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The role of erbium: YAG laser in amputation stump

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Abstract
Amputation is a very common case dealt by any General surgeon, orthopaedic surgeon, and plastic surgeon. The rehabilitation of the patient with amputation is equally important as a successful surgery. The scar over the amputation stump can sometimes be a problem, which requires special care during the rehabilitation of the patient. Numerous procedures such as surgical excision, intralesional steroid injection, cryotherapy, dermabrasion, soft tissue augmentation, chemical peeling and laser therapy are available for the correction of various types of scars. This article highlights the role of Erbium: YAG Laser in management of scar following transfemoral amputation.

Keywords: amputation stump, Er-YAG Laser, stump scar

Introduction

The scar over the amputation stump can sometimes be a problem in the rehabilitation of the patient. Scar tenderness, scar hypertrophy, scar contracture, ulceration etc are the common problems associated with scar over the amputation stump. Skin resurfacing with the use of laser therapy forms an important component of rejuvenation. An Er: YAG laser is a solid state laser whose active laser medium is erbium-doped yttrium aluminium garnet ($Er:Y_3Al_5O_{12}$) and typically emit infrared light of wavelength 2940 nm. This article assesses the use of Er: YAG laser as a means of improving wound healing outcomes following amputation.

Material and methods

The study was conducted in The Department of Plastic Surgery in a tertiary care centre during April 2021. Department Ethical committee clearance and informed consent from the patient were obtained. The patient was a 45-year-old male with no known comorbidities was admitted following RTA with vascular injury to right lower limb at mid-thigh level with extensive soft tissue injury. He underwent amputation of the right lower limb at Trans femoral level. He was managed with multiple sessions of wound debridement and negative pressure wound therapy. His wound gradually improved, and later raw area was covered with a Split thickness skin graft. The patient's amputation stump as well as the STSG donor sites were (FIGURE 1) given Er YAG Laser therapy to improve the Stump. The settings used for the same was Er YAG 2490nm, Fluence 1, Pulse width 0.3MS, Tip 9mm. One pass of Thermal pulse of 400J and one pass of 800J.Total of 4 sessions were given at one-month intervals. The stump was assessed with visual assessment and Vancouver scar scale score at before the beginning of the laser therapy and one month after the last session.

Fig 1: Er:YAG LASER given over the amputation stump

Fig 2: Er:YAG Laser applied over the STSG donor site

Results

The stump showed improvement in scar. No complications were noted during the study.

Discussion

Amputation involves severance of a limb or a part of a limb from the rest of the body. There are many factors which impact wound outcomes after amputation- nutritional status, age, tissue perfusion, smoking habits, infection and the presence of comorbidities. These risk factors can lead to complications associated with poor quality of life. Some of the potential wound healing complications include infection, tissue necrosis, hematoma, wound dehiscence, blistering of skin, pain, bone erosion and osteomyelitis, stump edema and problems arising due to scar. These complications may require use of sophisticated management strategies. The key lies in prevention, early recognition and appropriate management. There are various modalities which are used to accelerate wound healing, like platelet rich plasma, local infiltration of insulin, irritant substances, and laser therapy.

Skin resurfacing with the use of laser therapy forms an important component of rejuvenation surgery. The clinical use of lasers in plastic surgery was introduced by Anderson and Parrish in 1983 with the concept of photothermolysis [1]. At present, there are two laser wavelengths commonly used for skin resurfacing: pulsed carbon dioxide (CO2) and erbium: yttrium aluminium-garnet (Er:YAG) laser. The wavelength of CO_2 lasers is not efficiently absorbed by water, so most of the energy is absorbed by the dermis thereby causing more thermal necrosis [2]. Erbium-doped yttrium aluminum garnet (Er: YAG) lasers were developed as an alternative to the CO_2 lasers, catering to the main concern of excessive thermal damage to the skin [3]. Er: YAG lasers produce energy with a wavelength of 2940 nm, which is very near the peak absorption of water [1]. This wavelength has 10 times the water absorption of CO_2 lasers and a very short extinction. As a result, Er: YAG lasers deliver more efficient tissue ablation with minimal thermal damage, shorter recovery times, and lower incidence of side effects [4]. Another advantage of Er: YAG laser is the lack of requirement for recipient site anesthesia owing to minimal pain associated with the shots of Er: YAG laser [7].

Some of the mechanisms by which they have a role in scar management include decreasing angiogenesis, improve the pliability and erythema of immature scar by destruction of small blood vessels by photothermolysis, decreased cellular activity due to laser-induced anoxia or through collagenolysis by laser stimulation of cytokine release [8, 9].

Conclusion

This report highlights the use of Er: YAG laser in the scar following amputation and was associated with better outcomes. Further studies are needed to allow for use on a large scale.

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