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Authors
Zachary, Christopher B
Elsanadi, Rachel
Maghfour, Jalal
et al.

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Controlled hyperthermia and monitored protocol for basal cell carcinoma: interim report

AUTHORS

Christopher B. Zachary[1], Rachel Elsanadi[1] Jalal Maghfour [2], Indermeet Kohli[2], Kristen M. Kelly[1], Rachana Soni[3], Craig Fortier[4], Jon Holmes[4], Hachi Heckt[3], Alexander Makowski[3], Dan Negus[3], Linda Doan[1] Anna-Marie Hosking[1], Solomiya Grushchak[1], John Soliman[1], John Wuenneberg[2], Joe Mehrabi[1], Erica Baugh[1], Chris Robb [5], David Ozog[2].

[1]University of California Irvine,
[2] Henry Ford Health System,
[3]Sciton Palo Alto, USA,
[4] Michelson Diagnostics, Maidstone, UK
[5]Skin & Allergy Center, Spring Hill, TN,

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ABSTRACT

Heating has been known to cure cancer for over 2000 years[1], and recent studies have confirmed this in the treatment of basal cell carcinomas (BCC)[2]. The application of uncontrolled heating often results in unacceptable scarring. Our ability to control the delivery of heat using a forward looking infrared (FLIR) camera and a modulated long pulsed (LP) Nd:YAG 1064nm laser have resulted in better outcomes in comparison to traditional destruction techniques[3]. Use of optical coherence tomography (OCT) enhances our ability to define the tumor margins prior to treatment. The combination of FLIR and OCT allows very precise treatment of BCCs with at least comparable outcomes to conventional LP Nd:YAG treatments.

1. INTRODUCTION

We have previously demonstrated excellent control of skin tissue temperature using an integrated FLIR imaging system in normal skin with a LP Nd:YAG 1064nm laser, and defined optimal time and temperature parameters to impact skin tissue responses[3]. Outcomes were defined clinically and by dynamic OCT both to recognize incipient or frank blistering and necrosis, and assess tissue blood flow. We are providing an interim report of a three-center IRB-approved prospective study of n=90 lesions wherein we examined the use of a novel procedure, 'Controlled Hyperthermia and Monitoring Protocol' (CHAMP™). The procedure utilizes FLIR thermal imaging for in-procedure temperature control and OCT imaging to assess preoperative tumor margins and treatment response following the treatment of BCCs with the Nd:YAG laser. The objectives were to compare efficacy of the CHAMP™ method with conventional LP Nd:YAG treatment which lacks temperature control, while simultaneously assessing the benefits of OCT scanning for tumor margin mapping and monitoring.

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2. METHODOLOGY

To date, 73 biopsy-proven BCCs on the trunk and upper limbs were enrolled. Tumors were carefully examined, photographed and marked with a 5 mm margin to delineate clinical tumor. Lesions were then systematically mapped with an OCT device (Michelson Diagnostics™, Maidstone, UK) to assess lateral tumor extension. The mapped tumors were then injected with local 1% lidocaine and treated with the LP Nd:YAG laser (Sciton®, Palo Alto, USA) using randomly either a 'conventional' protocol or novel CHAMP™ protocol. The conventional protocol comprised of a series of scans of non-overlapping pulses (fluence: 120-140J/cm^2; pulse width: 8-10ms, spot size: 5mm) delivered in 1-3 passes, until clinically visual endpoint of greying was observed. Alternatively, the 'CHAMP™' method utilized a thermal imaging camera (Teledyne FLIR™, Wilsonville, USA) with a series of lower fluence LP Nd:YAG laser scans (fluence: 20-40 J/cm^2; pulse width: 8-10ms, spot size: 5mm), timed and monitored to maintain average tumor tissue surface temperatures of 55 ºC for greater than 60 seconds. Patients were observed clinically for BCC symptoms and re-scanned by OCT at 3-12 months intervals for any signs of residual tumor, and if deemed positive for BCC, were retreated with the same protocol as was previously received. Finally, lesions were excised for evidence of histological clearance at no less than three months after the final laser treatment.

3. RESULTS AND DISCUSSION

Pre-treatment OCT mapping of BCCs indicated that these tumors extended beyond their 5 mm clinical margins in 11/73 (15%) of cases. To date, 17/17 (100%) CHAMP™ treated tumors and 13/15 (87%) conventionally treated tumors have been determined histologically clear of BCC in this ongoing study. Using the CHAMP™ method, ulceration was less common and patients healed with modest erythema. Increased vascularity as measured by dynamic OCT was noted in the majority of CHAMP™ treated patients, as opposed to conventional treatments that display hallmark signs of local vascular coagulation. This was noted immediately after irradiation, suggesting that for the conventional method, cell death or thermal destruction was the primary mechanism of observed tumor clearance. The CHAMP™ protocol OCT data lies in stark contrast to the observed vascular coagulation seen in tumor tissue treated with the conventional protocol. Such coagulation of vascular supply has been posited to be a mechanistic cause of tumor clearance in the high fluence conventional protocol[2].

4. CONCLUSIONS

Treatment of superficial and nodular BCCs with the long pulse Nd:YAG 1064nm laser is useful for a subset of patients who are not Mohs surgery candidates. OCT and FLIR thermal imaging provide a rapid method for identifying and mapping these tumors. Preliminary histological evidence from this study suggests that the CHAMP™ treatment is efficacious in spite of the lack of notable vascular coagulation, and may provide the advantages of reduced risk of ulceration and improved recovery. OCT images provide accurate analysis of tumor margins and can help guide as to the necessity of further treatments in order to achieve histological clearance. Skin cancer surgeons might take note that preoperative assessment of tumors by OCT will likely improve accuracy of margin control using any modality, including Mohs surgery, excision or laser treatment.

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