Photometric and clinical assessment of localized UVB phototherapy systems for the high-dosage treatment of stable plaque psoriasis

Emil A Tanghetti & Paul R Gillis

Introduction

Although UVB phototherapy is safe and highly beneficial for psoriasis, its use has not traditionally extended to the vast majority of patients with mild to moderate disease. For patients with localized plaque-type psoriasis, it is undesirable to expose large portions of their body to potentially damaging UVB. These patients often rely on topical medications that are cumbersome, messy, less efficacious, and sometimes accompanied by undesirable side effects. The recent development of targeted UVB phototherapy systems addresses a previously unmet need within the dermatology community. These devices selectively deliver therapeutic light through flexible fiber-optic light guides to
Original Research

diseased skin. Reports in the medical literature have documented the successful use of lesion-targeted phototherapy for the treatment of various UV-responsive dermatoses.\textsuperscript{2–7} For psoriasis patients and their physicians, the advantages of localized phototherapy are numerous. Fiber-delivered UVB can be used to treat virtually all body surface areas including the intertriginous sites.\textsuperscript{8} A focused spot of manually directed phototherapeutic light limits UVB exposure to the desired locations while sparing the healthy skin. Consequently, targeted phototherapy systems are expected to be safer than traditional lightboxes. Furthermore, since thick and scaly psoriasis plaques tolerate higher UVB exposure doses than the normal skin, clearances can be achieved in substantially fewer treatment sessions relative to conventional lightbox phototherapy.\textsuperscript{3,5,9–11}

Despite an extensive body of medical literature demonstrating the safety and effectiveness of UVB phototherapy for the treatment of psoriasis,\textsuperscript{12–14} dermatologists have infrequently administered high-dosage\textsuperscript{15} or fiber-delivered treatments. Until recently, lesion-targeted UVB treatment systems were largely unavailable to the medical community. The introduction of high-intensity, incoherent UVB light sources and 308 nm excimer lasers provides a valuable addition to the armamentarium of phototherapy equipment. For the first time, highly effective and safe UVB phototherapy has become an appropriate treatment option for patients with limited skin disease. This study was designed to characterize and compare the performance of fiber-coupled incoherent UVB and excimer laser light sources for high dose monotherapy of stable plaque-type psoriasis.

Methods

The two phototherapy systems evaluated in this study were an incoherent, continuous-wave UVB light source (BClear\textsuperscript{TM}, Lumenis Inc., Santa Clara, CA) with a peak irradiance that falls between 311 and 315 nm, and a 308-nm excimer laser device (Xtrac\textsuperscript{TM}, PhotoMedex, Radnor, PA) that generates repeating 20–40 ns pulses. The spectral irradiances of these two systems are shown (Figure 1). Spatial beam profiles from the two systems were evaluated using type PS oscillograph recording papers, a CCD camera with image recording equipment and MED test spot responses on healthy, untanned skin.

Ten adult patients with skin phototypes II–V were screened and sequentially enrolled in an unblinded, prospective study to compare the safety and effectiveness of the targeted UVB phototherapy systems for the treatment of stable plaque-type psoriasis. All evaluations and treatments were conducted at the Center for Dermatology and Laser Surgery, Sacramento, CA after obtaining informed consent. Treatments began after first determining the MED for both devices on each patient’s lower back or upper buttocks. MED test spots consisted of six incremental doses from each device and were read 20–28 hours following exposure. Initial treatment fluences were two to five multiples of the MED depending on the condition and anatomical location of the psoriasis plaque. Patients returned one to three times per week for up to 16 treatments. Plaques that achieved at least 75% improvement before the twelfth session received up to four additional maintenance treatments. Emollients were frequently applied to the plaques immediately prior to treatment for improved transmission of UVB. For each enrolled patient, plaques, often occurring at bilaterally symmetrical body sites and, judged to be similar at baseline were designated to receive an equally erythemogenic dose from either the BClear or the Xtrac. Lower doses were sometimes used when the plaques thinned, but treatments were always administered at an equally erythemogenic dose from the two devices. Every patient also had an untreated control plaque that was observed throughout the course of the study. At baseline and prior to each treatment session, plaques were photographed and evaluated for erythema, induration and scale using 0–4-point scales. A modified, psoriasis severity index (PSI), equal to the sum of these individual scores, and photographs were used to track and record disease progress at each site. Patients did not receive additional medications and were advised regarding sun avoidance and protection. Adverse events and patient satisfaction were also noted throughout the course of the study.

Results

The irradiated spot shapes and sizes from the targeted UVB phototherapy systems were compared using UV sensitive oscillograph recording papers. For each of the radiant exposure doses tested, photodeveloped papers revealed that BClear light is emitted across a 16×16-mm square handpiece tip and the Xtrac laser beam measures roughly 18×18-mm in diameter at the treatment plane (Figure 2). While the BClear system exhibited a uniform output, the peak energy intensity of the Xtrac appeared to reside in the center of the laser beam and decrease toward the edges.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Spectral irradiance of the BClear and Xtrac systems. The relative intensity in arbitrary units (A.U.) of BClear light at each wavelength between 250 and 450 nm is normalized to the peak emission at 314 nm. Xtrac irradiance is monochromatic at 308 nm.}
\end{figure}
A more sensitive, semi-quantitative three-dimensional beam profile recording was made using a CCD camera and image capturing board. The fiber-coupled BClear output resembled a top-hat beam profile with few irregularities while the Xtrac laser beam approximated a Gaussian-curve energy distribution with peak intensity in the middle of the beam roughly 1.3 to 1.8 times greater than the intensity at the borders (Figure 3). In accordance with other reports from the medical literature, the non-uniform laser beam made 24-hour MED test spots difficult to interpret with a central macule of more intense erythema (Figure 4). With the BClear, the lowest dose test spot to exhibit well-demarcated, minimal erythema was easy to discern. On the unaffected skin of the ten enrolled participants the MED for BClear UVB was $186 \pm 50 \text{ mJ/cm}^2$ and for the 308 nm excimer laser the MED was $235 \pm 58 \text{ mJ/cm}^2$ (mean $\pm$ SD). Psoriasis treatments were generally well tolerated with only minor adverse reactions comparable to moderate sunburns. Side effects included erythema, occasional blisters, epidermal erosions and transient hyperpigmentation. In some instances, MED test spot ambiguities led to an overly aggressive initial dosing of plaques with the Xtrac laser. Blisters and erosions were seen with a four-fold higher incidence when compared to the BClear system (data not shown). Other adverse reactions presented with similar frequency and severity from the two UVB phototherapy devices.

For the treated plaques, the rate of disease symptom improvement was indistinguishable whether using the (MED dose normalized) incoherent UVB system or the laser device (Figure 5). The total number of treatments administered to the ten enrolled subjects was $12.0 \pm 2.3$ (mean $\pm$ SD). Psoriasis improvement was often evident after one or two treatments and was particularly apparent on plaques that were less severe at baseline (Figure 6). In most cases, a 50% reduction in PSI scores was achieved within 2–5 weeks of initiating treatments. Plaques cleared from all anatomical locations treated including the elbows, knees, legs, trunk, and hands (Figure 7). Eight of ten patients exhibited substantial plaque clearance. At the two-month post-treatment follow-up examination, all treated plaques that achieved clearance remained in remission and those that had improved without clearance remained stable without relapse. The remaining two patients who did not respond favorably to UVB treatment each had unstable or treatment unresponsive disease and developed new lesions during the course of the investigation.

**Discussion**

Fiber-delivered incoherent light and excimer laser systems provide safe and effective high-dosage UVB phototherapy treatments for localized plaque psoriasis. With localized UVB, a greater percentage of psoriasis patients achieve substantial improvement and fewer treatments are required than using non-targeted light sources. The clinical
performance of the BClear and Xtrac phototherapy devices was equivalent with regard to the rate and extent of plaque clearance. Individual treatment doses as large as 5 MED multiples were well tolerated with only minimal complications. Side effects were temporary and included erythema, blisters, epidermal erosions and hyperpigmentation. Patients encountered no discomfort during treatments and were generally satisfied with their outcomes. As with conventional lightbox treatments, localized UVB phototherapy can induce psoriasis remissions that extend for several months to years. 5,8,11,17,18

Although UVB excimer lasers generate rapid pulses of short duration, DNA damage, T-cell apoptosis and psoriasis clearance each occur independently of pulse frequency and intensity.19,20 These biological activities are strictly dependent on radiant exposure and wavelength.21

Figure 4
Photograph of MED test spots on the back 24 hours following exposure. BClear test spots are documented on the top and Xtrac test spots are on the bottom of the photograph. The radiant exposure doses tested (in mJ/cm²) are indicated in red ink.

Figure 5
Time course of psoriasis plaque clearance using high-dosage localized UVB phototherapy. The psoriasis severity index (PSI; mean ± SEM) scores for all plaques of responding patients were calculated at baseline and following the indicated weeks of treatment using the BClear and the Xtrac devices.

Figure 6
Elbow plaques at baseline, after three localized high-dosage UVB treatments administered with the indicated devices and at the one-month follow-up examination.

Figure 7
Hand psoriasis before treatment, after six targeted high-dosage UVB treatments administered with the indicated devices and at the two-month post-treatment follow-up examination.

Taking into account the action spectrum for the phototherapy of psoriasis, the BClear spectral irradiance is calculated to be slightly more effective at clearing psoriasis than an equivalent
Localized UVB phototherapy systems for high-dosage psoriasis treatment

Reference


