Split Treatment of Photodamaged Skin with KTP 532 nm Laser with 10 mm Handpiece Versus IPL: A Cheek-to-Cheek Comparison

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Background and Objectives: The treatment of photodamaged skin with potassium-titanyl-phosphate (KTP) laser and intense pulsed light (IPL) has been reported in several studies. Each device has strengths and weaknesses; however, patient and device variability have made it difficult to ascertain the optimal device for photorejuvenation. The objective of this study was to obtain a head-to-head comparison of IPL and KTP laser for photorejuvenation. Each patient received one KTP laser treatment on one side of the face and one IPL treatment on the other side.
Study Design/Materials and Methods: Seventeen patients with skin types I–IV were accepted into the study based on existence of dyschromias (pigmented and vascular) and/or discrete telangiectases. After performance of test spots on each patient to determine optimal settings for both devices, patients were treated with both devices in a split face manner. Evaluations and photographs were performed 1 week and 1 month after treatment. Patient and observer evaluations of results were recorded, as well as time to perform each treatment, and patient feedback with regard to pain and edema. No anesthesia was used in these treatments. Photographs were reviewed by a panel of blinded observers to assess changes in red and brown dyschromias.
Results: One month average improvement (evaluator) for IPL side was (mean) 38.16%/35.08% for vascular/pigment lesions versus 41.99%/30.21% for KTP side. Patient self-evaluated global improvement at 1 month was (mean) 65.59% for IPL side versus 60.88% for KTP side. A majority of patients found the KTP to be slightly more painful with a mean pain rating of 5.27 of 10 versus 4.4 of 10 for IPL. A majority of patients experienced subjectively greater post-procedure swelling on the KTP side. Time to conduct treatment was an average of 10.0 minutes for IPL, 8.7 minutes for KTP.
Conclusions: Both large spot KTP and IPL achieved marked improvement in vascular and pigmented lesions in one session. The KTP laser caused slightly more discomfort and edema than the IPL. On the other hand, the KTP laser was faster, and more ergonomically flexible.

Key words: dyschromia; photorejuvenation; pigment; telangiectasia

INTRODUCTION

Two popular devices for treatment of photodamaged skin are the pottasium-titanyl-phosphate (KTP) laser and intense pulsed light (IPL). Variations in devices, patient skin characteristics, and operator technique make it difficult to determine whether the KTP laser or the IPL device is a better choice for photorejuvenation (use of light-based technology for treatment of chronic photodamage). We performed a side-by-side study to compare the photorejuvenation capabilities of these two devices.

MATERIALS AND METHODS

Seventeen patients over the age of 18 with Fitzpatrick skin types I–IV were screened into this study based on the presence of pigmented and/or vascular dyschromias (discoloration of the skin caused either by variations in pigment density or ectatic blood vessels). To be included in the study, patients were not allowed to have used any topical or systemic medications for cutaneous skin disease or rejuvenation in the past 6 months. Also, patients were not allowed to have received any surgical or light-based rejuvenation treatments in the previous 6 months. Patients were excluded if they were immunocompromised or had an active infection, coagulation disorder, history of photosensitivity or allergy, history of vitiligo, psoriasis or keloid formation, or were currently pregnant or nursing.

After approval of the protocol by our Institutional Review Board, written consent from all patients was obtained. Patients were randomized to receive either KTP or IPL treatment on either side of the face. One device was the Gemini (Laserscope, San Jose, CA), a high power KTP laser with two types of handpieces. One handpiece has a fixed 10 mm spot size with variable pulse duration and a photon recycler (the inner chamber of the handpiece is coated with a white diffuse reflective material that returns energy

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remitted out of the skin). The second handpiece has a 1–5 mm variable spot size (changeable in 0.1 mm increments) with variable pulse duration and a clear sapphire window. The IPL devices were the Medilux and Starlux Systems (Palomar Medical Technologies, Burlington, MA) equipped with LuxG handpieces.

Pigment measurements were taken using a reflectance spectrophotometer (EMM-01, Palomar, Burlington, MA) at representative areas of the neck and cheeks. The readings allowed us, along with the experience of the principal investigator (EVR), to establish safe yet efficacious settings for each device, as follows. For the 10 mm spot KTP laser, three "test" spots were applied to the neck with escalating doses of 7, 8, and 9 J/cm^2 with a fixed pulse duration of 30 milliseconds. One test spot was delivered to each site. The IPL test sites were performed on the neck in a similar fashion, as follows. The green handpiece was used with the Palomar MediLux or Starlux system. Buttons 4, 5, and 6 (21, 26, 33 J/cm^2, respectively on the Medilux) or fluences of 32, 36, 40 J/cm^2 (Starlux) were used for the test sites. For both devices (KTP and IPL), if the facial pigmentation was the same as the neck, the maximum dose of light that did not leave well-circumscribed "footprint" type redness after 10 minutes was applied to the face. If the pigment on the face was greater than on the neck, the fluence was adjusted on the face by the formula $\text{Fluence}_{\text{face}} = \text{Fluence}_{\text{neck}} \times (\text{Pigment index}_{\text{neck}}/\text{Pigment index}_{\text{face}})$.

Once the maximum "safe" fluence was established via the aforementioned protocol, full-face treatments were performed with the respective devices. The KTP laser and the Starlux IPL used integrated contact cooling with a sapphire window. On the other hand, active integrated cooling was not available with the Medilux; with this device hand-held cold aluminum rollers were used to cool the skin directly (Palomar Cool Roller Applicator, Palomar Technologies). Also, every four pulses, the sapphire handpiece tip was cooled for 3 seconds with a cryogen spray (Coolspray cryogen spray, Palomar, Burlington, MA).

For both KTP and IPL devices, water-based refrigerated gel was used to ensure good contact between the handpiece tip and the skin (Aquasonic 100 Transmission gel, Parker Laboratories, Fairfield, NJ). Digital photographs were taken with an SLR camera (Fuji S1 Pro with Nikon Speedlight flash and Nikon 60 mm Nikkor macro lens, f-stop 32) with and without cross polarization filters.

No anesthesia was used in any patient. Photographs were taken after completion of each treatment. The elapsed time to perform each treatment was recorded as well as patient ratings on level of pain for each device. Patients returned for 1-week and 1-month post-treatment photographs. The pre-treatment photographs were compared to the 1-month post-treatment photographs and blinded observers (dermatology staff and residents) were asked to grade improvement of pigmented lesions (ephelides/lentigines) and vascular dyschromias (telangiectases or diffuse redness). No patients dropped out of the study.

Data was analyzed using the StATA statistics program (StataCorp LP, College Station, TX) with the Wilcoxon signed-rank test for the following treatment categories. (1) time to complete treatment, (2) vascular improvement (observer), (3) pigment improvement (observer), (4) reported pain, and (5) global improvement (patient). A binomial test was used for the presence or absence of edema.

RESULTS

Typical pre-treatment and 1-month post-treatment pictures are included (Figs. 1 and 2). One month average improvement (evaluator) for the IPL side was 38.16%/35.08% for vascular/pigment lesions versus 41.99%/30.21% for KTP side. Patient self-evaluated global improvement at 1 month was 65.59% for IPL side versus 60.88% for KTP side.

Use of the Palomar EMM-01 "pigment meter" was an important tool in treating each patient with settings that maximized efficacy for each device. As seen in Figures 3 and 4, the three test sites were performed with each device for each patient in a non-facial area of skin that was representative of the facial pigment. The fluences were adjusted based on these results, which allowed us to maximize safety for each individual. In general, lower fluences were used on the lateral face and forehead, with higher settings used for the central face (we noted pigment tended to be about 15% higher along the lateral cheeks). Typical settings used were based on the test site showing erythema that faded within 10 minutes of treatment. Using these settings, typical post-treatment appearance demonstrated erythema and edema and were similar on both sides, as demonstrated in the photo seen in Figure 5 taken immediately post-treatment.

A majority of patients found the KTP to be slightly more painful with a mean pain rating of 5.27 of 10 versus 4.4 of 10 for IPL. A majority of patients experienced subjectively greater post-procedure swelling on the KTP side. In two of the cases, the edema on the KTP side was significant enough to prompt calls from patients the day following treatment due to concerns of "blistering." Subsequent

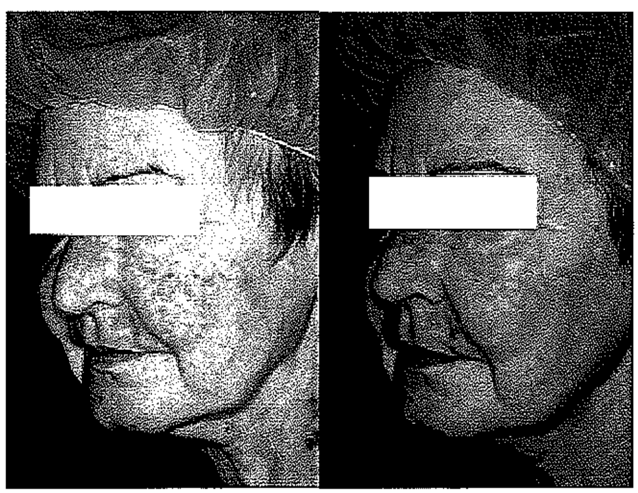

Fig. 1. Pre (**left**) and 1 month post-treatment (IPL). Settings of 32–36 J/cm^2 were used on the lateral cheek while 36–40 J/cm^2 were used on the central cheek and nose. Note the advantage of the polarizing filter.

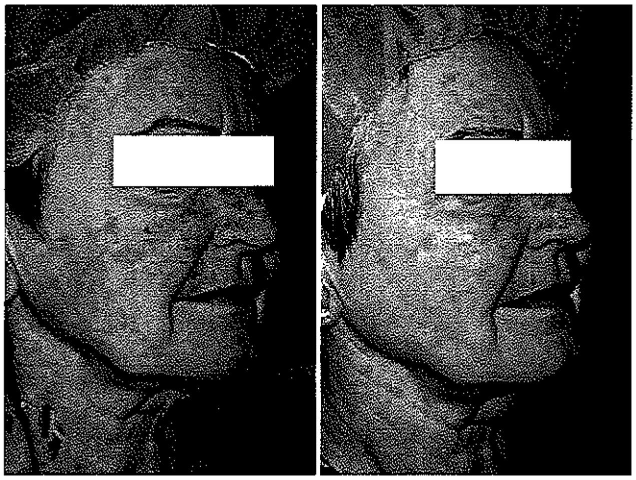

Fig. 2. Pre (**left**) and 1-month post-treatment (KTP). Lower fluences (8–9 J/cm^2 used on the lateral cheek while on the central cheeks and nose higher fluences (9–10 J/cm^2) were used.

examination demonstrated only erythema and edema, both in the infraorbital area of the KTP-treated side. No vesicles or bullae were detected. "Peppering" was a common post-treatment finding. This finding consisted of immediate post-treatment darkening of a pigmented dyschromia followed several days later by a fine desquamation of the dyschromia in the form of a crust-scale. The IPL-treated sides typically demonstrated more post-treatment "peppering" at the sites of brown colored dyschromias. This correlates with final improvement of pigment dyschromias on the IPL side. This peppering was uniformly resolved within the 1-month follow-up period. Time to conduct treatment was an average of 10 minutes for IPL versus 8.7 minutes for KTP. Among all the tested categories, only treatment pain (KTP worse than IPL) differences achieved statistical significance (P value = 0.0215).

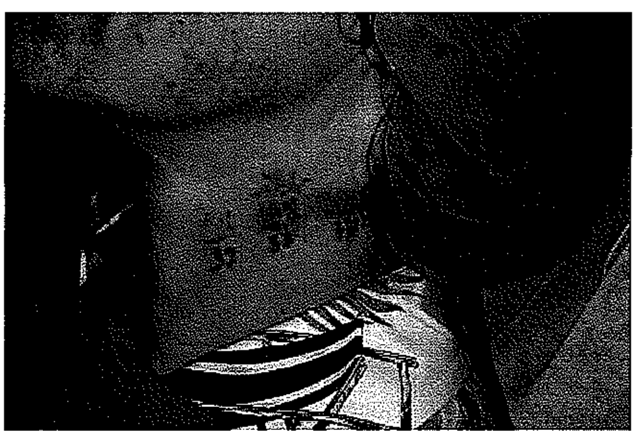

Fig. 3. Test spot results with the IPL (Starlux) Green hand piece at 32, 36, and 40 J/cm^2 from **left to right**. Note the more intense erythematous reaction as the fluence level is increased.

Fig. 4. Test spot results with the KTP at 7, 8, and 9 J/cm^2 from **left** to **right**. Note the increasing erythema as the fluence is increased.

DISCUSSION

IPL devices have been widely reported for the treatment of photodamaged skin [1,2,4–7]. The relatively large spot sizes achieve reduction of pigmented and vascular dyschromias in a relatively short treatment time. The KTP laser

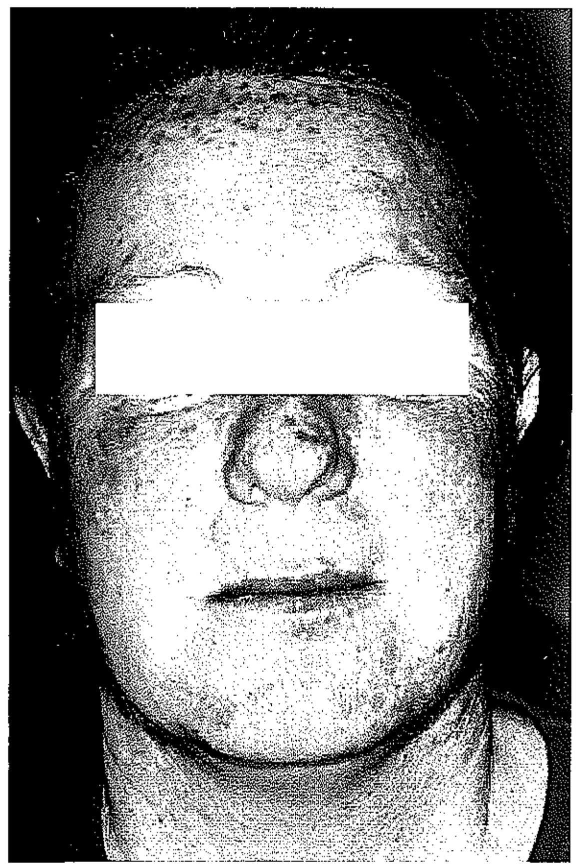

Fig. 5. Immediate post-treatment (IPL patient **right** side, KTP patient **left** side). Note nearly identical post-treatment appearance.

TABLE 1. Comparison of Selected KTP and IPL Systems

Laser	Spot size (mm)	Pulse duration (milliseconds)	Typical fluence (Type I–II skin) (J/cm^2)	Coverage rate (cm^2/second)
Iridex with scanner	0.7	10–25	14–18	0.26
Versapulse	4–5	15–20	9–11	0.5
Aura	4	35	9–11	0.25
IPL (Starlux)	10×15	20	25–36	0.9
Gemini	10	15–30	7–10	1–2

has enjoyed a good reputation for treating telangiectases on the face. However, small spot sizes and/or low repetition rates in most available KTP lasers have relegated usage to small areas of the face where individual vessels are "traced out." Three exceptions are (1) the Versapulse laser, (2) Iridex laser equipped with a scanner, and (3) the Aura laser. See Table 1 for typical settings for use in treating large areas with these devices. However, even when optimized for treating large facial zones, these lasers are much slower than IPLs. In Lee's report on the use of the KTP laser for photorejuvenation, the small spot size limited the coverage rate to about 1/4 of that of the Gemini KTP lasers used in this present study [3]. It follows that their practical use has been limited to treating small cosmetic areas such as the cheek.

The 10 mm handpiece in this study is driven by a high power (30 W) 532 nm laser that allows for coverage rates similar to IPL such that the physician can quickly treat entire cosmetic units without "aiming at" specific telangiectases and/or dyschromias. (See Fig. 6). With the 10 mm spot size, the KTP laser is as fast or faster than the typical IPL device.

This study demonstrates the efficacy of both the KTP 532 nm laser and the IPL as viable tools for photorejuvenation in a single treatment setting. The similarity in outcomes between the two devices is not unexpected if one examines the spectral emission of IPL and KTP laser versus the absorption spectrum of blood and melanin (Fig. 7). Based on these values, one can predict that both devices can achieve similar temperature elevations for pigmented and vascular lesions.

There are some important intrinsic differences between IPL devices and lasers. For example, the large umbilical cord associated with IPL device derives from the necessity to include high-voltage wires, cooling apparati, flashlamps, and control switches in the handpiece. It follows that the typical handpiece of IPL device is larger and heavier than a normal laser handpiece. Also, the rapid divergence of an IPL beam obliges contact or near contact between the IPL handpiece and the skin surface.

With the KTP laser, the light source (lamps and laser rod) is separated from the handpiece, and the emitted laser beam is focused into a fiber such that the handpiece can be held as comfortably as one holds a pencil. One of the advantages of the laser is the ability to change spot sizes during a treatment session to focus on specific resistant lesions and/or areas of the skin where the topography is more accommodating for a smaller spot. For example, the IPL device's large footprint (or 10 mm laser spot) is ideal for broad surfaces of the cheeks and the head. On the other hand, along the concave area of the nose and the regions around the columella, the flexibility to change spot sizes

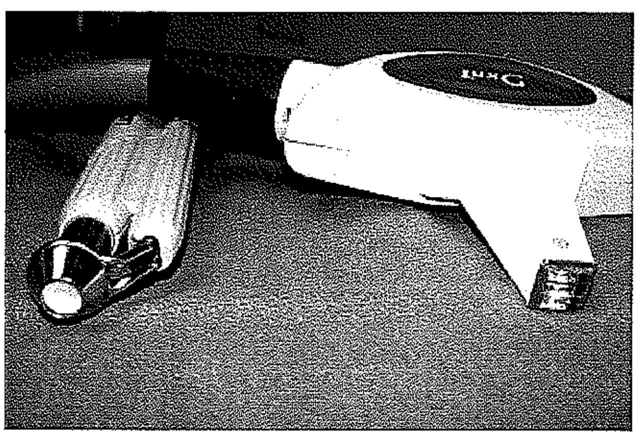

Fig. 6. Laserscope Gemini KTP 10 mm handpiece (left), Palomar IPL LuxG handpiece (**right**).

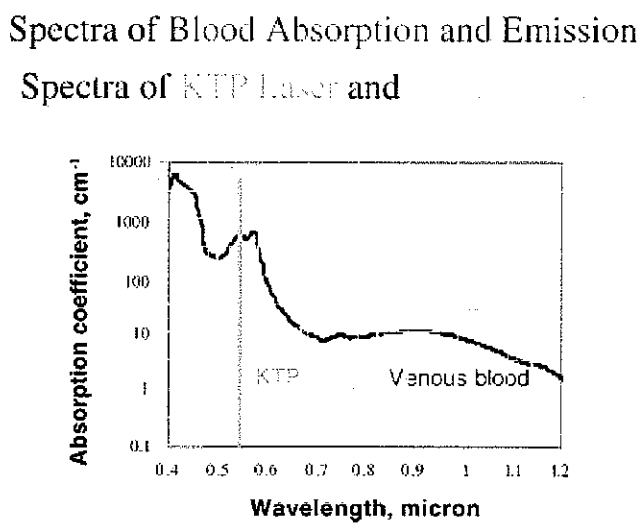

Fig. 7. IPL LuxG spectra versus KTP. Note that the LuxG spectrum may not be representative of other green-yellow IPL systems.

Fig. 8. Mild crusting of nose on IPL-treated side at 36 J/cm^2 (1-week post-treatment).

"on-the-fly" makes the laser an ideal instrument for treating small "irregular" areas of the face. With the smaller spot size range (1–5 mm) of one of the two available handpieces of this particular Gemini KTP laser, one can comfortably treat irregular skin surfaces. Also, the transparent sapphire window with the variable spot 1–5 mm handpiece allows for real time visualization of immediate desired endpoints, either pigment darkening (for dyschromias) or vessel disappearance. Another advantage of the KTP laser is that the relatively shallow penetration of the monochromatic green light will not affect hair growth. On the other hand, with the IPL we have observed hair reduction in the beard area of men after treatment over the lateral cheeks. Most likely this is due to the longer wavelength portion of the spectrum (see Fig. 7).

Although, the study did not show significant differences in efficacy between the devices, there are some distinctions in the devices that that can be culled from our results. One important finding was the vascular to pigment damage ratio for the two devices and the relationship between this ratio and treatment of darker skin. The sole study patient who developed crusting at a treatment site (Fig. 8) had darker skin (Fitzpatrick skin type IV) and only developed crusts at the IPL site. This observation illustrates one of the challenges in IPL treatment in darker skin types. In darker patients, for example, the threshold for telangiectasia clearance with the IPL in our study was 34 J/cm^2, however the threshold for epidermal damage was about 28–30 J/cm^2. On the other hand, the KTP laser with a 5 mm spot will normally clear a vessel with a fluence of about 8 J/cm^2 (15 milliseconds pw); the same vessel requires only 7 J/cm^2 with the 10 mm spot. The threshold for epidermal damage is just above this level. It follows that for those patients with darker skin types and telangiectases (albeit not as large a group as fair skinned patients with telangiectases), the KTP laser may represent a safer choice. Most candidates for photorejuvenation tend to be of the Fitzpatrick I or II skin type. Therefore, in this study, there was an inherent selection bias towards treatment of patients who would be suitable for treatment with either device. Overall, untanned Fitzpatrick I or II patients also showed greater pigment clearance with the IPL than the KTP laser after one treatment, though the results did not reach significance.

CONCLUSION

Both "large spot" KTP laser and IPL achieved marked improvement in vascular and pigmented lesions in one session. The KTP laser caused more discomfort and edema than the IPL. On the other hand, the KTP laser was faster and more ergonomically flexible.

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