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Role of Low Level Laser Therapy in Preventing Keystone Flap Necrosis

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Abstract

In plastic and reconstructive surgery, skin flaps are widely employed. Large wounds that cannot be closed with normal treatments are treated with skin flap surgery. Skin flap necrosis is a well-known post-flap cover issue that can affect cosmetic outcomes and patient satisfaction. Variable occurrence rates and inconsistent related factors have been reported in many retrospective studies of this condition. Despite advances in technology, the rate of flap necrosis remains significant in daily procedures. In this case study, we aim to evaluate the efficacy and safety of Low level laser therapy preventing flap failure.

Keywords: Keystone flap failure; Necrosis; Low-level laser therapy; LLLT.

Introduction

Skin flap necrosis is a well-known post-flap cover issue that can affect cosmetic outcomes and patient satisfaction. Variable occurrence rates and inconsistent related factors have been reported in many retrospective studies of this condition. Despite advances in technology, the rate of flap necrosis remains significant in daily procedures. There are many methods which are used to ensure flap survival, one of them and with very few data available is low-level laser therapy (LLLT). In this article we share our experience of using LLLT and aim to evaluate the efficacy and safety in preventing flap failure.

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Materials and Methods

This study was conducted in the Department of Plastic surgery in a Tertiary care center in South India. Departmental ethical clearance and consent from the subject were obtained. In this study, we have applied low-level laser therapy (LLLT) to a 20-year-old patient (no known comorbidities) who has undergone a keystone flap to provide cover for an exposed bony surface over the right lower limb (figure 1). The LLLT used in this study is, Gallium arsenide (gas) diode red laser of wavelength 650nm, frequency 10khz and output power 100mw, which has continuous beam laser with an energy density of 4 j/cm2(figure 2). The flap was then monitored for signs of failure on days 5,10,15 (figure 3,4,5).

Result

In our study, low-level laser therapy (LLLT) was successful in preventing skin flap necrosis of the keystone flap (figure 6). The viability of the flap was checked by the skin color, flap colour, turgor, warmth and type of bleed . No side effects were observed during the study.

Fig. 1: Low level Laser therapy being applied post keystone flap creation.

Fig. 2: Gallium arsenide (gas) diode red laser used for Low level laser therapy.

Fig. 3: Flap on Day 5.

Fig. 4: Flap on Day 10.

Fig. 5: Flap on day 15.

Fig. 6: Keystone flap after complete healing.

Discussion

In plastic and reconstructive surgery, skin flaps are widely employed. Large wounds that cannot be closed with normal treatments are treated with skin flap surgery. Keystone flaps are one of the preferred options to reconstruct different types of defects, especially in the extremities. The keystone flap is different from other loco-regional flaps in that it has a great capability for adaptability. The various factors that could contribute to skin flap necrosis are age, BMI, tobacco, smoking, Diabetes, wound type and size, etc. In our patient, none of these risk factors were present hence the effect of LLLT on preventing flap necrosis could be evaluated more efficiently.

A well-perfused, healthy flap will be pink, enlarged minimally in the postoperative period, and warm to the touch. Capillary refill is measured by pressing and releasing pressure on a skin paddle with a fingertip, then noting the initial pallor from direct pressure, followed by the restoration of a pink hue from reperfusion. A bluish tint, increased swelling and warmth, and a shorter capillary refill (less than 2 seconds) are all signs of a congested (venous compromised) flap. The flap will be pale in color, cold on touch, and have a delayed capillary refill (>3 seconds) in the case of ischemia (arterial compromised flap).

Skin flap necrosis is caused by a lack of circulation and oxygen to the tissue, and it can manifest anywhere from the second to the fourth day after surgery. It commonly shows as a black spot or a blood-stained blister on the flap's leading edge. Necrosis is a dangerous complication that can demand additional surgical procedures, induce infections, and delay treatment. Ischemia produces necrosis, especially in the flap's distal section, as a result of blocked arterial input.

A power density of 500 mW/ cm2 is used to define the acronym "light amplification by stimulated emission of radiation (LASER)." 1,2 The amount of energy utilised in LLLT is far smaller than that used in cutting and ablation therapy. LLLT is a type of phototherapy that uses electromagnetic radiation with sufficient energy to interact with biological tissues. With the goal of re-establishing cell homeostasis, it delivers photochemical and photophysical actions without generating heat. Light energy is provided topically in a controlled manner, where it is absorbed by photo absorbers (chromophores), which convert it to chemical energy.[3] Increased granulation tissue production and tissue repair speed, wound contraction, inflammation, modulation, and pain reduction are

all positive benefits.[3] According to the literature, low-energy photon emissions with wavelengths ranging from 600 nm to 900 nm has the following effects.

- enhance cell growth and wound healing.[4]
- stimulate respiratory chain components, boosting adenosine triphosphate (ATP) synthesis[6], and hence increase mitosis and fibroblast numbers.[5]
- encourage the formation of collagen and elastin.[6]
- increase microcirculation by dilating capillaries and promoting neovascularization.[7]
- activate macrophages by releasing inflammatory mediators such as histamine, serotonin, and bradykinin.
- improve lymphatic vessel regeneration.

In our study, we found that topical application of low-level laser therapy (LLLT) is efficacious, increases the chances of flap survival, easy to use, and is cost-effective. No adverse effects after the application low-level laser therapy (LLLT) were noticed during the study. The limitation of our study is that, since this single case report study, definite conclusions cannot be made. This study can also be used as the basis for a larger prospective study to determine the efficacy of low-level laser therapy (LLLT) in increasing the chances of flap survival.

Conclusion

Low-level laser therapy (LLLT) proved to be an excellent adjunct for improving flap survival in skin flaps. It has a good safety profile and is thus appropriate for empirical use.

Conflicts of interest: None

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