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SPECIAL TOPIC

Treatment of Sebaceous Hyperplasia With a Novel 1,720-nm Laser

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ABSTRACT

Background: Sebaceous hyperplasia is a common benign proliferation of sebaceous glands. Multiple treatment methods have been applied in the past, including electrodessication, ablative and visible light lasers, applications of acids, and photodynamic therapy. Often, however, only the superficial component of the lesion is treated, leading to rapid recurrence. It has been shown that human fat has absorption peaks at 1,210 nm and 1,720 nm. We report the first use of a novel 1,720-nm laser in the treatment of sebaceous hyperplasia in human subjects.

Methods: Four patients with sebaceous hyperplasia underwent a test spot treatment followed by 2 full treatment sessions using the 1,720-nm laser. Photos were taken before treatment, at each treatment session, and 3 months following the last treatment. Pretreatment photographs and 3-month follow-up photographs were compared to assess efficacy.

Results: Four weeks after the final treatment, 3 dermatologists blinded to the date of the photographs and uninvolved with the study evaluated the photos and scored them based on a global assessment comprised of: 1) lesion diameter, 2) lesion height, and 3) lesion color. Many of the lesions resolved almost completely after a single treatment, and no additional treatment was required. Overall, there was a reduction in the color, diameter, and height of the lesions. Crusts were noted by all patients and resolved within 10 days.

Conclusion: The use of this novel device that exploits the intrinsic selectivity of 1,720 nm achieved nearly complete clearance of sebaceous hyperplasia lesions without depressions or scarring. Complete heating of the sebaceous gland and sparing of the surrounding skin offered by this device resulted in clinically apparent improvement with a minimum of adverse effects.

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INTRODUCTION

Sebaceous hyperplasia is a common benign proliferation of sebaceous glands. Lesions are characterized by multiple lobules emptying into a large central duct. They normally present as round, yellow, umbilicated papules.[1] Although a number of treatment techniques have been reported, they seldom provide a complete cure and often lead to recurrence. Acid destruction, ablative lasers, electrodessication and curettage, isotretinoin, cryotherapy with a copper probe or cotton swab, visible light lasers, intense pulsed light, and finally photodynamic therapy using aminolevulinic acid have all been applied to the sebaceous hyperplasia lesions.[1-4] Although individual sebaceous glands range from 200 to 500 µm in diameter, larger sebaceous hyperplasia lesions usually range from 1 to 2 mm in diameter and can extend 2 mm deep in the dermis. The depth of the lesions demands more than a surface therapy if rapid recurrences are to be avoided. On the other hand, too deep a treatment can result in scarring. Most destructive techniques are nonspecific and are associated with potential complications such as atrophic scarring and dyspigmentation. Isotretinoin has been shown to temporarily shrink sebaceous hyperplasia, but the lesions recur with discontinuation of therapy, and there is a risk of hepatotoxicity, agranulocytosis, hypertriglyceridemia, and teratogenic effects.[5,6]

Laser treatment of sebaceous hyperplasia has the potential advantage of selectively targeting the sebaceous gland. Thus far, experience with laser treatment of sebaceous hyperplasia has been limited to devices that are commonly used to treat photodamage but are lacking in selective properties that can specifically target sebaceous glands. These lasers include the carbon dioxide (CO_2), erbium-doped yttrium aluminum garnet, and 1,450-nm diode lasers, which target water, and the pulsed dye laser (PDL), which targets hemoglobin. The absorption spectra of human fat have identified 1,210 and 1,720 nm as relative peaks.[7] It has been shown that at 1,720 nm, the photothermal excitation of fat is twice the background skin.[8] Therefore, the potential of selectively targeting fatty tissues, such as sebaceous gland hyperplasia, with preservation of the overlying skin is feasible by using the 1,720-nm near-infrared lipid absorption band. To date, a commercially available laser with the wavelength of 1,720 nm does not exist.

In addition to 1,720 nm, other wavelengths that show selective fat absorption include 920 nm and 1,210 nm. Recent work has characterized the selectivity of 1,210 and 1,720 nm for the sebaceous gland.[7,8] The 1,720-nm laser selectively targets sebaceous hyperplasia with minimal damage to surrounding tissues. A simple ex vivo "bacon study" demonstrated selective heating of the fatty tissue with minimal effect on the muscle tissue (Figure 1). However, human studies are lacking. In this report, we present the first clinical application of a novel 1,720-nm laser in the treatment of sebaceous lesions in humans.

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METHODS

Four patients were recruited into this institutional review board–approved study. All patients presented with at least twenty 0.5- to 1.5-mm umbilicated yellow papules consistent with sebaceous hyperplasia. The laser was a 1,720-nm laser (Del Mar Medical Technologies, Del Mar, CA) delivering up to 5 W through a 400-µm fiber (0.22 numerical aperture). Power was measured through a built-in power meter. Test spots were performed after photographs were taken with a Nikon digital SLR camera (Model D90; Melville, NY) equipped with a Canfield twin flash (Canfield Imaging Systems, Fairfield, NJ) with and without polarization. The power to tissue was up to 4 W. Dwell times ranged from 30 to 200 ms, The spot size was 500 to 750 µm, and average dwell time (on time) of 50 ms resulted in a fluence of about 45 J/cm^2. The desired end point was a change from a pretreatment granular yellow appearance to a creamy, white, smooth surface (Figure 2). In some cases, the individual lobules were observed to extrude from the surface. A pinpoint pirouetting technique was applied to treat larger lesions, where individual lobules were heated with the fiber tip held about 1 to 2 mm off the skin's surface. For smaller lesions, the entire lesion was treated with one pulse. Settings ranged from 3 to 3.8 W, and pulse durations in continuous wave mode from 50 to 200 ms. Representative settings are described in Table 1. After the test spots were performed, patients returned in 3 weeks for evaluation. The treating physician determined the best settings by noting the parameters that achieved the greatest reduction in lesion size with the lowest number of side effects. Two treatment sessions were carried out at 3- to 4-week intervals, and the final follow-up was 12 weeks after the final treatment. Test spots showed that the optimal setting combination was 4 W (maximum power to tissue) and 50 ms. The spot size at the skin's surface was estimated to be 0.075 to 1 mm. The resulting calculated fluence was about 45 J/cm^2. Smaller dwell times resulted in inadequate heating (lack of clear coagulation response), and longer dwell times and lower powers resulted in poorer heat confinement (coagulation that extended beyond the lesion perimeter). Damage to adjacent normal skin showed no change until the dwell time exceeded 2 times that of the sebaceous hyperplasia. One 2-mm punch biopsy was obtained just after treatment in 1 patient.

FIGURE 1. Slice of bacon just after irradiation with a 1,720-nm laser. Equal fluences were applied to fatty and nonfatty portions. Note selective changes in the fatty part of the bacon.

FIGURE 2. Pretreatment photo on left. Immediate posttreatment photo on right demonstrating whitening response to 1,720-nm pulses delivered at 45 J/cm^2 with a 50-ms pulse duration

TABLE 1.

Representative Settings for the 1,720-nm Laser

Wavelength (λ)	Spot Size (µm)	Power (W)	Fluence (J/cm^2)	Dwell Time (ms)
1,720 nm	400	4	45	50

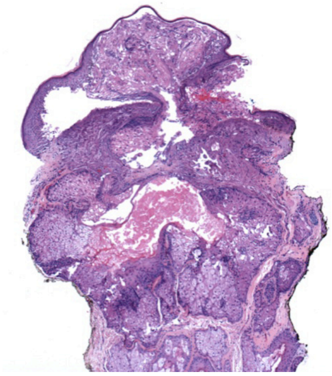
Four weeks after the final treatment, 3 dermatologists blinded to the date of the photographs and uninvolved with the study evaluated the photos and scored them based on a global assessment comprised of: 1) lesion diameter, 2) lesion height, and 3) lesion color. Diameter was measured by using the background identification tape that was scored in mm. Height was measured by scoring a lesion as flat or raised. The color was either yellow or flesh color. The grading system used the following scale to assess global improvement: 0 = no improvement, 1 = 1% to 25% improvement, 2 = 26% to 50% improvement, 3 = 51% to 75% improvement, 4 = 76% to 99% improvement, and 5 = complete removal.

RESULTS

All patients completed the study. The mean transmitted power and dwell times were 3.5 W and 50 ms. Immediate responses with increasing dwell times from 20 to 200 ms over the same power density ranged from no response to coagulation that

FIGURE 3. Pretreatment photo on left. Posttreatment photo on right demonstrating response 12 weeks after second treatment.

FIGURE 4. Punch biopsy demonstrating superficial damage to sebaceous gland.



extended slightly beyond the lesion perimeter. Many of the lesions resolved almost completely after a single treatment, and no additional treatment was required. The data are presented in Table 2. Representative preoperative and postoperative photographs are noted in Figure 3. Overall, there was a notable reduction in color, diameter, and height of the lesions. Crusts were noted by all patients and resolved within 10 days. The one biopsy showed damage to the sebaceous glands that extended about 800 μm deep to the surface. The very deep portion of the lesion (800 μm to 2 mm below the surface) was unaffected (Figure 4).

DISCUSSION

Sakamoto et al examined 1,720-nm sebaceous gland heating based on Monte Carlo modeling and ex vivo experiments with a free electron laser using an ≈8 mm spot.[8] Their data suggested a damage threshold fluence of about 67 J/cm² for a 50°C temperature rise based on 100 to 1,000 ms of heating. They also found about a 1.6 times differential between sebaceous gland heating and normal skin at selected fluences. Our clinical results are in line with their preliminary ex vivo results.

However, there are differences in the studies. In their work, a large spot was used, and normal-sized sebaceous glands were treated. In our case, only hyperplastic glands were treated. In these lesions, the glands almost abut the overlying skin surface.

TABLE 2

Results. Global improvement scores took into account lesion size, height, and color.

	Treatment Parameters	Global Improvement Average (0-5)
Patient 1	45 J/cm², 50 ms	4
Patient 2	45 J/cm², 50 ms	4.2
Patient 3	45 J/cm², 50 ms	4.2
Patient 4	45 J/cm², 50 ms	3

Also, we targeted the lesion with a very small spot vs a larger spot. We did show selectivity, however, as normal adjacent skin was unaffected by a range of fluences used in the study. However, only small increases in dwell time and therefore fluence resulted in changes in normal skin. Whereas sebaceous hyperplasia lesions showed coagulation at 50 ms and 3.8 W, normal skin showed graying only at about 100 ms. The size of an average sebaceous hyperplasia lesion (about 1-2 mm) has a thermal relaxation time of about (assuming a spherical geometry) 1 second. Therefore, almost complete thermal confinement would be expected during the pulse.

The clinical end points with 1,720-nm irradiation differed from typical clinical end points with other modalities. For example, with the hyfrecator (probably the most common tool used in sebaceous hyperplasia treatment), a slight graying at the surface is noted. With the PDL, purpura is a typical end point, and with the 532-nm laser, we observe "whitening" as a common end point. In the later 2 modalities, presumably we are targeting the Hgb (hemoglobin) that courses through a typical sebaceous hyperplasia lesion, and indeed those vascular-type sebaceous hyperplasia lesions respond well to Hgb-specific lasers. Photodynamic therapy using aminolevulinic acid relies on sufficient protoporphyrin IX production and adequate light doses to photochemically/photothermally alter the gland.

The advantage of sebum-selective approaches is a high likelihood of deeper heating of the gland. Most present methods only heat the most superficial portions of the gland, resulting in typical incomplete removal and rapid recurrence. Various physicians have tried to address this challenge. For example, Bader and Scarborough used the hyfrecator with a 1-second application of an epilating needle to heat up lobules without recurrences.[4] Aghassi et al examined the role of PDL in sebaceous hyperplasia and found specific damage to the blood vessels.[1] Our fiber delivery system and small spot allowed for precise placement of the beam and, together with the intrinsic selectivity of 1,720 nm, achieved almost complete clinical destruction of the lesions without depressions or scarring. By exploiting the primary differentiating feature of the sebaceous gland vs normal skin, we achieved complete heating of the superficial portions of the gland and sparing of the surrounding skin. The one biopsy shows that although selectivity is possible with this wavelength, the relatively shallow optical penetration depth prevents complete destruction of the deeper portions of some larger lesions. However, those deeper portions are less visible at the surface, and presumably mild fibrosis over the surviving portion of the lesion obscures the conspicuous yellow nature of the lesion.

This small pilot study supports the utility and safety of this wavelength in the treatment of sebaceous hyperplasia. Larger studies and broader applications of this wavelength should be undertaken.

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DISCLOSURES

Dr. Blalock and Ms. Houghton have no conflicts of interest. Dr. Winstanley is currently serving as a medical officer in the U.S. Navy. The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.

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