Effects of Ablative 10,600-nm Carbon Dioxide Fractional Laser Therapy on Suppurative Diseases of the Skin: A Case Series of 12 Patients

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Background and Objectives: We have used an ablative 10,600-nm carbon dioxide fractional laser system (CO2 FS) for suppurative diseases in order to attempt improvement. The purpose of our study was to demonstrate the effect of CO2 FS on the course of inflammatory reactions in suppurative diseases.

Materials and Methods: We reviewed a total of 12 Korean patients with suppurative diseases of the skin who had a history of treatment failure with several therapeutic modalities as well as active and multiple inflammatory lesions at the time of CO2 FS treatment.

Results: Improvement scores considering the number of suppurative lesions revealed that 3 of the 12 patients demonstrated clinical improvement of grade 4. Seven had clinical improvement of grade 3 and two showed improvement of grade 2. Improvement scores in severity were also evaluated; 2 of the 12 patients showed clinical improvement of grade 4. Six demonstrated clinical improvement of grade 3 and four had clinical improvement of grade 2. No patient showed a worsening of suppurative lesions.


Key words: fractional laser; carbon dioxide; acne vulgaris; folliculitis; furunculosis; hidradenitis suppurativa

INTRODUCTION

Fractional lasers have been proven to be effective and generally well tolerated for the treatment of various dermatologic diseases [1–3]. Although the non-ablative 1,550-nm erbium-doped fractional photothermolysis system (FPS) is the most popular fractional laser and yields decidedly reduced recovery times, the ablative 10,600-nm carbon dioxide fractional laser system (CO2 FS) has recently been introduced and produces excellent clinical outcomes with fewer treatment sessions [4]. However, reports of the effects of fractional lasers usually consider acne scars rather than active lesions. Many dermatologists are also reluctant to use FPS or CO2 FS for scars if patients present with active suppurative lesions.

A recent study described a patient with inflammatory acne vulgaris and acne scars who had successfully been treated with three sessions of combined 595-nm pulsed dye laser with dynamic cooling device and FPS [5]. However, because the 595-nm pulsed dye laser has proven therapeutic effects on acne vulgaris, the effect of FPS on active lesions could not be elucidated. In this report, we demonstrated the effect of CO2 FS on the course of inflammatory reactions in suppurative diseases through a retrospective analysis of 12 patients.

MATERIALS AND METHODS

This retrospective study was performed in accordance with the ethical guidelines of the 1975 Declaration of Helsinki as reflected in approval by the Institutional Review Board of Severance Hospital, Yonsei University College of Medicine, Seoul, Korea. Twelve male patients (mean age: 22.3 years, range: 20–26 years; Fitzpatrick skin type IV) who were treated using CO2 FS for suppurative diseases of the skin with various clinical diagnoses, including inflammatory acne vulgaris (n = 7), chronic recurrent furunculosis (n = 4), and hidradenitis suppurativa (HS, n = 1), were reviewed in this study. Table 1 details subject characteristics. Patients with a history of treatment failure with several therapeutic modalities as well as active and multiple inflammatory lesions at the time of CO2 FS treatment were enrolled. Subjects were excluded from this study if they had recently received systemic retinoids; CO2 FS, FPS, 1,450-nm diode laser, 585-nm pulsed dye laser, intense pulsed light, or photodynamic therapy within 6 months; or were treated with systemic and topical antibiotics, intralesional corticosteroid injection, incision and drainage, and surgical excision within 1 month.

Patients underwent 1–3 sessions (mean: 1.9 sessions) of CO2 FS using a 10,600-nm Neocin eCO2™ (Lutronic Corporation, Gyeong, Korea) laser. The Food and Drug Administration has approved the commercial release of

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<th>Pt. no.</th>
<th>Sex/age (years)</th>
<th>Site</th>
<th>Clinical diagnosis/duration (months)</th>
<th>Previous treatment modalities</th>
<th>No. of CO₂ FS treatments</th>
<th>Concomitant treatments for supplicative lesions</th>
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this laser for dermatological treatment. The lesions were cleansed with a mild soap and 70% alcohol. A topical eutectic mixture of 2.5% lidocaine HCl and 2.5% prilocaine (EMLA; AstraZeneca AB, Södertälje, Sweden) cream was applied to the lesions under occlusion 1 hour prior to laser therapy for local anesthesia. The laser fluence delivered to the lesions was 70–90 mJ and a density of 100 spots/cm² in static operating mode (percent coverage: 7.3–8.2). Additional treatments followed at settings of 50–70 mJ and a density of 100 spots/cm² to marked inflammatory papules and nodules in static operating mode (percent coverage: 6.4–7.3). According to the manufacturer’s instructions, the estimated maximal ablation depth using the 10,600-nm Mosaic CO2™ laser is 1.078μm at a setting of 70 mJ and 1.365μm at 90 mJ. We aimed to treat the follicular epithelium, sebaceous glands, upper dermal and perifollicular fibrotic lesions, and surrounding inflammatory cells.

To prevent an acute inflammatory reaction and reduce post-therapy edema, patients were prescribed 10 mg of oral prednisolone and 200 mg of oral doxycycline for 3 days. In the case of facial lesions, patients with a history of herpes virus infection were additionally prescribed oral valacyclovir hydrochloride (Valtrex; GlaxoSmithKline, Research Triangle Park, NC) for 3 days. Subjects were instructed to use a non-comedogenic moisturizer (Physiogel™ Cream; Stiefel Laboratories, Sligo, Ireland) several times daily for a few days after treatment to promote wound healing and prevent dryness. They were also told to avoid overexposure to sunlight and use a broad-spectrum sunscreen.

Photographs were obtained using identical camera settings, lighting, and patient positioning at baseline and 2 months after the last treatment. Objective clinical assessments were performed in a blinded fashion by two dermatologists who compared before and after photos in a non-chronological order using a global improvement scale (grade 0, worsened; grade 1, 0–25% = minimal improvement or steady state; grade 2, 26–50% = moderate improvement; grade 3, 51–75% = marked improvement; and grade 4, more than 75% = near total improvement). Improvement scores considering the number, severity, and overall skin pattern of suppurative lesions were separately recorded. Overall skin pattern was evaluated according to improvements in scars, skin tone, and texture.

Investigators assessed and recorded possible side effects including bleeding, crusting, post-therapy dyschromia, scaling, crusts, and erythema at each visit at 1- to 2-week intervals. Two months after the final treatment, the reported side effects were reassessed and analyzed.

RESULTS

Improvement scores considering the number of suppurative lesions evaluated at 2 months after the final treatment revealed that 3 of the 12 patients demonstrated clinical improvement of grade 4 (Table 1, Fig. 1). Seven had clinical improvement of grade 3 (Fig. 2) and two showed improvement of grade 2 (Figs. 3 and 4). No patient demonstrated a worsening of suppurative lesions. Figure 1 shows the clinical manifestations of patient 3 with moderate postural acne vulgaris at 6 months after the three sessions of CO2 FS. The mean clinical improvement score for the number of suppurative lesions based on dermatological clinical assessment was 3.0. Improvement scores considering the severity of the lesions were evaluated: 2 of the 12 patients showed clinical improvement of grade 4. Six demonstrated clinical improvement of grade 3 and four had clinical improvement of grade 2. No patient had minimal improvement of grade 1 or a worsening of lesions. The mean clinical improvement score for the severity of the lesions was 2.8.

Overall skin pattern was improved as 2 of 12 patients showed clinical improvement of grade 4. Seven patients

Fig. 1. A 28-year-old Korean male with moderate postural acne vulgaris (case 3): a: Before treatment. b: Two months after three sessions of ablative 10,600-nm CO2 FS treatment. c: Six months after the final treatment. Each session was performed in a single pass at 70 mJ and 100 spots/cm² on the entire face and an additional pass on active inflammatory lesions at 50 mJ and 100 spots/cm².
demonstrated clinical improvement of grade 3 and three had clinical improvement of grade 2. No patient demonstrated minimal improvement of grade 0 or 1. The mean clinical improvement score in overall skin pattern was 2.9.

Side effects included pain during the laser treatment, post-treatment crusting or scaling, edema, post-therapy erythema and hyperpigmentation, bleeding, and oozing from the treated sites. Nine of 12 (75%) patients presented with transient bleeding when CO₂ FS was delivered to the active lesions. Even the drainage of the pus was found in patients with nodular-type acne vulgaris. Post-therapy erythema was still noted in three patients (cases 1, 3, and 5) at 2 months after the final session; which gradually reduced without any further treatment (Fig. 1).

Post-therapy hyperpigmentation was markedly noted in cases 9, 10, and 11, who were treated with CO₂ FS on the buttocks. The hyperpigmentation in all three patients did not spontaneously improve in 4 weeks. In these cases, the 1,064-nm Q-switched Nd:YAG with low fluence therapy using Spectra VM-1™ (Lutronic Corporation) with settings of 2.0 J/cm², 7-mm spot size, and 3–4 passes with appropriate overlapping at 1-week intervals was delivered and resulted in noticeable improvement. Other possible adverse events, including post-therapy blister formation, scarring, hyperpigmentation, secondary bacterial infection, or viral infection, were not encountered.

**DISCUSSION**

Our study demonstrated the effect of CO₂ FS on the course of inflammatory reactions in suppurative diseases of the skin through a retrospective analysis of 12 patients. However, our results cannot constitute a conclusive therapeutic effect of a CO₂ FS due to several limitations of our study: disease entities in this study have different pathogeneses although all of them present an active inflammatory reaction as one of the major pathogenetic factors, the follow-up period was short, the risk of recurrence could not be properly determined, and some patients also received concomitant antibiotic treatment.

In the case of acne vulgaris, the action mechanisms of currently available treatment modalities are explained based on four major factors attributable to acne formation: excess of sebum production, follicular epithelial hyperproliferation and resultant follicular plugging, presence of Propionibacterium acnes and production of free fatty acids, and follicular and perifollicular inflammation [6,7]. Laser or light therapy appears to kill P. acnes and energy from lasers such as pulsed-dye lasers is absorbed by oxyhemoglobin, which reduces vascularity and thereby alters the inflammatory response of acne [8,9]. Moreover, non-ablative infrared lasers, such as 1,450-nm diode
lasers, cause thermal damage to sebaceous glands and reduce sebum production [7,11]. In our study, we observed that most patients did not present with inflammatory lesions immediately after CO2 FS treatment. Recurrence of inflammatory lesions, which generally developed 1 or 2 weeks after CO2 FS, was revealed to have clinical improvement in both the number and severity of lesions.

In the pathogenesis of HS, follicular plugging by keratinized squamous epithelium is believed to be an essential initial step that progresses to secondary infection and the development of abscesses and sinus tracts [12–15]. The clinical course of this type of disease tends to be chronic and recurrent in a significant portion of cases, despite various pharmacological and surgical treatments [16]. Madian et al. [14] suggested that recalcitrant and severe HS could be effectively treated with the CO2 laser, although scar contracture following CO2 laser treatment was noted. The advantages of using the CO2 laser included good hemostasis, excellent visualization of the operative field, and accurate assessment of residual diseased tissue [14]. In our study, one patient with HS showed clinical improvement in both the number and severity of lesions, although new lesions were observed. Moreover, granulation tissue and contracture scars improved.

We believe that CO2 FS is beneficial in our patients due to physical breakage and thermal stimulation of lesions, which may induce regeneration and realignment of thick and intricate collagen bundles of scar tissue resulting from recurrent chronic inflammation. The diseased follicular epithelium of pilosebaceous units and follicular plugging, which are major pathogenetic factors in recurrent suppurative diseases, may be affected by laser therapy through the use of fractional technology [17].

In conclusion, we observed in this study that the use of CO2 FS did not make active lesions worse, rather it might have a therapeutic effect on suppurative diseases and their related scars. However, this experimental laser treatment for suppurative diseases should not replace conventional management until optimized and prospective studies confirm the safety and efficacy of our findings.

REFERENCES