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808 nm LASER TREATMENT WITH BLUE TOLUIDINE EXOGENOUS CHROMOPHORE OF ORAL CAVITY LESIONS

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Aim of our study is *to* verify effectiveness and safety of 808 nm wavelength on oral cavity benign lesions colored with blue toluidine exogenous chromophore in Nashberg solution. A spectrographic study has been carried out on the absorption curve of diluted Nashberg, observing the highest peak at 634 nm, with discrete absorption of the 808 nm.This solution is used in stomatology surgery to define selectively the borders of para-neoplastic lesions (leukoplastic and erythroplastic).In our experience on ten cases coloration has been obtained also of serious cystic and angiomatous lesions and of fibromata. The choice of 808 nm wavelength from a diode power laser (Eufoton Italy) was made because it is well absorbed by the healthy normochromic mucosa. Non-contact photocoagulation has been applied artificially on the coloured lesions, in pulsed 50 msec without anaesthesia down to their total disappearance also in depth, while, during the intervention, healthy margins were preserved. It has not been necessary to apply any suture point. The treated area has then been cooled externally with ice cubes for five minutes. Margins of leukoplakia lesions have been submitted to biopsy and to histological study before and after treatment. Controls have been made after 3, 7, 15 and 30 days. Leukoplakia areas have been controlled at 6 months. Post-operative course and events have been painless, without undue reactions and infections. Vaporized lesions coloured with Toluidine Blue after slight aedema and erythema, disappeared in 48 hours, have healed completely and without any medication in 5–7 days with slight residual, functional, white, elastic sears. There have been no haemorrages and no infections. Use has been made of external cooling in cycles of 15 minutes three times on the day of the intervention. The preliminary results of this experience on oral cavity benign lesions, pigmented with Toluidine Blue and photocoagulated with 808 nm, confirm, also at oral mucosa level, the good results obtained on skin lesions coloured with exogenous chromophores.

DERMATOLOGY/PLASTIC SURGERY

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PROPHYLACTIC TREATMENT OF FRESH SURGICAL SCARS AFTER EXCISION WITH PULSED DYE LASER

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Purpose: To investigate whether pulsed dye laser treatment of non-facial surgical scars immediately after suture removal results in improved final scar appearance.
Methods: This was a randomized, controlled, non-blinded study involving twenty patients with either two comparable non-facial scars or one non-facial scar measuring at least 6.0 cm long. One of two scars or half of one scar received a single treatment with a 595 nm pulsed-dye laser (V-Beam, Candela Corp., Wayland, MA) at fluences of 7 J/cm^2, 7 mm spot size, 1.5 ms pulse duration and dynamic cooling of 30 ms spray, 20 ms delay. The other scar or other half were left untreated and served as the control. Treatment was performed immediately after suture removal. Results were assessed at one and six weeks following treatment by the patients, investigators and a blinded, independent panel of experts.
Results: All patients tolerated treatment well. No purpura was seen in the majority of patients and when present faded within one week. When comparing paired excisions from the trunk and extremities, those lesions treated with the pulsed dye laser had an improved cosmetic result when assessed six weeks following treatment. There was less erythema and a smoother surface. Similar results were noted in the majority of instances on one-half of a non-facial single scar that received treatment with the pulsed dye laser. Details of these results will be presented.
Conclusions: Use of pulsed 595 nm laser light to healing wounds improved the wound healing characteristics. Routine use of this modality may decrease the likelihood of prolonged erythema, raised or hypertrophic scars or a cosmetically less acceptable result.

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EVALUATION OF ONE-PASS CO_2 LASER RESURFACING FOR INFRAORBITAL HYPERPIGMENTATION

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Purpose: To evaluate the clinical efficacy of one-pass carbon dioxide laser resurfacing for patients with infraorbital hyperpigmentation.
Methods: A series of 50 patients (Fitzpatrick skin phototypes I-VI) underwent periorbital one-pass CO_2 laser resurfacing for amelioration of infraorbital hyperpigmentation. Patients were evaluated by two independent assessors at 1 week, 1 month, and at regular time intervals up to 1 year postoperatively. The degree of improvement in pigmentation (clinical grading score) was determined at each visit.
Results: One-pass CO_2 laser resurfacing produced substantial improvement of infraorbital hyperpigmentation in all treated patients. The most common side effect of treatment was transient hyperpigmentation, particularly in patients with darker skin tones. No incidences of permanent pigmentary alteration or scarring were observed.
Conclusions: One-pass CO_2 laser resurfacing is a viable treatment modality for the long-term amelioration of infraorbital hyperpigmentation. It is not associated with significant morbidity and can be performed safely in individuals with dark skin phototypes.

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LASER ASSISTED LIPOSUCTION: THE ROLE OF THE DIODE LASER IN LIPOSUCTION AN INITIAL EVALUATION OF PHYSIOLOGY AND MECHANISM OF ACTION

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Purpose: The Helium/Neodymium Laser has been used in wound healing studies to evaluate its role as a low dose laser source of biostimulation. This laser with peak output of 635 nm has now been used as an adjunct to liposuction procedures to affect outcome. The present study was initiated to evaluate what role, if any, laser biostimulation might play in liposuction surgery.
Methods: A multicenter study was initiated to evaluate the effect of laser light liposuction procedure. The HeNe laser was applied in a random double blind fashion to the right or left side of the abdomen for 12 minutes, line generated beam which spreads out 1 milliWatt of wattage across the beam, wavelength 635 nm, fluence 10.8 J. The laser handpiece was held perpendicular to the skin at approximately 6 inches, passing it slowly and evenly across the entirety of the skin area to be treated.
Results: Subjective improvement in the ease of passing the cannula was documented during the surgery. Similarly the extracted effluent appeared to be more watery in consistency and had diminished heme content. Diminution of post-operative induration and maintenance of normal skin turgor and elasticity in cosmetic units treated with this modality compared to control sites was noted.
Gas chromatographic evaluation of treated and non-treated sites showed no difference in adipocyte triglyceride a free fatty acid content. Histopathology and electron microscopy evaluation showed diminished adipocyte edema on the laser treated side.
Conclusion: The Helium/Neodymium laser may be an excellent modality for improving results and easing the technique of liposuction surgery.

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EFFECT OF PULSED DYE LASER ON BASAL CELL CARCINOMA

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Purpose: To test the hypothesis that selective photothermal injury to the vasculature of basal cell carcinomas (BCC) will lead to destruction of these tumors with preservation of surrounding normal skin tissue.
Methods: In Phase I of this study, superficial and nodular BCC in 8 subjects were treated with minimally overlapping pulses from a PDL (Candela ScleroPlus HP) at wavelengths varying from 585 to 600 nm using dynamic cooling, and immediately excised for histologic analysis of the extent of laser-induced vascular injury. In Phase II, 8 subjects with superficial or nodular BCC in low risk anatomic locations were enrolled for 3 treatments with the PDL at 595 nm and fluence 15 J/cm^2, at 2 week intervals. Pulses were minimally overlapping and included a 3 mm margin. Two weeks after the last treatment, the site of the tumor was surgically excised in its entirety and subjected to histopathologic analysis. Phase III was the same as Phase II, with the exceptions that the 8 subjects enrolled had superficial or nodular BCC in high risk locations or BCC of aggressive histologic type (morpheaform, sclerosing, or micronodular), and 2 weeks after the last laser treatment the tumor site was excised by Moh's surgery.
Results: All 3 Phase II subjects who have completed the study at this time have had complete response of their BCC to PDL treatment as indicated by the absence of residual tumor cells in the excised tissue. Of the 6 Phase III subjects, 2 have shown complete response and 4 have had residual tumor cells. Normal skin margins were minimally affected and cosmetic outcome was good.
Conclusions: The preliminary results of this study suggest that photothermal vascular targeting maybe a means of eradicating BCC, and that PDL treatment of low risk superficial and nodular BCC merits further clinical evaluation.

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TEMPERATURE MEASUREMENTS AND ANALYSIS OF SKINS WITH A HIGH-SPEED INFRARED DETECTOR FOR THE OPTIMAL PARAMETER OF INTENSE PULSED LIGHT

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The intradermal temperature changes by Intense Pulsed Light source were directly measured with a high-speed infrared detector to elucidate the mechanisms of action and the relations between the different parameters and temperature rises with IPL (Quantum SR 560). The measurement system was straightly lined and the superficially irradiated pulse light was detected from the backside of the specimen with the high-speed reaction time of 1 micro second detector. The signal is passed to an amplifier, which is digitally converted and displayed over the digital oscilloscope for observation and recording. The specimens used in this study were surgically obtained split thickness human skins and a skin phantom which comprised of gelatin, intralipid and melanin pigment. The computer simulation program "Quick Therm" (RCCM Inc. Tokyo) was also used for the analysis of different parameter changes of IPL. Since there were close consistency of measured results between the human skins and skin phantom, most of the measurements were done with the phantom because human skins denatured after each irradiation. The representative results measured with the parameter of first pulse width of 2.8 ms, delay time of 20 ms and second pulse width of 5.0 ms showed the temperature rises of first and second pulses of 34.5 C and 41.4 C for 20 J/cm^2, 48.0 C and 79.5 C for 26 J/cm^2, respectively. The various first pulse widths of 2.0 ms, 2.4 ms and 2.8 ms with the 20 J/cm^2 output power showed the temperature rises of 38.5 C, 36.5 C and 34.5 C respectively. The various second pulse width of 4.0 ms, 4.6 ms and 5.0 ms with the 20 J/cm^2 output power and 2.8 ms first pulse and 20 ms delay showed the temperature rises of 41.5 C, 32.0 C and 32.5 C respectively. The 10 ms, 20 ms and 30 ms variations of delay times with the 2.8 ms of first pulse and 5.0 ms of second pulse width showed the lower temperatures with the longer delay times. The computer simulation of temperature rises, which mimics the actual measurements with different parameters, will be shown.

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LASER TREATMENT OF ACNE THROUGH SELECTIVE DERMAL HEATING

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We investigated the effects of selective dermal heating on active acneform papules and pustules. A 1450 nm laser was used in combination with cryogen spray cooling. Four treatments were performed at 3–4 week intervals on the backs of 24 volunteers with active acne lesions. The treated areas were 6 cm × 6 cm. A control site was treated with cooling alone. Acne lesion counts were performed preoperatively, prior to each treatment, and at 6 weeks and 12 weeks after the final treatment. Biopsies were performed just after treatment in four consenting patients. At six weeks and twelve weeks after the fourth treatment, a statistically significant decrease in lesion counts was observed. For example, at six weeks after the fourth treatment, the average lesion count decreased from 5.43 to 0.43 with a p value of 0.00013, whereas at the control sites, the change was from 5 to 3.86 (non-significant, p value of 0.17). Immediate postoperative reactions included erythema and edema that typically resolved after two hours. In type IV patients, some hyperpigmentation was observed at the treatment sites. This dyschromia resolved within 6–9 weeks. Evaluation of histological sections after treatment showed necrosis to the duct epithelium and sebocytes of the sebaceous glands. We conclude that active acne can be reduced by selective dermal heating with a 1450 nm laser coupled with cryogen spray cooling.

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SELECTIVE PHOTOTHERMOLYSIS OF SEBACEOUS GLANDS FOR THE TREATMENT OF ACNE

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Purpose: This study was designed to evaluate the efficacy of the long-pulsed diode laser (Cynosure, Inc) in combination with ICG to treat acne.
Methods: Ten treatment sites were used on the backs of patients with active acne. Topical ICG was applied to a 10 × 10 cm area and covered with an occlusive dressing for 24 hours. The remaining topical ICG was removed and the area was treated with a single pass of the long-pulsed diode laser using the following parameters: 4 mm, 800 nm, 50 msec, and 40 J/cm^2. Photographs were taken before and at designated intervals following laser irradiation.
Results: All patients tolerated the laser treatment and no adverse skin effects were noted following the treatment. Follow up photographs demonstrate an improvement of the acne condition in the treated areas.
Conclusion: Selective photothermolysis using ICG and the long-pulsed diode laser is effective for the treatment of active acne.

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MAGNETITE TATTOOS

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Purpose: Tattoo removal is a significant problem. We studied whether magnetite ink tattoos could be extracted by a magnetic field with and without Q-switched Ruby laser treatment.
Methods: Magnetite particles (1.4 um) were used to make mature black skin tattoos on hairless albino rats. A Q-switched Ruby laser, 3.5 J/cm^2, 6.5 mm spot size, 40 nsec pulse width was used for treatment. Permanent magnets (1.4 Tesla, 6 mm diameter) were used to extract the magnetite particles, alone and after laser treatment. Lightening of treated tattoos was measured from digital photographs, and the amount of ink and distribution of magnetite in skin biopsies was scored blindly.
Results: Brief (one hour) application of magnets alone did not significantly extract, lighten, darken or change histologic appearance of mature magnetite tattoos. In contrast when applied immediately after laser treatment, magnets extracted some ink when epidermal injury was present, and caused significant redistribution of magnetite into the upper dermis with vertical banding along magnetic field lines. When applied for a long time (3 weeks) following laser treatment, magnets caused darkening of tattoos.
Conclusion: Magnetite skin tattoos can be manipulated by external magnets, especially after Q-switched laser treatment. Magnetically-extractable tattoos deserve further study.

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Q-SWITCH LASER AND TATTOO PIGMENTS—A CHEMICAL ANALYSIS OF LASER INDUCED DECOMPOSITION COMPOUNDS

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Purpose: In the western world there are at least 20 to 30 millions of people with tattoos. Improved self-image and social stigmatization are the main reasons for removing tattoos from skin. Q-switched lasers are applied in order to destroy the tattoo compounds in the skin, however, using the high laser intensities the molecules of the pigments can break up, resulting in decomposition products or molecular structure change. In the present study the widely used tattoo pigments "I8" (Pigment Red 9) and "Cardinal Red" (Pigment Red 22) were prepared in suspension and irradiated using a Q-switch laser. The laser induced decomposition products were analyzed.
Methods: A 1 ml suspension of the tattoo pigments were irradiated by a frequency doubled Q-switched Nd:YAG-laser at 532 nm using a fluence of 3.5 J/cm^2. The repetition rate was 10 Hz and the exposure time was up to 5 min. Before and after laser irradiation the tattoo pigments were analyzed using chromatography (HPLC) and mass spectrometry. The decomposition products were quantified.
Results: Among others 2,5-dichloraniline and 1,4-dichlorobenezene were quantitatively identified as decomposition products of I8. With cardinal red the decomposition products 2-methyl-5-nitroaniline and 4-nitrotoluol were found.
Conclusions: The present results provide evidence that the use of a Q-switched laser in order to destroy tattoo pigments leads to a chemical decomposition of the pigment molecules. The destruction of the above mentioned molecules takes place by the cleavage of the azo group inside the molecules. Moreover, these decomposition products are toxic or carcinogenic. Further studies must be undertaken to prove whether the amount of these decomposition products plays a role regarding laser therapy of coloured tattoos.

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THEORETICAL EVALUATION OF PULSED PHOTOTHERMAL RADIOMETRY FOR ESTIMATING INTERNAL SKIN TEMPERATURE DISTRIBUTION DURING PORT WINE STAIN LASER TREATMENT

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During laser treatment of port wine stains (PWS), incident light is absorbed by epidermal melanin and blood hemoglobin. The initial temperature rise varies among patients due to differences in epidermal melanin concentration and PWS geometry. Pulsed photothermal radiometry (PPTR) is a technique that has been adapted to reconstruct the initial temperature distribution from knowledge of the time-resolved infrared signal emitted from skin after irradiation with a low-energy laser pulse. The PPTR reconstruction involves application of an iterative conjugate gradient algorithm to solve the inverse problem. Theoretical modeling is typically used to test the efficacy of the reconstruction algorithm. A known initial temperature distribution [$T_{init}(z)$] is assumed and a time-resolved PPTR signal is calculated. This signal is used as input into the algorithm, and an estimate [$T_{est}(z)$] of the initial temperature distribution is calculated. A limitation of previous models is that unrealistic $T_{init}(z)$ distributions were assumed.

The purpose of this study was to test the PPTR reconstruction algorithm with improved T_{init} distributions. Four classifications of skin morphological profiles were assumed, from which 24 $T_{init}(z)$ distributions were generated using diffusion theory. Results indicated that T_{est}(epidermis) agreed well with T_{init}(epidermis). The reconstructed PWS depth was in general agreement with the modeled depth, but T_{est}(blood) consistently underestimated T_{init}(blood). The degree of underestimation increased with PWS blood vessel depth. The presence of superficial "normal" blood vessels appeared to affect the accuracy of T_{est}(blood).

Therefore, the PPTR reconstruction algorithm is valuable for depth profiling of PWS skin but is limited in providing accurate knowledge of T_{init}(blood). Efforts are currently underway to improve the effectiveness of the inversion process.

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PDT/ALA IN THE TREATMENT OF ACTINIC DAMAGE: REAL WORLD EXPERIENCE

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To determine the safety and efficacy of Photodynamic Therapy (PDT) with Levulan Kerastick in patients with actinic damage including actinic keratoses, Levulen Kerastick was applied either to the entire face (14) or to individual actinic keratoses (18) in 32 consecutive patients. 15–20 hours after application the treated area was exposed to BLU-U light for 1000 seconds. Patients were given ice during treatment and/or Elamax prior and/or after treatment. All patients were placed on topical mid potency corticosteroids for 1 week after treatment. Patients were seen back 1 day, 1 week, 2 weeks, 1 and 3 months after treatment to evaluate treatment response.

Pain during treatment was rated 7.9 (full face) or 6.3 (spot treatment) on a scale of 1–10 irrespective of application of ice, Elamax or oral acetaminophen. All patients had had prior treatment with LN2. 62.5% felt that PDT was less painful, 12.5% similar, 16% more painful than LN2 treatment. 9% were unsure. Complete healing to normality occurred in 3–28 days (average 11 days). 72% had an improvement in skin texture. The average improvement was graded by the patient to be 74%. 74% of patients were satisfied with PDT therapy but only 60% of all patients would undergo treatment again. 80% of patients who only had individual lesions treated would undergo treatment again. PDT/ALA with Levulen Kerastick is well tolerated. Most patients also achieve an improvement in skin texture. Pain control needs to be improved.

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LASER-ASSISTED PHOTODYNAMIC THERAPY OF ACTINIC KERATOSES

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Prospective pilot study of 595 nm pulsed dye laser (PDL) following topical 20% 5-aminolevulinic acid (5-ALA) solution application for the treatment of actinic keratoses (AKs).

10 adults with AKs on the head and extremities were included. Pretreatment clinical examination, lesion counts, and photographs were obtained. Patients were treated 2-steps with initial application of topical 5-ALA 20% (Levulan Kerastick, Berlex) to lesions. After a 14-to-18 hour period, sites were irradiated with a PDL (595 nm, V beam, Candela) at fluences of 4–17.5 J/cm^2, pulse durations of 1.5–40 ms, 7-mm spot size, and 0–20 ms cryogen/30 ms delay. Patient and investigator pain assessments, presence and duration of stinging, burning, purpura, crusting, and erythema, and time to complete healing were recorded. Patients were examined at 1 and 3-months post-treatment for lesion counts, clearance rates and photographs. Patients were aged 35–85 and skin phototypes I–II. Following 5-ALA application, stinging and burning was reported by 2/10 and erythema was noted in all patients. Patient and investigator assessments indicated no-to-slight pain during laser treatment. Purpura was observed in 3 patients treated at 15–17.5 J/cm^2 and 1.5–40 ms. Absence of purpura was noted in 7 patients at 4–7.5 J/cm^2 and 10 ms. Crusting was observed in 2/10 treated at 17.5 J/cm^2. Erythema only was observed in the remainder. In 10/10, complete healing without residual erythema was observed at 10 days post-treatment. At 1-month follow-up, complete resolution of lesions was observed with no evidence of scarring or recurrence. Laser-assisted photodynamic therapy using the PDL (595 nm) and topical 5-ALA results in effective and safe treatment of AKs. Potential advantages include less pain, erythema and crusting, faster recovery, and comparable efficacy as compared to other modalities. A randomized, vehicle-controlled, double-blinded study is currently underway at our center to further investigate this approach.

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PHOTODYNAMIC TREATMENT OF PSORIASIS WITH ROSE BENGAL AND GREEN LASER LIGHT

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Purpose: To study the anti-psoriatic effect of a single treatment with the photosensitizer Rose Bengal (RB) and green laser light.
Method: Each subject served as his or her own control with each treatment including a drug alone, light alone, and no treatment control; a fourth area of plaque was used for the PDT treatment area. Rose Bengal 0.001% was applied as a topical solution to the skin for 30min with subsequent photodynamic activation using 100 J/cm^2, 532 nm green light at 200 mW/cm^2 as a single treatment. Treatment effect was monitored by high frequency (20 MHz) ultrasonographic plaque thickness measurements at Day 0, 7, 14, 30 and 90.
Results: Reduction in plaque thickness from baseline were marked (55.6% reduction) and statistically significant at study Day 90 for RB+laser ($p = 0.025$) treatment. In general, all treatment conditions were well tolerated. Of the ten subjects, one reported pain during Laser Only treatment and one reported pain during RB+Laser treatment. No subjects reported pain for any treatment area at subsequent follow-up visits.
Conclusions: By combining localized delivery of RB to psoriatic plaques with photodynamic activation using minimally-penetrating green light, psoriatic plaque thickness could be reduced by more than 50% after a single treatment. Repeated treatments may be assumed to produce clinical remission of psoriasis.

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LIGHT-TISSUE INTERACTIONS I: PHOTOTHERMOLYSIS VS PHOTOMODULATION LABORATORY FINDINGS

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The purpose of this study was to investigate and define responses to photomodulation of living cells by non-ablative light therapies and to compare these responses to traditional photothermolytic therapies.
The stimulation or inhibition of procollagen I as well as other markers were used to profile the effects of various parameters of light while attempting to isolate a single parameter for each study. The effects of a single pulse of narrow band or monochromatic 585-595 nm visible light was determined for pulse durations ranging from microseconds to minutes. Using selected pulse durations derived from this study, the effects of a single pulse of light at a range of energy densities from nano, micro, milliJoules/cm^2 through energy densities typically associated with current non-ablative wrinkle therapies (2.5 J/cm^2) and those associated with vascular/scar therapies (7-10 J/cm^2) were evaluated and 'dose response' curves were generated for stimulation and inhibition of cellular responses. Analysis of effects of various multiple pulse regimens from 10-1000 pulses was performed using selected parameters. Pulse number was also fixed and the interpulse interval (dark period) was used as a variable. Selected parameters displaying maximal production of procollagen I and other markers were performed with wavelength as the variable using selected visible and near infrared wavelengths. Studies of signal transduction and other dermal matrix components were also evaluated using normal and photoaged fibroblast activity as well as cutaneous malignancies. The effects of temperature gradients produced by various light parameter protocols were also evaluated. Profiles of light tissue interactions measured by procollagen I and other markers for photomodulation were obtained. Experiments using serial isolation of individual variables demonstrated quantitative changes in cellular responses to light-tissue interactions for nonablative photomodulation. These changes were determined and quantified for various parameters.

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LIGHT-TISSUE INTERACTION II: PHOTOTHERMOLYSIS VS PHOTOMODULATION CLINICAL APPLICATIONS

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The purpose of this study was to explore the clinical results of non-ablative light therapy and combination light therapy with topical agents using light sources and parameters defined in prior basic science experiments. Various randomized and blinded split face clinical trials of various light sources including: visible and infrared lasers, intense pulsed broadband light source and narrow band fluorescent and light emitting diode sources were performed using parameter sets previously determined by basic science studies with procollagen I and other assays. Digital photography, colorimetry, ultraviolet digital photography, elasticity measurements, digital profilometry, standard and immunofluorescent pathology from skin biopsies and other types of non invasive clinical skin analysis were utilized. Comparisons of different thermal and non-thermal protocols as well as comparison of different light sources/devices were performed. Various 'eye safe' photomodulation protocols that may qualify as 'non prescriptive therapies' were evaluated, and prototype light devices were tested. The use of adjunctive topical cosmeceutical agents specifically designed to enhance, inhibit or manipulate signal transduction pathways of these photomodulation procedures, as well as agents which provided 'raw materials' for certain cellular pathways, were also evaluated in split face clinical trials. Agents were tested alone and in combination with the light therapies. Photomodulation studies to evaluate the reduction of acne scarring and hair growth stimulation were also conducted. Photomodulation can be performed using either non-ablative thermal or non-thermal protocols and visible light sources. These nonthermal photomodulation produced clinical results superior to evaluated current non-ablative thermal techniques. Photomodulation by non-thermal, non injuring pathways can produce significant clinical improvement in photoaged skin and other disorders. A new expanded overview of light tissue interactions will be presented. that addresses non-ablative treatments.

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TREATMENT OF PSEUDOFOLLICULITIS BARBAE IN VERY DARK SKIN WITH A LONG PULSE NEODYMIUM YAG LASER

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Pseudofolliculitis barbae affects many individuals with coarse curly hair, and currently available treatment modalities are often inadequate. Lasers have been shown to be potentially helpful in mitigating disease severity by reducing the number and/or thickness of hair shafts. This was a side-by-side interventional study conducted at a military tertiary medical facility. The study group included 26 patients (22 of whom were Skin Type VI) referred from primary care physicians with a diagnosis of pseudofolliculitis barbae refractory to conservative therapy. A neodymium YAG laser (Lyra, Laserscope, San Jose, CA) was used to treat one half of the neck. A scanning handpiece and large cooling window were applied. The fluence was 50 J/cm^2 with a 50 msec pulse duration. EMLA was applied one hour prior to irradiation. One month later, shaving bumps were counted and compared to their preoperative levels on both sides. Mean papule counts were 11.6 ± 6 (SD) and 30.1 ± 19 (SD) on the treated side and untreated sides ($p < 0.05$ via paired t test) respectively. No blistering or epidermal damage was observed. In two patients, folliculitis was diagnosed 2–5 days after treatment (culture+*Staph aureus*). The pustules resolved rapidly after oral antibiotic therapy. Neodymium YAG laser treatment represents a safe and effective option for reducing papule formation in patients with pseudofollicultis barbae.

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TREATMENT OF PSEUDOFOLLICULITIS BARBAE IN TYPE V AND VI SKIN WITH A LONG PULSED Nd:YAG LASER

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The long pulsed Nd:YAG laser has recently been shown to be safe and effective for hair removal in darker skin types. We investigated the use of a long pulsed Nd:YAG laser for the treatment of pseudofoliculitis barbae in skin types V and VI.

Fifteen patients with longstanding pseudofolliculitis barbae underwent 1–3 treatments at 6–12 week intervals. The 1064 nm Nd:YAG laser (Coolglide, Altus, Burlingame, CA) is equipped with a contact cooling handpiece set at 4°C. Eight of the fifteen subjects chose to have the area anesthetized with EMLA prior to laser treatment. The laser was used with a pulse duration of 30 msec and a fluence of 30 J/cm^2. Standardized 35 mm photography and papule/pustule counts were performed prior to and 6 to 12 weeks following treatment.

The mean papule/pustule counts decreased >50% in >75% of patients after 1 treatment. No blistering, crusting, hyperpigmentation, or hypopigmentation was observed. One patient developed an immediate hypersensitivity reaction to EMLA cream. There was marked improvement in pseudofolliculitis with complete hair growth delays up to 12 weeks in duration. Patients with type V and VI skin can be safely and effectively treated for pseudofoliculitis barbae with a long pulsed Nd:YAG laser equipped with contact cooling.

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DYNAMICALLY COOLED MILLISECOND DOMAIN 1064 nm Nd:YAG LASER HAIR REMOVAL IN SKIN TYPES IV–VI

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Short-term results for hair removal on darkly pigmented skin was studied using a dynamically cooled 1064 nm laser system utilizing cooling both before and after the laser pulse. The objective was to determine safety and efficicacy of this system. Sixteen subjects with skin phototypes IV through VI containing black terminal hair on the face, thigh, or axilla were treated with a single treatment. Hair counts were obtained at adjacent control sites and treatment sites averaging 2 regions of 1 cm^2. Treatment parameters included 50–80 J/cm^2, pre-cooling cryogen spray of 20 msec and post-cooling of 20 msec with a delay of 10 msec. (CoolTouch Varia, CoolTouch Corp, Roseville,CA) Pulse duration was 50 msec. Hair counts at 3 months after a single treatment demonstrated an average of 55% reduction. With the dynamically cooled system no side effects were seen including no epidermal injury, color change or scarring. Pain was rated by most participants as mild (grade I) on a quartile scale, no topical anesthetic was utilized by any of the subjects. We concluded that dynamic cooling with a thermal quenching post-cooling pulse significantly reduced side effects and increased patient acceptance without influencing outcome of hair reduction in ethnic skin.

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HAIR REMOVAL ON DARKER SKIN TYPES (IV-VI) WITH A VARIABLE PULSED (3–100 ms) Nd:YAG LASER WITH CRYOGEN DYNAMIC COOLING

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Purpose: To evaluate the efficacy and safety of variable pulsed (3–100 ms) Nd:YAG laser with cryogen dynamic cooling for hair removal on darker skin types (IV-VI).

Method: 12 adult subjects, representing darker "Fitzpatrick skin types" (6-VI, 4-V, 2-IV) were treated in the study. 24 test sites per subject, were marked and hair counts obtained using digital imaging. Test sites were treated with the Nd:YAG laser system (Candela Corporation) with combinations pulse durations (3–100 ms) and fluence levels (10–100 J/cm^2). The Nd:YAG laser utilizes a dynamic cryogen cooling device (DCD) to improve epidermal protection. Hair regrowth, hair shaft diameter and associated epidermal side effects were assessed at 1,2 and 3 months post laser treatment.

Results: Preliminary results from the Nd:YAG laser demonstrate that short pulse durations (3–10 ms) does not significantly decrease the safety on darker skin types (IV-VI). The ability to alter the pulse durations from very short (3 ms) to very long (100 ms) allows you to effectively treat a variety of hair types (diameters and colors). Hair loss was strongly correlated with fluence, regardless of pulse duration. Additionally, very long pulse durations allow for all skin types to tolerate substantially higher fluences. Transient pigment changes were the most common side effect, which is reduced with longer pulse durations.

Conclusion: A variable pulsed (3–100 ms) Nd:YAG laser with cryogen dynamic cooling appears to allow for effective hair removal of pigmented hair in darker skin types (Skin Types IV-VI).

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LONG-TERM SAFETY OF LASER HAIR REMOVAL NEAR THE EYE

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The purpose of this study was to evaluate the long-term safety of laser hair removal procedure in the periorbital region. Five patients with trichiasis secondary to trachoma were studied. The 810 nm Dioderm laser (Cynosure Inc, Chelmsford, MA) was used to treat the eyelash follicles on lower eyelid of each patient. Cox III metal eye shields (Oculo-plastik Inc, Montreal, Canada) were placed behind the eyelids of both eyes during the laser procedure. Prior to irradiation, a comprehensive ophthalmic evaluation including pupillary and slit lamp examination, funduscopy and full field electroretinograms (ERGs) was performed. A comprehensive ophthalmic evaluation including ERG testing was repeated 30 zminutes and 3–6 months after completion of treatment. An independent blinded assessor evaluated the ERG studies. Subjective reports of laser light sensation, pain and discomfort during and after the laser procedure were also assessed.

There was no detectable change in slit lamp, pupillary or funduscopic evaluations after periorbital laser irradiation. Similarly, the pre- and post treatment ERGs were unchanged at 3–6 month post-operative evaluations. Three patients reported seeing flashing lights during the procedure.

We found no ERG evidence of retinal damage after laser hair removal in the periorbital region at 3–6 months post operative even when patients subjectively reported “flashing lights” during laser irradiation.

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THE IN SITU EFFECT OF AIR COOLING ON 810 nm DIODE LASER TREATMENT FOR HAIR REMOVAL

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Purpose: To demonstrate the epidermal sparing benefits of using air-cooling for laser hair removal.

Methods: Temperature measurements were monitored at two different skin (phototype III) sites during diode (810 nm) laser hair removal treatment using air cooling at 18°C. At the epidermal level an infrared camera allowed for precise (+/− 5°C) skin surface T inframetric measurements. For deeper hair follicle T measurements in the reticular dermis, a thermocouple (probe) connected to a data acquisition device was inserted 4–5 mm under the skin surface. Four T readings per second were monitored during 810 nm diode laser treatment using 7 mm spot size, 4 hertz repetition rate and fluences of 20 and 40 J/cm^2 respectively.

Results: Peak epidermal temperatures during laser pulses were ranging from 0 to 5°C providing adequate epidermal sparing effect for safe laser hair removal. T measurement probes at the hair bulb level (4–5 mm deep) reached effective coagulative endpoints for irreversible damage from 62 to 70.5°C with or without air-cooling.

Conclusion: While diode laser can effectively remove hair at both low (20 J/cm^2) and high (40 J/cm^2) fluences, air-cooling provides adequate epidermal protection and analgesia without excess transcutaneous cooling. Expected deep follicular photocoagulative endpoints are not altered by this new skin cooling method.

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MULTI-SPECTRAL REFLECTANCE IMAGING FOR THE ASSESSMENT OF NONMELANOMA SKIN TUMOR MARGINS

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The aim of the study was to develop technique and equipment for the intraoperative assessment of non-melanoma skin tumor margins. For this purpose we have built imaging equipment and developed a technique to enable multi-spectral dye-enhanced polarized light tissue imaging. We employed a Xenon arc lamp combined with interference filters as a monochromatic light source and a CCD camera as an imaging device. Linearly polarizing filters were introduced into the pathways of incident light and light collected by the camera. A filter positioned in front of the camera was rotated to allow imaging using the light polarized in a plane parallel (I_p) and/or perpendicular (I_s) to the polarization plane of the incident light. An image obtained by subtraction I_p-I_s provides information about superficial tissue layers only. To enhance the contrast of acquired images we used aqueous solutions of phenothiazinium dyes, namely, methylene blue (MB) and toluidine blue (TB). To test the technique we imaged discarded freshly excised human tumor material obtained from Mohs surgery. We topically applied the dye with varying concentrations for several minutes to the tumor samples and then rinsed the specimens in saline solution. We acquired polarized light images before and after dye application at the selected wavelengths. The wavelengths of 390 nm, 410 nm, 440 nm, and 577 nm correspond to the hemoglobin absorption bands, while the wavelengths of 577 nm, 610 nm, and 620 nm correspond to the absorption bands of TB and MB. These two sets of wavelengths were used to distinguish between the areas of enhanced hemoglobin and dye absorption, respectively. The images acquired at 710 nm were used for the background subtraction since neither hemoglobin nor the dyes absorb the light of this wavelength considerably. The results indicate that sufficient contrast can be achieved for reliable differentiation between tumor and surrounding tissue. The suggested technique has significant potential as a guidance tool in tumor excision surgery.

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SPATIALLY CONFINED PHOTOTHERMOLYSIS OF DERMAL TARGETS USING AN IR-FIBERLASER IN COMBINATION WITH FOCUSING AND CONTACT COOLING

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Purpose: To determine if a new method of spatially confined photothermolysis within the skin using a combination of an IR fiber-laser, cooling, and focusing can produce well-defined areas of intradermal damage.

Methods: 6 healthy subjects of light pigmented skin were enrolled in a prospective clinical study. 24 test sites (each 1 cm^2) and 8 controls were mapped on the back. Within each test sites an array of 16 to 36 single pulses was applied. The positioning of the spots was performed by a computer-controlled x-y micro-stage. We tested the effects of wavelength (1065 nm, 1206 nm, and combination), pulse energy (3.5–25 J), pulse duration (1–5 s) and spacing between the laser pulses (1.7, 2 and 2.5 mm). Epidermal cooling (4°C) and intra-dermal focusing to a depth of 1mm was used. Follow-ups were performed at 1, 2, 4 weeks and 3 months.

Results: We have not observed any clinically evident epidermal damage or scarring for any of the subjects or test sites. All exposures could be performed without the need for any additional anesthesia. We observed varying degrees of erythema. For some test sites we observed consistently elevations of skin surface ("bumps") that matched exactly the pattern of the laser spots. For these spots histology revealed sharply demarcated elliptical areas with loss of collagen birefringence. For other spots without any elevation we have found small areas of confined damaged with an elliptical shape with a diameter of the small axis of less than 200 μm at a depth of about 800 μm.

Conclusions: Intra-dermal damage including collagen denaturation with sharp demarcation and without any evidence for epidermal damage can be generated by a combination of this new IR-fiberlaser, cooling and focusing. This technique can be used for precise direct treatment of intra-dermal targets including collagen, sebaceous glands, vessels and hair follicles without the need for a selective chromophore.

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A NOVEL SOLUTION FOR CAPTURING LASER PROCEDURE ENCOUNTER INFORMATION

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We have developed software to rapidly capture laser procedure encounter data using handheld computer technology.

The software runs on any Palm OS® based handheld computer. This portable solution integrates seamlessly into the clinical workflow allowing the laser surgeon to capture patient encounter information, including standard laser procedure settings and follow-up information. Data is primarily entered by tapping on a series of drop-down menus. Writing is thus minimized and data entry standardized. The data from the handheld computer is then synchronized with inexpensive database software on a personal computer (PC). From the PC, operative reports and letters to referring physicians are generated. Advantages over traditional paper charting include automation of note and letter generation. Additionally, this process can facilitate analysis of outcomes associated with different laser parameters and patient characteristics; such information can improve laser surgeons' ability to create optimal treatment algorithms.

Data currently being captured using this technology saves time spent with manual charting and/or dictation costs.

This is the first reported handheld computer-based solution to efficiently capture laser procedure data and generate reports. It is a low-cost, portable, easily customized solution for evolving documentation needs. Future uses include multicenter data collection and outcome based analysis.

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IN-VIVO 3D IMAGING IS MORE PREDICTIVE OF OUTCOME THAN REPLICA PROFILMETRY IN PHOTODAMAGED SKIN FOLLOWING NON-ABLATIVE LASER TREATMENT

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Nonablative skin resurfacing selectively heats the upper dermis, inducing a wound healing response in the papillary and upper reticular dermis without epidermal ablation. Although histologic studies have shown that these treatments can stimulate matrix synthesis and deposition it is not clear that this results in an objectively quantifiable outcome. Optical profilometry of silicone replicas has been shown to measure changes in skin topography following various cosmetic treatments. However, the current state of the technology is characterized by direct 3D *in-vivo* skin imaging. The device (PRIMOS, GFM, Tetlow, Germany) used in this study deploys a parallel stripe pattern imaging technique that is created by a digital micromirror projector (Texas Instruments, Irving TX). The pattern is projected onto the skin surface and depicted on the CCD chip of a high resolution camera. The 3D effect is achieved by minute elevation differences on the skin surface deflecting the parallel projection stripes creating a quantitative measurement of the skin's microtopography. Twenty patients were enrolled, ten in each group, and treated with either the 1320 nm Nd:YAG laser & dynamic cooling system (CoolTouch, Roseville, CA) or the 1064 nm Q-Switched Nd:YAG laser (Medilite IV, Continuum, Santa Clara, CA). Subjects were given 4–5 treatments with either laser at 2–4 week intervals and were evaluated by 3D *In-vivo* Skin Imaging and replica profilometry to quantitatively measure changes in the skin's microtopography following treatment. Measurements were taken before and after treatment at initiation, one, two and three months. Blind evaluation of pre and post photographs indicate a slight but reproducible improvement using both systems. Evaluation of the skin's microtopography with *In-vivo* 3D imaging in the lateral canthus demonstrated a quantifiable change at one and three months following therapy. These data positively correlated with subjective clinical assessment and patient self-assessment. This change was more evident using the 1320 nm Nd:YAG laser & dynamic cooling system than with the 1064 nm Q-Switched Nd:YAG Laser at the settings tested. Profilometry of skin replicas did not clearly demonstrate the change in wrinkle depth suggesting that facial wrinkles can be more accurately and objectively quantified by 3D *In-vivo* Skin Imaging.

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TREATMENT OF PHOTODAMAGED SKIN USING LONG PULSED DYE (595 nm)

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Clinical, subjective and histological evaluations for effectiveness and side effects of the long pulsed dye laser for photorejuvenation. Twenty patients with mild to moderate photodamage received three treatments spaced 6 weeks apart. Assigned randomly, one side of the face received long pulsed dye laser (4.5–7 J/cm^2, 20 & 30 ms pulse width) and cryogen spray the other side only the cryogen spray. The subjects were blinded as to the treatment provided to each side. Patient photographs and assessment of side effects were done on 1 and 6 days post-treatment, then 12 and 24 weeks after the last treatment. Profilometry molds were made of the periorbital area before the first treatment and at the 24 week follow-up. Blinded observers of the photographs scored the percent clearance of wrinkles, and changes in erythema and pigmentation of the treated areas. In six subjects 3 mm skin biopsies were taken from the treatment area prior to treatment, and at either the 12 or 24 week follow-up visit. These were examined histologically and compared. At the 24 week visit the subjects were asked to rate their satisfaction with the laser therapy.

Scores tabulated from clinical photographic assessments showed no statistical improvement of fine lines and wrinkles and mild improvement of hyperpigmentation and erythema. Quality of life survey revealed that 40% of the patients saw some improvement. Profilometry molds were analyzed using the PRIMOS imaging system confirming the clinical observations. Histology results show improvement of actinic damage.

This study demonstrated that at the treatment parameters used there were no side effects and mild improvement of wrinkles, hyperpigmentation and erythema.

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EFFECTS OF INTENSE PULSE LIGHT ON SUN-DAMAGED HUMAN SKIN ROUTINE AND ULTRASTRUCTURAL ANALYSIS

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Background: Several techniques have been used to improve the aesthetic appearance of sun-damaged skin. Among them, light-based devices, such as lasers, have been employed to remove the upper, sun-damaged portions of the dermis to induce a synthesis of new collagen. More recently, some authors have proposed to use non-ablative methods to induce collagen/elastic tissue synthesis without removing the overlying epidermis. Among them, the intense pulse light system emits a non-coherent multi-wavelength light (500–1100 nm). We decided to examine the morphologic effects of an intense pulse light (IPL) on sun-damaged skin.
Objective: Histologic and ultrastructural analysis of the IPL effects on facial, sun-damaged skin.
Methods: 24 subjects (mean age 47 years) were treated in a private practice setting with an IPL Quantum SR light device [ESC-Lumenis, Palto Alto, CA]. (Fitzpatrick skin types I-IV) Patients were treated up to 5x at 1 month intervals with 25–46 J/cm^2. Two-mm biopsies were processed for routine histology and electron microscopy. Two-mm punches were taken from untreated facial skin as controls.
Results: Routine histologic analysis of control specimens confirmed the presence of variable degrees of solar elastosis. Early biopsies of some hair follicles displayed a lymphocytic infiltrate (seborrheic dermatitis) which resolved at 3-month biopsies. Treated areas showed minimal changes during the treatment regime at both .5-1 hour post 1st treatment, 1 week after 1st treatment, and 3 months after the 3rd treatment. Six months after the last treatment significant neocollagenesis occurred. There were neither epidermal nor dermal necrosis, fibrin thrombi, or dermal hemorrhage. Demodex organisms appeared coagulated in the immediately post-treatment specimens. Demodex organisms were mostly absent in the follow-up biopsies. Ultrastructural analysis showed subtle, more compact packing of collagen fibers within the papillary dermis. There was not significant morphologic damage to epidermal or dermal structures.
Conclusion: IPL induces morphologic changes in human, moderately sundamaged skin at 6 months. At least some of the aesthetic improvement in terms of reduction in erythema may be secondary to clearing of Demodex organisms and reduction in lymphocytic infiltrate.

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PHOTO REJUVENATION WITH A DOUBLE EXPOSURE PROCEDURE USING A NEW IPL SYSTEM

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Purpose: To evaluate the effect of a dual-mode filtering IPL System for full facial photo rejuvenation.
Methods: Twenty women aged 30 to 58 years, skin type I to III were treated for photo damage. Treatments were performed with an IPL system (Ellipse Flex, DDD) using a double exposure procedure where both telangiectasia and pigmented disorders were treated in one session. First area containing telangiectasia with individual visible vessels were treated with a single pulse with a pulse duration of 14–30 ms. Second path a full facial treatment taken care of sun-damaged pigmentation and diffuse redness was performed with a double pulse with a pulse duration of 2.5 ms spaced by 10 ms. The patients were split into two equal groups of 10. The first group were treated with a wavelength band of 555–950 nm and energy settings of 13–19 J/cm^2 for telangiectasia and 10 J/cm^2 for the full facial treatment. The second group were treated with a wavelength band of 530–750 nm and energy settings of 11–17 J/cm^2 for telangiectasia and 7 J/cm^2 for the full facial treatment. Standardised photo documentation and questionnaires were used for evaluation of the treatment results. No active skincare were used during the test period. Histology of the reaction was performed.
Results: Clear improvement of the pigmentation and the telangiectasia were observed after a single treatment in all patients and they all reported an overall improvement of their skin texture and a high degree of satisfaction with the outcome. The effect was further improved after the second treatment. The difference between the two modalities was reported non-significant. None of the patients got scarring or atrophy
Conclusion: A few number of IPL treatments with a double exposure procedure provides a safe and effective treatment of sun-damaged skin with no down time.

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ASSOCIATION OF PULSED LIGHT WITH INDOCYANINE GREEN FOR THE TREATMENT OF SKIN REJUVENATION: A NEW PROTOCOL

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Photo-damaged skin is clinically characterized by several and different aspects including not only wrinkles but also telangiectasias, skin coarsenesss, areas of hypo and hyperpigmentation, epidermal and dermal atrophy, laxity et al. Intense pulsed light (Ipl) rejuvenation is a non-invasive breakthrough treatment that simultaneously can treat and correct many of the degenerative changes associated with photo-damage.

This non-ablative treatment is developed on the principle that there can be stimulation of dermal collagen even without epidermal injury, through termal effects, with well documented clinical benefits.

Objective: the aim of this study is the optimization of skin rejuvenation protocol with Ipl. In our procedure we associated a chromophore molecule to the Ipl treatment in order to better control the quantity of distributed energy and its penetration level.

Methods: we have applied to 20 patients a selective chromophore containing indocyanine greenon the area to be treated before Ipl procedure at a wavelength of 750-1200 nm.Eachpatienthas been treatedwith a fluence of 6-8 J x cm^2 andhehas underwent 10 Ipl sessions at week intervals.

To test the final results,we have considered the following parameters:

- Hydration
- Production of sebum
- Change of pH
- Skin temperature
- Subjective test

Results: we checked an increase of skin hydration, a reduction of sebum production, without essential changes inskin pH and temperature.

All the appearances of photo-damage showed a substantial improvement with high patient satisfaction.

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USE OF THE NLITE LASER FOR NON-ABLATIVE WRINKLE REDUCTION

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Purpose: To evaluate the efficacy of a short pulsed dye laser for non-ablative wrinkle reduction.

Methods: 72 patients of Fitzpatrick skin types I-VI with Fitzpatrick photodamage scores of 3 to 9 were treated in the peri-orbital area with the NLite laser. 36 patients received a single treatment and 36 received a second treatment three weeks after the initial treatment. At the treatment session, each patient was randomized to have an NLite treated and a sham treated side. Patients were evaluated both pre treatment and post treatment at 30 and 90 days with standardized 35 mm and digital photographs. Optical profilometry using the Primos imaging system provided three dimensional in vivo measurements in microtopography as an integral part of the clinical evaluation. Skin biopsies were also obtained from eight patients prior to treatment and at the 90 day follow up visit. Adverse effects were noted immediately post treatment and at each follow up visit.

Results: Patients tolerated the periorbital treatment with little discomfort. Occasional transient mild purpura was noted which faded within two to three days when present. The degree of photodamage and presence of rhytides was less prominent on the treated side when assessed at 90 days. The Primos imaging system is a very sensitive tool which shows superficial topographic changes even when these are not easily appreciated on clinical inspection. The findings on skin biopsies reflected the changes noted by photography and with the Primos system.

Conclusions: Short pulsed dye laser is an effective treatment to bring about mild to moderate improvement in periorbital rhytides. This can be documented with digital photography, standardized 35 mm photography, and advanced microtopography system, as well as with histologic examination.

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MEASUREMENT OF TRANSIENT CYANOSIS INDUCED DURING NON-ABLATIVE DYE LASER WRINKLE REDUCTION AND ITS CORRELATION TO ENHANCED COLLAGEN PRODUCTION

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Purpose: Use of a novel optical detector to measure the level of transient cyanosis induced during non-ablative wrinkle reduction using a pulsed dye laser, and to correlate the level of transient cyanosis with the level of increased collagen production post laser irradiation.

Method: Twenty subjects were treated with a non-ablative dye laser wrinkle reduction system (NLite, ICN Photonics Ltd, Wales, UK) utilising varying laser temporal pulse forms and fluences. Measurement of transient cyanosis was undertaken using a novel dual wavelength, non-invasive optical detector. The rate of collagen production post treatment was measured using biochemical analysis for the amino-terminal propeptide of procollagen type III (PIIINP) in suction blister fluid.

Results: The results showed that transient cyanosis induced following laser irradiation strongly correlates to increased collagen production. The level of collagen production related to both intensity and duration of the induced cyanosis, which were highly dependent upon the laser parameters utilized.

Conclusions: Non-invasive real-time optical measurement of induced transient cyanosis during non-ablative wrinkle reduction provides immediate feedback of treatment effect and is a clear indicator of enhanced collagen production.

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NON-ABLATIVE TREATMENT OF ACNE SCARS USING PULSED DYE LASER

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Purpose: To evaluate the safety and efficacy of a non-ablative technique for the treatment of depressed acne scars.
Method: Twenty subjects with varying degrees of facial acne scarring were included in a controlled study and were treated with the NLite system (ICN Photonics Ltd, Wales, UK). Reviews were performed at 30 and 90 days to record any incidence of side effects and degree of cosmetic efficacy. Blinded evaluation was performed using standardized photography. Surface profilometry was used to quantify treatment outcome and high frequency ultrasound was used to determine the effect of the treatment on the dermal layer. Patient satisfaction was also determined by means of a simple 4-point scale.
Results: Immediately post treatment there was no indication of any visible changes to the skin surface. At the three side-effect review points no adverse textural or pigmentary changes were observed. Evaluation of pre and post treatment photographs showed significant improvement in skin texture, corresponding to measured reduction in scar depth through profilometry. Patient perceived improvement was recorded as 2.8 out of 4.
Conclusions: The results of the study indicate that the technique described offers a completely safe, non-invasive method for the reduction in the appearance of facial acne scars.

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NON-ABLATIVE DERMAL REFODELING: COMPARING 3 DIFFERENT WAVELENGTHS: DOES IT MAKE A DIFFERENCE?

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The purpose of this study was to determine if different choices of laser wavelengths had any impact on the subjective improvement seen after non-ablative dermal remodeling. 10 female subjects, with Class I-III periorbital and perioral rhytides and Fitzpatrick skin phenotypes II-IV were treated in 3 different anatomic locationss with 1) a millisecond 532 nm KTP laser, 2) a millisecond 1064 nm Nd:YAG laser and 3) sequential millisecond 1064 nm Nd:YAG and millisecond 532 nm KTP laser. All anatomic areas were treated 3 times over the course of three months. KTP laser treatment was undertaken at 532 nm, 10–15 J/cm^2 and pulse durations of 40–50 msec. Nd:YAG treatment was undertaken at 1064 nm, 50–80 J/cm^2 and pulse durations of 40–50 msec. Only 1 subject showed any improvement with 532 nm treatment alone, only 4 subjects were noted to have improvement after treatment with the 1064 nm laser. Eight subjects showed some improvement after treatment with sequential 1064 nm Nd:YAG followed by 532 nm laser treatment. This study represents one of the first to compare different non-ablative approaches. The proposed mechanism of action for each wavelength will be discussed.

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OBJECTIVE EVALUATION OF NON-ABLATIVE FACIAL RESURFACING WITH THE 1320 nm Nd:YAG LASER

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The 1320 nm Nd:YAG laser has been used for non-ablative skin resurfacing. Clinical improvement is difficult to quantify. Recently, clinical improvement after treatment with the 1064 nm Q-switched Nd:YAG laser demonstrated correlation with objective measurements. In this, a follow-up study, the same objective measures were used to evaluate the efficacy of non-ablative resurfacing with the 1320 nm Nd:YAG laser. Ten adult subjects (Skin type I-VI) with Class I-III periorbital and/or perioral rhytides were treated. Each patient received 5 treatments at 4-week intervals with the 1320 nm Nd:YAG laser using a cryogen cooling device (10 mm spot, 12–18 J). At each treatment, 2 passes were performed. During the first pass, cryogen was administered 30 ms prior to each laser treatment, while the second pass consisted of cryogen administered 30 ms after each laser treatment. Fluences were adjusted to achieve epidermal temperature between 42–44 degrees Celsius. Clinical assessment included standardized photography, patient questionnaires, histologic studies, and objective biometric studies. The biomedical Tissue Characterization system (BTC-2000, SRLI Technologies, Nashville TN) provides quantitative in vivo evaluation of the skin. The Primus imaging system (Johnson & Johnson) provides three-dimensional in vivo measurements of the microtopography of the skin. All information was obtained prior to the first treatment and during the follow-up period. The 1320 nm Nd:YAG laser with cryogen spray produced substantial improvement of facial rhytides with minimal adverse effects.

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3D IN-VIVO OPTICAL SKIN IMAGING AND BIOMECHANICAL CHARACTERIZATION FOLLOWING NONABLATIVE LASER TREATMENT

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The 1064 nm QS Nd:YAG has recently been proposed as a nonablative laser technique. Given the inherent limitations of photographic and clinical evaluation in measuring changes in surface topography, we performed 3D In-vivo optical skin imaging to objectively quantify the efficacy of multiple treatment sessions with the 1,064 nm QS Nd:YAG laser for acne scarring. We also performed biomechanical characterization of skin tone before and after treatment with the QS Nd:YAG laser.
Twenty-four adult subjects (skin type I-III) with mild to moderate atrophic acne scarring or class I-III bilateral periorbital or perioral rhytides were treated. Subjects were evaluated over a 6-month period after receiving 5 treatments in 2 to 3 week intervals with the QS Nd:YAG laser (Medlite IV, Continuum, Santa Clara, CA). Skin microtopography was measured by phaseshift, in-vivo skin imaging (PRIMOS^{TM}, GFM, Teltow, Germany) The instrument projects sinusoidal intensity distributions of the skin using a Digital Micromirror Device (DMD^{TM} Texas Instruments, Irving, TX) and reconstructs the data using temporal phase shift algorithms to generate a 3D surface profile. Biomechanical characterization of skin was performed with the BTC-2000 Dynamic skin analyzer (SRLI, Nashville, TN), an instrument designed to measure the elastic deformation of skin during dynamic stress.
Patients with acne scarring demonstrated a 14–64% improvement in skin smoothness (1/Ra) 1-month after 5 treatment sessions. Patients demonstrated the greatest improvement in skin smoothness 3-months after the 5th treatment session, and maintained this level of correction at the 6-month follow-up. Skin stiffness increased from 176 to 211 mmHg/mm ($p = 0.03$) and energy absorption decreased from 69.2 to 56.7 mmHg/mm in the male subjects at the 1-month follow-up, indicating an improvement in skin tone.
After three to five treatment sessions with the QS-Nd:YAG laser, we quantified improvement in surface topography of patients with mild to moderate acne scarring using 3D In-Vivo skin imaging. We also quantified improvement in skin tone as measured by a dynamic skin analyzer in a subset of patients.

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SHORT-TERM HISTOLOGIC EFFECTS OF NON-ABLATIVE RESURFACING: RESULTS WITH A DYNAMICALLY COOLED MILLISECOND DOMAIN 1320 nm Nd:YAG LASER

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It is widely believed that non-ablative laser techniques can lead to dermal collagen remodeling without the obvious epidermal injury and the wound created with ablative approaches. This occurs when dermal collagen injury is induced without visible injury to the overlying epidermis. We examined the acute histologic effects both one hour and several days after standardized treatment protocols of dynamically cooled millisecond domain Nd:YAG 1320 nm laser with a 6 mm spot size (CoolTouch1, CoolTouch Corp, Roseville, CA) to provide further insight into the mechanism of action of non-ablative resurfacing. Multiple adjacent sites on the pre-auricular area of the cheek of 10 patients were biopsied following one to three laser passes of dynamically cooled millisecond domain Nd:YAG 1320 nm laser. Biopsies were performed at one hour and at 3 days following a single treatment. The number of passes was varied from one to three and Tmax (peak temperature measured by integrated radiometer) during treatment was targeted for 45–48°C. At 1 hour post-treatment, epidermal spongiosis and edema of the basal cell layer were present in all the specimens treated with three passes. At 3 days, the three pass samples also showed micro-thrombosis, widened vessels, sclerosis of the vessel-walls, and infiltration of neurophilic granulocytes. The occurrence of these histologic findings correlated well with the presence of clinical improvement (judged by photographs) at 8 weeks post-treatment. Acute histologic changes and clinical improvement were not clearly observed below treatment temperatures of Tmax 45°C or after one pass alone. Repeated temperatures above Tmax of 48°C incurred risk of epidermal injury. Even though longer-term histologic findings have confirmed the collagen synthesis component of 1320 nm Nd:YAG laser, our data indicate that there may be some additional factors other than dermal collagen heating with subsequent collagen repair. The concept of true "non-ablative resurfacing" may involve some form of sub-clinical epidermal injury that improves the clinical outcome. Our acute histologic findings suggest that 3 passes with fluence and cooling adjusted to a target temperature of Tmax between 45 and 48°C yields improved clinical results with dynamically cooled 1320 nm Nd:YAG laser treatment.

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COMBINATION AURA 532 nm AND LYRA 1064 nm LASERS FOR NON-INVASIVE SKIN REJUVENATION AND TONING

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A. Purpose: This study is the first to evaluate a combination technique using a 532 nm and a 1064 nm laser for non-invasive photorejuvenation and skin toning/collagen enhancement.
B. Statement of methods: A total of 150 patients were treated with the variable pulse KTP 532 nm (Aura) and long-pulsed Nd:YAG 1064 nm (Lyra) lasers both separately and combined. Patients included skin types I through IV. The fluences varied between 7 and 15 J/cm^2 at 7 to 20 msec pulse duration with a 2 mm handpiece and 6 to 9 J/cm^2 and 30 msec with a 4 mm handpiece for KTP. The LP Nd:YAG fluences were set at 24 J/cm^2 for a 10 mm handpiece and 30 J/cm^2 for a SmartScan Plus scanner. These energies were delivered at 30 msec pulse durations. All subjects were treated at least 3 times and at most 6 times were observed between 3 and 6 months following the last treatment.
C. Summary of results: The first group of 50 patients was treated with the KTP laser alone. After 3–6 treatments they showed improvement as follows: 70–80% in redness and pigmentation, 40–50% in skin tone/tightening, 30–40% in skin texture, 20–30% in rhytids. The second group of 50 patients was treated with the Nd:YAG laser alone. They showed improvement as follows: 10–20% in redness, 0–10% in pigmentation, 10–30% in rhytids, 10–30% in skin tone/tightening, 20–30% in skin texture. The third group treated with both KTP and Nd:YAG lasers showed improvement as follows: 70–80% in redness and pigmentation, 40–60% in skin tone/tightening, 40–60% in skin texture, 30–40% in rhytids. Skin biopsies taken at 1 month, 2 month, 3 month and 6 month intervals demonstrated new collagen formation.
D. Conclusions reached: All 150 patients exhibited a mild to moderate degree of improvement in the appearance of rhytids, moderate degree of improvement in skin toning and texture and great improvement in the reduction of redness and pigmentation. The KTP used alone was superior to the Nd:YAG laser in terms of results. The KTP and Nd:YAG laser combination was superior to either laser used alone.

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NON-ABLATIVE REMODELING: A 14 MONTH CLINICAL, ULTRASOUND IMAGING AND PROFILOMETRIC EVALUATION OF A 1540 nm Er:GLASS LASER

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Purpose: A previous study has already evaluated the efficacy and safety of non-ablative skin remodeling with a 1540 nm Er:Glass laser and contact cooling on peri-oral and peri-orbital rhytids at 6 months. The follow up at 14 months aims to show stability and/or improvement on patients.
Methods: 42 female patients (mean age: 47 years), skin types I-IV, were treated 5 times at 6 weeks intervals, and checked 14 months after enrollment. Patients were evaluated using clinical data, patients satisfaction (scale 1 to 4), digital pictures, ultrasound imaging and profilometric data from silicone imprints in order to quantify the degree of improvement.
Results: All subjects reported an improvement in the quality and visual aspect of their skin 6 months and 14 months after enrollment (mean patient's satisfaction: 2,9/4). This was confirmed by a 40.2% reduction of anisotropy six months after the 5th treatment. Ultrasound imaging demonstrated a 13% increase of the dermis thickness 6 months after the 5th treatment. Objective data correlated to the clinical improvement at 14 months show an important reduction of the anisotropy and an increase of the dermis thickness.
Conclusion: This study demonstrates that irradiation with a 1540 nm Er:Glass laser increases dermis thickness, reduces the anisotropy of the skin and finally improves clinical aspects. The outstanding feature of this study is that the improvement is lasting, and even improving at least until 14 months after enrollment. The lack of adverse effects over more than one year confirms that all this procedure is safe.

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TREATMENT OF TRANSVERSE NECK LINES WITH A NONABLATIVE 1450 nm DIODE LASER

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Purpose: Improvement of neck rhytides is difficult to achieve, even with surgical lifting procedures. Current ablative laser systems used for this purpose is often associated with prolonged wound healing and significant postoperative complications. The purpose of this study is to evaluate the safety and effectiveness of a nonablative 1450 nm mid-infrared diode laser in the treatment of transverse neck lines.

Methods: 20 patients (skin phototypes I-V) with transverse neck rhytides received 3 monthly treatments with a 1450 nm diode laser (*SmoothBeam*, Candela Corp., Wayland, MA). Symmetrical matched areas were left untreated to serve as controls. Patients were evaluated using digital photography and three dimensional *in vivo* microtopography measurements (PRIMOS Imaging System, GFM, Germany) at each treatment session and at 1, 3 and 6 months after the final laser treatment. Patient satisfaction scores were obtained at each treatment session and follow-up visit.

Results: Mild to moderate improvement in treated transverse neck rhytides was observed in all patients. Patient satisfaction scores and *in vivo* microtopography measurements paralleled the clinical improvements seen. Side effects were limited to occasional erythema and edema lasting up to 48 hours after treatment. No scarring, adverse textural changes or dyschromia resulted from the laser treatment.

Conclusion: The nonablative 1450 nm diode laser is a safe and effective treatment modality for transverse neck wrinkles.

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COMPARISON OF A 1450 nm DIODE LASER AND A 1320 nm Nd:YAG LASER IN THE TREATMENT OF ATROPHIC FACIAL SCARS

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Purpose: To evaluate and compare the efficacy and safety of the 1320 nm Nd:YAG and the 1450 nm diode lasers in the treatment of atrophic facial scarring.

Methods: A series of 20 patients with mild to moderate atrophic acne scars on the face (skin phototypes I-V) were randomly assigned to undergo 3 successive monthly treatments with a 1320 nm Nd:YAG laser (*CoolTouch*, CoolTouch Corp., Auburn, CA) on one side of the face and a 1450 nm diode laser (*SmoothBeam*, Candela Corp., Wayland, MA) on the contralateral side. Patients with mild to moderate atrophic scarring (skin phototypes I–V) were included in the study. Patients were evaluated using digital photography and three dimensional *in vivo* microtopography measurements (PRIMOS Imaging System, GFM, Germany) at each treatment visit and at 1, 3 and 6 month follow-up visits. Biopsies were obtained from several patients ($n = 7$) for histologic evaluation prior to treatment, immediately after the first treatment, and during the 1, 3 and 6 month follow-up visits. Patient satisfaction scores were obtained at each treatment session and follow-up visit.

Results: Mild to moderate clinical improvement was observed in all patients. Patient satisfaction scores and *in vivo* microtopography measurements paralleled the photographic and histopathologic changes seen. Side effects were limited to mild transient erythema and edema. No scarring, adverse textural changes or pigment alteration resulted from the use of either laser system.

Conclusion: The nonablative 1320 nm Nd:YAG and 1450 nm diode lasers each offer clinical improvement for patients with atrophic scarring without significant side effects or complications. Nonablative laser systems are a good treatment alternative for patients with atrophic scarring who are unable or unwilling to endure the prolonged healing associated with an ablative resurfacing procedure.

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COMPARISON OF SKIN REJUVENATION RESULTS WITH 1450 nm DIODE AND WITH COMBINED USE OF MICRODEMARBRASION, 595 nm LPDL, 1450 nm DIODE AND 755 nm Q-SWITCHED ALEXANDRITE

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Purpose: To demonstrate that combined therapy involving various lasers and microdermabrasion will improve photodamaged skin (erythema, citrin coloration, lentigos, roughness, rhytids, skin elasticity).

Methods: 10 patients (mean age 40, skin types I-IV, Glogau scale I-IV) were treated with a 1450 nm diode laser (Candela Smoothbeam) at the following parameters: 14–16 J/cm^2, DCD setting 3, 4 rx at 4 week intervals. 10 patients (mean age 40, skin types I-IV, Glogau scale I-IV) were treated with a different device (cycle treatment of 4 weeks) every week for 4 complete cycles of 4 weeks. The rx parameters were as follows: light pressure full-face microdermabrasion (week 1); 595 nm LPDL (Candela Vbeam) at 6 ms, 5.5–6.5 J/cm^2, 10 mm (week 2); 1450 nm diode (Candela Smoothbeam) at 14–16 J/cm^2, DCD setting 3 (week 3); 755 nm Q-switched Alexandrite (Candela AlexLAZR) at 2.5–3.5 J/cm^2, defocused 3 mm spot (week 4). Results are measured qualitatively and quantitatively. Phase I (qualitative) involves patient and physician satisfaction scores (1 to 10) and before & after photographs. Phase II (quantitative) involves measurement of wrinkle depth by profilometry (Messtechnik PRIMOS), of skin roughness (CK Electronic Skin Visiometer SV 500), of skin elasticity (CK Electronic Cutometer Sem 575 and Reviscometer 600), and of skin melanin and erythema index (CK Electronic Mexameter 18).

Results: Both qualitative and quantitative results indicate a superior efficacy of the combined modality in comparison to the 1450 nm diode for all photodamage signs except wrinkle improvement, which is not significantly different in either treatment group.

Conclusions: The preliminary results of this study suggest that wrinkles can be improved by a 1450 nm diode, but that additional modalities are necessary to erase other signs of photodamage.

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THE INTERACTION OF RADIO FREQUENCY ENERGY WITH THE SKIN

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Collagen regeneration in skin is a continuous process that is accelerated when the skin is damaged. Significant damage can produce scars through the overproduction of collagen. However, moderate heating of the dermis can increase collagen production with few side effects while improving the texture and feel of the skin.

A new radio frequency (RF) device is being used to treat skin. Evidence of skin tightening and improvement in wrinkles has been observed. RF heats the skin through resistive heating, which provides unique opportunities for targeting different depths of thermal damage. Due to the unique properties of RF, the area of the treatment tip affects the depth of penetration. Different layers of skin have different resistive and thermal characteristics, for example fat is 5 to 10 times more resistive than dermis. These two factors of depth of penetration and tissue resistance must be considered when designing treatment algorithms to produce the desired temperature.

A computer modeling program was developed to help predict and understand tissue heating and cooling with a RF device that is coupled with contact cooling. This program is able to show the depth of penetration for different sized treatment tips, location of maximal heating, and the effectiveness of cooling on the upper layer of the skin.

In animal studies the Thermage TC radio frequency system has been shown to change the structure of the skin. Disruption of the fat layer and the formation of new collagen have been observed through histology.

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NEW NON-ABLATIVE REHEATING DEVICE: ANESTHETIC METHOD TO ALLOW INCREASED FLUENCE AND ACCEPTABLE PATIENT COMFORT AND SAFETY

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A study was performed to evaluate the efficacy and safety of a new radiofrequency device for non-invasive browlifting and improvement of wrinkles in the peri-orbital area. Six patients were treated at the highest fluence tolerated with topical anesthesia alone. Ten patients were treated at higher pre-determined maximum fluence after nerve block anesthesia. Patients were asked to evaluate the pain of each treatment as well as the improvement seen at 1, 2 and 3 months post-op. The investigator evaluated adverse effects at 1 hour post-op and at visits for judgement of clinical efficacy 1, 2 and 3 months post-op. All treatments were conducted without evidence of side effects. Higher fluences resulted in greater clinical improvement. Volumetric decimal heating with radiofrequency is more effective at fluences greater than those tolerated with topical anesthesia alone. The fluence limiting factor is pain control rather than local adverse effects.

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SUCCESSFUL TREATMENT OF VITILIGO WITH THE 308 nm EXCIMER LASER

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Purpose: Evaluation of the 308 nm excimer laser as monotherapy for vitiligo in a larger series of patients.

Methods: 48 patients with vitiligo were treated with the 308 nm excimer laser three times per week. The energy output of the laser is fixed, with exposure time as the only variable. Therapy was begun at the lowest exposure time, and increased every other treatment. Repigmentation was assessed visually on a 4 point scale: 1 (0–25%), 2 (25–50%) 3 (50–75%) 4 (75–100%). Treatment was held if a sunburn developed.

Results: Group 1: 16.7%, group 2: 37.5%, group 3: 20.8%, and group 4: 25%. Overall, 45.8% of patients developed greater than 50% repigmentation. Repigmentation begins after 4–16 treatments (2–8 weeks) and in those patients with complete repigmentation, 6–30 treatments (2–10 weeks) were required.

Conclusion: Phototherapy with the 308 nm excimer laser results in partial repigmentation in the majority of patients in a fraction of the time conventional phototherapy requires. Proximal areas (face, trunk) respond better than distal areas (hands, feet). Darker skin types respond better, and newer lesions respond better than older lesions.

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TREATMENT OF FACIAL HYPOPIGMENTATION AND HYPOPIGMENTED SCARS WITH USE OF THE 308 nm EXCIMER LASER

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Purpose: Various resurfacing procedures have been problematic in that they sometimes will create hypopigmentation post-operatively. This has become a problem in some patients treated with the CO_2 laser for either acne scarring or facial photodamage. Particularly, the area of the jawline and the neck have been prone to this problem. There have been no effective treatments in the past except to decrease the pigmentation of the surrounding areas in order to diminish the contrast. Recently however, the Excimer laser has been shown to be capable of stimulating the pigment in these areas. The purpose of this study is to evaluate the response of hypopigmentation and hypopigmented facial scars to treatment with the Excimer laser.

Methods: Patients were treated at a twice weekly basis starting with 300 mJ/cm^2 with the intent of inducing erythema at 24 to 48 hours post-op. If erythema was seen, the same treatment dose was held for the next treatment. If there was not erythema, the dosage was increased by 50 mJ. The response of pigmentation to treatment was evaluated at each clinical visit.

Results: All patients responded with at least 50% increase in pigmentation. The number of treatments required to reach this level of improvement varied from 2 to 14 treatments. Adverse effects included occasional blistering and peeling.

Conclusions: The 308 nm Excimer laser shows promise in the treatment of hypopigmented scars and hypopigmentation secondary to resurfacing.

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308 nm EXCIMER LASER USED IN REPIGMENTATION OF SCARS AND STRIAE

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To assess safety and efficacy of the 308 nm excimer laser in repigmentation of hypopigmented scars and striae.

15 adults with hypopigmented scars or striae were included. Pretreatment minimal erythematous dose (MED) tests were performed. Prior to each treatment, investigator assessment, photographs, and spectrophotometric analyses of treated and matched control sites were conducted. A starting dose of MED minus 1 MED was delivered biw until 50–75% repigmentation, followed by q2w thereafter for a maximum of 10 treatments, 75% increase in spectrophotometric ratio to baseline, or 100% clinical repigmentation. If no erythema or no response by spectrophotometric analysis, the dose was increased 1 MED per treatment. If blistering or burning occurred, the dose was decreased by 1 MED. Subjects were evaluated at 1, 2, 4, and 6 months post-treatment.

The mean percent repigmentation by visual assessment was 5% after 1, 10% after 2, 20% after 3, 30% after 4, 35% after 5, 40% after 6, 45% after 7, 60% after 8, 70% after 9, and 70% after 10 treatments. The mean percent change in pigment by spectrophotometry was 1.46% after 1, 1.84% after 2, 3.41% after 3, 4.69% after 4, 1.39% after 5, 2.86% after 6, 2.24% after 7, 3.06% after 8, 3.42% after 9, and 10.20% after 10 treatments. The mean percentage ($\pm$SD) pigmentation relative to matched control sites by spectrophotometry at baseline was $96.39 \pm 5.24\%$; this increased to $97.98 \pm 5.41\%$ after 1, $98.57 \pm 5.98\%$ after 2. $99.26 \pm 5.52\%$ after 3, $100.15 \pm 6.86\%$ after 4, $99.10 \pm 4.69\%$ after 5, $99.17 \pm 4.03\%$ after 6, $97.74 \pm 4.77\%$ after 7, $101.80 \pm 6.64\%$ after 8, $100.21 \pm 6.20\%$ after 9, and 101.48% after 10 treatments.

Treatment with the 308 nm excimer laser is safe and effective in repigmenting hypopigmented scars and striae. Mean final repigmentation rates of 70% by visual assessment and of 100% relative to control sites by spectrophotometric analysis were observed after 9–10 treatments administered at biw intervals.

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308 nm EXCIMER LASER VS 595 nm FLASHLAMP PULSED-DYE LASER FOR THE TREATMENT OF PLAQUE PSORIASIS

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Our intent was to compare the effectiveness of the 308 nm excimer laser (Photomedex, San Diego, CA, Model #AL 7000) to the 595 nm flashlamp-pulsed dye laser (Candela Laser Corp., Wayland, MA) for the treatment of stable plaque psoriasis through a non-blinded, randomized, controlled study. 10 consecutive volunteers with stable plaque psoriasis were enrolled. Plaques measuring at least 8 cm by 8 cm were trisected. One-third of the plaque was treated with the excimer laser. Another third was treated with the flashlamp pulsed-dye laser. The remaining third served as the control. After mineral oil application excimer laser pulses with 25% overlap were given to the first third at 3-week intervals for up to 4 treatments. The initial dose was based on the plaque grade and varied from 3000 mJ/cm^2 to 12000 mJ/cm^2. Subsequent treatment doses began at 500 mJ/cm^2 and were incrementally increased as tolerated. Another one-third was treated with the 595 nm flashlamp pulsed-dye with non-overlapping 7 mm spot-size pulses of 9 J/cm^2 every 3 weeks for up to 4 treatments. A modified psoriasis area severity index (PASI) score was determined before each treatment for each segment. The follow-up period was 6 months. Adverse effects were minimal. Both lasers produced a therapeutic response relative to the untreated control area. Immediate clinical response was different between the two lasers but at the time of abstract submission final response data was not available.

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SKIN PIGMENTATION INDEX AS A PREDICTIVE PARAMETER FOR OPTIMIZING LASER AND LIGHT TREATMENTS

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A quantitative and objective technique for predicting possible side effects and optimizing treatment parameters of a laser- or light-based dermatological procedure is highly desirable. Until now, no commercial devices realizing this function were available.

In this study, we investigated the feasibility of using real-time measurements of the skin pigmentation index (PI) for this purpose. The PI is defined as a quantity proportional to the concentration of melanin in the skin. The PI was determined from the slope of spectral dependence of the skin reflectance in the red spectral range. Group of patients with different skin types and PIs varying in wide limits has been test-treated with a flash-lamp-based photoepilation system. The PI has been measured pre- and post-treatment. We found a strong correlation between the pre-treatment PI and the incidence of side effects. In addition, the safety threshold levels of fluence and pulsewidth have been determined as a function of the pre-treatment PI. Based on these results, we have built a prototype of the control feedback system, which integrates a PI sensor into design of a flash-lamp-based device. The integration area of the PI sensor coincides with the treatment area of the device. Thus, the PI data are collected exactly from the site designated for treatment immediately prior to the procedure. The control unit then selects optimal treatment settings (fluence and pulsewidth) according to the measured PI value.

The proposed feedback system may significantly decrease risk of side effects and extend patient population for a number of laser- and light-based dermatological procedures.

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A COMPARISON OF COLD AIR VS. A THERMOELECTRICALLY COOLED SAPPHIRE WINDOW FOR EPIDERMAL PROTECTION

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Purpose: To compare the epidermal protection provided by a cooled sapphire window and cold air during cutaneous irradiation with an 810 nm diode laser.
Methods: The Nidek 810 nm diode laser (Epistar®) was used to irradiate farm piglets with light (Fitzpatrick I-II) and dark (Fitzpatrick >III) skin. The skin was treated without skin cooling (control), and with cooling provided by the Zimmer cold air blower (cold air at -20°C) and a single thermoelectric chip cooled sapphire window (5°C). The fluence was increased until epidermal injury was observed. This fluence was considered the maximum tolerated fluence (MTF). Pilot studies were performed to determine the cooling parameters with each device that would provide maximum epidermal protection. All studies were approved by the Vanderbilt University Animal Care and Use Committee. Biopsies were taken acutely and on days 7, 14, 21, and 28.
Results: When treating light colored piglets without additional surface cooling the maximum tolerated fluence was 250 J/cm^2. When the epidermis was protected by the cooled sapphire window, the MTF increased to 325–350 J/cm^2. With the cold air device cooling the epidermis 400 J/cm^2 could be delivered without producing epidermal injury. When treating dark colored piglets without supplemental cooling, the MTF was only 50 J/cm^2. This increased to 75 J/cm^2 when using the cooled sapphire window and to 150 J/cm^2 when using cold air. Histopathologic evaluation of biopsy specimens taken from air-cooled treatment sites revealed the expected thermal changes around hair follicles and collagen remodeling in the mid-dermis. When a dual-chip window was used on a light colored piglet, the MTF was equal at 350 J/cm^2.
Conclusion: The cold air device provided greater epidermal protection than the single-chip cooled sapphire window when light and dark colored farm piglets were irradiated with an 810 nm diode laser. Cold air-cooling may play a useful role in cutaneous laser surgery.

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A CLOSER LOOK AT DYNAMIC COOLING

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Epidermal melanin is often an undesired target chromophore during laser treatment of dermal targets such as blood vessels and hair follicles. Irreversible epidermal injury can be minimized by epidermal cooling, which is especially important in darker skin types. There are several methods for skin cooling, all of which extract heat by conduction into an external, cold medium. The rate of epidermal cooling depends on temperature, quality of contact, motion, and thermal properties of the external medium. Cryogen spray cooling (CSC) provides aggressive and dynamic cooling, by aerosol spurt application of a liquid cryogen layer at the skin surface during or before delivery of a laser pulse. CSC has been shown to provide useful epidermal protection, but it is not clear what events other than simply skin cooling are occurring. For example, a patient with apparent cryogen-induced injury (permanent hypopigmentation) was seen, after treatment with CSC during hair removal. We studied fast events during CSC in combination with an alexandrite laser, using a high-speed video imaging device at 2 kHz frame rate. During sprays from 10–100 ms duration, the skin surface is grossly indented by pressure, and a light-scattering cloud of cryogen droplets is present above the skin surface. On impact of the laser pulse, liquid cryogen is blown away laterally across the skin. Residual pools of liquid cryogen occasionally form, especially after long spray durations. These pools continue to freeze the skin long after both the CSC spurt and laser pulse, and may account for CSC-induced injury in some cases. Frost (atmospheric water condensation and freezing) then forms on the skin surface, well after the end of CSC spurts greater than about 30 ms. Frost formation requires that the skin itself be frozen. We conclude, that CSC is a useful and aggressive mode of skin cooling which allows somewhat higher fluences to be used in dark skin. However, the CSC spray and ice formation inside the skin may also block some of the laser beam by optical scattering. Pooling of residual cryogen after sprays of about 100 ms or more may be capable of unwanted cryogen injury, such as the classic response of hypopigmentation due to skin freezing.

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TWO RANDOMIZED, DOUBLE-BLIND, PLACEBO-CONTROLLED STUDIES EVALUATING S-CAINE PEEL FOR INDUCTION OF LOCAL ANESTHESIA PRIOR TO LP Nd:YAG LEG VEIN THERAPY

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Evaluate efficacy of S-caine local anesthetic peel (1:1 7% (w:w) eutectic mixture of lidocaine and tetracaine base) induction of local anesthesia prior to LP Nd:YAG laser leg vein therapy. Two consecutive randomized, double-blind, placebo-controlled studies. Study #1: 60 adults received active S-Caine and placebo cream randomized to top/right or bottom/left section of leg vein for 30 or 60 minutes (m). 30 m was inadequate, and all subsequent (48) patients received 60 m applications. The cream dried to form flexible membrane, peeled off prior to irradiation. Ten-to-50 pulses of LP Nd:YAG (1064 nm, 140–400 J/cm^2, 30–100 ms,1.5–5-mm spot, contact cooling) were delivered. Efficacy was evaluated by patient visual analog pain scale (VAS) (0-100) and impression, investigator pain scale (1-4) and impression, and independent observer pain scale (1-4); and safety by investigator erythema/eschar (0-4), edema (0-4), and blanching (0-5) scales, and recording adverse reactions. Study #2: 30 adults with same parameters, comparing 60 and 90 m applications. Study #1: Patient VAS lower for active sites ($p = 0.046$) with adequate relief in 48% of active vs. 23% of placebo sites ($p < 0.001$). Investigators reported no-mild pain in 50% of active vs. 33% of placebo ($p = 0.007$), and adequate anesthesia in 65% vs. 43%, respectively ($p = 0.002$). Independent observer assessed no-mild pain in 52% of active vs. 37% of placebo ($p = 0.067$). Safety evaluation showed 1 case of erythema after 60 m, resolving in 20 m. Study #2: Median VAS scores were 14.5 for active vs. 49.0 for placebo; 23 points better for active vs. placebo after 60 m ($p = 0.010$), and 27 points better after 90 m ($p < 0.001$). Patients assessed adequate anesthesia in 55% of active vs. 15% of placebo after 60 m ($p = 0.003$), and 65% vs. 0% after 90 m ($p < 0.001$). Investigators assessed less pain in 65% of active vs. 20% of placebo after 60 m ($p = 0.012$), and 75% vs. 10% after 90 m ($p = 0.002$); adequate anesthesia in 65% vs. 20% after 60 m ($p = 0.029$), and 70% vs. 5%, after 90 m ($p = 0.001$). Independent witness evaluated less pain in 65% of active vs. 15% of placebo after 60 m ($p = 0.008$) and 65% vs. 10% after 90 m ($p = 0.004$). Overall, VAS scores were lower in 83%, with no pain in 80%, investigators assessed no-slight pain in 80% and adequate anesthesia in 78%, and independent observer assessed no-slight pain in 83%. The S-Caine peel provides safe and highly effective local anesthesia when applied for at least 60 minutes. Facile removal of the peel provides a unique advantage and ease in administration.

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INVESTIGATION OF THE USE OF CHEMICAL AGENTS TO IMPROVE LASER TREATMENT OF PORT WINE STAINS

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Laser treatment of port wine stains (PWS) requires delivery of a sufficient amount of laser light to the targeted blood vessels to heat and destroy them. Laser wavelengths currently under investigation for PWS treatment (e.g., 577, 585, and 595 nm) are highly scattered by the dermis. We hypothesize that a reduction in light scattering would improve the efficacy of PWS laser treatment. Previous studies have shown that hyperosmotic agents can reduce the amount of dermal scattering, rendering the skin more transparent. The results of these studies were obtained either through injection or direct application to the dermis. Ideally, an agent can be applied directly to the skin surface and passively diffuse into the skin. However, the stratum corneum acts as a resilient barrier to chemical delivery into the underlying skin layers. The goal of this study was to identify compounds that can diffuse into the skin after topical application. *In vitro* human skin samples were placed on Franz diffusion chambers and sealed with an o-ring to minimize dehydration. 100 μL of a given compound was placed onto the skin surface, and optical coherence tomography (OCT) was used to measure the depth-resolved skin backscattering signal at different timepoints over a 24-hour period. In total, 14 compounds were evaluated, of which two were identified as substantially improving OCT imaging depth and hence skin transparency. We are currently investigating different methods for improving the rate of agent diffusion into the skin.

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THE EFFECTS OF MULTIPLE PASSES ON PURPURIC THRESHOLD AND DEPTH OF TISSUE INJURY IN EXTENDED PULSE DYE LASER (PHOTOGENICA V-STAR)

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Introduction: The use of multi-pass treatments with pulse dye lasers has largely been avoided due to a greater risk of side effects associated with treatment. However, previous research has shown that appropriate use of multiple passes can be used for successful treatment of vessels due to additive vessel damage, while limiting collateral damage. But treatment was traditionally too slow to be used. New extended pulse dye lasers provide a broad range of parameters and faster treatment allowing judicious use of multi-pass procedures. To better understand multi-pass treatments, it is necessary to understand how time between pulses, and the number of passes affects the purpuric threshold and the extent of tissue damage.
Methods: 10 subjects were recruited and exposed to a series of test spots on normal buttocks skin to determine purpuric threshold and depth of injury for a variety of pulsewidths, inter-pulse intervals, and number of passes. The test spots consisted of exposures at 0.5-msec from 2 to 6 J/cm^2 and at 40-msec from 6 to 12 J/cm^2. Exposures consisted of 1x, 2x, and 3x passes, at intervals of 1, 2, 5, and 10 sec between consecutive pulses. All treatments were done using the PhotoGenica V-Star, with SmartCool air cooling. 3 Biopsies were taken at the fluence of the 0.5-msec, single pass purpuric threshold for 1, 2 and 3 pass treatments to determine the extent of tissue damage associated with multiple passes.
Results: Purpuric thresholds were reduced with multiple pass treatments. Reduction in threshold was found to be inversely proportional to inter-pulse interval. The extent of injury was found to be greater with multiple passes. Guidelines for multi-pass treatments and inter-pulse intervals effects treatment planning and clinical outcomes will be discussed.

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ROBOTIC TREATMENT OF MICROVASCULAR LESIONS

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A robotic laser tool (called the "Smart Scalpel") is being developed for the treatment of microvascular lesions. The purpose of this work is to study the clinical effectiveness of this treatment device on animal model. The Smart Scalpel employs reflectance spectroscopy and computer vision to identify and selectively treat hundreds of small blood vessels with a focused treatment laser. In our study, we used the Smart Scalpel to treat vessels on rabbits' ears. Each individual vessel is spatially traced with a focused laser, and the laser dosimetry is adjusted according to the size of the vessel. Our results showed that the vessels are successfully and selectively treated using this new method. Histology showed vessel thermal coagulation with minimal or no damage to surrounding tissues. This observation is expected because the laser from the Smart Scalpel only targets blood vessels, leaving the surrounding healthy tissue unexposed. We conclude that a computer vision-guided laser could potentially be used as an alternative approach to the treatment of microvascular lesions. Moreover, selective targeting is achieved by beam steering such that different skin targets might be addressed by software rather than hardware changes.

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ENDOLUMINAL LASER TREATMENT OF THE GREATER SAPHENOUS VEIN AT 810 nm

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Purpose: To evaluate the safety and efficacy of closing the greater saphenous vein with an 810 nm diode laser.
Methods: Twenty consecutive patients with incompetent greater saphenous veins (GSV) with reflux from the saphenofemoral junction (SFJ) were treated with endoluminal laser ablation with a 810 nm diode laser. Veins were accessed in the mid thigh through an ambulatory phlebectomy technique under tumescent anesthesia. The laser fiber was placed within the lumen of the GSV up to the SFJ. The location was checked by transillumination and with Duplex evaluation. The vein segment distal to the SFJ was exposed to intermittent laser exposures of 1 sec. Duration at 12 W every 2–4 mm. Patients were evaluated 1 day, 1week, 3 and 6 months after laser treatment with duplex examination to the GSV.
Results: Average of 20 cm of the GSV distal to the SFJ was treated with an average of 915 J of energy during an average 2.48 minute total exposure (approx. 8 cm/min). Two patients had recurrent flow and reflux of the GSV. Two patients had normalized flow without reflux of the GSV. 16/20 patients (80%) maintained complete closure of the GSV throughout the 6 month follow-up period. All patients had resolution of painful varices. Of the 5 patients with ankle edema, 4 had resolution of the edema. No adverse sequelae occurred in any of the patients. Purpura lasted 7–14 days.
Conclusion: Endoluminal laser closure of the GSV in the presence of SFJ reflux is safe and effective. This treatment compares favorably with both ligation and striping and endoluminal radiofrequency closure.

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COMPARISON OF ENDOVENOUS RADIOFREQUENCY VERSUS 810 nm DIODE LASER OCCLUSION OF LARGE VEINS IN AN ANIMAL MODEL

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Endovenous occlusion using radiofrequency (RF) energy has been shown to be effective for the elimination of sapheno-femoral reflux and subsequent elimination of varicose veins. Recently, endovenous laser occlusion has been introduced with initial clinical reports indicating effective treatment for varicose veins. However, in our practice we note increased peri-operative hematoma and tenderness with the laser. Little is known regarding the mechanism of action of this new laser vein therapy. To better understand the mechanism of action of endovenous laser versus the endovenous RF procedure in the jugular vein of the goat model. A bilateral comparison was performed using 810 nm diode laser transmitted by a bare-tipped optical fiber versus the RF delivery by engineered electrodes with a temperature feedback loop using a thermocouple (Closure^{TM} procedure) in 3 goat jugular veins. Immediate and one week results were studied radiographically and histologically. Temperature measurements during laser treatment were performed by using an array of up to five thermocouples, spaced 2 mm apart, placed adjacent to a laser fiber tip during goat jugular vein treatment. Immediate findings were that 100% of the laser treated veins showed perforations by histological examination and immediate contrast fluoroscopy. The RF treated side showed immediate constriction with maintenance of contrast material within the vein lumen and no perforations. The difference in acute vein shrinkage was also dramatic as laser treatments resulted in vein shrinkage of 26%, while RF treated veins showed a 77% acute reduction in diameter. At one week, extravasated blood that leaked into the surrounding tissue of laser treated veins acutely, continued to occupy space and impinge on surrounding structures including nerves. For the laser treatment, the highest average temperature was 729°C (peak temperature 1334°C) observed flush with the laser fiber tip, while the temperature feedback mechanism of the RF method maintains temperatures at the electrodes of 85°C.

Vein perforations, extremely high intravascular temperatures, failure to cause significant collagen shrinkage and intact endothelium in an animal model justify a closer look at the human clinical application of the 810 nm endovenous laser technique.

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TREATMENT OF LEG VEINS WITH EXTENDED PULSEWIDTH PULSE DYE LASER (PHOTOGENICA V-STAR)

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Purpose: Successful laser treatment of leg veins requires both and understanding of the pathophysiology of the particular malformation, and an understanding of the specific laser tissue interactions required for proper resolution. High energy, extended pulse dye lasers [EPDL] with cooling provide an opportunity to treat these larger vessels with longer pulse durations and multi-pass technique. Understood and used properly, these new effects allow treatment of a greater range of vascular malformations.

Methods: To evaluate appropriate treatment of leg veins using high energy EPDL (PhotoGenica V-Star, Cynosure, Inc.), we treated 20 patients presenting with red and red-purple leg veins from .3 to 1.2-mm in diameter. Treatment performed using the 40-msec pulse duration, a 7-mm handpiece, fluences ranging from 13 to 16-j/cm^2, and simultaneous air cooling (SmartCool, Cynosure, Inc.). Treatment was delivered in multi-pass fashion, using intravascular coagulation as the treatment endpoint. Lesions were photographed prior to and following treatment. Comparison of results with pre-treatment photos allowed grading of efficacy on a quartile scale (0–25% = poor, 26–50% = fair, 51–75% = good, 76–100% = excellent).

Results: The majority of patients exhibited excellent clearance. No reported significant side effects other than immediate purpura and post inflammation hyperpigmentation lasting months. The ability to use longer pulse durations and higher fluences in conjunction with multiple passes provides new options to use reliably on the treatment of leg veins. High energy, extended pulse width pulse dye laser with cooling provide a practical opportunity to finally treat these larger vessels in an office environment with pulse duration and multiple pulse techniques which in the past have only been possible in laboratories. The effects of pulse duration, pulse format, fluence, and parallel cooling will be discussed.

MINI–TALK SUMMARIES

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INTERACTION OF UV WITH CELLS IN LASER SURGERY*

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UV laser has been widely used in laser surgery. The interaction of UVC and UVB with cells is resonant. For example, UVB directly activates death receptors on the cell surface including CD95 to induce cell apoptosis. Although the central intensity of the UVA laser beam is so intense that it destroys the tissue, the edge intensity is so low that the non-resonant interaction of UVA with cells can induce biomodulation. In this paper, we extend our biological model of low intensity laser irradiation (BIML) to UVA biomodulation on cells, which was called UBIML. According to UBIML 3, UVA at dose 3 should activate cAMP phosphodiesterase through G_i protein or activates phosphoinositide phospholipase C (PLC) through G_q protein or activates one of receptor-linked enzymes. UBIML 3 is directly verified by the study of Klotz et al. (1999) and Zhang et al. (2001) on UVA irradiation at 300 and 160 kJ/m^2, respectively. Our investigation showed that biomodulation of UVA on cells might play an important role in the long-term effects of UVA laser surgery.

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