Fractional Photothermolysis for the Treatment of Facial Wrinkle in Asians

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***Background**: Fractional photothermolysis is a novel aesthetic-laser-surgical modality for the treatment of facial wrinkle in Caucasians apart from other conventional treatments. However, there are limited reports regarding the effectiveness and side effects of this treatment in Asians' skin.*
***Objective**: To evaluate the effectiveness and side effects of 1,550 nm Erbium fiber Laser as a treatment for facial wrinkle in Asians' skin (Fitzpatrick's skin type III-V).*
***Material and Method**: Twenty patients with mild to moderate facial wrinkle were included in the study. Half of the forehead in each patient was randomized to receive the treatment and the other half served as control. The treatment was done with FINE SCAN 1550™ (TNC SPECTRONICS, Bangkok, Thailand), 1,550 nm Erbium fiber laser once a week for 8 successive treatments. Photographs had been taken by VISIA at 0, 4 weeks and 12 weeks after the treatment and were evaluated by three experienced dermatologists using a quartile grading scale. Patient satisfaction score and side effects during each treatment were also recorded.*
***Results**: At 4 weeks after the treatment, mean wrinkle, dyspigmentation, irregularities and the overall improvement scores were 0.35, 0.10, 0.20 and 0.50 respectively. At 12 weeks post treatment, the score decreased to 0.20, 0.05, 0.10 and 0.20. All of the improvement scores were significantly higher ($p < 0.05$) in the treatment group than the control group except for the dyspigmentation improvement score. Patients' satisfaction score was graded as 2 (good) in 35% (7/20) of the patients. Side effects included transient erythema and edema which were mild and self-limited. Mean pain score using visual analog scale was 1.32. No serious side effect was observed.*
***Conclusion**: Fractional photothermolysis with1,550 nm Erbium fiber Laser is one of the effective treatments for facial wrinkle. However, the improvement score decreased with time. Side effects are few and tolerable, even in patients with fitzpatrick's skin type III-V.*

***Keywords**: Wrinkle, Fractional photothermolysis, Fine Scan*

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The community's desire to achieve a long lasting youthful skin as people age has increased during the last few decades. Many laser treatment modalities have been developed to fulfill the population's needs. These include ablative laser resurfacing, non ablative laser remodeling, and the new technology called fractional photothermolysis[1].

Ablative laser resurfacing such as CO_2 or Er:YAG resurfacing is regarded as a main option in facial rejuvenation for photodamaged skin. In spite of its impressive results[2], a long down time and risk of developing serious adverse side effects especially pigmentary changes especially in Asians skin are important drawbacks.

Non ablative laser or light remodeling system, for instance, 1,064- and 1,320-nm Nd: YAG, 1,450-nm diode, 1,540-nm erbium glass and intense pulse light (IPL) system offers a less invasive treatment with minimal down time, however the results are less dramatic and required multiple treatments[3].

Recently Manstein et al have proposed a new laser system called fractional photothermolysis[1]. In contrast to the aforementioned system, fractional photothermolysis system induces multiple columns of

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microscopic thermal wounds that composed of tissue denaturation with diameter of 50-100 μm. These microscopic injuries are called microscopic treatment zones (MTZs). These wounds are surrounded by normal viable tissue which allows rapid regeneration of the laser-injured skin. In each laser treatment sessions, a variable area of tissue is targeted. Approximately 16-20% of the skin is treated depends on MTZs density setting and number of passes of laser treatment[4]. The depth and width of the MTZs depend on pulse energy setting[5].

There are a number of previous experimental studies to evaluate the effectiveness of fractional photothermolysis in treatment of photoaging skin[6-8]. All were carried out in Caucasian population that has Fitzpatrick skin phototype I to III. There are studies demonstrated the effectiveness of fractional photothermolysis as a treatment of facial and non-facial photodamaged skin and a treatment for reduction in periorbital rhytides.

The objectives of this study were to examine the efficacy and adverse events of fractional photothermolysis in treating Asians facial wrinkle.

Material and Method

Twenty patients (Nineteen female and one male, n = 20) with mild to moderate forehead wrinkle were included in the study. The mean age of the group was 47.6 years with a range from 37 to 60 years. The patients' Fitzpatrick skin type were type III to V (type III-15%; type IV-75%; type V-10%). The inclusion criteria were as follows: 1) age ranges from 35 to 60 years 2) mild to moderate forehead wrinkle 3) able to give inform consent. The exclusion criteria included 1) treatment with topical vitamin A derivatives, isotretinoin use, laser, and light therapy within six months before the study period 2) patients who smoke 3) pregnant and lactating women 4) patients with history of keloid or hypertrophic scar and 5) allergic to topical lidocaine and/or prilocaine.

Half of the forehead (30 cm^2) was randomized to receive a Laser treatment and the other half served as control. The area of the treatment side was cleaned by soap and water. A topical anesthetic cream (2.5% xylocaine and 2.5% prilocaine, Racser®, Abcar Pharmalab, Thailand) was applied and left on for 60 minutes and wiped off just before the treatment.

The treatment was delivered with FINE SCAN 1550™ V1.0 (TNC SPECTRONICS, Bangkok, Thailand), 1,550 nm Erbium fiber laser once a week for eight successive weeks. Each treatment was performed with a setting of 10 mj/cm^2, a density of 150 dots per 1 cm^2 and an accumulative number of dots for thirty cm^2 were 4,500 dots. The total energy was approximately 0.035 kJ.

The laser source of FINE SCAN 1550™ V1.0 was 1,550-nm diode pump Er:fiber laser. The equipment emitted laser with pulse energy from 4 mJ up to 100 mJ, together with scanning resolution of 25-2,500 dots/cm^2. It had a fast dual axis scanner and a noncontact tip to deliver the treatment. With a pulse energy of 10mJ, depth of each dot (MTZ) was 530 μm(Data from the company).

Series of photographs of patients' treatment and control areas were taken by standard photographic documentation (Canfield VISIA CR system, Canfield, NJ) before treatment, 4 and 12 weeks after the last treatments. The pre- and post- treatment photographs were evaluated by three-experienced dermatologists using a quartile grading score (0 = below 25% improvement, 1 = 25%-50% of improvement, 2 = 51%-75% of improvement, 3 = more than 75% improvement). Photographs were evaluated according to the improvement of wrinkle, dyspigmentation and surface irregularities. The statistical analysis was performed using Wilcoxon sign's rank test.

After completing each laser treatment session, side effects, its severity, and durations were evaluated. Finally, at the twelfth week after the last treatment patients were interviewed and satisfaction score were obtained (0 = not satisfied, 1 = fair, 2 = good, 3 = very good, 4 = excellent).

Results

At four weeks after the completion of eight treatments, all patients achieved 0 to 25% of improvement in treated side in term of wrinkle, dyspigmentation, irregularities and overall appearance. The mean wrinkle, dyspigmentation, irregularities and overall improvement score were 0.35, 0.10, 0.20 and 0.50 for the treatment side (Fig. 1).

At twelve weeks after the Laser treatments. The improvement was still observed. Even though these scores decreased to 0.20, 0.05, 0.10 and 0.20 (Fig. 2).

The mean improvement score was significantly higher ($p < 0.05$) in the treatment side compared to the control side except for dyspigmentation improvement score (Fig. 1, 3). These differences were detected at both 4 and 12 weeks after the last treatment.

Most of the patients satisfied with the

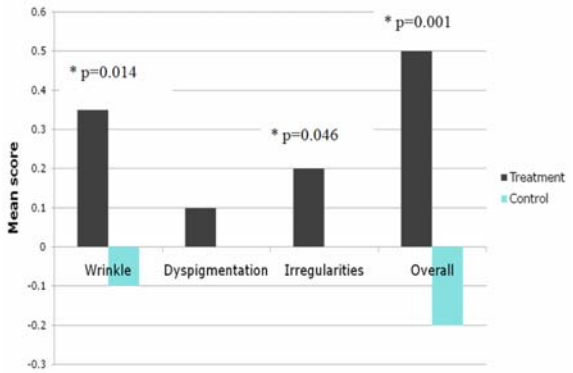

Fig. 1 Mean clinical improvement score at 4 weeks after the last treatment, compared between the treatment and the control group. The grading score: (0 = below 25% improvement, 1 = 25%-50% of improvement, 2 = 51%-75% of improvement, 3 = more than 75% improvement)

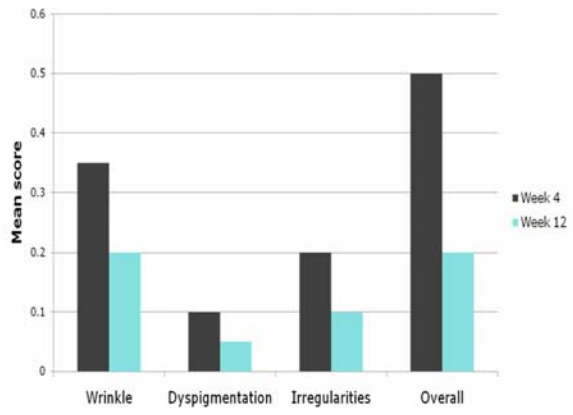

Fig. 2 Mean clinical improvement score, compared between 4 and 12 weeks after the treatment. The grading score: (0 = below 25% improvement, 1 = 25%-50% of improvement, 2 = 51%-75% of improvement, 3 = more than 75% improvement)

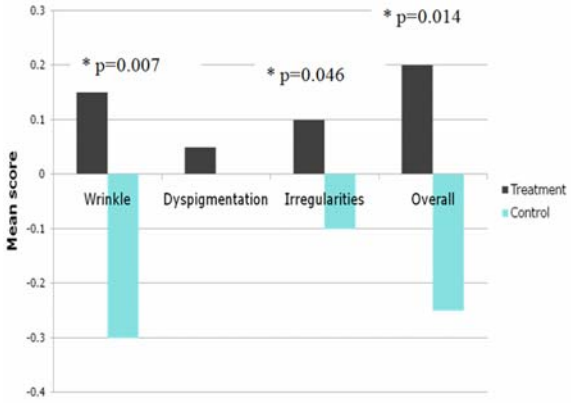

Fig. 3 Mean clinical improvement score at 12 weeks after the last treatment, compared between the treatment and the control group. The grading score: (0 = below 25% improvement, 1 = 25%-50% of improvement, 2 = 51%-75% of improvement, 3 = more than 75% improvement)

treatment. (0 = 15%, 1 = 15%, 2 = 30%, 3 = 35%, 4 = 5%, 0 = not satisfied, 1 = fair, 2 = good, 3 = very good, 4 = excellent). Mean patient's satisfaction score was two.

The Laser treatment adverse effects were mild and transient. These included pain, erythema and edema. Mean pain score measured by visual analog scale was 1.32 $\pm$ 1.7. Pain score was decreased in the subsequent treatments. Erythema occurred at 60% (96 times from the total of 160 treatments). The severity was graded as mild and the mean duration of erythema was 4.95 $\pm$ 8.4 hours. In addition, edema was observed in 8.1% (13 times from the total of 160 treatments). The severity was also mild and lasted for 0.37 $\pm$ 2.7 hours. Neither bronzing nor postinflammatory hyperpigmentation was observed in the treatment group.

Discussion

From this study, fractional photothermolysis appeared to be a safe and effective way for facial rejuvenation. The improvement was evident at one month after treatment and gradually decreased overtime. The side effects were few and tolerable.

The proposed mechanism for improvement in rhytides and skin texture in fractional phothothermolysis is the formation of new collagen in dermis surrounding microscopic treatment zones (MTZs), as in wound healing response[9]. The study from Jih MH and colleges[6] showed thickening of the epidermis and increased dermal collagen density with compact collagen fibers from the skin biopsy post fractional laser treatment. This data is concordant with the suggested mechanism.

Furthermore, skin lightening after fractional photothermolysis treatment can be explained by transepidermal melanin elimination. After the laser is administered to the skin, the numerous formation of microscopic epidermal necrotic debris (MENDS) is seen one day later. MENDS is packed with melanin pigments and it migrates upward through the epidermis and sheds out. This is thought as the mechanism to remove melanin pigment[9].

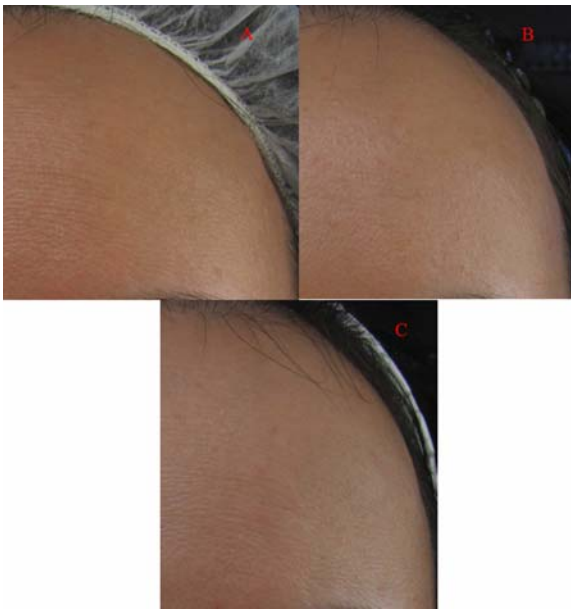

Fig. 4 (A) Baseline. (B) four weeks after treatment. (C) Twelve weeks after treatment.

Fig. 5 (A) Baseline. (B) four weeks after treatment. (C) Twelve weeks after treatment.

Compare to previous studies that focused on fractional photothermolysis in treatment of facial and non-facial photoaging, our result is consistent with prior studies with some dissimilarity. In a study by Wanner et al[8], fractional photothermolysis was delivered by Fraxel, Reliant technologies Inc., Sandiego, CA. Their treatment were performed three times every 3 to 4 weeks with a different setting (for facial area of eight passes at a fluence of 8 mJ/ cm^2 and a density of 250 MTZ/ cm^2 to an end point of 2,000 MTZ/ cm^2 or 3 kJ). Results of their study revealed the maximal improvement at 3 months with the mean improvement score for the facial area as 2.23. The improvement was observed through 9 months after the last treatment (1.96 at nine months follow-up). Unlike our findings, the mean improvement score was higher and the improvement was more sustainable in their study. This can be elucidated by the different density of MTZs (150 vs. 2,000 MTZs/cm^2) and the approximate delivered energy (3 vs. 0.035 kJ). With relatively lower density and energy, more frequent treatments were required; we therefore performed our treatment every week for eight consecutive weeks. However, the disparity was still observed. The outcome in our study possibly was the result from fewer numbers of MTZs (density), which allow less tissue repairing process. Future study with a setting of higher MTZs density and energy is warrant to evaluate the maximal improvement that can be achieved.

In our study, mean improvement score was significantly higher in the treatment group in almost every feature. However, the improvement score in term of pigmentation, which is also higher in the treatment group, was not statistically significant compared to the control group. This can also be explained by a relatively low density of MTZs (150 dots per 1 cm^2), which allow less transepidermal elimination of melanin pigment. In addition, more sensitive surrogate markers may be required to evaluate the subtle pigment changes between each group.

A number of previous studies[4,10] showed that fractional photothermolysis treatment of patients with Fitzpatrick skin type III to V is associated with unfavorable adverse effects, especially, post inflammatory hyperpigmentaiton (PIH). The prevalence of PIH in non-ablative fractional laser resurfacing for skin rejuvenating/pigment in Chinese population was recorded as high as 12.4% in a study from Hong Kong. In our study, with relatively low density of MTZs and accumulative energy, there was no post inflammatory hyperpigmentation observed (0/160 treatments) even though the majority of our patients had Fitzpatrick skin type IV. Furthermore, no other serious adverse event is seen in the study group.

The limitations of our study were the small number of populations in the study, the relatively short

term follow-up period and the lack of subjective assessment of the clinical outcomes. In addition, the machine used in the study is the first generation.

In conclusion, fractional photothermolysis with low-density setting and multiple treatments appeared to be a reasonable choice for facial rejuvenation. The treatment offers some degree of improvement (0-25% improvement) without pigmentation side effects that frequently observed in Asians skin. The cost effectiveness of the treatment may be a concern. Further study that evaluates more appropriate parameter settings to maximize clinical outcomes with fewest adverse events is warrant.

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การรักษาริ้วรอยบนใบหน้าด้วยเลเซอร์ลอกผิวระบบแบ่งส่วนในชาวเอเชีย

ภาวิณี ฤกษ์นิมิตร, มาริษา พงศ์พฤฒิพันธ์, วัณณศรี สินธุภัค

การรักษาริ้วรอยบนใบหน้ามีหลายวิธี การรักษาด้วยเลเซอร์ลอกผิวระบบแบ่งส่วน เป็นการรักษาแบบใหม่ ซึ่งยังไม่มีการทดลองในประชากรซึ่งมีสีผิวเข้ม

วัตถุประสงค์*: เพื่อประเมินประสิทธิภาพ และผลข้างเคียงของเลเซอร์ลอกผิวระบบแบ่งส่วน ความยาวคลื่น 1,550 นาโนเมตร ในการรักษาริ้วรอยบนใบหน้าในประชากรไทย*

วัสดุและวิธีการ*: ศึกษาในกลุ่มตัวอย่าง 20 ราย อาสาสมัครแต่ละรายได้รับการรักษาที่ครึ่งหนึ่งของหน้าผาก และหน้าผากอีกด้านเป็นกลุ่มควบคุม ทำการรักษาด้วยเลเซอร์ลอกผิวระบบแบ่งส่วน FINE SCAN 1550TM สัปดาห์ละ 1 ครั้ง นาน 8 สัปดาห์ติดต่อกัน ประเมินผลการรักษาด้วยรูปถ่ายจากเครื่อง VISIA ที่ 0, 4 และ 12 สัปดาห์หลังการรักษา โดยแพทย์ผิวหนัง 3 ท่าน ทำการให้คะแนน บันทึกผลข้างเคียงของการรักษาและความพึงพอใจของอาสาสมัคร*

ผลการศึกษา*: ที่ 4 สัปดาห์หลังสิ้นสุดการรักษา พบว่าคะแนนริ้วรอย สีผิว ความสม่ำเสมอ และคะแนนโดยรวมเป็น 0.35, 0.10, 0.20 และ 0.50 ตามลำดับ และคะแนนลดลงเป็น 0.20, 0.05, 0.10 และ 0.20 ที่ 12 สัปดาห์หลังการรักษา ซึ่งคะแนนดังกล่าวสูงกว่าในหน้าผากด้านที่ได้รับการรักษาเมื่อเทียบกับกลุ่มควบคุม อย่างมีนัยสำคัญทางสถิติ ยกเว้นคะแนนในด้านสีผิว อาสาสมัครร้อยละ 35 มีความพึงพอใจในระดับดี ผลข้างเคียงในการรักษา พบรอยแดงและบวมเล็กน้อย ซึ่งหายไปเอง ระดับความเจ็บปวดโดยเฉลี่ยเท่ากับ 1.32 ไม่พบผลข้างเคียงที่รุนแรงอื่นๆ*

สรุป*: เลเซอร์ลอกผิวระบบแบ่งส่วนเป็นทางเลือกอย่างหนึ่งที่ได้ผลดีในการรักษาริ้วรอย แม้ว่าผลการรักษาจะค่อยลดลงในเวลาต่อมา นอกจากนี้ยังไม่พบผลข้างเคียงที่รุนแรงใดๆจากการรักษา*