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Application of Low Level Laser in Managament of Biofilm

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Abstract

Management of biofilm in chronic wounds is rapidly becoming a primary objective of wound care. However management of biofilm is an undeniably complex task. Beyond the basic steps of initial prevention (use of anti-biofilm agents), removal (debridement, desloughing) and prevention of reformation (use of antimicrobial agents), there are myriad patient, environmental and clinical parameters that must be considered when identifying a tailored solution. Systemic treatment strategies are required for infected chronic wounds, whereas in non-infected wounds where the presence of biofilm is impeding healing, strategies can be adopted to break up the biofilm. The antimicrobial effects of various lasers have been studied in vitro, and most reports have indicated that laser irradiation is useful for bacterial suppression. In the present case report we discuss the use of low level laser therapy in chronic leg wound.

Keywords: Biofilm; Chronic Wound; Low Level Laser Therapy.

Introduction

Biofilms are described as bacteria attached to surfaces, encapsulated in a self-produced extracellular matrix and tolerant to antimicrobial agents (this includes antibiotics and antimicrobials). Less than 10 studies have visualised biofilms in non-healing chronic wounds using the accepted approaches of microscopy with or without molecular analysis [1,2]. These studies identified the presence of biofilms in 60% to 100% of samples. Currently, there is no 'gold standard' diagnostic test to define the presence of wound biofilms and no quantifiable biomarkers. Clinicians should 'assume all non-healing, chronic wounds that have failed to respond to standard care have biofilms' and, therefore, treatments should be targeted towards this [3]. Targeted therapies could be used to improve healing in cases where microbial biofilms is a causal component of chronic wounds as unique strategies to make microbes more susceptible to antimicrobials for clearance by the host immune system and therapiesdirected at preventing a prolonged inûammatory component of wound healing.

Low level laser therapy (LLLT) is the application of light usually alow power laser or LED in the range of 1mW – 500mW. Thelight is typically of narrow spectral width in the red or near infrared(NIR) spectrum (600nm – 1000nm), with a power density (irradiance) between 1mw-5W/cm^2. LLT is not an ablative or thermal mechanism, but rather a photochemical effect comparable to photosynthesis in plants whereby the light is absorbed and exerts a chemical change [4]. In our case report we discuss the application of LLLT in chronic leg wound and the changes in the wound leading to effective treatment of a debilitating condition.

Material and Methods

57 year male with wounds over right leg since 8months post traumatic injury which was non progressive in nature with minimal, non-foul smelling discharge with no associated fever. On examination wounds were of size 6 x 5cm and12x8cm over medial and anterior aspect of lower one-third of leg respectively, both covered by pale, slimy granulation tissue with slough, surrounding skin hyper pigmented and indurated. No evidence of arterial or venous insufficiency confirmed by

Doppler study. Patient tissue culture was positive for pseudomonas and proteus. Biopsy showed no evidence of malignancy.

Patient underwent LLLT therapy using Gallium Arsenide laser for 10 minutes over the raw area of the wound over the medial surface and saline dressing of wound for 2 weeks every alternate day. At the end of 2 week wound over medial surface showed pink granulation tissue with reduction of surrounding oedema whereas wound over anterior surface remained pale. During this period patient was splinted, no debridement of wound performed and systemic antibiotics were administered as per sensitivity report. No local antibiotics used.

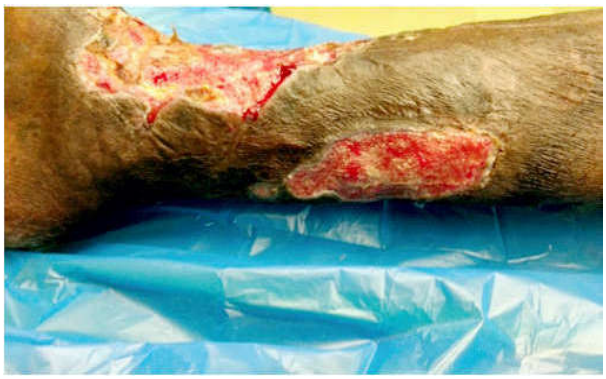

Fig. 1: Wound at presentation

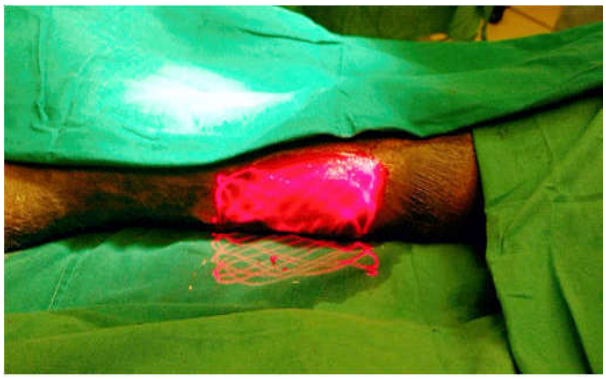

Fig. 2: LLLT of wound over medial surface

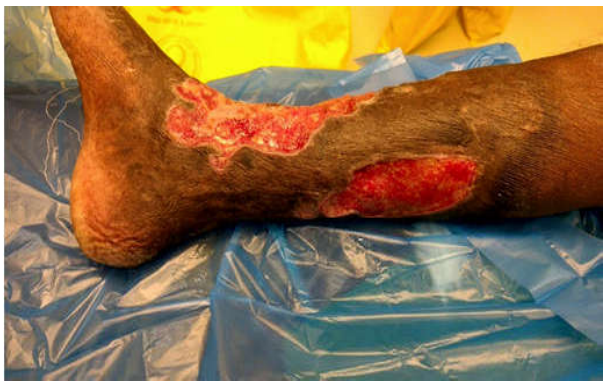

Fig. 3: wound at the end of second week

Discussion

The prevention and management of biofilms in chronic wounds is rapidly becoming a primary objective of wound care, with the presence of biofilms acknowledged as a leading cause of delayed wound healing. The biofilms interfere with normal wound healing, apparently by 'locking' the wound bed into a chronic inûammatory state that leads to elevated levels of proteases (matrix metalloprotease and neutrophil elastase) and reactive oxygen (ROS) that damage proteins and molecules that are essential for healing, biofilms maintain localised low oxygen tensions in the wound, thus contributing to chronicity [5,6]. A large percentage of bacteria in biofilms communities are metabolically dormant, which generates tolerance to antibiotics. Identification of biofilms in clinical practice is difficult, with few guidelines availableto facilitate its recognitionKeast et al. propose four main features that may increase suspicion of the biofilm presence, as follows:

1. Antibioticfailure
2. Infection of >30 days duration
3. Friable granulation tissue
4. A gelatinous material easily removed from wound surface that quickly rebuilds[7].

Once the likelihood of biofilms presence is established, an appropriate treatmentstrategy should be determined with aims to reduce burden and preventits reconstitution.

Low level laser therapy is irradiation of pathology (raw area) with light of near infrared radiation spectrum affects the biofilm and the wound. LLLT causes to disaggregation of microorganisms which form the biofilm and lose of adherence but doesn't reduce the number of micro-organisms.Different microbial species have different susceptibility to LLLT [8]. Nussbaum et al. also demonstrated that LLLT (λ=810 nm) at 5, 10, 20 and 50 J/cm2 doses was effective in inhibiting growth of Pseudomonas aeruginosa and Staphylococcus aureus [9].

LLLT not only affects biofilm but has effect on surrounding tissue. The molecular and cellular mechanisms LLLT suggest that photons are absorbed by the mitochondria; they stimulate more ATP production and low levels of ROS, which then activates transcription factors, such as NF-κB, to induce many gene transcript products responsible for the beneficial effects of LLLT. ROS are well known to stimulate cellular proliferation of low levels, but inhibit proliferation and kill cells at high levels. Nitric

oxide is also involved in LLLT, and may be photo-released from its binding sites in the respiratory chain and elsewhere. It is possible that NO release in low amounts by low dose light may be beneficial, while high levels released by high dose LLLT may be damaging. The third possibility is that LLLT may activate transcription factors, up regulating protective proteins which are anti-apoptotic, and generally promote cell survival [10,11].

Hence LLLT can be an effective tool in management of chronic wound. Further research is needed to evaluate the behaviour of different microorganisms, and their interaction in biofilms when subjected or not to LLLT and substantiate benefit of LLLT on wound healing.

Conclusion

LLLT an evolving option for chronic wounds and biofilm management can be considered during routine wound care.

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