammatory cell infiltration. The control flaps demonstrated comparatively worse results. Vascular endothelial growth factor staining showed that the difference in integrated OD between the irradiated flaps and the control flaps was not statistically significant. α-smooth muscle actin and factor VIII staining showed significantly greater numbers of arterioles and capillaries in the irradiated flaps than the control flaps after 4 days of irradiation. ***Conclusions:*** PBMT with 810 nm NIR laser could enhance ischemic flap revascularization and increase flap viability.

Keywords: 810 nm, near-infrared laser, ischemic flap, revascularization

Introduction

Flap transplantation is one of the most fundamental and common techniques in plastic and reconstructive surgery. Skin flaps have a wide range of uses. They can be used to repair traumatic tissue defects, to cover chronic wounds, and to correct deformities. A random flap based on the longitudinal subdermal plexus can be harvested safely if the length:width ratio in the range of 1.5–2:1, and a ratio exceeding this range is at risk of distal flap necrosis.[1] Axial flaps and free flaps too may develop ischemia and even necrosis if the blood flow is decreased.

Photobiomodulation therapy (PBMT), formerly known as low-level laser therapy (LLLT),[2] is a noninvasive, safe application of light in use for the treatment of a variety of pathophysiological conditions, including inflammation, pain, and chronic wounds, with a few side effects.[3] Moreover, as such a treatment can improve the blood flow, it can be used to improve flap viability.[4]

In this study, we treated ischemic flaps with 810 nm near-infrared (NIR) laser,[5] to observe the effect of this treatment on flap revascularization, and attempted to elucidate the mechanism of action.

Materials and Methods

Animals

This study was conducted in accordance with the Guide for the Care and Use of Laboratory Animals and was approved

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