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Phototherapy for Chronic Rhinosinusitis

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Objectives: Near-infrared laser illumination (NILI), with or without photo-activated (PA) agents, has bactericidal and wound healing promoting effects. NILI may have a potential role managing chronic rhinosinusitis (CRS).
Methods: A prospective randomized study with 23 symptomatic post-surgical CRS patients with positive cultures was conducted. Two groups (GR1 and GR2) were treated with NILI. Objective nasal endoscopic scoring (NES) was elaborated. GR1 was treated with a 940 nm laser, while GR2 was treated with a topical PA agent, indocyanine-green, followed with 810 nm laser. SNOT20 scores, NES, and cultures were obtained prior to illumination. Saccharin test was performed 1 week following treatment.
Results: Some cultures remained positive through treatment, with *Staph. aureus* predominating. Both therapy arms demonstrated clinical efficacy. The SNOT20 score change was 0.9, 0.8 for GR1 and GR2, respectively ($P < 0.05$). Improvement ($P < 0.05$) was observed based on NES. No significant difference was observed between two treatment groups. All passed the saccharin test. Therapeutic effect was sustained for a minimum of 2 months. Side effects were minimal.
Conclusions: NILI was objectively and subjectively beneficial in managing CRS, safe, reproducible, sustained and appeared not to interfere with ciliary motility. CRS exacerbation was avoided without using antibiotics or steroids. Lasers Surg. Med. 43:187–191, 2011.

Key words: chronic sinusitis; near infra red diode laser; photosensitizer; ICG; endoscopy; SNOT; CRS

INTRODUCTION

Otolaryngologists implemented lasers in the early 70's and were among the pioneers of lasers being incorporated into medicine. Near-infrared laser illumination (NILI) in treating chronic wounds is rapidly growing. However, it has not yet found its way into otolaryngology. NILI has a modulating role in cells involved in tissue repair and a significant effect on slowing or negating bacterial growth. Irradiance is a significant variable in NILI and effects are dependent on time and radiant exposure. Proliferation in various cell models has been demonstrated using different irradiances. A lower irradiance is possible with the use of a photo-sensitizer. Bacterial inhibition has been studied widely with a range of laser wavelengths, laser combinations, and laser combined with photo-sensitizer, as well as different irradiance and radiant exposures [1].

Mechanisms of Microbial Killing and Inflammation Reduction With NILI

Numerous in-vitro and in-vivo studies support the effect of NILI in surface microbial killing based on the following three mechanisms.

1) Optical killing: According to the seminal discovery of Neuman while using optical traps for detecting microbial movements, NIR illumination at specific wavelengths was found to be extremely bacteriostatic [2].
2) Photo-activated killing: Multiple photo-active (PA) agents have been used in order to achieve bacterial reduction in-vitro such as methylene blue, toluidine blue, and indocyanine-green (ICG). When these agents are excited with specific lights they are converted into triplet state and either react with the substrate to produce radical ions which in turn react with oxygen to produce cytotoxic species such as superoxide and hydroxyl radicals (type I reaction), or directly with molecular oxygen to produce singlet oxygen (type II reaction). The cytotoxic species produced can then cause bacterial cell death, via loss of membrane integrity and lipid peroxidation [3].
3) Heat or hyperthermia as a source of microbial killing and infection control is well-documented [4,5]. During NILI therapy the surface tissue temperature rises up to 10–12° (F) from baseline [6].

Chronic rhinosinusitis (CRS) is a debilitating disease with indolent activity and multiple contributing factors [7]. Studies indicate that patients with CRS, despite at least one surgical attempt of functional endoscopic sinus surgery (FESS), are likely to have a diminished rate of success with an additional surgical procedure and an increased rate of post-surgical infection [8].

With these challenges in mind, we have assessed the role of NILI in reducing the symptoms associated with inflammation and infection as NILI has the possible advantage of addressing both [9].

Our pilot study used near-infrared lasers, with or without a PA agent. We selected ICG as our PA due to its photo-

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