

Therapeutics

Ultraviolet B 308-nm excimer laser treatment of psoriasis: a new phototherapeutic approach

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Summary

Background Excimer laser-derived 308-nm ultraviolet (UV) B therapy is a new alternative for treating psoriasis by phototherapy. Some studies have been made showing the effectiveness of intralesional phototherapy technology in treating psoriasis. However, there has been no information available so far with regard to the cumulative dosage on a larger group of patients and on therapy optimized treatment strategies.

Objectives One hundred and twenty psoriatic patients were treated according to standard protocol to define the effectiveness. Our aim was to develop new parameters and determine whether effectiveness could be improved and whether treatment exposure, the cumulative UVB dose and adverse effects could be minimized.

Methods Initially, the excimer laser's effectiveness in treating psoriasis was evaluated in an open prospective study according to standard protocol. This included 120 adult patients (67 female/53 male) with chronic plaque psoriasis and <20% involved body surface. The initial dose was based on three multiples of a predetermined minimal erythema dose (MED). Patients were treated twice a week for the first 3 weeks, then once a week until clearance was achieved. The main parameters were the initial starting dose, psoriasis area and severity index (PASI), the number of treatments needed, the time in treatment and the cumulative dose needed to clear psoriatic plaques. Thereafter, 43 patients were treated as a second comparable group. Therapy began with a starter dose, defined as MED-I. MED-I was defined as a UVB 308-nm dose which provoked a visible increase in erythema after 24 h. In addition, the epidermal thickness of the plaques was measured on an individual basis by 20-MHz ultrasound and correlated to the MED-I.

Results Of the patients who met the standard protocol, 65.7% were at least 90% clear after a maximum of 10 treatments; an even greater number (85.3%) showed a $\geq 90\%$ improvement in PASI after 13 sessions, while 14.7% of patients had only a $\leq 50\%$ PASI improvement. The cumulative UVB dose was $11.25 \pm 4.21 \text{ J cm}^{-2}$ and the average treatment time was 7.2 weeks. Patients treated individually with the MED-I starter dose showed nearly identical rates of clearance (83.7%), but were clear in 7.07 ± 2.15 sessions with a cumulative dose of $6.25 \pm 4.02 \text{ J cm}^{-2}$.

Conclusions The majority of our patients benefited greatly from laser-derived 308-nm UVB therapy, which cleared skin lesions faster than conventional phototherapy. As this therapy targets only the involved skin, the thickness of the plaques and individual MED-I should determine the initial dose, thus increasing the effectiveness of the therapy. We propose that light therapy sparing uninvolved skin will become predominant in the future.

Key words: excimer, laser, MED-I, psoriasis, ultrasound, ultraviolet B

choice of therapy is based on the characteristics of the lesions, their locations and the body surface involved.¹ Lesions have different degrees of scaling and inflammation, but only the extent of the areas involved (e.g. > 20% of body surface) determines the therapy, moving from topical treatment to phototherapy or systemic treatment, e.g. with immunomodulating fumaric acids.^{2,3} Recently, a review was published stating that it is obviously unrealistic to completely clear psoriasis by topical treatment.⁴ Although topical corticosteroids have been the mainstay of psoriasis treatment, their use in the reduction in clinical symptoms is associated with well-known side-effects. Therefore, it is not surprising that only 26% of patients were satisfied with the current therapy and 44% of the patients with psoriasis state that the twice-a-day routine of applying creams and ointments is only cosmetic and is unacceptable.⁵

A very effective method to clear psoriatic skin lesions was introduced by Goeckermann⁶ more than 75 years ago. Nowadays, his refined light therapy with the possibility of a remission period of up to 1 year or longer is standard. This is attained by photochemotherapy (PUVA) or ultraviolet (UV) B phototherapy using suberythemogenic doses of light.^{3,7} A few years ago, narrowband UVB lamps (TL-01) were introduced with a maximum light emission of 311 nm, resulting in fewer treatments than broadband UVB but still requiring more than 25 treatment sessions to clear the skin lesions.^{8,9} Factors limiting light therapy are the high number of treatment sessions, ranging from 25 to 40, and the radiation of both involved and uninvolved skin, even if the disease is limited to only a few areas. The radiation dose depends on the reaction (sunburn) of the uninvolved skin, thus requiring a longer period of time to clear a plaque.^{10,11}

The excimer laser, generating monochromatic UVB light of the 308-nm wavelength using xenon chloride gas, is a further development of narrowband UVB and was recently reported to be an effective treatment for psoriasis.¹²⁻¹⁴ Excimer stands for excited dimer, a diatomic molecule usually of an inert gas atom and a halide atom, which are bound in excited states only. These diatomic molecules have very short lifetimes and dissociate releasing the excitation energy through UV photons. Applied by means of a hand-piece, the light hits only the areas requiring treatment, thus enabling the dose of radiation to be increased to a level which induces a visible reaction in the psoriatic plaque. Therefore, it is not surprising that the development of a UVB 308-nm xenon chloride laser is expected to be a

future mainstay in the treatment of psoriasis. It has been reported that lesions were cleared in 75% of the patients attending only 10 sessions using high-intensity UVB on the plaques with a three-sixfold minimal erythema dose (MED) and inducing blisters in 45% of the plaques treated.¹⁵ Meanwhile, more than 100 UVB 308-nm excimer lasers are in use in the U.S.A. and eight systems in Germany. However, a study analysing the number of treatment sessions necessary, the cumulative UVB dose as well as a standardized clinical protocol or guidelines are still not available. In order to close this gap, to define and to improve the clinical effectiveness of a 308-nm excimer laser in the treatment of psoriasis, we investigated excimer laser therapy in 120 patients, not taking the epidermal thickness of the psoriatic plaque into consideration at the beginning of therapy, and in 43 patients, having performed an individual light test (MED-I) at the beginning of therapy, the result of which was dependent on epidermal thickness.

Materials and methods

Patients

First, in order to demonstrate the effectiveness of UVB laser therapy, 120 patients (67 female, 53 male, mean age 48.5 years) were included in an open prospective study from October 2001 and May 2002 after informed consent was obtained. All had a long history of psoriasis, > 1 year with a mild to moderate plaque-type psoriasis affecting < 20% of the body surface. Psoriasis area and severity index (PASI) ranged from 6.2 to 15.2. All typical plaques and lesions on the body, e.g. elbow, knee, lower leg, back, etc., were treated. Patients fulfilling one or more of the following criteria had to be excluded from the study: systemic antipsoriatic treatment during the last 2 months, topical treatment (e.g. glucocorticosteroids) and other types of light therapy during the last 2 weeks, concomitant or previous malignant skin tumours and age less than 16 years. Patients with psoriasis capitis, psoriasis palmoplantaris and psoriasis pustulosa palmaris et plantaris were also excluded as areas to be treated were too limiting for the study and the aim was to achieve full remission in a homogeneous collective.

Secondly, in order to optimize the therapeutic strategy and to reduce side-effects, 43 patients (18 female, 25 male, mean age of 48.8 years) were recruited into a subsequent branch of the study and treated between July and October 2002, as described below. PASI

ranged from 6.8 to 13.8 in this group and patients fulfilled the same criteria as described above.

Excimer 308-nm laser

Stella[®], an excimer laser made by TUI Laser AG (Munich, Germany), generating monochromatic light on the wavelength 308 nm by means of xenon-chloride gas was used in treatment. The area to be treated is illuminated through an 800- μm flexible fibre delivery system with intense narrowband laser radiation of 307.9 ± 0.15 nm with a fixed repetition rate of 200 Hz at an intensity of 400 mW cm^{-2} at the square hand-piece treatment area. Individual pulses are electronically controlled at a stabilized fluence of 2 mJ cm^{-2} to ensure constant irradiation, regardless of laser or fibre condition. Special delay circuits ensure a pulse duration of 60 ns to moderate peak intensities for smooth irradiation and longer component lifetimes. The system has been approved in Europe for use in the treatment of psoriasis since July 2001. Other indications, such as vitiligo and leukoderma, have been recently certified. Dosages (measured in mJ) were applied solely within the plaques by a 14×14 mm hand-piece and were adjusted each time according to the reaction of the plaques to previous treatment.

Treatment strategy I

Effectiveness was studied according to excimer-generated UVB skin laser treatment therapy procedures,^{13,15} as already described. The MED was determined on non-psoriatic unexposed skin, either on the inside of the lower forearms or on the buttocks before the trial. Doses of 200, 300, 400 and 500 mJ cm^{-2} were administered for skin phototypes I and II, 700 mJ cm^{-2} for skin type III. MED was the lowest dosage provoking an obvious erythema after 24 h.

Therapy started with a threefold MED in the plaque, sparing uninvolved skin. If a visible reaction could not be seen on psoriatic skin or was not reported by the patient, then the dose was increased by 1 MED until an erythematous reaction could be observed on the involved skin. The dose was reduced by 1 MED to avoid blistering if the plaque became thinner without massive hyperpigmentation. The dose had to be maintained or increased to attain an erythematous reaction if the plaque became thinner but hyperpigmented. This area was avoided during the next two to three treatments if blistering (second degree sunburn) occurred and the dose was generally reduced by 1

MED. Patients were treated twice a week during the first 3 weeks and once a week thereafter.

If a large quantity of large scales were present, then pretreatment with 10% salicylic acid in vaseline took place during the week prior to laser treatment and, in addition, all patients were allowed to use an emollient cream as needed. Patients were treated until clearance was achieved within 13 treatments.

The effectiveness of the treatment was defined as the investigator's overall assessment of the response to treatment in percentage improvement compared with the original extent of the disease,¹⁶ i.e. a PASI reduction of $\geq 90\%$ was defined as clearance, a PASI reduction of $\geq 50\%$ a considerable improvement, and a PASI reduction of $\leq 50\%$ a slight improvement compared with the beginning of treatment.

The primary parameter used to assess treatment effects on psoriasis was the PASI score.⁸ PASI was evaluated at baseline before initiation of light treatment. Furthermore, itching, joint pain, irradiation doses, side-effects and reasons for dropouts were documented. Photographs were taken at baseline and at the end of treatment.

Treatment strategy II (individual)

We noticed during the treatment of our 102 patients who completed the study described in treatment strategy I that the 'uniformly' performed starter dose with the threefold MED was not sufficient. Patients with thin plaques on the body (not on the elbows) developed blisters with the threefold MED but patients with thick plaques reacted sometimes only to a sixfold MED. Therefore, we wanted to find the optimal starter dose for excimer laser treatment which produces redness in the plaque and is specifically tailored to each individual case and each individual form of psoriasis.

This UVB plaque reaction basically depends on the epidermal thickness of the psoriatic skin lesion and not on the skin type and the MED of uninvolved skin. Obvious redness (increase in erythema) can be seen after 24 h in psoriatic plaque which has been subjected to laser treatment at a defined mJ dosage of 308-nm UVB light. This laser-induced erythema can be seen clearly although the psoriatic lesion is erythematous by nature. The first visual colour change in the plaque, which can be seen as a print 24 h after 308 nm of laser treatment is defined as the MED of involved skin (MED-I). MED-I is determined by further peeling of plaque as described above using salicylic acid in vaseline.

As MED-I depends on the psoriatic plaque's thickness and therefore on the thickness of the epidermis, high-resolution ultrasound examinations of the skin were analysed in 43 patients to determine the relationship of the epidermal thickness in different plaques to the light dose that induced an erythematous reaction. The epidermal thickness of psoriatic plaques was measured prior to and after laser treatment using the DUB 20-E, a 20-MHz ultrasound system made by Taberna Pro Medicum (Lüneburg, Germany). The sonogram obtained by these high-frequency probes enables extremely accurate assessment of the skin's thickness, especially the epidermis, in a non-invasive manner.^{17,18}

MED-I was determined in each patient depending on the thickness of psoriatic plaque. Doses of 400, 500, 600 and 700 mJ cm⁻² were administered on involved skin < 300 nm, and 700, 900, 1000, 1200 and 1400 mJ cm⁻² were tested on thick epidermis > 300 nm. As a patient can have old, thick, chronic plaque on the elbow (400 µm), for example, and fresh, thin psoriatic lesions (200 µm) on the stomach, for example, a total of 66 MED-I measurements and an equal number of 66 ultrasound examinations were carried out on 43 patients in order to determine the individual starter dose. The lowest dosage, producing an increased erythema in the involved skin (MED-I) but no blisters was taken as a starter dose for typical lesions measured. The range is fairly high—from a visual erythema in the plaque to visual blisters with an average 400–500 mJ. This enables simple analysis and the correct starter dose can be easily determined. This means, for example, that an erythematous reaction of up to 1000 mJ could be observed when determining an MED-I of 600 mJ in the plaque, and visual blisters only started forming at 1100 mJ.

Furthermore, slight blistering, which was barely visible, occurred initially at approximately 30% of the highest dosage within the MED-I definition ranges. If the maximum sub-blistering dose were to be used, this often caused blistering in the treatment sessions, for example, a thick plaque on account of differences in the skin and infiltration thickness.

For these reasons, we define MED-I as the starter dose to be applied to avoid blistering as, histologically, we have already observed a definite spongiosa at a dosage level of MED-I + 2 MED.

The 43 patients were then treated with the excimer laser in the same way as described above and the same parameters were evaluated and compared with group I which was treated uniformly. This therapeutic protocol, which is taken from the results of therapy

Table 1. Dosage of 308-nm ultraviolet (UV) exposure—clinical protocol

Clinical protocol	MED-I	MED
First treatment	100%	
Following treatment		
No erythema		+1 MED
Moderate erythema		No change
Marked erythema/ initial blisters		-1 MED
Blisters		No irradiation
Thinning/healing process		-1 MED

MED, minimal erythema dose; MED-I, the 308-nm UVB dose which provoked a visible increase in erythema after 24 h of testing on involved skin.

strategies I and II, is summarized for new therapeutic guidelines in Table 1.

Statistical methods

Data collected included the number of treatments, the time and the cumulative doses needed to achieve clearance. PASI at baseline was also compared with that at the end of treatment. The Wilcoxon–Mann–Whitney test was used to compare these data from the two groups. Data were significant when $P < 0.5$.

Results

There were 102 patients who completed the full therapy strategy I protocol. Eighteen patients dropped out. The main protocol deviations occurred in patients who terminated treatment earlier and those who had fewer than three treatment sessions. These patients did not find enough time for therapy; none terminated because of side-effects.

With regard to those patients who met the protocol requirements, 65.7% (67 of 102) achieved a ≥90% clearance after 10 or less treatments; 87 of 102 patients (85.3%) achieved a ≥90% or complete clearance after 13 treatments (Fig. 1); 14.7% (15 of 102) attained an improvement of only ≤50% or less. PASI reduction of an average of 12.8–2.4 after 13 sessions is shown in Figure 2. If the nearly 15% non-responder group were taken out of this figure, then PASI would be less than 1 in the clearance group after 13 sessions. Thus, impressive clearance results were attained, even for those patients with thick, chronic plaques at typical localizations (elbow, knee).

The cumulative UVB dose was 11.25 ± 4.21 J cm⁻² and the average length of treatment was 7.2 weeks.



Figure 1. (A,B) Female patient, age 27 years, psoriasis area and severity index 11, affected for 7 years, initial dose 750 mJ cm^{-2} , treated 12 times with a cumulative dose of 10.25 J cm^{-2} . (C,D) Male patient, age 48 years, affected for 3 years, initial dose 1200 mJ cm^{-2} , treated nine times with a cumulative dose of 9.3 J cm^{-2} .

Blistering, which is a known side-effect, occurred at least once in 40% of the patients, and 26% in this group had erosions and pain. This means that nearly every second patient had at least one occurrence of blistering during the whole treatment. More than five blisters occurred in one-quarter of the patients (26%) with the result that these patients stated upon questioning that they had had tolerable pain. Figure 3 shows blister formation when the respective plaque thickness are not treated individually. The areas where blistering occurred were not treated for at least 2 weeks. However, in these cases, therapy was not prolonged because the areas of blistering cleared the lesion in most cases, meaning that less laser treatment was needed as a result. Medication, such as topical steroids, was not administered to aid the healing process.

The other side-effects of sunburn sensitivity, erythema and hyperpigmentation were generally well tolerated and no patient discontinued treatment due to adverse effects.

The starter dose was determined by means of MED-I and these results were used in addition to calculations regarding the epidermal thickness of the psoriatic

plaques in 43 patients in order to minimize the side-effects of sunburn with blisters and to develop an individually tailored therapeutic regimen. The correlation between the starter dose, which induced an erythema in the plaque, and epidermal thickness was determined at 66 measuring points on the patient as shown in Figure 4, as a patient can have thick plaques on the elbow but thin plaques on the stomach and thigh areas. These psoriatic plaques require different laser treatment doses. As can be seen in Figure 4, thinner plaques reacted earlier to UVB 308 nm with a visible increase in erythema compared with thicker plaques. The starter dose was $814.9 \text{ mJ} \pm 226.9 \text{ mJ cm}^{-2}$ with a range between 400 and 1400 mJ cm^{-2} . This correlates to a 2.6–7.0-fold MED. A few individual blisters (< 5) were detected after the first laser treatment in 8% of cases between two adjacent areas where the laser dose had overlapped. Forty patients finished the therapy; three dropped out after either the first treatment or the MED-I measurement. Comparable side-effects were seen in 14.8% of cases during the later stages of therapy as seen in therapy strategy I where multiple blisters (> 10) and pain occurred. The cause of this can be found in varying

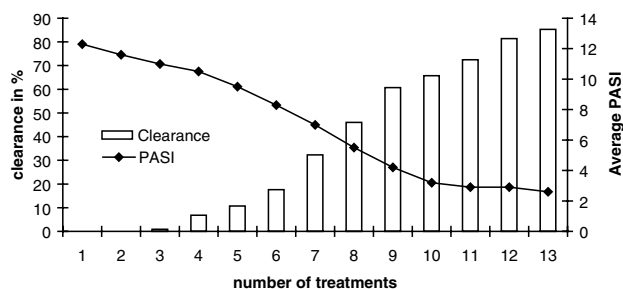


Figure 2. Average psoriasis area and severity index and clearance of psoriatic lesions is correlated with the numbers of excimer laser treatments.



Figure 3. Side-effects: erythema, blisters and sunburn sensation.

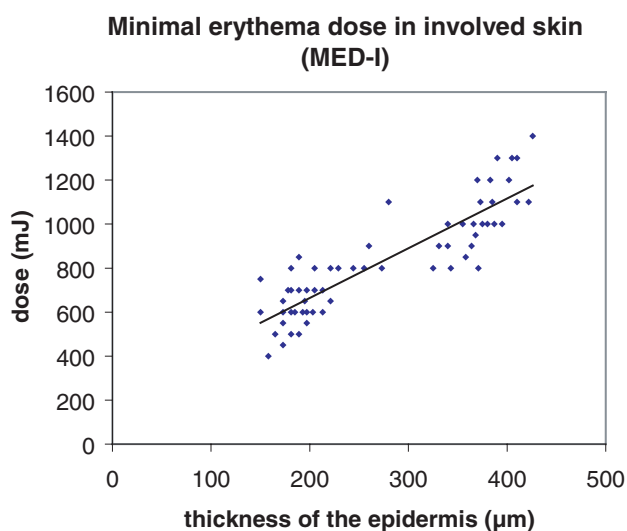


Figure 4. The dose inducing an erythema but not blister in a plaque (MED-I) depends on the thickness of the epidermis (determined by 20-MHz ultrasound) and its infiltration.

plaque thickness and varying healing speeds of different psoriatic lesions on one and the same patient.

We found the same clearance rate, as in the large group, of 83.7% (34 of 40). However, in contrast, this result was reached in 7.07 ± 2.15 sessions with a cumulative dose of $6.25 \pm 4.02 \text{ J cm}^{-2}$. If we split the group into responders (34) and non-responders (six; clearance < 50%), then there are great differences in treatment numbers and the cumulative UVB dose: 6.3 ± 1.4 treatment sessions with $5.15 \pm 2.14 \text{ J cm}^{-2}$ in the clearance group and 11.2 ± 2.4 sessions with $11.96 \pm 3.98 \text{ J cm}^{-2}$ in the non-responder group, respectively.

A comparison of the different results in group I (102 patients) and patients with a starter dose depending on the ultrasound examination and MED-I (40 patients) is shown in Table 2.

Discussion

Phototherapy has been shown to be one of the most effective treatment forms for patients with psoriasis.^{6,7,10} A recent advance in psoriasis phototherapy has been the introduction of narrowband UVB (N-UVB) using a fluorescent irradiation device delivering virtually monochromatic light at 311 nm. Phototherapy with N-UVB is currently considered to be the safest therapeutic option for moderate to severe psoriasis.¹⁹ However, in contrast to excimer-derived UVB 308-nm therapy, N-UVB 311 nm affects involved as well as uninvolved skin. Conventional phototherapy has to be orientated to the individual skin type; suberythemogenic doses 10–20% lower than MED are administered and give rise to the need for more than 30 sessions with a median cumulative UVB dose of 20 J cm^{-2} .^{1,9,10,20} Clearance can be induced in 80% of patients after 8 weeks using this ‘whole body therapeutic regimen’, but chronic plaques on elbows or knees often failed to clear with N-UVB even when different kinds of topical treatments were administered.^{5,10,21}

Therefore, developing 308-nm UVB radiation, which affects only involved skin, seems to be the logical evolution of N-UVB treatment. Indeed, Asawanonda *et al.* have remarked that the advantage of lasers with the capacity to deliver such high doses within a relatively short period of time represents a breakthrough in UVB phototherapy. These authors saw long remission periods after single irradiations with 8–16-fold MED.¹³ The protocol we used in the first group of our study (120 patients) tried to avoid the typical side-effects, such as painful blistering, because we did not

Table 2. Comparison of initial and cumulative doses to clearance and treatment numbers

Study	No. of patients	PASI baseline	PASI end	Start dose (mJ)	Cumulative dose (J)	Median treatments	Total clearance (%)
Group I	102	13.7 ± 2.1	2.1 ± 1.2	472.0 ± 127.3	11.25 ± 4.21	10.8 ± 3.3	85.3
Group II	40	12.9 ± 1.9	2.2 ± 1.0	814.9 ± 226.9*	6.25 ± 4.02*	7.1 ± 2.2*	83.7

* $P < 0.05$ for start dose, cumulative dose and median number of treatments between the two groups. PASI, psoriasis area and severity index.

start treatment with more than a threefold MED. We achieved clearance in nearly 85% of our patients after 13 treatments with a median cumulative UVB dose of 11.2 J cm^{-2} . All the literature which has been published on UVB 308 nm laser treatment so far has reported on its healing effects. Even Feldmann *et al.*'s multicentre study,¹⁵ which, however, observed only 80 patients to the end of their treatment—far fewer than the number of cases in our study—does not provide any data regarding cumulative dosage. However, we were of the opinion that cumulative dosage measurements were extremely important as it is then easier to draw comparisons with conventional N-UVB therapy. In fact, we were able to measure a cumulative UVB dosage using non-individual, so-called 'uniform' laser treatment in 13 treatment sessions, which is 50% lower on average than the dose required for N-UVB therapy. Therefore, not only is a 50% lower UVB dose required to heal psoriatic lesions using excimer laser therapy, but, at the same time, a 100% lower UVB dose is applied to healthy skin as healthy skin is spared the treatment in the first place. This is not the case in conventional N-UVB therapy.

But we saw the same rates of side-effects with our uniform protocol as reported recently by Feldmann *et al.*¹⁵ namely, blisters, erosions and pain in 26–40% of the patients.

However, these side-effects, particularly the formation of blisters, are well-tolerated by patients. As was the case with Feldmann *et al.* we also found that therapy was not terminated for this reason. However, several dozen 1-cm^2 blisters can appear if the dose is too high on large treatable areas, such as the lower back, which the patient can then find very painful for several days. When the blisters have dried up and the skin has healed, then we observed that the psoriatic lesion healed without leaving any scars, as mentioned above. We did not notice that there were any cumulative problems of side-effects, e.g. fever, when large areas were treated. However, it is very probable that these problems could arise if laser treatment were applied incorrectly and/or at too high a dosage.

The effectiveness of UVB radiation is thought to result, at least in part, from the induction of immunomodulatory effects.²² In particular, UV radiation has been shown to affect the production of soluble mediators and the expression of cell-surface receptors, particularly in the epidermis.^{23–25} However, apoptosis induction in pathogenetically relevant T cells plays a major role in PUVA as well as in UVB-irradiated skin *in vivo* and could be determined after N-UVB irradiation and also after excimer-generated 308-nm radiation.^{26–28} Novak *et al.* reported a quantitatively higher induction of T-cell apoptosis after excimer laser treatment than after N-UVB radiation.²⁸ Changes in frequency and intensity of excimer laser impulses did not influence its therapeutic and T-cell apoptosis-inducing effectiveness. These histological findings correlate with our data, which demonstrated that moderate doses also clear psoriatic lesions. As it is not known whether long-term DNA damage to keratinocytes and/or melanocytes can be induced when administering too high a UVB dose which causes blistering, intralesional UVB laser therapy must be optimized to develop and define a low side-effect profile.

The second purpose of this study was to define a new therapeutic strategy to avoid supraerythematous doses which induce blisters, erosions and pain. Therefore, we defined the MED-I. MED-I is the UVB 308-nm dose which induces visible redness in the psoriatic lesion involved (supraerythematous dose) but which does not induce a blister/second degree sunburn. The correlation between the induction of an erythema and the epidermal thickness of the plaque was shown in Figure 3. Even a threefold MED is too much in patients with thin plaques and induces blisters, but patients with thick plaques needed the five–sixfold MED for redness to occur in the plaque. These patients required three to four laser treatment sessions using the former MED until first reactions could be observed.

The group of 40 individually treated patients who were MED-I tested before treatment and whose epidermal thickness was measured with 20-MHz ultrasound showed the same clearance rates in a markedly lower number of treatment sessions than the major group,

but the median cumulative dose was 40% less and side-effects were only 8% compared with 40% in the first group. Consequently, MED-I testing is now routine in our clinic and dosage is only increased in the next session if hyperpigmentation is noticed in the plaque and there is no visible sign of a reaction. However, consideration must be given to varying plaque thicknesses in one and the same patient. Therefore, therapy optimization by determining MED-I is not aimed just at interindividual variations but enables the correct dosage for each individual plaque. MED-I does not have to be tested in each individual plaque of a patient with different-sized plaques but can be easily measured by 20-MHz ultrasound and these data will determine the individual starter doses in each plaque (Fig. 4). However, determining the MED as an additional process is still important as an increase or reduction in the dosage can be ascertained by means of MED. If blistering occurred, the dose was usually reduced by 1 MED, obviously not for 1 MED-I, as the latter would reduce the dose to zero. We defined a protocol which is sufficiently gentle to be suitable for use in the clinical setting (Table 1).

Treatment time and costs depend on the number of areas of the skin affected and the thickness of the plaques. Treatment of a patient with plaques on the elbows and knees usually takes an average of just 10 min per session, as a dose of 1000 mJ is applied in < 2 s. The system currently costs about €100 000 depending on the system. It must be maintained every 6 weeks if used extensively (20–30 patients per day), and the tubes must be replaced after approximately 200 patients. Costs of the full treatment are about €1000–1500 per patient. Patient compliance and satisfaction is extraordinarily high as treatment is quick, easy and painless because therapy is given only to affected skin and patients see the success which they have not had with other types of therapy after just a few sessions.

In conclusion, excimer laser-generated 308-nm UVB radiation is one of the most effective treatment forms for moderate and chronic forms of psoriasis.^{12,13,15,29} Conventional UVB radiation affects involved as well as uninvolved skin, the N-UVB dosage depends on the redness (sunburn) of uninvolved skin and patients require 30 sessions on average with a cumulative dose over 20 J cm⁻². UVB laser treatment for localized psoriasis has considerable advantages over current topical and conventional UVB treatment. We observed a faster clearance rate at less exposure and a greater risk–benefit ratio as there is less risk for uninvolved

skin. Exact determination of the initial UVB dose is the most important strategy in this new therapy. We propose a therapeutic regimen of UVB 308 nm excimer treatment, avoiding the side-effects of large-sized blisters which are the clinical signs of second- to third-degree dermatitis solaris, and a dosage which depends only on plaque erythema, determined by MED-I and/or determination of epidermal thickness by means of ultrasound. Furthermore, the study has shown the excimer laser to be effective in treating thick, scaled plaques on the knees and elbows, which are often resistant to any conventional treatment. We are of the opinion that individual light therapy sparing uninvolved skin will become the predominant light therapy in moderate psoriasis. In addition, further studies will show that excimer-derived UVB light therapy may be of benefit for other localized inflammatory skin diseases.^{30,31}

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