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Introduction

Acne vulgaris is a chronic, inflammatory and multifactorial skin disease. Follicular keratinization, increased sebum production, proliferation of Propionibacterium acnes (P. acnes), and inflammatory processes play major role in its pathogenesis. A number of therapeutic modalities affecting different steps in pathogenesis have been used for the treatment of acne vulgaris. Among those, topical comedolytics and anti-inflammatory agents have been widely used for mild to moderate acne vulgaris. Combination of systemic antibiotics with topical agents are generally preferred for the treatment of moderate acne vulgaris. Whereas severe or nodulocystic acne needs to be treated with systemic retinoids that mainly affect sebum production and follicular keratinization. All these medications provide effective control for acne patients but need to be used for long term, sometimes have serious side effects and cannot be tolerated by some patients.

Recently light-based therapies and lasers have been proposed for the treatment of acne vulgaris. Among these; phototherapy, photodynamic therapy, 585-nm pulse dye laser (PDL), 532-nm KTP laser, 1320-nm Nd: YAG laser 1450-nm Diode laser, 1540-nm erbium YAG laser have been all used for this purpose (1–5). They can offer an alternative treatment method to conventional acne modalities in selected patients, such as antibiotic resistant, nonresponder or noncompliant patients.

The 532-nm KTP laser is generated by using potassium titanium oxide phosphate (KTiOPO₄) for frequency doubling of Nd:YAG laser radiation. This wavelength is appropriate for the treatment of superficial vascular and pigmented lesions and used for the treatment of both acne vulgaris and rosacea. For acne vulgaris, photoactivation of bacterial porphyrins, reduction of sebum production and collateral damage to sebaceous glands are the proposed mechanisms for its mode of action (2,6).

ORIGINAL RESEARCH REPORT

Evaluation of 532-nm KTP laser treatment efficacy on acne vulgaris with once and twice weekly applications

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Abstract

Background: Light-based therapies and lasers have been proposed for the treatment of acne vulgaris but the efficacy and application periods of 532-nm KTP laser treatment are not clear. Objective: To evaluate the efficacy and safety of 532-nm KTP laser and compare the effects of once and twice weekly applications in the treatment of mild to moderate acne vulgaris.

Methods: Totally 38 patients were treated once weekly and twice weekly in group I and in group II respectively. One half of the face of each patient was treated with 532-nm KTP and the other half was remained as untreated. Patients were evaluated at the beginning, one and four weeks after the last treatment session with Michaelsson acne severity grading score (MASS).

Results: Statistically significant improvement was found at second control ($p<0.005$) in group I, and at the first ($p=0.004$), and second ($p<0.001$) controls in group II for treated sides. For both groups, changes of MASS were insignificant for untreated sites. Improvement of MASS of treated sides was not statistically significant between two treatment groups for both controls. Conclusion: 532-nm KTP laser treatment may be an alternative method in selected acne vulgaris patients. No significant difference was noted between once and twice weekly applications.

Key Words: 532-nm KTP, acne vulgaris, laser

Introduction

Acne vulgaris is a chronic, inflammatory and multifactorial skin disease. Follicular keratinization, increased sebum production, proliferation of Propionibacterium acnes (P. acnes), and inflammatory processes play major role in its pathogenesis.

A number of therapeutic modalities affecting different steps in pathogenesis have been used for the treatment of acne vulgaris. Among those, topical comedolytics and anti-inflammatory agents have been widely used for mild to moderate acne vulgaris. Combination of systemic antibiotics with topical agents are generally preferred for the treatment of moderate acne vulgaris. Whereas severe or nodulocystic acne needs to be treated with systemic retinoids that mainly affect sebum production and follicular keratinization. All these medications provide effective control for acne patients but need to be used for long term, sometimes have serious side effects and cannot be tolerated by some patients.
The aim of the present study is to evaluate the efficacy and safety of 532-nm KTP laser and compare the effects of once and twice weekly applications in the treatment of mild to moderate acne vulgaris.

**Materials and methods**

**Study design**

Forty-four patients clinically diagnosed as mild to moderate acne vulgaris, who had at least four inflammatory lesions and skin phototype I–III according to Fitzpatrick classification, were enrolled in this single-center prospective study. Patients, who had had systemic retinoid treatment for the last 6 months, treated with microdermabrasion within last 3 months, had systemic treatment for acne vulgaris within last two months or topical therapy for acne within last month, prone to hypertrophic scar and keloid formation, had seizures or autoimmune diseases and had been pregnant or on lactation were excluded from the study.

The local ethical committee (2009–45) approved this study. After signing informed consent form; personal information, severity scores of acne lesions and skin types were recorded.

Patients were randomly divided into two groups. Group I was treated once weekly for four weeks. Group II was treated twice weekly for two weeks. Both groups were treated with total of four treatment sessions. Laser treatment was applied to half of the face, and the other half remained as untreated. Laser treatments were performed with Gemini laser (Laserscope, San Jose, CA, USA). Patients were treated with the 532-nm KTP laser, by using 4-mm spot size, 20–40-ms pulse duration and 5–12 J/cm² fluence according to the skin type. Side of face to be treated was selected randomly. After application of the cooling gel to the entire face, laser treatment was applied by painting method with versaStat I to only one half of the face. Untreated side of the face was painted only by cold probe without irradiation. After treatment, patients were informed about photo-protection and recommended to apply at least SPF-30 sunblock.

**Evaluation of the lesions**

Evaluation of the patients was performed clinically by the same dermatologist according to Michaëlsson acne severity grading score (MASS), at the beginning, i.e. zero (MASS 1), one (MASS 2) and four (MASS 3) weeks after the last treatment session. For this purpose, lesions including open and closed comedones, papules and pustules located on both halves of the face were counted, acne severity score was calculated and photographed. Acne severity score was calculated according to the MASS. This was obtained by sum of the products which were calculated by multiplying the number of each type of lesion (comedones, papules, pustules and nodules) by its severity coefficient (0.5 for comedones, 1 for papules, 2 for pustules, and 3 for nodules). At the end of the treatment, success rate was evaluated by decrease of MASS between control visits, treated and untreated sides, and lastly between two groups (Figures 1 and 2). Side effects such as erythema, edema, burning sensation, colour changes and scar formation were scored between 0 and 3 (0, none; 1, slight; 2, moderate; 3, severe) by the patients.

**Statistical analysis**

Statistitical analysis was performed with SPSS (version 13.0, Release 13.01, license code 9071653; SPSS Inc. Chicago, IL, USA). For descriptive statistics, mean ± standard deviation and median (minimum - maximum) were used.

For the comparison of age, gender, skin phototype and previous therapies between two groups, Pearson chi-square test was used. Changes in the MASS were evaluated by Mann–Whitney U test, and treatment outcomes between two halves of the faces were compared with Wilcoxon signed ranks test. \( p < 0.05 \) was considered as significant.
532-nm KTP laser treatment on acne vulgaris

Results

Patients’ characteristics

Forty-four patients were included but only 38 (24 male 63%, 14 female 37%) of them completed the study. There were 12 male and 8 female patients in group I, 12 male and 6 female patients in group II. Mean ages (± standard deviation) of the patients were 21.0 ± 3.5 and 20.7 ± 2.7, durations of the disease were 1–10 years (4.5 ± 3.0) and 2–8 years (5.6 ± 2.0) in group I and group II respectively. There was no statistically significant difference between two groups according to gender (p = 0.929), age (p = 0.851), duration of the disease (p = 0.099) and skin photo type (p = 0.745).

Results of the clinical evaluation

MASSs at the beginning (MASS1) were significantly higher in group II for both sides of the face (p = 0.018). Since evaluation was based on decrease in MASS, this difference was not taken into consideration.

There was statistically significant improvement only at second control for group I (p = 0.005), whereas improvement was significant for the first (p = 0.004), and second (p < 0.001) controls for group II at the treated sides. For both groups, changes of MASS were insignificant for untreated sites. Improvement of MASS of treated sides was compared between two treatment groups for first and second controls, and it was also found to be statistically insignificant. Changes in MASS were presented in Tables I and II. None of the patients complained about the side effects such as erythema, edema, burning sensation, colour changes and scar formation.

Discussion

There are different treatment options for acne vulgaris such as topical antimicrobial creams, comedolytics, systemic antibiotics and retinoids that have different concerns regarding their efficacy, possible skin irritation, antibacterial resistance, teratogenity and long-term patient compliance. These issues forced clinicians to look for new treatment options such as light-based therapies. Different systems have been used for this purpose including 532-nm KTP laser, 585- and 595-nm PDLs, 1064- and 1320-nm Nd: YAG lasers, 1450-nm diode laser and 1540-nm Er: YAG laser. In addition to lasers a number of non-invasive acne treatments emerged recently including short and broad band visible light, photodynamic therapy (PDT) and radiofrequency energy (1–5,7,8). Traditional treatment options need longer treatment periods compared with lasers and light sources (4–6 months vs. one or two treatment sessions with lasers).

Table I. Changes in MASS between controls.

<table>
<thead>
<tr>
<th>Group I</th>
<th>Group II</th>
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<tbody>
<tr>
<td>Mass</td>
<td>Mass</td>
</tr>
<tr>
<td>Treated side</td>
<td>Untreated side</td>
</tr>
<tr>
<td>20.0 ± 14.1</td>
<td>17.5 ± 13.7</td>
</tr>
<tr>
<td>16.3 ± 19.0</td>
<td>16.5 ± 15.2</td>
</tr>
<tr>
<td>(21%)</td>
<td>(2%)</td>
</tr>
<tr>
<td>p = 0.005</td>
<td>p = 0.004</td>
</tr>
<tr>
<td>Mass 3</td>
<td>Mass 3</td>
</tr>
<tr>
<td>14.1 ± 16.0</td>
<td>15.1 ± 12.3</td>
</tr>
<tr>
<td>(31%)</td>
<td>(6%)</td>
</tr>
<tr>
<td>p = 0.005</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>

*Percentage of improvement is according to the first control.
There are two mechanisms proposed for the laser treatment of acne vulgaris: targeting porphyrins produced by *P. acnes* and targeting sebaceous glands. As a part of its normal metabolic processes *P. acnes* produces porphyrins mainly protoporphyrin, uroporphyrin and coproporphyrin III. With the exposure to light, a photodynamic reaction is initiated and endogenous porphyrins produce highly reactive free radicals that cause destruction of the bacteria (1,2). Laser treatments also cause thermal coagulation of the sebaceous glands and associated hair follicles, which result in decreased sebum production. Longer wavelengths are more appropriate for deeper penetration and can reach deeper structures such as sebaceous glands. Other modalities that target these structures are photodynamic therapy with aminolevulinic acid, infrared lasers and radiofrequency devices (1,2). The 532-nm KTP laser causes not only photodynamic stimulation of porphyrins secreted by *P. acnes* but also non-specific collateral thermal injury to sebaceous glands due to its depth of penetration (2). In addition, wavelengths absorbed by oxihemoglobin (PDL and KTP), may increase collagen production and dermal regeneration by inducing selective photothermolysis of dilated vascular components of acne vulgaris (6).

There are some limitations of the study. Patients were followed up for one month, so long term effects could not be evaluated. Because of technical reasons, sebum production and erythema of the lesions could not be evaluated. Similarly, histopathological evaluation could not be performed because of the facial location of the lesions.

In summary, our results indicate that laser treatment of acne vulgaris is safe but offers limited effectiveness in the short term.

### Table II. Comparison of decrease in MASS between two groups at first and second controls.

<table>
<thead>
<tr>
<th>Group I</th>
<th>Group II</th>
</tr>
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<tbody>
<tr>
<td>MASS 2</td>
<td>-3.7 ± 9.5 (21%)</td>
</tr>
<tr>
<td>MASS 3</td>
<td>-5.9 ± 7.9 (31%)</td>
</tr>
<tr>
<td>p</td>
<td></td>
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</tbody>
</table>

Baugh and Kucaba evaluated the effects of 532-nm KTP laser on 26 mild to moderate acne patients (6). They randomly treated one half of the face of the patients by 532-nm KTP laser (12 J/cm², 30–40-ms pulse duration) with continuous contact cooling. They applied four laser sessions and evaluated the MASS and side effects at control visits which were at first and fourth weeks after final treatment. They noted decrease in MASS at first and second control visits by 34.9% and 20.7%, respectively.

Sadick et al., used photosensitizer (aminolevulinic acid) to improve the treatment efficacy with 532 nm KTP laser and found increased efficacy with the use of photosensitizer (12).

There are a few reports regarding KTP treatment of acne vulgaris in which different number of treatment sessions and periods had been used. Limited degree of improvement had been noted in those studies (6,9–12). Although effectiveness of 532-nm KTP laser, alone or in combination with topical agents or photosensitizers had been evaluated in those studies, there is no data regarding the effects of different weekly treatment sessions. In this study, we compared the effects of once and twice weekly application of 532-nm KTP laser (total of four sessions). We used treatment parameters similar to Baugh and Kucaba’s study (6). Patients treated twice weekly (group II) showed 26.4% and 39.7% improvement at first and second controls, and once weekly treated group (group I) showed 21.2% and 31.4% improvement at first and second controls respectively. These results were similar with that of Baugh and Kucaba, and significant improvement of MASS was noted by the second control for both groups. This significance may be due to higher fluences used in our study, which might have significant effect in long term. Side effects observed with the use of 532-nm KTP are slight erythema, edema and transient crusting. However, pigmentedary side effects should be considered in dark skinned patients. In this study, no side effects related to treatment was recorded; this was because of the adjustment of doses according to skin photo-type.

Lee performed a study in which 25 patients were treated with the KTP alone but prescribed topical medications and cleaners after laser treatment, and 125 patients were treated with both laser and topical treatment together.

After six treatment sessions with the 532-nm laser (4 mm spot, 6–12 J/cm², 30–40-ms pulse), 60–70% clearance was found in the 25 laser-only patients whereas clearance was reported as 80–95% for 90% of the 125 patients who were treated concomitantly with topical agents. It was suggested that laser treatment might provide an effect like oral antibiotics in combination with topical medications (11).
improvement. No significant difference was noted between once and twice weekly applications. Absence of requirement for daily application, absence of severe side effects and efficacy on acne scars are advantages of laser treatment, on the other hand need for application by trained health personnel in health care centres and treatment expenses are disadvantages of laser treatment. For that reason laser treatment may be a beneficial alternative for patients who have problems with treatment compliance, have not got any benefit, have contraindication or experienced side effects from conventional treatment methods. Addition of topical agents or treatment for longer periods may offer increased benefit.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References