Received: 15 December 2017 | Accepted: 29 June 2018

DOI: 10.1111/jocd.12738

MASTER CASE PRESENTATION

WILEY JCD Journal of Cosmetic Dermatology

Antera 3D camera: A novel method for evaluating the therapeutic efficacy of fractional CO_2 laser for surgical incision scars

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Summary

Objective: To introduce a novel method for evaluating the therapeutic efficacy of fractional CO_2 laser for incision scars.

Methods: A total of 72 patients after incision healing for at least 2 years were included in the series, with scars on neck, thyroid, chest, and limb from September 2013 to September 2016. The image of scar was taken by Antrea 3D camera before the treatment, VSS, and UN4P were also applied for scar evaluation. A total of four sessions at 4-6 intervals were conducted to each patient. After 3 months of last session, a final assessment was carried out by Antera 3D and VSS, UN4P independently.

Results: The Antera scores for color after 4 sessions were 8.78 ± 2.11, which were significantly lower than the prior treatment (9.62 ± 1.90, $t = 2.51$, $P < 0.05$). The Antera scores for texture after four sessions were 22.80 ± 5.23, which was significantly lower than the prior treatment (30.33 ± 5.41, $t = 8.48$, $P < 0.05$). The Antera scores for melanin levels after four sessions were 0.52 ± 0.05, which was significantly lower than the prior treatment (0.54 ± 0.05, $t = 2.4$, $P < 0.05$). The Antera scores for hemoglobin levels after four sessions were 1.88 ± 0.50, which was significantly lower than the prior treatment (2.11 ± 0.45, $t = 2.90$, $P < 0.05$). The Vancouver Scar scores after four sessions were 7.1 ± 2.0, which showed no statistically significant differences with the prior treatment (7.5 ± 2.4, $t = 1.09$, $P = 0.25 > 0.05$). The University of North Carolina "4P" Scar scores after four sessions were 6.6 ± 1.5, which also showed no statistically significant differences with the prior treatment (7.0 ± 1.9, $t = 1.40$, $P = 0.15 > 0.05$).

Conclusions: For scar therapeutic evaluation, Antera 3D camera is objective and accurate, and is worthy of wide promotion.

KEYWORDS

fractional CO_2 laser, incision scar

1 | INTRODUCTION

Surgical incision healing procedures of modern surgical operation require the reconstruction of the skin structure, which forms scars inevitably no matter what the length of the incisions is, and maybe they remain for a whole lifetime. There are many factors influencing the formation of scar, such as surgical methods, incision tension, as

well as the race, complexion, heredity, age, gender, and other factors. As scar tissue is different from the surrounding normal skin in color, texture, and thickness, with itching and other problems, which thereby perplexes the majority of patients, it may even induce psychological problems.[1]

At present, there are a variety of scar treatments, including pressure therapy, external use of drugs, fractional CO_2 laser, Er: YAG laser, pulsed dye laser, intense pulse light, and so on. The fractional CO_2 laser is considered to be an effective means to reduce the scar hyperplasia.[2] The theory is that through the fractional photothermolysis, it achieves instant gasification of scar tissue, thus blocking the micrangium, starting tissue self-reparation, and rearranging the collagen.

However, the current assessment of its therapeutic efficacy often adopt the Vancouver Scar Scale (VSS), University of North Carolina "4P" Scar Scale (UNC4P), Observer Scar Assessment Scale (OSAS), Patient Observer Scar Assessment Scale (POSAS), although various assessment scales were available, not one had been shown to be reliable, consistent, feasible, and valid at the same time. To eliminate the observer or patient factors, an objective evaluation method was needed urgently. The Antera 3D camera was invented on the above considerations. It is a new three-dimensional camera developed by Miravex to evaluate skin objective indicators, measuring the texture and color of the skin by reconstructing three-dimensional images.

As articles on the therapeutic effects of fractional CO_2 laser are common, this study has focused instead on the use of Antera 3D camera. In this study, the author evaluates the objective treatment indicators of the fractional CO_2 laser with the use of Antera 3D imaging system, and the details are as follows.

2 | MATERIALS AND METHODS

With the stability of mature scars, there was no need for a control group as the similar study. At least two years of mature scars after incision healing were involved in the study from September 2013 to September 2016. Patients with keloid tendency, patients with connective tissue disorders, patients with hypersensitivity to lidocaine, or pregnant females were excluded. A total of 72 patients with surgical scars were permitted to receive the treatment after chosen Table 1. Every patient signed the informed consent and was well informed of the treatment procedures and adverse effects. Treatments were carried out with four sessions at 4- to 6-week intervals. Antera 3D camera was used to take the images of the treated area before the treatment and three months after the last session. The evaluation scores for color, texture,melanin and hemoglobin expression levels were processed by Antera Pro (v2.8.6; Miravex Limited, Dublin, Ireland). Meanwhile, the Vancouver Scar Scale (VSS) and University of North Carolina "4P" Scar Scale (UNC4P) of the scars were also conducted by two experienced doctors blinded.

Regular disinfection and topical anesthetic were taken before treatment. Fractional CO_2 laser treatment was then delivered to the whole scar area with the UltraPulse® (Lumenis, Santa Clara, CA, USA). Energy ranged from 150 to 175 mJ with the frequency of 40 Hz in ActiveFX™ fractional mode, MTZ distance was 4 mm or 5 mm, and other parameters was as follows: flare pattern (1-8), size selection (3-7 grade), density (10%-100%), scanning pattern repeat delay (0.1-0.3 seconds). The shape of the treatment spot was varied according to the shape of the treated scar. The treatments were repeated at 4- to 6-week intervals with a total of four sessions to each patient. Postoperative considerations were made clear to every patient at each follow-up visit, and a survey for adverse effects was also carried out by phone or each visit (Figures 1 and 2).

Statistical analyses were performed using the Statistical Package for the Social Sciences 21.0 (SPSS; IBM Corp., Armonk, NY, USA). Continuous variables were reported as mean ± SD. P values < 0.05 were considered significant.

3 | RESULTS

There were 26 males and 46 females in the treatment group and age ranged from 14 years to 45 years with a mean age of 30.3 + 10.2 years, and the scar locations were as follows: neck (24, 33.33%), face (19, 26.39%), abdomen (18, 25.0%), limb (9, 112.5%), and chest (2, 2.78%; Table 1). All the patients were completed the 4 sessions, and there were no dropouts. There was no adverse effect, and the mild pain was tolerated well.

The Antera scores for color after four sessions were 8.78 ± 2.11, which were significantly lower than the prior treatment (9.62 ± 1.90, $t = 2.51$, $P < 0.05$). The Antera scores for texture after four sessions were 22.80 ± 5.23, which was significantly lower than the prior treatment (30.33 ± 5.41, $t = 8.48$, $P < 0.05$). The Antera scores for melanin levels after 4 sessions were 0.52 ± 0.05, which was significantly lower than the prior treatment (0.54 ± 0.05, $t = 2.4$, $P < 0.05$). The Antera scores for hemoglobin levels after four sessions were 1.88 ± 0.50, which was significantly lower than the prior treatment (2.11 ± 0.45, $t = 2.90$, $P < 0.05$;Table 2).

However, the Vancouver Scar scores after four sessions were 7.1 ± 2.0, which showed no statistically significant differences with the prior treatment (7.5 ± 2.4, $t = 1.09$, $P = 0.25 > 0.05$). The University of North Carolina "4P" Scar scores after four sessions were 6.6 ± 1.5, which also showed no statistically significant differences with the prior treatment (7.0 ± 1.9, $t = 1.40$, $P = 0.15 > 0.05$; Table 3).

TABLE 1 Basic data of the treatment group

			Scar location				
	Male/female	Average age (y)	Neck	Face	Abdomen	Limb	Chest
Patients (n = 72)	26/46	30.3 ± 10.2	24	19	18	9	2

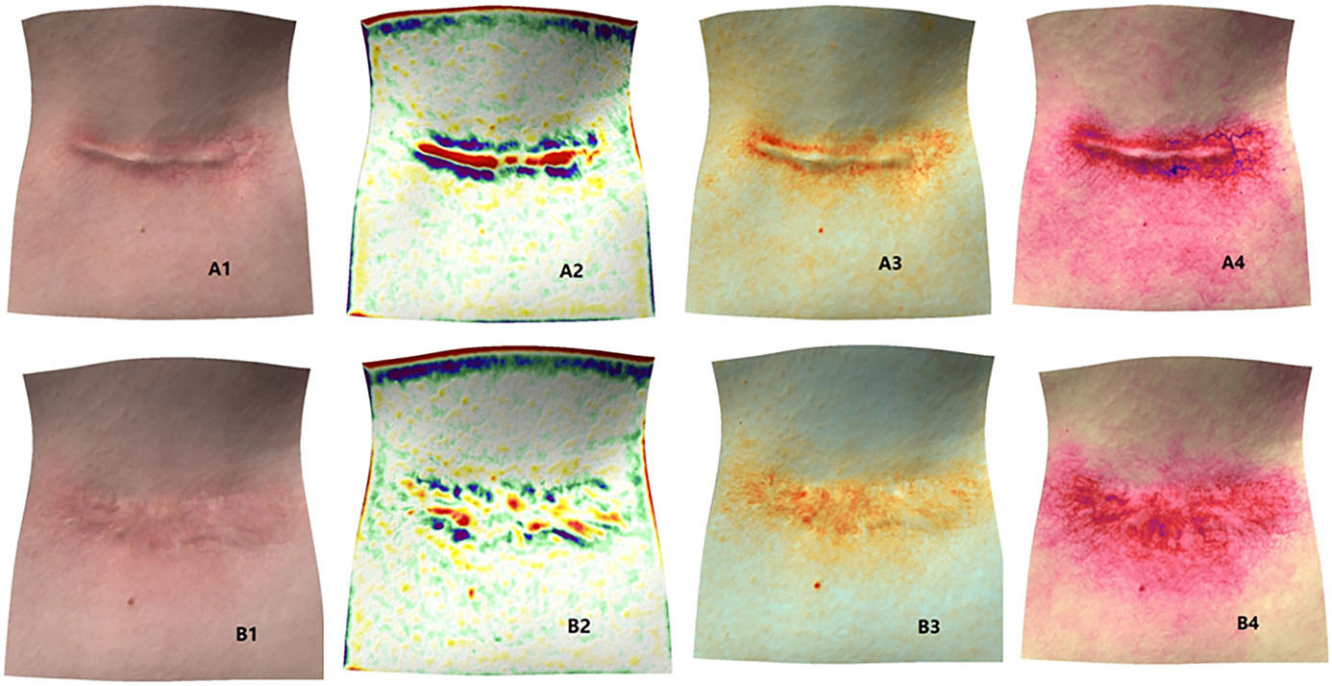

FIGURE 1 A1, The 3D image of the color of a 38-year-old woman after thyroid surgery for 3 years. A2, The 3D image of texture. A3, The 3D image of melanin level. A4, The 3D image of hemoglobin level. B1, The 3D image of color after fractional CO_2 laser therapy. B2, The 3D image of texture after therapy. B3, The 3D image of melanin level after therapy. B4, The 3D image of hemoglobin level after therapy

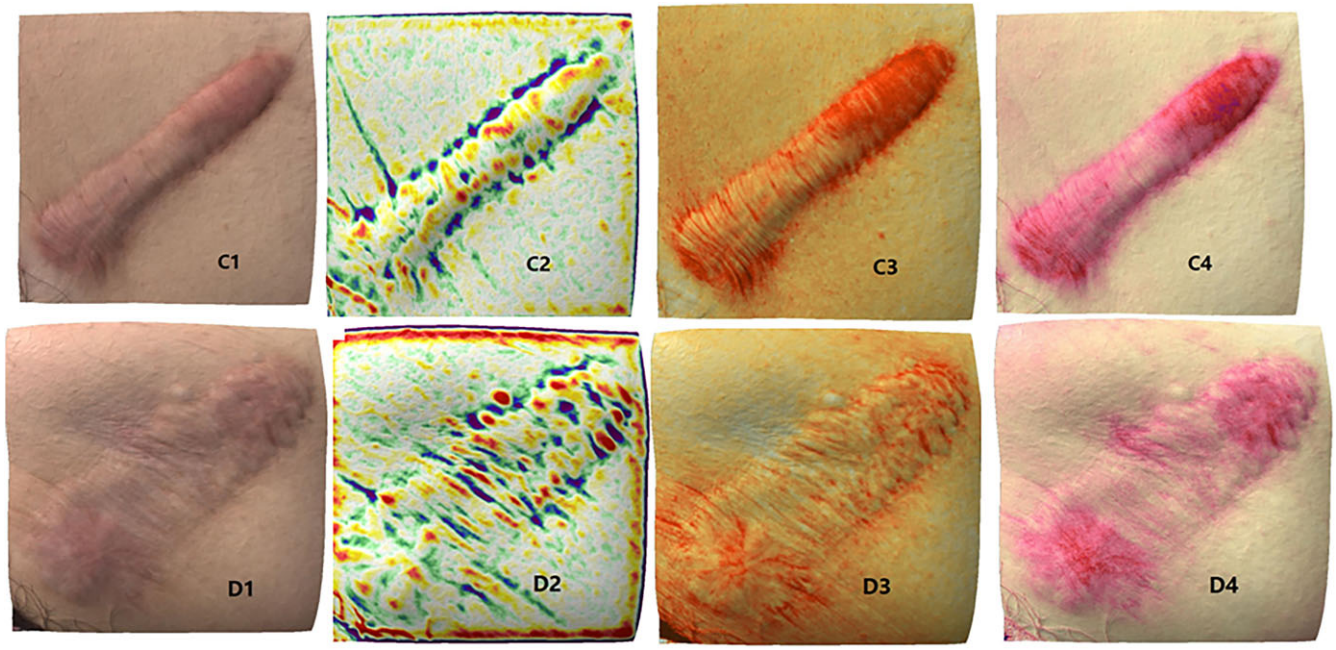

FIGURE 2 C1, The 3D image of color of a 32-year-old woman after cesarean surgery for 1 year. C2, The 3D image of texture. C3, The 3D image of melanin level. C4, The 3D image of hemoglobin level. D1, The 3D image of color after fractional CO_2 laser therapy. D2, The 3D image of texture after therapy. D3, The 3D image of melanin level after therapy. D4, The 3D image of hemoglobin level after therapy

TABLE 2 The score changes of color, texture, melanin, and hemoglobin evaluated by Antera Pro

	Color	Texture	Melanin	Hemoglobin
Prior treatment (n = 72)	9.62 ± 1.90	30.33 ± 5.41	0.54 ± 0.05	2.11 ± 0.45
Posttreatment (n = 72)	8.78 ± 2.11	22.80 ± 5.23	0.52 ± 0.05	1.88 ± 0.50
P value		$P < 0.05$		

TABLE 3 Vancouver Scar Scale (VSS) and University of North Carolina "4P" Scar Scale (UNC4P) of the prior treatment and posttreatment for the incision scars

	Prior treatment	Posttreatment	*P* values
VSS	7.5 ± 2.4	7.1 ± 2.0	0.25
UNC4P	7.0 ± 1.9	6.6 ± 1.5	0.15

4 | DISCUSSION

The wound healing process can be divided into hemostasis phase, inflammation reaction phase, tissue proliferation, and remodeling phase. Even if the stitches of the incision are taken out successfully and incision heal very well, the formation of incision scars is still achieved gradually,[3] and postintervention methods, such as pressure therapy, hormones injection, and silicone drugs, are often needed, but these treatment effects cannot satisfy the patient's expectations.

Based on the pursuit of the better appearance of incision scars, laser technology is applied in the treatment of scars, among which fractional CO_2 laser is a kind of common technology used most widely. It uses microwaves technique to generate a great deal of matrix-arranged ultrashort pulsed beam, the advantages of which are as follows: (a) With strong penetrating ability, it can easily penetrate into the dermis to stimulate self-repair process, resulting in more collagen rearrangement, as Hsiao[4] found that fractional CO_2 laser can facilitate transdermal delivery of vitamin C for treating melasma; (b) More fast postinjury microvascular healing process, as laser wound will be healed in 3-6 days, without seepage, bleeding, or infection[5]; and (c) By customizing individualized treatment program according to different needs, the diameter of the pores and the depth of irradiation can be adjusted, and a single treatment often causes a visible effect. With the promotion of clinical application, the combined applications of a variety of scar restraining means are proposed to obtain better therapeutic results.[6]

However, as a kind of clinical experience technology, the therapeutic efficacy of fractional CO_2 laser is often subject to the technique and experience of doctors, which may cause the differences among treatment results. The evaluation of therapeutic efficacy is often dealt with the use of the Vancouver Scar Scale, University of North Carolina "4P" Scar Scale or patients' subjective evaluation. Although these scales are simple without special equipment, they are artificial subjective evaluation system, relying on the experience of observers and hand feeling of evaluators, with the lack of objectivity and repeatability, which will generate bias or error inevitably.[7] In addition, Jaspers[8] recently found that the blood flow, capillaries, and erythema of scar tissue had no significant correlation, and an accurate evaluation of different indicators should be made independently. There is a need for an objective and independent assessment, not only from the thickness, texture, color generally, but also from the degree of microvascular proliferation, melanin levels, and hemoglobin levels to distinguish. Antera 3D camera solves the above problems well. It is a new kind of three-dimensional skin imaging technique invented by the University of Dublin. Through shining on the skin with multispectrum emitted by the light emitting diodes, with the use of different optical penetration lengths of different waves, it can collect the reflections after irradiated to the skin. The light signals need a digital processing to reestablish three-dimensional image (Figure 3). The pigment, texture, capillaries, and other indicators of the scar tissue are made quantitative processing, and it facilitates the comparison of these indicators before and after treatment.[9] What's more, the camera is small, light-weighted, and

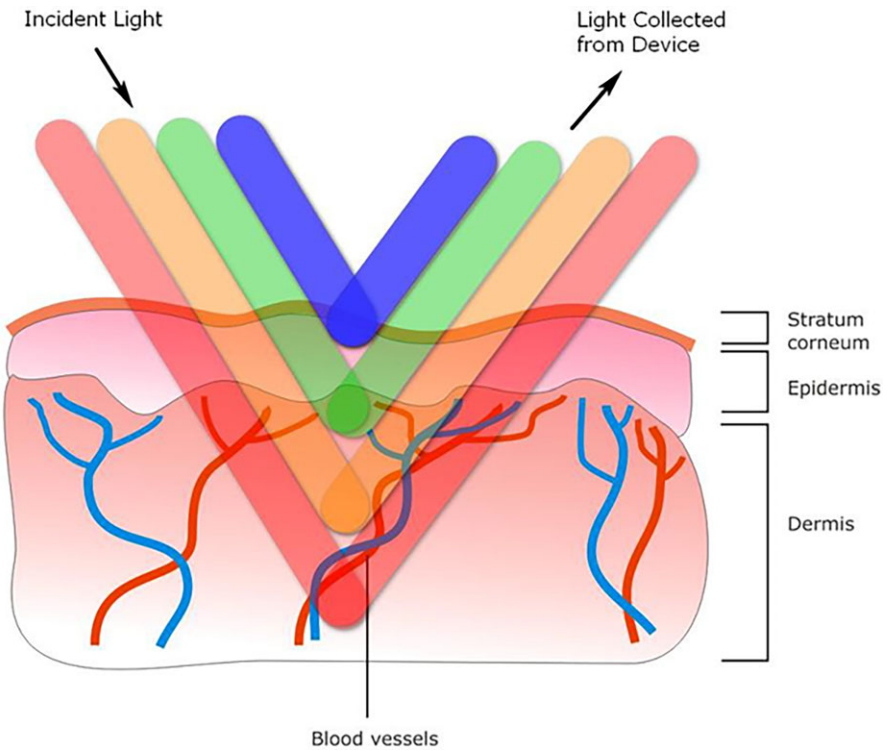

FIGURE 3 Working principle of Antera 3D

portable, which can avoid the influence of subjective evaluation, achieving objective measurement of skin texture, texture, and color, which shakes off the defects of previous scar evaluation system,[10] thus getting the effect of "seeing is believing."

In this series, the results of Vancouver Scar scores and University of North Carolina "4P" Scar scores showed no statistically significant differences, which may result from the limited patient numbers and treatment sessions. Recently, Blome-Eberwein et al[11] also found a similar result using Vancouver Scar scores to evaluate the physiology and appearance of burn scar after fractional CO_2 laser therapy and reaching a conclusion for which Vancouver Scar scores may not be sensitive enough to detect outcome differences. For Antera 3D scores, there were statistically significant differences in color, texture, melanin, and hemoglobin expression levels before and after the treatment. The results indicated the advantages of Antera 3D for scar scores, which can directly show the treatment changes, even micro changes can be expressed directly without bias or error. Different results of evaluation methods showed the shortcomings of the traditional scar treatment evaluation scoring scales; as the traditional VSS and UNC4P scoring scales depended much on the observers' experience and patients' feeling, these interference factors caused the otherness of the evaluation results and thus affected the subsequent treatment planning. The Antera 3D scoring system was a new means of 3D imaging, which objectively obtained the images before and after treatment; the comparison results were objective and accurate, and avoiding the interference factors. In our study, the differences in the results of different evaluation methods in the same group may highlight the advantages of Antera 3D evaluation system, which elaborated the treatment effects in four aspects, respectively, namely color, texture, melanin, and hemoglobin levels. Doctors could adjust the treatment plan according to the changes of different indexes before and after the treatment time, and obtain a better curative result.

5 | CONCLUSIONS

Through this series of cases, the evaluation of Antera 3D camera on the effectiveness of scar treatment is objective, even micro changes can be expressed directly, so it is worth to be promoted widely, and we can adjust the laser therapy parameters according to the Antrea 3D scores in the future clinical treatment. But it should be noted that Antera 3D camera is still at the perfecting stage, it can only cut out scar picture of the same area with the camera head. For the evaluation of scars with a larger area, a division of areas should be made. But compared with the current scar evaluation means, it is an effective method to evaluate the efficacy of scar treatment.

ACKNOWLEDGMENTS

Special thanks to Dr. Guido Mariotto (CEO, Miravex Limited) for providing the newest software of Antera 3D (Antera Pro-2.8.6).

Role of funding source: None.

Informed consent: Informed consent was obtained from all individual participants included in the study.

ETHICAL APPROVAL

All procedures performed in the study involving human participants were in accordance with the ethical standards of the Ethics Committee of the First Hospital of Jilin University. All experimental procedures complied with the Ethics Committee's guidelines and the 1964 Helsinki Declaration for experiments with live vertebrates.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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How to cite this article: Zhang N, Shi K, Hong L, Zhao J, Yu J. Antera 3D camera: A novel method for evaluating the therapeutic efficacy of fractional CO_2 laser for surgical incision scars. *J Cosmet Dermatol*. 2018;00:1–5. https://doi.org/10.1111/jocd.12738