

*Original Research Article*

## **Burn Scars Treatment Using Fractional Carbon Dioxide “CO<sup>2</sup>” Laser**

Naseer Issa Mousa

Al-Wasity Teaching Hospital for Plastic and Reconstructive Surgery, Baghdad, IRAQ

E-mail:alwasityhospital@yahoo.com

Accepted 9 May, 2016

### **Abstract**

Burns are generally classified into four types: Thermal burns (flame, flash and contact with hot objects), Scald burns (hot fluids), Chemical burns (necrotizing substances like acids and alkali) and Electrical burns (intense heat from an electrical current). Skin burns can leave scar tissue ranging from mild to extensive. This study is an attempt to show the effect of fractional carbon dioxide laser (10.6 μm) as a treatment modality in regard to dose and application parameters to treat post-burn scars in different body regions like face, neck and chest.(31)Patients complaining from post-burn hypertrophic and atrophic scars were examined and treated in Al-Wasity Teaching Hospital from June 2011 to September 2012 using fractional carbon dioxide laser system (ALT). The sites of post-burn scars were: the face, neck, chest and some in the back, upper and lower limbs. After treating patients with fractional CO<sub>2</sub> laser, the results are easy and short duration procedure with no or minor complications, very good patients' response and high satisfaction because of its unique healing properties and depth of penetration. At the end of this study, we found that fractional CO<sub>2</sub> laser resurfacing of burn scars proved to be a therapeutic option for the extensive scarring and provides faster healing and recovery than the traditional treatments.

**Key words:** Burn, Scars, Fractional, CO<sub>2</sub> laser, Complications

### **الخلاصة**

اجريت الدراسة لتقييم تأثير ليزر ثنائي اوكسيد الكربون في معالجة الندوب عقابيل الحروق .  
احدى وثلاثون مريضاً تم فحصهم وعلاجهم في مستشفى الواسطي التعليمي للفترة من نيسان ولغاية تشرين الاول 2012 اغلب الندوب في الوجه والرقبة والصدر والقسم الآخر في الظهر والاطراف العليا والسفلى، تم باستخدام جهاز ليزر ثنائي اوكسيد الكربون .  
في نهاية الدراسة تبين ان استخدام ليزر ثنائي اوكسيد الكربون في علاج ندوب الحروق هو عملية فعالة، سهلة، دقيقة، ومقبولة وبدون اعراض جانبية ذات اهمية .

### **Introduction**

The basic science of current laser system was described in 1916 when Einstein proposed his theory of spontaneous and stimulated emission of radiation[1]. Medical laser therapy began in 1983 when Anderson and Parrish postulated their theory of selective photo thermo lysis (SPTL).This is based on the interaction of a specific wave length of emitted energy with a molecule in the skin, termed a

chromophore, which absorbs this targeted energy. According to the theory, a pigmented target having a greater optical absorption than its surrounding tissue at a particular wavelength will accept a brief radiation pulse, leading to a transient confinement of heat energy within the chromophore. As a result, the targets temperature may reach thermal denaturation, while the surrounding tissue remains below this level. The result is a preferential

destruction of the chromophore and relative sparing of the surrounding tissue. Each chromophore absorbs a very specific range of energy that will effectively excite that particular chromophore. The development of this theory revolutionized the modern laser in dermatology[2].

There are two types of laser: ablative and non-ablative laser therapy. The non-ablative laser treats the upper layer of the skin while the ablative laser bypasses the epidermis and treats the dermis. Understanding the basic mechanisms of CO<sub>2</sub> laser resurfacing is essential in order to achieve maximal results. These mechanisms include:

1. Single pulse vaporization: that allows efficient removal of skin layers without significant heat transfer to surrounding tissue.
2. Collagen shrinkage with subsequent skin tightening.

3. New collagen formation and remodeling.
4. Multiple pulse vaporization: that produces additive thermal effects and may be used cautiously to achieve deeper ablation [3].

### **Patients**

Between June 2011 and September 2012, (31) patients were treated in Al-Wasity Teaching Hospital (“4” male patients and “27” female patients), all complaining from post-burn hypertrophic and atrophic scars and all referred from other hospitals. Patients with hypertrophic scars were (12) cases and patients with atrophic scars were (19) cases.

From table (1), we find that only 3 patients are under 10years because the procedure requires general anesthesia in children.

**Table 1:** Number of patients in relation to the age group

Number of patients	Age
3	1-10
9	11-20
12	21-30
7	31-40

### **Materials and Methods**

#### **Patients' selection**

For each patient, detailed medical & surgical history regarding the cause of burn, duration, location of burn scar, progress and

type of previous treatment or neglecting. The cause of burn was scald in (12) cases, flame in (16) cases, chemical burn in (2) cases and electrical burn in (1) case.

**Table 2 :** Number of patients regarding the duration of burn scar

Duration	Number of patients
0-6 months	4
1-2 years	8
More than 2 years	19

**Table 3 :**Number of patients regarding the location of burn scar

Location of scar	No. of patients
Face	19
Neck	4
Back	2
Chest	3
Upper limb	1
Lower limb	1
Elbow joint	1

**Table 4 :**Number of patients regarding the conventional treatment

Conventional treatment	No. of patients
Pressure and message	31
Surgery	22
Topical agents	31
Local steroid injection	14

The size of the scar is evaluated according to Wallace rule of nine. The body is divided

into areas of 9%, and the total burn area can be calculated (Table-5) [4].

**Table 5 :** Wallace rule of nine

Burn area	Surface area
Head and neck	9%
Chest and abdomen	18%
Back	18%
Right upper limb	9%
Left upper limb	9%
Perineum	1%
Right lower limb	18%
Left lower limb	18%

### **Methods**

Before starting the session, moist drapes were placed around the field and patient's eyes were protected with proper eye shields

or goggles. Laser sessions were started by sterilizing the area with Povidone Iodine 10% and local Xylocaine spray 5% or injection infiltration with Xylocaine 2%

which was used in (2) patients with scars in the face because the procedure was more painful.

The laser power usually started with 4W in the first session and increased to 5W or 6W when we need more resurfacing especially when patient's skin is not thin and in unexposed areas like abdomen, back & chest. This power is also used for the scar edges which are elevated to obtain more resurfacing & effect.

Holding the articulated arm is very important during the work because in some angles the diode aiming beam becomes faint with less power generated and this will affect the result.

The time of each session is variable regarding the size or surface area (percentage) of the scar & usually lasts about 10 to 20 sec. The period between sessions is not less than 1 month so that re-epithelization & healing will occur before next session.

The control of the procedure is visual only and we stop exposure to laser when redness increases and the whole area should be covered without overlapping.

The parameters used: Power: 4-6W, Time on: 1.5-2ms, Form: rectangle, Area A: 20mm, Area B: 20mm, Spacing: 1-1.5mm, Energy/pulse: 6-10mJ

### **Specifications f CO<sup>2</sup> Laser System**

Laser type	Sealed off CO <sub>2</sub> laser
Wavelength	10.6 $\mu$ m
Mode structure	TEM 00
Max output power	30W
Spot Size	0.2mm
Lens Focal Distance	100 mm / 50mm
Power Fluctuation	$\leq$ 10%
Aiming Beam	630nm Red Laser ( adjustable brightness )
Delivery System	Articulated Arm With Scanner
Operation Mode	Continuous Wave , Single Pulse , Repetition Pulse , Super Pulse , Scanning
Scanning Pattern	Circle , Triangle, Rectangle, Line
Scanning Size ( max )	20 mm x 20 mm
Pulse Width	Single Pulse ( 0.01-1s) Repetition Pulse ( 0.001-1s) Super Pulse ( 0.01-1s ) Scanning ( 100 $\mu$ s-10 ms )
Cooling System	Internal Closed-loop Water Cooling Circulation
Power Supply	100~120VAC , 50/60Hz or 200~240 VAC , 50/60 Hz
Input Power	500 VA
Environment Temperature	5-40° C
Relative Humidity	$\leq$ 80%
Dimension (W*L*H )	260mm X 360mm x 960mm
Weight	46 kg

### **Laser Safety Issues Specific To The Co<sup>2</sup> Laser**

A primary area of concern is the eye, where the cornea can be injured. Eye shields with CO<sub>2</sub> laser should be metal, as that plastic shields will burn with prolonged irradiation. Black surfaces have been advocated for laser

surgery, but these may deteriorate after many passes. The teeth should be covered during resurfacing, as dentin charring and cracking can occur [5,6].

Other hazards peculiar to the CO<sub>2</sub> laser are related to the plume. There are carcinogenic

nitrosamines, and some particles are either too small to be filtered by the upper airway or too large to be removed from the alveoli. The particulate matter in the plume has a mean diameter of  $\sim 0.3\mu\text{m}$  and can be reduced with the use of an ultra-low penetration air filter. Smoke evacuation

system has been reported to protect, if they can trap particles of  $0.3\mu\text{m}$  or less. The smoke evacuator should provide at least 40CFM (cubic feet per minute) suction as the lower limit for efficient collection of debris [7,8].



**Figure 1:** CO<sup>2</sup> laser system (ATL) in Al-Wasity Teaching Hospital

### **Postoperative Care**

In our procedure, we usually keep the scar moist before and after sessions by application of topical agents like Vaseline & steroid ointments because fatty ointments penetrate easily into the scars and the surrounding normal skin, so they will diminish the period of aseptic inflammation and reduce irritation by the exfoliation of the new scar [9]. The patient should be informed to avoid exposure to sunlight after sessions especially the first few days to prevent hyperpigmentation with application of sun block or scar dressing, this is why CO<sub>2</sub> laser resurfacing is preferred in winter.

### **Results**

After treatment of (31) patients with every 3 weeks visits and 6 months follow up, the results were:

1. The ease of the procedure:

It was easy & short duration procedure and well tolerated by the patients due to: little or no pain, no bleeding, no need for suturing, no dressing, no hospital stay (outpatient procedure).

2. Patient's response and satisfaction:

There was good response and satisfaction in 29 cases. Patients have wide scars in the chest and back about 15% of body surface area and because of long time of treatment and unrealistic expectations, their satisfaction was unpredicted.

3. Complications:

- Redness appeared immediately and subsided after 4-7 days and then became milder after 3-4 sessions.

- Oedema was observed immediately in all patients and subsided within 5-7 days with ointment and massage.

- Ulceration was observed in 2 patients and subsided after 1-2 weeks with antibiotic and steroid ointments.
- Hyperpigmentation was observed in 3 cases with facial scars exposed to sun light and treated with Hydroquinone cream 4%.
- Hypopigmentation was observed in 1 case with fair skin type 2 and subsided after 2-3 weeks without treatment.
- Crustation appeared in the first week. The patients were informed to apply Vaseline ointment without peeling off the crust.
- No infection found in all cases.

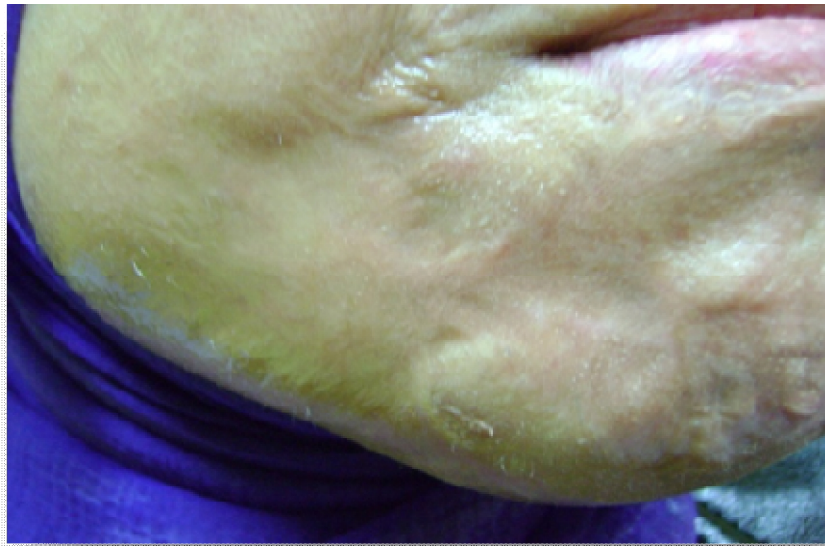


**Figure 2-A:**Before CO<sub>2</sub> laser resurfacing

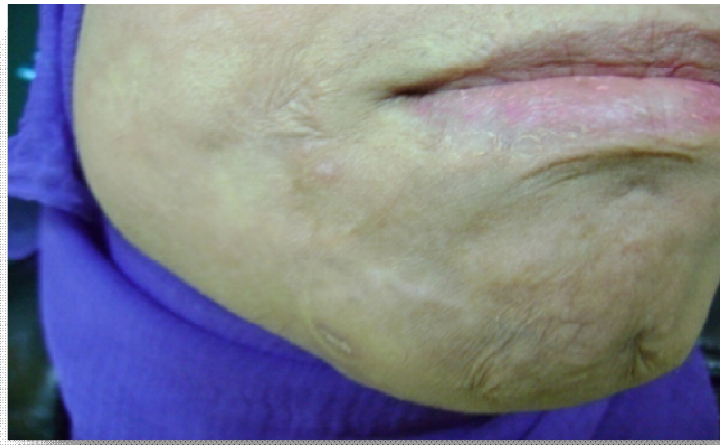


**Figure 2-B:**After 2 sessions





**Figure 3-A:**Before CO<sub>2</sub> laser resurfacing



**Figure 3-B:**After 3 sessions



**Figure 4-A:**Before CO<sub>2</sub> laser resurfacing



**Figure 4-B:**After 3 sessions

### **Discussion**

In this study, fractional CO<sub>2</sub> laser is used for the treatment of both hypertrophic scars (less than 1 year duration) and atrophic scar (more than 2 years up to 10 years) with improvement in texture and appearance. This goes with Bernstein who stated that fractional CO<sub>2</sub> laser stimulates neocollagenesis and dermal remodeling to improve the appearance of the atrophic and hypertrophic burn scars [10].

Regarding the cause of burn, we found that scald burn constitutes 38%, flame 51%, chemical and electrical burn 1%. This goes with Wilkinson who stated that scald 40%, flame 55%, chemical and electrical burn 5% [11].

Regarding the age, we found that age group (15-40 years) constitutes 70% and Wilkinson found it 60% and this is due to his larger sample (1-64 years) [11].

Better improvement of burn scars was observed in the face and neck than in the chest and limbs due to thin texture. This goes with Alster and Zaylyanov who stated that the area of the body is an important determinant of treatment outcome due to different texture [1].

Improvement is also observed in patients with extensive wide scars in the face, chest and limbs. This goes with Alster, Tanzi and

Lazarus who stated that the fractional CO<sub>2</sub> laser is an effective treatment for extensive cutaneous scars in burn patients because of unique healing properties and depth of penetration. One obvious parameter is the depth of injury, with a significantly deeper penetration level can be achieved with different fractional modalities to reach deeper aspects of scarring resulting from a higher degree of thermal injury. Collagen remodeling, heat shock proteins and cytokines are the cause of improvement rather than a physical heating of the scar tissue [2].

In fractional photothermolysis, thermal damage results in increased expression of heat shock proteins. This in turn, activates transient amplifying epidermal stem cells located in the basal layer which begin to proliferate to rapidly replace the damaged epidermal tissue.

The procedure is bloodless, less pain, less oedema and provides faster healing than the conventional treatments. This goes with Ratner who stated that CO<sub>2</sub> laser offers significant advantages to patients such as: bloodless, less pain, less oedema and provides faster healing and recovery than the traditional methods [12].



**References**

1. Alster T, Zauilyanov L. laser scar revision: A review. *Dermatol Surg.* 2007.
2. Alster T, Tanzi E, Lazarus M. The use of fractional laser photothermolysis for the treatment of atrophic scars. *Dermatol Surg.* 2007.
3. Chernoff G. Cutaneous laser resurfacing international journal of Aesthetic & reconstructive surgery 1995.
4. BMJ Volume 328 5 June 2004.
5. Baca Raton asersafy Manuel 1999 Radiation safety programs.
6. Michael Drewser notes on laser hazards 2002.
7. Fisher J. The laser Education Foundation syllabus on Basic Laser Biophysics and safety and Resurfacing of skin with CO<sub>2</sub> Laser-1998.
8. Fulton J. Complications of laser resurfacing in dermatological surgery 1998.
9. Durani, P., McGrouther, D.A., Ferguson, M.W.J. Current scales for assessing human scarring: A review. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, 2009.
10. Bernstein A short and long term effects of CO<sub>2</sub> laser resurfacing derm. *Surg.* 1997.
11. Willkinson E. the epidemiology of burns in secondary care, in population of 2.6 million people. *Burns* 1998;24:139-43.
12. Ratner D. Cutaneous laser resurfacing *Journal of American Academy of Dermatology* 1999.