Combined Autologous Lipotransfer, and Fractional CO_2 Laser Treatment for Scars

Mahmoud Saber *, Wessam Wahdan**
*Surgery unit, National Laser Institute, Cairo University
** Plastic Surgery Department, Faculty of Medicine, Cairo University

ABSTRACT

Many treatments have been proposed for cosmetic or functional improvement of scars. It is known that fat grafts and laser treatment can have beneficial effects on the remodeling of scar tissue. We hypothesized that laser and fat graft combination would be effective in improving scars appearance. ***Objective****: The purpose of this study was to evaluate the efficacy of this combination in the treatment of scars.* ***Methods and Results****: From 2012-2014, we treated with this combination 44 patients affected by scars involving different body parts. At 6 months the patients' overall satisfaction rate was excellent for over 50% of the patients.* ***Conclusion****: The association of an ablative CO_2laser with and autologous fat graft seems to be a promising and effective therapeutic approach for scars.*
Keywords*: scar, fat graft, Fractional CO_2, Laser.*

INTRODUCTION

All wounds leave scars, unless they are very small or superficial; over 100 million people acquire postsurgical scars each year in the developed world alone [1]. Skin scars have a unique impact on patients' lives; so many treatments have been proposed for cosmetic and functional improvement of scars. Regenerative medicine is an emerging and rapidly evolving field of research and therapies, thanks to the new discovery on stem cells. The discovery of preadipocytes, their mesenchymal origin, and their role as pluripotent stem cells have been used to maintain graft tissue [2,3]. So, fat grafting, a well-established technique in surgery, became an important tool in regenerative medicine due to the preadipocytes' capability to differentiate and its role in collagen synthesis and angiogenesis and to produce more preadipocytes [4]. Autologous fat grafts have been used in a number of settings to improve the quality of overlying tissues. Clinical improvement of burn scars was noted following autologous fat grafting beneath the burn site [5].

Many therapies have been employed in treating atrophic scars, such as chemical peeling, surgical excision, mechanical dermabrasion, punch grafting, tissue augmentation with fillers, and laser resurfacing. some of these modalities cause incomplete improvement, postoperative infection, worsening of scars, and pigmentary change. [6]. Ablative resurfacing using a 10,600-nm carbon dioxide (CO_2) laser and the 2,940-nm Erbium-doped yttrium aluminium garnet (Er:YAG) laser has yielded significant improvement in the treatment of facial scars after two to three treatments [7]. Fractional resurfacing is a new concept in the laser field, which causes minimal disruption of the epidermis and generates macrocolumns of coagulated tissue that extend deep into the dermis. The fractional laser CO_2 treatment causes tissue tightening and collagen remodeling both initially and for a 3 to 6 months period after treatment [8]. Some authors advised a combination approach involving the synergy between ablative laser and fat injection as a regenerative techniques which they called the "Adipo laser rejuvenation" approach They claimed this combination could be effective and long-lasting alternative to provide improvement of overall skin tone and condition[9]. In this present study we sought to evaluate the benefits of this combination approach over standard minimally-invasive mono therapy techniques and if the Laser-stimulated fat grafts gives better appearance of scars.

PATIENTS AND METHODS

Between June 2012 and November 2014 at Cairo University, 44 patients with scar from different etiologies were enrolled in the study. All the patients gave an informed consent, their full medical history and were photographed before

and after the treatment. Their skin type ranged between III and IV on Fitzpatrick scale.

The procedure for the fat harvesting and lipofilling done with following steps: most cases done under local infiltration anesthesia after administration of intravenous antibiotic prophylaxis a 3-mm incision was made in the umbilical region then tumescent solution consisting of saline 0.9%, lidocaine2%, and epinephrine in order to minimize bleeding thus facilitating fat harvesting, and reduce postoperative pain. Using a blunt, 2-mm-diameter cannula attached to a 10-50ml luer lock syringe, fat was manually suctioned with a 1:1 ratio of the amount of infiltrated solution to the tissue harvested. The syringe with the obtained tissue was lift vertical in place for 20-30 min to separate the fat tissue from the oils (supernatant), serum (subnatant), and red blood cells (pellet). A sterile nylon cloth with 0.5-mm mesh size was mounted over a sterile canister, and the supernatant was poured over it in order to have a micro fat droplets. The fat tissue was then transferred to 1 ml syringes and transplanted into the recipient scar area with the aid of thin diameter cannula (20- to 22-gauge). The postoperative process consisted of antibiotic and non-steroidal anti-inflammatory drug therapy and dressings for the harvesting place 24-48 hours.

For laser resurfacing of the scars, we used a fractional carbon dioxide (CO_2) (10,600nm) (SmartXide DOT; DEKA, Calenzano, Italy). The settings included 8–15 W, 500– 750 µm DOT spacing was adjusted, and 500–1200 µs dwell time. Only 1 pass is performed with the hand piece each treatment session entailed one pass only per area with numerous (3-6) successive and consecutive pulses in the same point without moving the scanner and using the Pulse Stacking' function. The laser parameters were matched with individual Fitzpatrick type. The procedure was generally performed under no or local anesthesia. All the patients followed a pre- and post-operating protocol. All patients were recommended emollient creams and creams with SPF 50+ for 1 month and combined antibiotic and steroid cream for only one week following the procedure.

The combination process included injection into the scar first then waiting for 3-4 weeks after the injection then staring the application of laser one session session per month for about three sessions then another assessment is done for the scar quality and degree of improvement. The follow-up took place after, 1, 3, 6 months after the procedure.

During clinical examinations, the scars were assessed using the Vancouver Scar Scale (VSS) as regard these parameters: vascularity, pigmentation, pliability and height, the total scores range from (0-13) [10]. Assessment performed independently by the two authors. Photographs were also taken during every medical examination in the same room and with standard parameters to enable the comparison of subsequent images. For patient satisfaction the following aspect "scar appearance" was assessed on a 4-point scale as excellent, good, fair, and poor.

Statistical Methods:

Data were statistically described in terms of mean ± standard deviation (± SD). Comparison between before and after treatment effect was done using Student *t* test for independent samples. *P* values less than 0.05 was considered statistically significant $P < 0.05$. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc: Chicago, IL, USA) version 15 for Microsoft Windows.

RESULTS

The purpose of this study was to investigate the effect of combined micro lipo filling and fractional CO_2 laser as a therapy for scars. Forty four patients participated in this study, there were 27(61.4%) females and 17 (38.6%) males, age range from 20 to 46 years old (mean± SD 24.73±2.79 years). The etiology of the scar was 16(36.4%) post burn, 15(34.01%) traumatic scars, 7(15.9%) surgical scars and 6 (13.6%) from other pathologies. The site of the scar was 14 (27.3%) at the face, 6 (13.6%) at the arm, 3(6.8%) at forearm, 5(11.3%) at hand, 8(18.2%) at thigh and 8 (18.2%) at the trunk.

Wilcoxon signed ranks test for comparison between pre and post treatment median values of Vancouver Scar Assessment Scale (VSS) of all the study cases (Table 1) was compared and showed a significant decrease in the median value of VSS total score post treatment to 6 as compared to 9 pretreatment total score ($p \leq 0.0001$).

The median value of scar pliability (fig 1) pre treatment was 3 that decreased significantly to a median score of 2 post treatment ($p \leq 0.001$). The median value of the scar height pre treatment was 2 that decreased significantly to a median score of post treatment ($p \leq 0.0001$). The median value of the scar vascularity pre treatment was 2 that decreased significantly to a median score of 2 post treatment ($p \leq 0.0001$). The median value of the scar pigmentation pre treatment was 2 that decreased significantly to a median score of 1 post treatment ($p \leq 0.0001$).

Table 1: Comparison between pre and post treatment median values of (VSS)

Vancouver Scar Assessment Scale	*Pre median*	*Post median*	*z-value*	*p-value*	*Sig.*
Pliability	3	2	3.25	0.001	S
Height	2	1	3.41	0.001	S
Vascularity	2	2	2.69	0.001	S
Pigmentation	2	1	3.27	0.001	S
Total score	9	6	2.21	0.001	S

Z- value: *Wilcoxon signed ranks test value* *S:signficant*

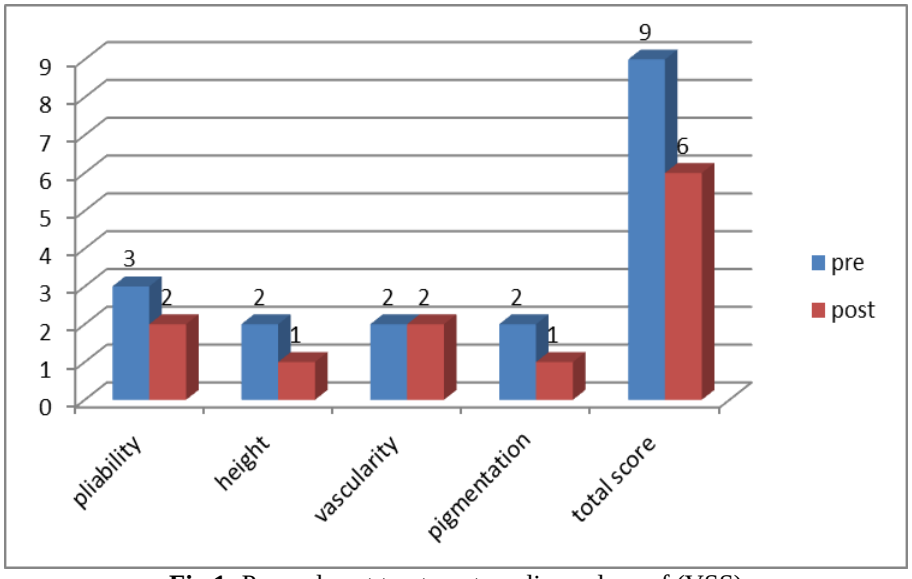

Fig 1: Pre and post treatment median values of (VSS)

Regarding the patients' overall satisfaction rate, 25 patients (56.8%) rated the treatment as good while 9 patients (20.4%) rated the treatment as excellent 7 patients (15.9%) said the appearance of scars was fair to them and only three patients (6.8%) rated the treatment as poor (**Fig. 2, Fig. 3**).

Fig. 2 (a:Pre, b: Post): Scar on the arm 6 months after the 4 fractional CO_2 laser sessions and one injection with micro fat

Fig. 3 (a:Pre, b: Post): Atrophic scar on the arm 6 months after the 3 fractional CO_2 laser sessions and one injection with micro fat

The most bothersome symptom was post lipofilling edema, lasting in some cases, up to 1 month, more pronounced in the face scars. Most lesions were 2 years old and thus createed higher adhesions and when there was cutting of the adhesions with a hypodermic needle 16 G- before lipofilling there were a greater degree of swelling and bruising. The scars in other areas as abdomen and legs were found with fewer side effects were more easily tolerated by the patient, and recovery was rapid. About nearly half of the cases 21 have been in a need a 2nd procedure

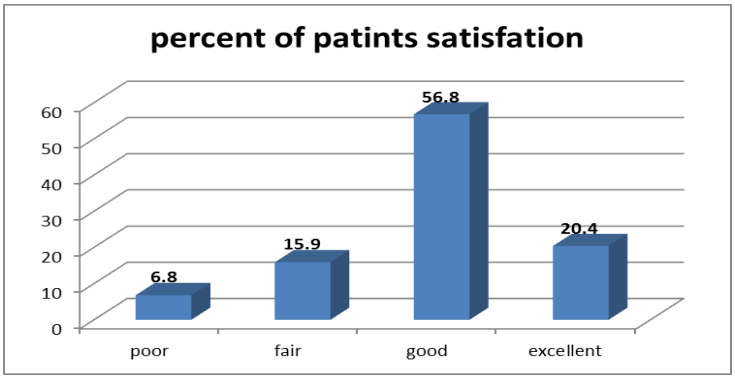

Figure 2: Post-treatment assessment of patient satisfaction rate at 6 months

DISCUSSION

Mature scars resulting from several different etiologies imply particularly difficult circumstances in their treatment because of abnormal fibroplasia, hypertrophy. During the past 20 years, advances in scar therapy despite this, scars still a social, economical, and psychological problem in terms of both functional and aesthetic aspects [11]. The management of scars has focused on addressing the aberrant collagen deposition seen in mature scars. Treatments used today include scar excision, dermabrasion, intralesional corticosteroids, chemical peels, silicone gel sheeting, compression therapy, skin flaps, split thickness and full-thickness skin grafts, autografting, cadaver skin transplants, and lasers [12]. Ablative devices including the Er:YAG and carbon dioxide lasers have been found effective in improving the appearance of scars, including mature scars[13].

The concept of fractional photothermolysis was used for inducing dermal remodeling, in this process, microthermal treatment zones composed of columns of destruction are created while the surrounding islands of untreated tissue promote rapid healing and re-epithelization. This technology has proven to be effective for treating mature scars [14]. Although the adverse effect profile of fractional carbon dioxide lasers is improved compared with fully ablative devices, there are still reports of adverse effects, particularly in areas of thinner skin and decreased adnexal structures such as the neck. These adverse effects may be due to bulk heating of tissue and penetration of laser energy beneath the dermis [15]. For this reason the treatment parameters used in this study had been previously used on many aesthetic patients in the practice with no adverse sequelae.

The reaction in tissue following such laser irradiation is therefore above the survival threshold of normal tissue, causing death or disruption, classed as high level laser treatment. Even with ablative fractional lasers, concomitant effects leave tissue alive and well, but also stimulate the tissue, and these are classified as low level laser therapy [16].

The macroablative columns associated with ablative CO_2 fractional resurfacing induce wound healing, with elastinogenesis and neocollagenesis in the upper and mid dermal layers, resulting in a much better-organized dermal matrix and younger-looking epidermis but also have an associated zone of low photon intensity surrounding the damaged tissues, thereby assisting with the acceleration of the wound healing process and also photobioactivation of the transplanted fat cells to ensure better graft take with less initial resorption. So, in this case, we can say that CO_2 laser is a non-contact low level laser device for our fat graft that was grafted before the laser session started for that previous reason [17]. Low level laser (LLLT) on the other hand, works at temperatures under 40°C, or with no temperature rise at all, and induces photobioactivation without any damage. The resulting photochemical, photodynamic, photoenzymatic, and photoimmune effects act directly on cells at a subcellular organelle level to achieve a variety of results including cell repair, enhancement of cellular function and cellular proliferation. It is well accepted that the energy of photons when absorbed directly in cells or tissue during the (LLLT) process may affect cellular metabolism and signaling pathways. Reported results include increased cell proliferation and migration (particularly by fibroblasts), increased tissue oxygenation, modulation in the levels of cytokines, growth factors and inflammatory mediators [18].

We demonstrated that autologous lipofilling represents an excellent technique for enhancing the general appearance of scars. These results confirm the findings of other researchers, where their Showed improvement on scar scores at the final follow-up on tracheotomy scars with autologous fat injections. Whereas Ulrich et al. demonstrated the enhancing effects of autologous fat injection on scarification and cicatricial contractures in the finding that lipoaspirate leads to skin thickening and skin rejuvenation has also been observed in lipo-facelifts. In our study, we observed both an aesthetic and functional improvement in the treated scars, which led to a high patient satisfaction rate [19,20].

Our results are matched with the results presented by Cervelli V. in 2012 [17], regarding the association of fat graft, and laser in scar treatment. The differences were between the lasers; we used an ablative fractional laser, they used a non-ablative one.

According to the given results we can conclude that the association of an ablative laser

CO_2 and autologous fat graft seems to be a promising and effective therapeutic approach for scars. In general, we can affirm that the treated areas regained characteristics similar to normal skin, which are clinically observed, leading not only to aesthetic but also functional results. Further studies are needed to explore the potential use of this combined treatment patients with atophic skin condition.

REFERENCES

1. Brown BC, McKenna SP, Solomon M, Wilburn J, McGrouther DA, Bayat A. The patient-reported impact of scars measure: development and validation. Plastic and reconstructive surgery. 2010 May 1;125(5):1439-49.
2. Zuk PA, Zhu M, Mizuno H, Huang J, Futrell JW, Katz AJ, Benhaim P, Lorenz HP, Hedrick MH. Multilineage cells from human adipose tissue: Implications for cell-based therapies. Advances in Tissue Engineering: Stem Cells. New York: Mary Ann Liebert. 2010:119-33.
3. Yingbo Z, Daping Y. Supplementation of Fat Grafts With Adipose-Derived Regenerative Cells Improves Long-Term Graft Retention. Annals of plastic surgery. 2012 Jan 1;68(1):111.
4. Lambros V. Fat injection: from filling to regeneration. Plastic and Reconstructive Surgery. 2010 Mar 1;125(3):1039-40.
5. Sultan SM, Barr JS, Butala P, Davidson EH, Weinstein AL, Knobel D, Saadeh PB, Warren SM, Coleman SR, Hazen A. Fat grafting accelerates revascularisation and decreases fibrosis following thermal injury. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2012 Feb 29;65(2):219-27.
6. Hu S, Chen Mc, Lee Mc, Yang Lc, Keoprasom N. Fractional resurfacing for the treatment of atrophic facial acne scars in Asian skin. Dermatologic Surgery. 2009 May 1;35(5):826-32.
7. Tanzi EL, Lupton JR, Alster TS. Lasers in dermatology: four decades of progress. J Am Acad Dermatol 2003;49:1–31.
8. Lanbach HJ, Tannous Z, Anderson RR**.** Skin responses to fractional photothermolysis. Lasers Surg Med. 2006; 38:142-149.
9. Jianu DM, Filipescu M, Jianu SA, Nita AC, Chirita DA. The sinergy between lasers and adipose surgery in face and neck rejuvenation: A new approach from personal experience. Laser therapy. 2012;21(3):215-22.
10. Durani P, McGrouther DA, Ferguson MW. Current scales for assessing human scarring: a review. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2009 Jun 30;62(6):713-20.
11. Lau JC, Li-Tsang CW, Zheng YP. Application of tissue ultrasound palpation system (TUPS) in objective scar evaluation. Burns. 2005 Jun 30;31(4):445-52.
12. Brusselaers N, Pirayesh A, Hoeksema H, et al. Skin replacement in burn wounds. J Trauma. 2010;68(2):490-501.
13. Kawecki M, Bernad-Wis´niewska T, Sakiel S, Nowak M, Andriessen A. Laser in the treatment of hypertrophic burn scars. Int Wound J. 2008;5(1):87-97.
14. Ozog DM, Liu A, Chaffins ML, Ormsby AH, Fincher EF, Chipps LK, Mi QS, Grossman PH, Pui JC, Moy RL. Evaluation of clinical results, histological architecture, and collagen expression following treatment of mature burn scars with a fractional carbon dioxide laser. JAMA dermatology. 2013 Jan 1;149(1):50-7.
15. Haedersdal M. Fractional ablative CO(2) laser resurfacing improves a thermal burn scar. *J Eur Acad Dermatol Venereol*. 2009;23(11):1340-1341.
16. Ohshiro T. New classification for single-system light treatment. Laser Therapy. 2011; 20: 11-15.
17. Cervelli V, Nicoli F, Spallone D, Verardi S, Sorge R, Nicoli M, Balzani **A.** Treatment of traumatic scars using fat grafts mixed with platelet-rich plasma, and resurfacing of skin with the 1540 nm nonablative laser. Clinical & Experimental Dermatology.2012; 37(1):55-61.
18. Vranova J, Remlova E, Jelinkova H, Rosina J, Dostalova T. Comparison of quality of facial scars after single lowlevel laser therapy and combined lowlevel with highlevel (PDL 595 nm) laser therapy. Dermatologic therapy. 2015 Jul 1;28(4):201-9.
19. Mazzola IC, Cantarella G, Mazzola RF. Management of tracheostomy scar by autologous fat transplantation: a minimally invasive new approach. J Craniofac Surg;24:1361e4.
20. Ulrich D, Ulrich F, van Doorn L, Hovius S. Lipofilling of perineal and vaginal scars: a new method for improvement of pain after episiotomy and perineal laceration. Plast Reconstr Surg;129: 593ee94e