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The efficacy of low energy fractional carbon dioxide laser therapy in management of post-surgical hypertrophic scars

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Abstract--Background: aberrant & accelerated wound-healing process that results in hypertrophic scarring causes extracellular matrix & collagen to deposit abnormally in the dermis. After tissue damage occurs, a defensive reaction called tissue repair occurs. Aim; in this review; we aimed to present the effectiveness of low-energy fractional carbon dioxide laser therapy in treating hypertrophic scars following surgery. Summary: A safe & effective approach for treating hypertrophic burn scars is fractional ablative CO2 laser therapy. Even though more treatment sessions have been necessary for satisfying outcomes, a big improvement can be seen after just one round of therapy. Combination therapy with other modalities can decrease the need for repetition of therapy as efficacy increases. Though, in some studies, combination therapy may shorten the duration of studied case downtime & in others, combination therapy may increase side effects. essential for laser energy setting needs to be adjusted for each hypertrophic scar condition. larger research population & longer follow-up period are recommended.

Keywords--low energy fractional, carbon dioxide laser therapy, post-surgical hypertrophic scars.

Introduction

Aberrant & accelerated wound-healing process that results in hypertrophic scarring causes extracellular matrix & collagen to deposit abnormally in the dermis. After tissue damage occurs, a defensive reaction called tissue repair occurs. Fibrosis, also known as scar tissue, is the result of a delayed, recurrent, or incomplete healing process. Significant wounds, including profound burns, trauma, & large surgical incisions, have the potential to heal into scar tissue. Skin fibrosis disease causes aberrant shape changes & may restrict physiological functions, such as regular movement. When skin is under tension or in a specific

location with sluggish wound-healing characteristics, hypertrophic scars typically show as hard, nodular growths that are erythematous, elevated, hypopigmented, & in some cases, hypopigmented (1).

There are numerous techniques available to improve the appearance & functionality of hypertrophic scars. the problem can occasionally recur despite the use of conventional treatments like silicone gel sheeting & pressure dressings, dermabrasion, 5-fluorouracil, intralesional steroid injections, bleomycin, cryosurgery, radiation, & surgical revision with skin grafting. There is still no specific recommendation about the modality to be used to treat hypertrophic scars. In comparison to alternative treatment options like topical pressure & silicone therapy, intralesional injection seems to be most effective. Yet, it is demonstrated that using fractional laser technology to heal scars can produce long-lasting favorable clinical results (2).

Scar tissue can be treated using a CO2 fractional laser. Fractional CO2 lasers are effective at treating both atrophic & hypertrophic scars. majority of skin types have demonstrated this therapy to be safe & effective, with transitory side effects that are tolerable. With an emphasis on the absorption of water, which makes up a significant portion of soft tissue, CO2 is helpful in surgery on highly vascularized organs. There is evidence that CO2 lasers are useful in the treatment of aging & persistent scar tissue. disorganized ECM proteins are broken down into re-epithelialization & deposition of new collagen as fractional 10 600-nm CO2 laser ablates skin & scar tissue in a columnar pattern to a depth of numerous centimeters. To evaluate the efficacy of fractional CO2 laser therapy in enhancing the clinical look of hypertrophic scars, this research will conduct a systematic review (3).

To evaluate the expression of inflammatory mediators that are involved in the development of hypertrophic scars, clinical, histological, & immunohistochemical observations of improvement in the status of hypertrophic scars may be made. Clinically, the usual effects of laser therapy include a decrease in scar height & redness, increase in pliability, & decrease in pruritis. look of scarring may be evaluated using a variety of methods. Vancouver Scar Score is 1 of the most often utilized (4). Hypertrophic scars may develop after skin trauma that penetrates the dermis at a 2nd-degree burn or deeper level. Injuries to the skin's surface that do not penetrate the reticular dermis never result in abnormal wound healing that is distinguished by localized inflammation for a lengthy period, an abundance of inflammatory cells, fibroblasts, newly created blood vessels, & collagen deposits. a clinical sign of hypertrophic scars is a scarred surface that is higher than normal skin around it & scar texture that is thicker & harder than the surrounding skin. Pro-inflammatory genes in the skin have been sensitive in people with keloid susceptibility and may cause invasive keloid formation in chronic situations (5).

cascade of collagenases-collagenolysis cycle has been triggered by localized epidermal necrosis & collagen denaturation brought on by purposeful thermal injury during fractional CO2 laser treatment. fresh & promising technology called fractional photothermolysis produces microthermal zones in epidermal & dermal layers. Because of regulated, limited skin injury that results from fractional photothermolysis therapy & is surrounded by healthy tissue, hundreds of

microscopic columns in the epidermal & dermal layer are thermally damaged. This allows for quick epidermal healing. Scar remodeling is caused by the stimulation of numerous cytokines & growth factors by microthermal zones produced throughout the photothermolysis process (6).

Significance is given to transforming growth factor $\beta 1$ in fibrotic scarring response. One potential treatment option for hypertrophic scars is fractional CO₂ laser. According to histological imaging & alteration in TGF- $\beta 1$ expression, it normalizes dermal collagen. Additionally, it had been believed that laser treatment caused a large rise in MMP9 levels in scar locations, which led to improved collagen organization. low concentration of MMP9, an enzyme involved in the breakdown of connective tissue, had been discovered in keloid & hypertrophic scars. considerable decrease in collagen percentage and a large rise in MMP9 level were observed in hypertrophic scars following many FCO₂L therapy sessions. Yet, more research is required to clarify other cellular & molecular factors linked to this event (7).

It has been demonstrated that fractional CO₂ lasers can reduce chronic erythema, which is a problem in hypertrophic burn scars, & hence enhance the appearance of burn scars. According to research, nevertheless, mature hypertrophic burn scars treated with fractional CO₂ laser exhibited a statistically significant rise in vascular density in the superficial dermis. Each component of the scar has improved at a different rate. Pliability, pigmentation, & vascularity were shown to be the three factors that improved the most. This is in line with research that had been reviewed in a comprehensive review of updated hypertrophic scar therapy, which revealed a significant increase in skin elasticity despite nonsignificant reduction in erythema & pigmentation. Treatment with fractional CO₂ laser is reported to improve pigmentation. Encouraging normal melanocytes to move from nearby tissue to freshly exposed tissue, caused hypopigmented scars to develop repigmentation (8).

Deeper penetration & more heat damage from CO₂ laser led to severe dermal remodeling. Persistent Pixel Stamping Marks, which have been indicators of micro scarring caused by delayed healing post-thermal injury by fractional CO₂ laser & commonly occur in hyperpigmented, protracted hypertrophic, or burn scars, is another unique consequence that has recently been explored. deeper hue & longer scar duration as measured by VSS had been more strongly linked to the emergence of PPSM. Nevertheless, the research found that treating postburn hypertrophic scars in pediatric studied cases with powerful topical steroids and fractional CO₂ laser resurfacing provides considerable therapeutic effects. More research is required to determine whether FCO₂ laser therapy, either alone or in conjunction with other treatments, is effective in treating hypertrophic scars (9).

As combination therapy with a 595-nm adjustable pulse width pulsed dye laser, fractional CO₂ laser treatment appears to have a positive therapeutic impact on fresh red hypertrophic scars without any major adverse responses being observed. To shorten the studied case's treatment cycle & overall potential downtime, the gap between combination treatments during clinical treatment may be set at three months. With no negative side effects noted, this fractional resurfacing technique showed promise in treating hypopigmented scars on the

face. As a result, fractional laser modalities have broader therapeutic applications & potential advantages. Van Drooge & colleagues found frequent & substantial adverse impacts even at six-month follow-up, with satisfactory outcomes & excellent safety profile. This reaction varies according to skin type, laser energy level, lesion location, cause of scar, & length of scar. New scars are thought to heal more quickly & effectively. Even in studies that did not demonstrate improvement that had been anticipated in doctors' opinion, studied cases often reported much better looks after CO₂FL therapy (10).

safe & effective approach for treating hypertrophic burn scars is fractional ablative CO₂ laser therapy. Even if further treatment sessions are necessary for satisfactory outcomes, big improvement may already be seen after just one round of therapy. As treatment efficacy rises, combination therapy with various modalities can lessen the requirement for therapy repetition. Combination therapy, nevertheless, has been shown in some trials to reduce the length of a studied case's downtime &, in other research, to lengthen negative impacts. Each hypertrophic scar condition necessitates a different laser energy setting. It is advised to increase the research population & extend the follow-up time (11).

most significant long-term side effect of burn injuries or other skin trauma is scarring. Dermabrasion, laser resurfacing, or surgical correction are the only available treatments for such scars. There are two types of lasers used for scar resurfacing: ablative & nonablative lasers. According to theory, laser resurfacing stimulates the formation of collagen in the dermis & modifies collagen fibers in the dermis. carbon dioxide laser is an ablative laser with a wavelength of 10,600 nm that emits energy in far-infrared regions. Scars & aged skin can both be effectively treated with CO₂ laser resurfacing. Yet, its application in standard dermatology practice has been constrained by protracted downtime & high rate of negative impacts. Additional long-term side effects include persistent hyperpigmentation, hypopigmentation, & scarring (12).

Several of the above-mentioned drawbacks of laser resurfacing are avoided using fractional photothermolysis. With FP, intervening skin is left untreated and only a portion of the outermost layer of skin is treated in pixelated pattern. Longitudinal microthermal zones in the skin are formed after FP treatment and are separated by healthy, untreated skin with intact epidermis. This enables treating doctors to perform far more thorough procedures than they could with conventional laser resurfacing. negative impacts of FP are also temporary & milder than those of complete skin resurfacing. Atrophic acne scars have been successfully treated using fractional CO₂ laser resurfacing, together with skin renewal. Additionally, some findings suggest that it can help with burn scars and hypertrophic scars. Qray-FR XR system from Dosis, Korea, which has a variable spot size of one to twenty cm² & output ranging from one to thirty J/cm², had been a fractional CO₂ laser device employed in this studied case series (13).

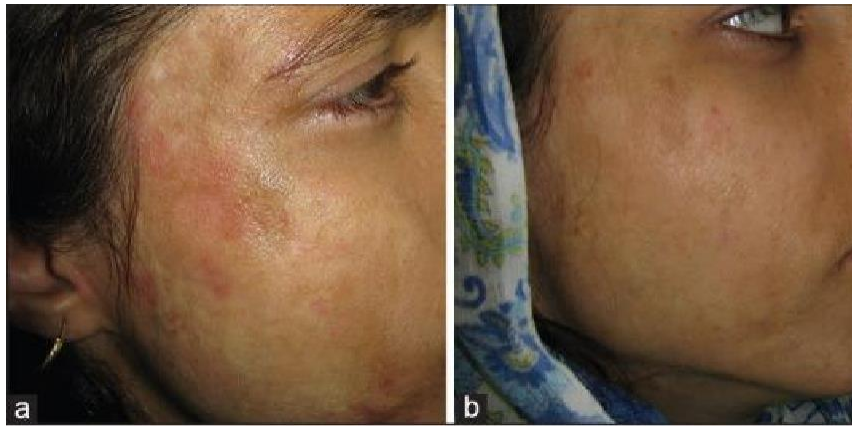


Figure 1. (a) Post-burn scars on the face (b) After 4 sessions of fractional laser treatment (14)

There are few treatment options available for post-burn or post-traumatic atrophic scars, & none of them assure ideal results. final cosmetic outcome is not expected to be "perfect" even if the scar is amenable to surgical excision or scar revision because some residual scarring persists even after the scar has undergone surgical treatment. Treatment of post-acne atrophic scars of various morphologies using fractional laser resurfacing is successful. Because the process behind all these aetiological types of scars is fundamentally the same, similar therapeutic benefits may be anticipated in post-traumatic & post-burn scarring. With different degrees of success, both ablative and non-ablative fractional laser devices are used to treat burn scars. mature scar had been demonstrated to significantly improve after five monthly sessions with a fractional Er: YAG device in 1 of the first investigations using fractional lasers in burn scars. look of scar and contracture both improved, according to the authors. In a randomized controlled experiment, another investigation using a non-ablative Er: YAG laser found that skin texture significantly improved after three monthly treatments (15).

Burn scars can be effectively treated with fractional CO₂ laser, even in studied cases with dark skin tones. In addition, after using fractional CO₂ devices, no lasting dyschromia was observed in these clinical studies. After fractional CO₂ laser resurfacing on burn scar, studies have shown histological evidence of a large rise in Type 3 collagen & reduction in Type 1 collagen (16). Burn scars are typically hypertrophic, & this kind of scarring is more challenging to heal. Several scoring methods, including the Visual Analogue Scale, the Vancouver Scar Scale, the Manchester Scar Scale, & studied case & Observer Scar Assessment Scale, are used to evaluate the severity of burn scars & their response to treatment. All these grading methods are most helpful for determining how severe hypertrophic & keloidal burn scars are. These scoring methods have been used in clinical research to evaluate scar severity and therapy response. While evaluating our findings, we employed the same characteristics as those listed in MSS scoring, but we left out 2 factors "scar contour" & "matte vs. shiny" from our scoring scale. This had been done since research had been limited to the

treatment of atrophic/non-hypertrophic scars, so determining therapeutic response would not be affected by scars' flattening (impact on shape) (17).

3 factors were evaluated by the doctor: the color of the scars, their shape, & texture of the skin. All these factors showed improvement, however, fractional laser resurfacing had the biggest impact. appearance & feel of this scarred skin, in addition to its softer & more uniform texture, were both improved. Skin texture had been 1st area to exhibit discernible change, with both studied cases and researchers observing improvement even after 1st laser resurfacing session. scar's overall look changed as a result of steady improvement in pigmentation over scars. Yet, completely depigmented scars required additional treatment modalities like skin grafting to address this irregularity because they did not repigment with fractional laser resurfacing (18).

mean of all scores attained in 3 variables had been calculated to obtain the final score, which served to quantify response in each studied case. This had been done to provide each of the various characteristics of scar appearance its fair consideration. studied cases saw improvements in other factors like skin texture & surface irregularity even when 1, such as skin depigmentation, did not respond. Scars from burns & other trauma can be treated safely & effectively with CO2 laser fractional resurfacing. Anywhere on the body, scars are anticipated to respond to this treatment approach with outcomes that range from passably good to outstanding. In all our studied cases, we performed 4 fractional laser resurfacing sessions spaced four to six weeks apart to repair scars at nearly all of the body's various locations. At the most recent follow-up appointment, both researchers and studied cases reported improvement in the look of the scar. 4 out of 6 disappointed studied cases reported unsatisfactory outcomes on objective evaluation as well, demonstrating a strong link between the investigator & studied case-based assessments (19).

clinical improvement of scar look is a challenging issue since it depends on a variety of variables, including the amount of scarring, wrinkling, pigmentation, & uniformity of skin surface. Although there is a positive response from each of these variables, the degree of improvement varies across ranges. As a result, the scar's pigmentation or volume cannot improve as much as the scar's surface irregularities or wrinkles. It is crucial to use a score that takes each of these factors into account separately because of this. Additionally, it implies that measuring volume change in scar alone with objective methods is insufficient to determine how fractional laser resurfacing or any other scar treatment option will perform (20).

enhancement in function that therapy provides is another significant factor that must preferably be considered when evaluating therapeutic response to laser resurfacing. When scars on the neck or mandibular area had been treated, for instance, studied cases who had treatment did perceive improved neck movement. This, some of our studied cases with scars on their hands or wrists reported improved hand movement following fractional laser resurfacing therapy. This crucial variable must ideally be included in any scoring system that deals with the problem of response evaluation whenever it is applicable (21).

1 of the frequent causes of cosmetic deformity necessitating a dermatologist's examination is scars. Although post-acne scars have been extensively studied, there is little information available regarding how to treat post-traumatic & post-burn scars, especially in people with darker skin. Contrary to what individuals seeking therapy might believe, scars can never completely improve. However, improvements in texture, depth, & pigmentation frequently result in less noticeable scars, which raises one's quality of life. Ablative carbon dioxide fractional laser is utilized with varying degrees of success, but there is no set standard for the appropriate duration, intensity, or quantity of sessions. In this retrospective research, we sought to determine the efficacy of carbon dioxide fractional ablative laser in treating studied cases with skin types four & five who primarily had post-traumatic & post-burn scars (22).

Scars are the result of fibrosis & changed skin morphology during the healing of cutaneous wounds. Modern developments in laser technology have improved laser devices' capacity to target dermal collagen, leading to the remodeling & enhancement of all scar types of appearance, texture, & pliability. Scar resurfacing has been accomplished using both ablative & non-ablative fractional lasers. Although the former is said to be the safest of 2, studies have shown that the latter is more effective and results in higher studied case satisfaction (23). There isn't as much research on laser's effectiveness in treating post-traumatic, post-burn scars as there is on post-acne scars. In comparison to skin types with lighter pigmentation, type four & type five skin has significantly different side effect profiles, studied case preferences, & laser parameters. In this investigation, we discovered that fractional CO₂ laser was useful in reducing the visibility of scars. IGA & PGA reported that scars improved by over fifty percent in 13.43 percent & 41.78 percent of cases, respectively. literature has previously used a variety of result evaluation measures, making comparisons among research challenging (24).

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