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Original article

Preventing pathological scar formation: Treatment of surgical scars with mixed technology: Fractional CO2 laser plus Er:Glass laser

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Abstract. *Background:* Scar treatment is a very challenging field. One of the major challenges in managing scars is their variability, which depends on the patient's etiology, severity, distribution, skin type, comorbidities, genetics, age, changes over time, and patient compliance, to name just a few. Despite best efforts and research over the decades, the quality of analytical studies on scars remains unsatisfactory compared to other fields of clinical and scientific activity. However, doctors and scientists continue to work to implement clinical and scientific strategies aimed at making treatments more effective. *Objective:* to study the new Mixed technology (MT) laser technology to prevent the formation of pathological scars during the wound healing process. *Method:* To this end we used a laser YouLaser mixed technology (MT) laser whose characteristic consists in the combination of two different wavelengths: fractional CO2 laser (10600 nm - ablative) and Er:Glass laser (1540 nm - non-ablative). 15 patients were enrolled and 20 surgical scars were selected. The protocol was completed on 7 patients for a total of 13 scars, of which 6 women and 1 man, with ages between 20 and 60 years and phototype according to Fritzpatrick between I and III. The selected scars were the results of surgery performed less than 6 months ago. *Results:* The severity and characteristics of scars were assessed via photographic images and using the POSAS (The Patient and Observer Scar Assessment Scale) questionnaire, a standardized and internationally recognized tool for scar assessment. The collected data were analyzed and interpreted with the help of a specific Likert scale, allowing a statistical evaluation of the progress of the severity and characteristics of the scars. All the characteristics analyzed showed a significant improvement, with scores that went from an average value of 6 to significantly lower values, between 2 and 4. The results showed significant improvements in terms of texture, color and thickness of the treated scars. *Conclusions:* According to the results of this study, early intervention on recent scars is effective because it guarantees preventive activity on the lesions, blocking the pathological evolution of the scars themselves. This is confirmed by the fact that one year after the surgery none of them had a pathological course in the hypertrophic or keloid sense.

Key words: Scar Prevention, Laser Therapy, Fractional CO2 Laser, Wound Healing, Hypertrophic Scars

Introduction

Scar treatment represents a complex challenge. One of the major difficulties in the management of scars lies in their wide variability, influenced by factors such as etiology, severity, distribution, skin type, comorbidities, genetics, age, evolution over time and patient compliance, to name a few[1]. This is why no two scars are the same, that there is no such thing as a "standard" scar. The difficulty of evaluating scars

together with the critical elements in the use of lasers make it complex to achieve the levels of evidence and objective results we desire. The objective of this study is to intervene during the wound healing process using the new Mixed Technology (MT) laser technology, in order to prevent the development of pathological scars.

Scar formation is the normal physiological response to skin trauma (Figure 1); however, the complex interaction that occurs between the numerous cells and their inflammatory mediators during the healing process does not necessarily lead to the formation of smooth, normal skin[2]. Dysregulation, in particular phases of the healing process, causes abnormal deposition of collagen, thus leading to excessive scar formation, thus giving rise to a spectrum of scar types, of which three are particularly susceptible to laser treatment: atrophic scars, hypertrophic scars and keloids. Hypertrophic scars occur as a result of an exaggerated proliferative response to wound healing, resulting in excessive collagen deposition that by definition typically remains within the confines of the original wound[3,4]. Clinically they present as raised, itchy, erythematous nodular lesions, which are frequently found in areas of thicker skin[4]. They are normally present within 1 month of the onset of the lesions, regress over time and are classified into two types: linear and diffuse. The linear subtype is a cord-like injury that usually occurs following direct trauma or surgery while the diffuse subtype is found following burns, extensive skin trauma or infections[5]. Histologically, hypertrophic scars consist of a disorganized arrangement of collagen assembled in a spiral pattern instead of the usual parallel orientation found in normal skin, giving it its characteristic raised appearance[6,3]. Current literature shows a wide range of incidence of hypertrophic scarring, with estimated rates of 30-91% after burns and 40-94% after surgery[5]. This wide variation in rates has been attributed to inconsistencies in its correct identification. Unlike hypertrophic scars, keloid scars are characteristically more extensive and by definition extend beyond the wound margins, thus invading the normal adjacent skin[7,8]. Like hypertrophic scars, they are benign hyperproliferative growths that develop from dense fibrous tissue following abnormal wound healing. Histologically, they consist of nodules of thickened collagen bundles with

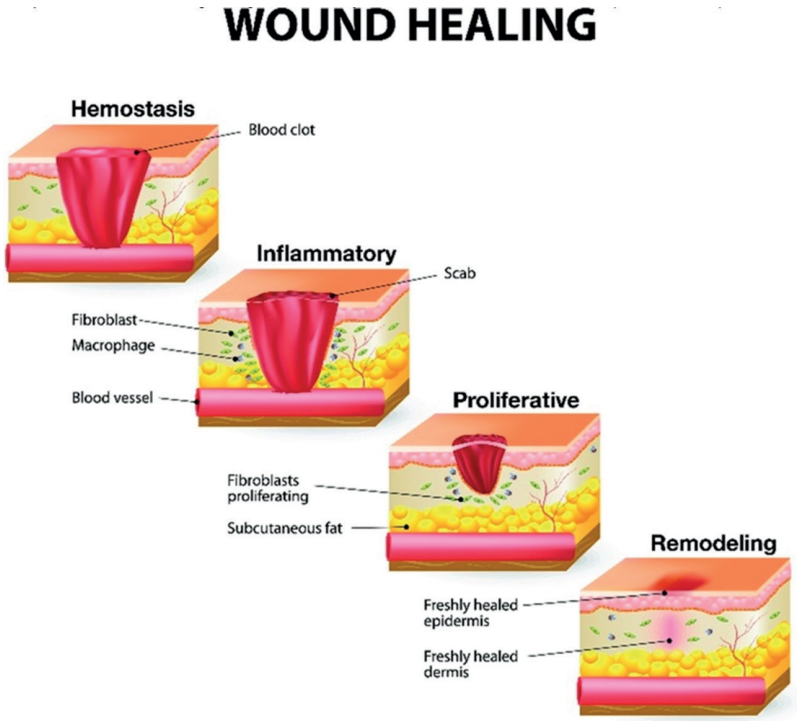

Figure 1. Healing process.

relatively few fibroblasts, which pathognomonically invade the normal dermal layer of the skin, resulting in a subcutaneous mass[8,9]. Clinically, this results in a characteristic raised, itchy, and often painful scar that extends beyond the wound margins[10]. They can be differentiated into minor or major keloids, the latter being larger (>0.5 cm) and more pronounced[11]. Despite their unclear etiology, keloids tend to occur within 12 months of localized trauma, which may occur following surgery, tattoos, lacerations, bites, vaccinations, or blunt trauma, and generally fail to regress in time[9,12]. Both hypertrophic scars and keloids form in all phototypes; However, a greater predisposition is found in individuals with darker phototypes. Other variables, including genetic factors, hormonal levels and age, play a role in the formation of this lesion, with the majority of keloids occurring between the ages of 10 and 30[12]. Additionally, both of these scars have a propensity to develop in areas that exhibit high tension and slow wound healing as well as motion- and pressure-dependent areas, with keloids commonly found on the earlobes, upper arm, upper back and anterior chest, particularly the pre-sternal area[9,13]. The clinical distinction between keloid and hypertrophic scars is of great importance in establishing the correct management plan, in particular when deciding how to manage the laser. Overall, while both scars result from a similar disease process, the main distinguishing features are the extension of the scar beyond the wound margin and the lack of regression over time which is common to keloids alone[13].

Atrophic scars are a complication resulting from inflammatory changes that lead to the loss of dermal fat and collagen[10,14,15]. Clinically, they present as large oval-type dermal depressions, which reach the classic peak of incidence between late adolescence and early adulthood. Histologically, the loss of collagen and dermal fat causes a downward shift of the epidermis, thus giving rise to these characteristic lesions. These generally tend to worsen over time due to the increased loss of elasticity of the skin with age[15,16]. In addition to the clinical impact of the scars described above, such defects can be disfiguring and therefore lead to significant aesthetic concerns by patients, thus causing considerable emotional, physical and psychological distress[17]. Consequently, numerous research has been conducted in this field in order to minimize the psychological impact of such injuries and avoid their further progression. Although medical devices and numerous technologies are used for scar management, this work focuses on a new laser modality (mixed technology).

Objectives

The purpose of this study is to explore how the new Mixed Technology (MT) laser technology affects the wound healing process through use. The intent is to positively influence the tissue repair phase, reducing the risk of pathological scar formation. This innovative technology aims to modulate the cellular and molecular mechanisms involved in healing, with the aim of preventing scar complications and promoting optimal aesthetic and functional recovery. To this end we used a laser with mixed technology (MT) whose characteristic consists in the combination of two different wavelengths: CO2 laser (10600 nm - ablative) and fractional Er:Glass laser (1540 nm - non-ablative).

Laser Er:Glass

In the vast panorama of laser technologies used in medicine, the Erbium Glass laser emerges as one of the most innovative and versatile tools. Also known as Er:Glass, this laser has a wavelength of 1,540 nm, positioning itself in the infrared range[18]. Its peculiarity lies in its ability to selectively interact with tissues, offering a balance between precision and safety[19].

Origins and Operating Principles:

It owes its name to the element erbium, a rare metal which, when inserted into a glass matrix, becomes the source of laser emission. The wavelength of 1,540 nm allows moderate penetration into tissues, making it particularly effective for superficial and medium depth treatments. Unlike other types of lasers, Er:Glass produces controlled thermal damage in tissue, stimulating cell regeneration and collagen production without causing excessive damage to surrounding structures. This makes it ideal for procedures that require precision and minimization of recovery time. Thanks

to its specific wavelength of 1,540 nm, it has unique properties that make it particularly effective in various medical procedures, including tissue coagulation.

Here's how the Erbium Glass laser affects coagulation:

- The 1,540 nm wavelength of the Erbium Glass laser is strongly absorbed by water present in tissues. When the laser hits the tissue, the energy is rapidly absorbed, causing local heating. This heating induces a controlled coagulation of tissue proteins, in particular collagen.
- Unlike other types of lasers, Erbium Glass produces mainly superficial coagulation. This means it can effectively treat the surface of the skin or mucous membranes without penetrating too deeply, reducing the risk of damage to underlying tissues.
- One of the main advantages of Erbio Glass laser-induced coagulation is the ability to reduce bleeding during surgical procedures since it is a non-ablative coagulative laser. When the laser is used to make incisions or remove lesions, blood vessel coagulation occurs almost instantly, limiting blood loss and improving visibility of the operating field.
- In addition to immediate coagulation, controlled tissue heating stimulates the production of new collagen and accelerates the healing process. This can lead to better healing and faster recovery times after the procedure[19,20].

Laser-induced clotting can also reduce the risk of infection. By creating a coagulative barrier, the laser can prevent pathogenic bacteria from entering the treated site. This laser has found application in several areas of medicine. Its ability to stimulate cell renewal makes it effective in the treatment of acne and its scarring, for skin rejuvenation, the treatment of surgical or traumatic scars, stretch marks and discolouration. It is also very useful for skin resurfacing, smoothing wrinkles and fine lines, and improving skin texture. Thanks to its ability to stimulate collagen production, it is used for tissue regeneration treatments[21].

Laser CO_2

Although fully ablative (non-fractionated) and fractional CO_2 lasers differ in some technical aspects, the characteristics are similar between devices. All CO_2 lasers carry a wavelength of 10,600 nm in the infrared range, which specifically targets water as a chromophore. To ablate the target without disproportionate surrounding thermal damage, it is preferable to deliver a minimum fluence of 5J/cm^2 with a pulse duration <1 millisecond (ms), characterized as the thermal relaxation time of the skin[22]. The device used is designed to operate with different energy levels, allowing the ablation depth to be modulated based on the specific needs of the treatment. The graph below illustrates the average ablation depth achieved at various energy levels (Table 1).

According to the protocol recommended by the manufacturing company, the optimal parameters are 30 W with pulses of 1-2 ms, equivalent to 30-60 mJ, guaranteeing an ablation that varies in a range between 240 and 720 micrometers. There are currently available on the market numerous fractional CO2 devices. While the basic principles apply to these lasers, the specific settings differ depending on the machine. Therefore, the doctor must familiarize himself with the depth, energy, power and density parameters related to the device. The working principle of fractional laser is mainly fractional photothermolysis. It creates microscopic burn areas, known as a microscopic thermal zone (MTZ), sparing a certain amount of dermal and epidermal tissue. These spared normal tissues lead

Table 1. Ablation depth at different energy levels.

10600 nm laser	Energy (mJ)	Estimated Depth of Ablation (μm)
	3	24
	5	60
	10	120
	20	240
	40	480
	60	720
	80	960
	100	1200

Table 2. Suggested parameter e protocol.

Condition	Mode	Emission	1540 nm	10600 nm	Ton 1540 nm	Ton 10600 nm	Density	Passes
1 Redness	Fractional	1-1540 nm	8 W	-	4 - 6 ms	-	75 - 100 CD	2
2 White/Pink Hypertrophic	Fractional	1-1540 nm 2-10600 nm	8 W	30 W	4 - 6 ms	1-2 ms	50 - 75 CD	2
3 White/Pink Atrophic	Fractional	1-1540 nm 2-10600 nm	8 W	30 W	4 - 6 ms	0,25 – 0,50 ms	75 - 100 CD	2

*Scanner Fill Mode: Random.

to rapid repair of laser-induced thermal damage[23]. A significant increase in procollagen type 1 and type 2 mRNA is demonstrated after treatment with a CO2 laser[1].

Mixed technology

The vaporization of water caused by CO2 causes fragmentation and removal of the scar, to create a pore within the scar tissue up to 4 mm deep, around which there is an area of thermocoagulation that goes down beyond 6 mm of depth. The use of the mixed technology of ablative fractional co2 laser (10600) with Er:Glass 1540 through the YouLaser MT modality allows these two lasers together to determine the modulation of the anomalous scar and the production of new collagen in a controlled way[24]. In this study, the following parameters recommended by the manufacturer of the YouLaser mixed technology laser were applied (Table 2).

Study population

In the period between March 2022 and May 2023, we undertook a clinical study aimed at evaluating the effectiveness of Mix Technology in the treatment of surgical scars for the prevention of pathological scar formation. In this period, 15 patients were enrolled and 20 surgical scars were selected. The protocol was completed on 7 patients for a total of 13 scars, of which 6 women and 1 man, with ages between 20 and 60 years and phototype according to Fritzpatrick between I and III. The selected scars were the results of surgery performed less than 6 months ago. None of the selected patients had any notable health problems or allergies. Before starting treatment, a preclinical evaluation was carried out. A detailed medical history was collected for each scar. The severity and characteristics of the scars were assessed via photographic images and using the POSAS (The Patient and Observer Scar Assessment Scale) questionnaire, a standardized and internationally recognized tool for scar assessment. The collected data were analyzed and interpreted with the help of a specific Likert scale, allowing a statistical evaluation of the progress of severity and general characteristics. Each scar received 6 treatment sessions with Mix Technology, with intervals between sessions varying between 3 and 5 weeks, depending on the clinical needs and tissue response. During each session, standard parameters were used, provided by the company producing the technology. After each treatment, patients were prescribed a repairing and soothing barrier cream to apply for 7-10 days following the laser procedure. At the end of the cycle of sessions, a follow-up was scheduled three months after the last treatment for each patient. This final appointment was fundamental to evaluate the stability and duration of the results obtained, recompile the POSAS scale and compare the photographic images (Figures 2-14).

POSAS scale

The POSAS scale represents a complex and multidimensional assessment tool for scars, which integrates both the doctor's and patient's perspectives[25]. This duality in assessment ensures a more complete and holistic understanding of the scar, taking into account not only the objective clinical results, but also the patient's perception of his scar. The scale focuses on several key characteristics of scars, including

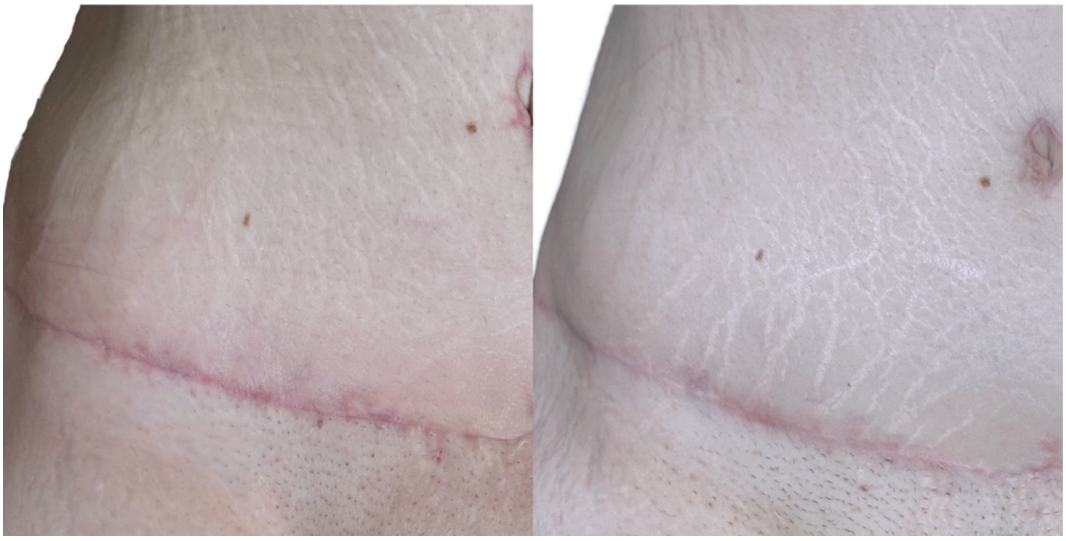

Figure 2. Before and after: GR, 30 years old, female, scar on right side, 1 month after surgery.

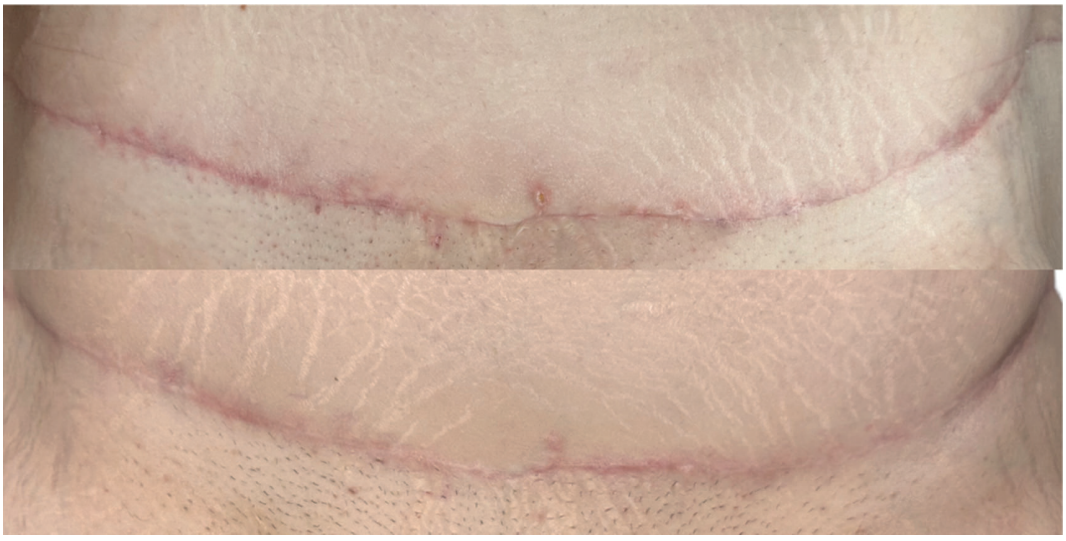

Figure 3. Before and after: GR, 30 years old, female gender, abdominal scar, 1 month after surgery.

vascularity, pigmentation, thickness, relief, elasticity and surface area. Each parameter is accompanied by explanatory notes that provide detailed guidance for an accurate and standardized evaluation. This attention to detail ensures that every aspect of the scar is examined precisely, thus offering a complete overview of its evolution and current state. Using the POSAS scale (Figure 15), doctors can gain a clear, in-depth view of scars, allowing them to monitor progress over time and tailor treatment strategies based on the patient's individual needs.

The POSAS questionnaire was completed before and after the end of the established laser path. The table summarizes the data that emerged for each questionnaire. Table 3 reports the observer values and Table 4 the values reported by the patients.

To quantify and interpret the results emerging from the POSAS questionnaires filled out by both

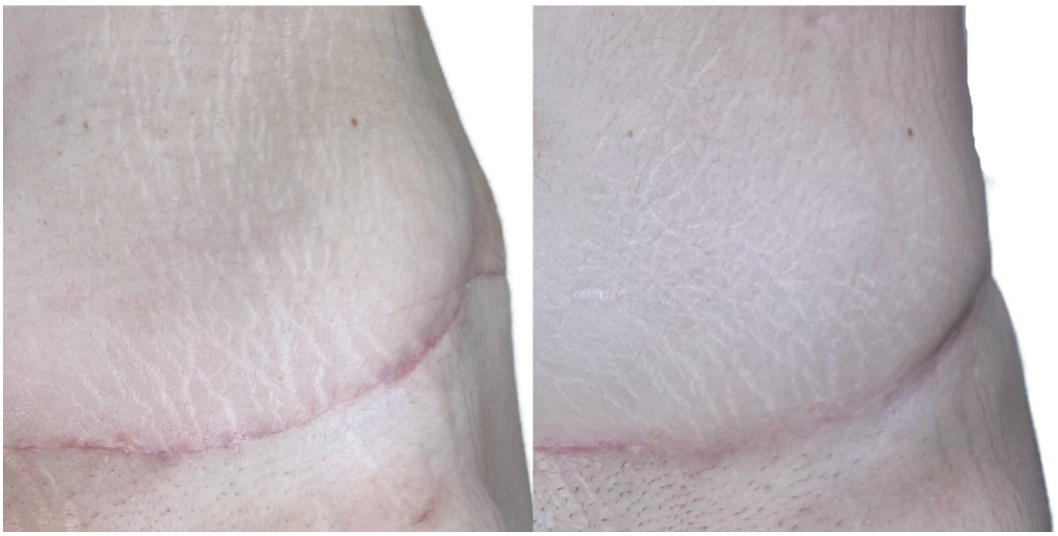

Figure 4. Before and after: GR, 30 years old, female, scar on left side, 1 month after surgery.

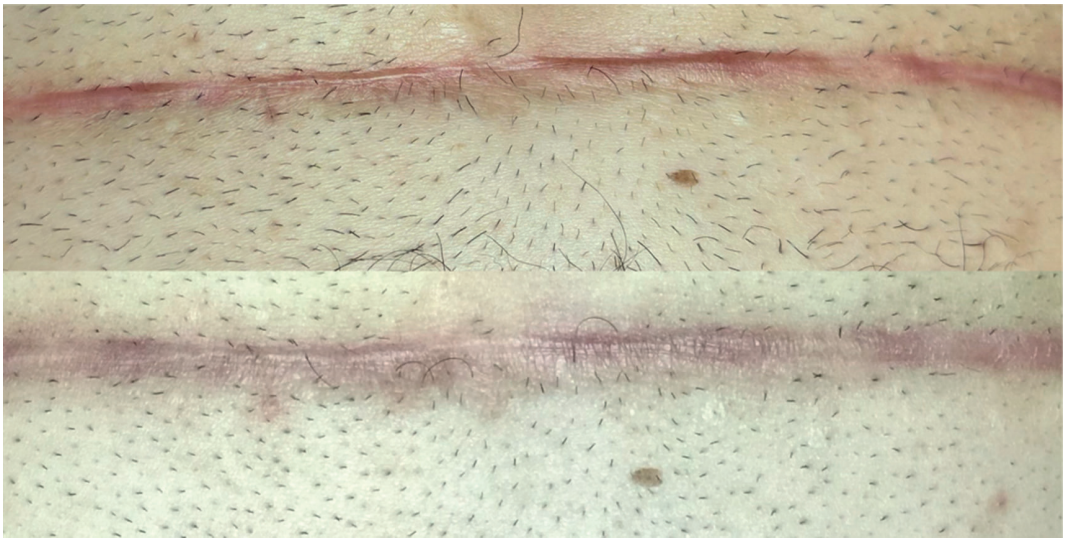

Figure 5. Before and after: FR, 27 years old, male, abdominal scar, 1 month after surgery.

doctors and patients, we adopted a specific Likert scale.

The Likert scale used to evaluate the results varies from 1 to 10, with the following interpretative parameters:

1: Maximum Improvement - Indicates an optimal response to treatment, with a significant or complete reduction of imperfections and unwanted scar characteristics.

5: No Change - Indicates that there have been no perceived changes in the condition or appearance of the scar following treatment.

10: Absolute Worsening - Indicates a negative response to treatment, with an increase in imperfections or the onset of new scar-related problems. The intermediate values (from 2 to 4 and from 6 to 9) represent variable degrees of improvement or worsening, allowing a more

Figure 6. Before and after: RR, 57 years old, female, right iliac crest scar, 2 months after surgery.

Figure 7. Before and after: RR, 57 years old, female, right wrist scar, 2 months after surgery.

nuanced and detailed evaluation of the response to treatment.

The adoption of this scale for data analysis offered several advantages:

1. Quantification of Results: It allowed us to transform patients' subjective perceptions into quantitative data, facilitating the analysis and interpretation of results.
2. Comparison Objective: It provided a standardized basis for comparing the effectiveness of treatment on different scars and between different patients.
3. Patient Feedback: Gave patients the opportunity to express their opinions and perceptions in a structured way, contributing to a deeper understanding of the results.

Figure 8. Before and after: AP, 60 years old, female gender, right wrist scar, 1 month after surgery.

Figure 9. Before and after: LR, 20 years old, female gender, right breast fold scar, 5 months after surgery.

Chart Description (Figure 16):

4. Category Axis (y-axis): Variables (Vascularity, Pigmentation, etc.) are shown on the vertical axis. Each bar represents the average score for one of these variables.
5. Pre and Post Bars:
   - Blue: Indicates the mean pre-intervention scores for each variable.
   - Red: Indicates the average post-intervention scores.

   Bars to the right of the center line (positive) represent pre values, while bars to the left (negative) represent post values, facilitating visual comparison.
6. Measurement axis (x-axis): Indicates the average value for each variable, which varies from 0 to 10. The measurements are symmetrical with respect to 0 to visually represent the difference between pre- and post-intervention.

Figure 10. Before and after: LR, 20 years old, female gender, left breast fold scar, 5 months after surgery.

Figure 11. Before and after: LC, 23 years old, female, right breast fold scar, 3 months after surgery.

7. Center line: The vertical line at the zero value serves as a reference point to easily compare how much each value differs before and after the intervention.

Observations:

- In all variables, mean post-intervention scores (red) are lower than pre-intervention scores (blue). This suggests an overall improvement in the conditions assessed, as lower scores on the POSAS scale indicate a reduction in the negative aspects of the scar, such as vascularity, relief, thickness, etc.
- Elasticity and Relief show a marked difference, with a large drop in post-surgery values compared to pre-surgery, indicating a notable reduction in these negative scar characteristics.

This type of Likert chart is useful for clearly highlighting the differences between pre- and

Figure 12. Before and after: LC, 23 years old, female gender, left breast fold scar, 3 months after surgery.

Figure 13. Before and after: RR, 57 years old, female, right hip scar, 4 months after surgery.

post-assessments, making the improvements achieved thanks to the intervention visible.

Student's t test for paired data:

The paired t test evaluates whether there is a statistically significant difference between the pre- and post-intervention scores for each variable. Here are the results:

- Vascularity: t = 12.75, p = 2.46e-08 (significant)
- Pigmentation: t = 6.75, p = 2.05e-05 (significant)
- Thickness: t = 5.37, p = 1.67e-04 (significant)
- Finding: t = 13.57, p = 1.22e-08 (significant)
- Elasticity: t = 12.54, p = 2.96e-08 (significant)
- Surface: t = 7.14, p = 1.18e-05 (significant)
- Overall opinion: t = 8.38, p = 2.33e-06 (significant)

In all cases, the results indicate a significant difference between pre and post measurements, suggesting that the intervention had an impact on all variables.

Figure 14. Before and after: RR, 45 years old, female gender, abdominal scar, 6 months after surgery.

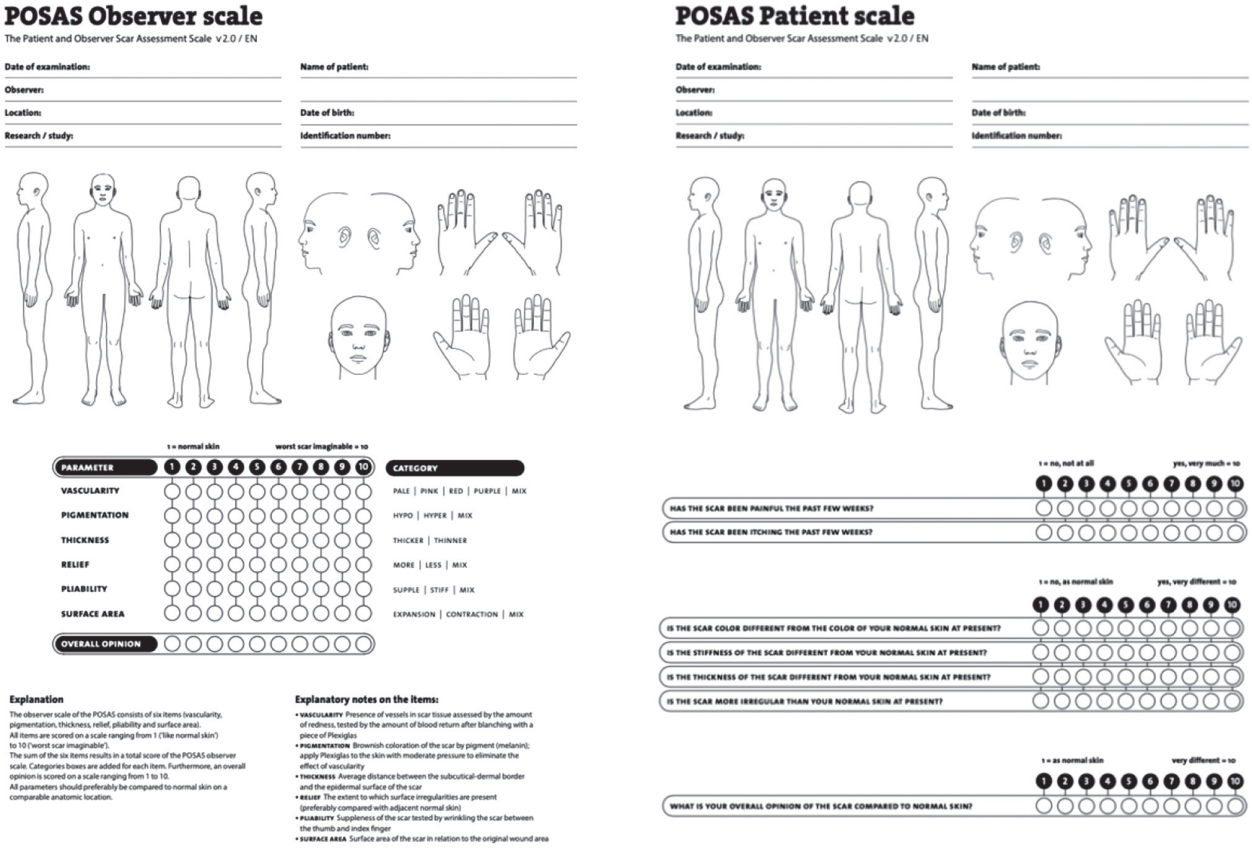

Figure 15. Reporting observer values.

Table 3. Observer scale.

Patient	Start of treatment	Vascularity	Pigmentation	Thickness	Relief	Elasticity	Surface	Overall opinion
GR, 60 y.o., ♀, right flank scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
CH, 30 y.o., ♂, abdominal scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
BK, 59 y.o., ♂, abdominal scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
TR, 37 y.o., ♂, abdominal scar	2 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
RP, 52 y.o., ♂, right epic scar	2 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
TT, 51 y.o., ♂, right flank scar	2 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
AR, 60 y.o., ♀, right breast fold scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
PK, 49 y.o., ♀, right breast fold scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
FB, 60 y.o., ♀, left breast fold scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
TT, 54 y.o., ♂, right flank scar	3 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
AR, 60 y.o., ♀, abdominal scar	4 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
PK, 49 y.o., ♀, abdominal scar	4 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After

The graph (Figure 17) represents the average scores reported by patients on various aspects of the scar, both before (pre) and after (post) surgery. The comparison between the scores highlights a significant reduction in problems related to the scar, demonstrating a general improvement perceived by patients.

Discussions

During our study on the treatment of scars with the MT laser, we observed remarkable and consistent results in all patients treated. The regression of pain and itching was a tangible outcome, highlighting the effectiveness of the treatment in improving patients' quality of life. At the same time, we noticed a marked aesthetic improvement of the scars: the color became more uniform, the stiffness was reduced, the thickness decreased and the surface irregularities were attenuated. These changes helped make the scars less visible and more similar to the surrounding skin. It is particularly relevant to underline that, despite the limited number of cases treated, none of the recent scars showed signs of pathological evolution, suggesting a potential preventive effect of the treatment. Furthermore, the safety of the treatment was confirmed by the absence of serious side effects. Although some patients experienced slight redness after treatment, this symptom was always short-lived and resolved spontaneously, without the need for further intervention. In summary, the results of our study highlight the effectiveness and safety of MT laser treatment in managing and improving scars, offering patients a promising therapeutic solution.

Table 4. Reporting patients' values.

Patient	Start of treatment	Has the scar been painful the past few weeks?	Has the scar been itching the past few weeks?	Is the scar color different from the color of your normal skin at present?	Is the stiffness of the scar different from your normal skin at present?	Is the thickness of the scar different from your normal skin at present?	Is the scar more irregular than your normal skin at present?	What is your overall opinion of the scar compared to your normal skin?
GR, 60 y.o., ♀, right flank scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
CH, 30 y.o., ♂, abdominal scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
BK, 59 y.o., ♂, abdominal scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
TR, 37 y.o., ♂, abdominal scar	2 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
RP, 52 y.o., ♂, right epic scar	2 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
TT, 51 y.o., ♂, right flank scar	2 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
AR, 60 y.o., ♀, right breast fold scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
PK, 49 y.o., ♀, right breast fold scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
FB, 60 y.o., ♀, left breast fold scar	1 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
TT, 54 y.o., ♂, right flank scar	3 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
AR, 60 y.o., ♀, abdominal scar	4 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After
PK, 49 y.o., ♀, abdominal scar	4 month after surgery	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After	Before / After

Conclusions

For the treatment of hypertrophic scars and keloids, modern laser technology offers better opportunities than in previous decades.

It is able to improve both the symptoms and the characteristics of the scar itself in a safer and more effective way. The use of laser for the treatment of scars can help significantly improve the psychological and physical well-being of patients. Although today they are mostly complementary to conservative treatment options, the future role of lasers in scar therapy may prove more decisive. Due to its potential in controlling symptoms and improving functional and aesthetic disorders, laser treatment and especially ablative fractional resurfacing have acquired a more important role in current guidelines and recommendations of various scientific committees. This may not only lead to further incorporation into future scar therapy paradigms, but also lead to greater application of early laser

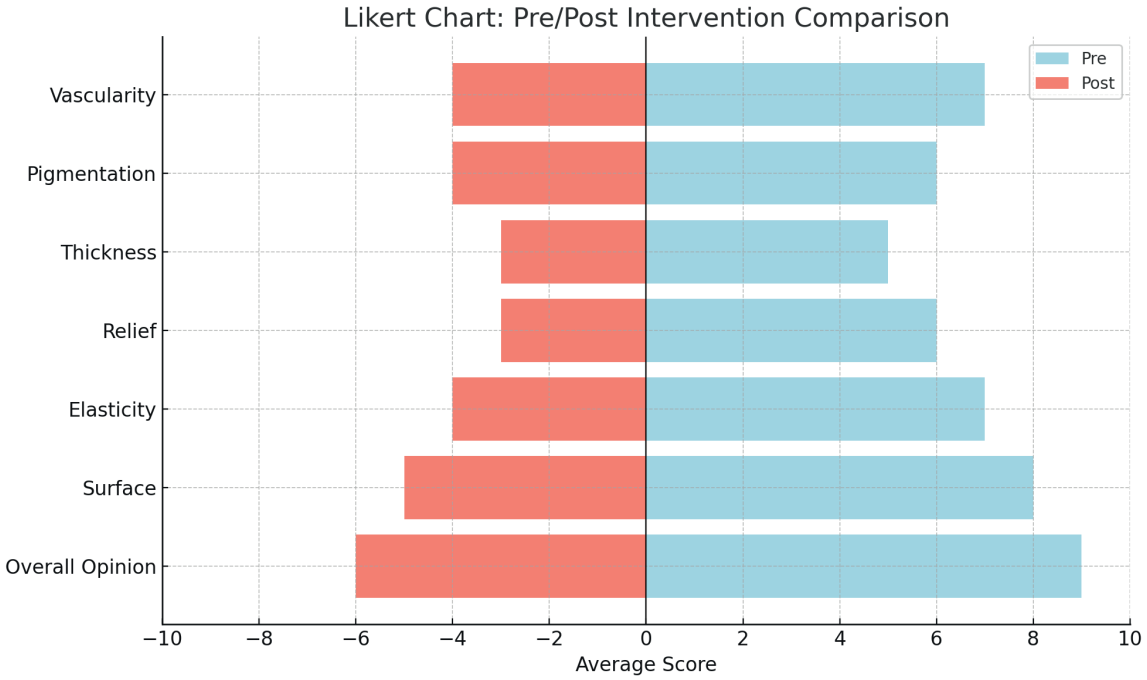

Figure 16. The Likert graph shows a comparison of pre- and post-intervention mean values for seven variables rated by doctors: Vascularity, Pigmentation, Thickness, Relief, Elasticity, Surface Area and Overall Opinion.

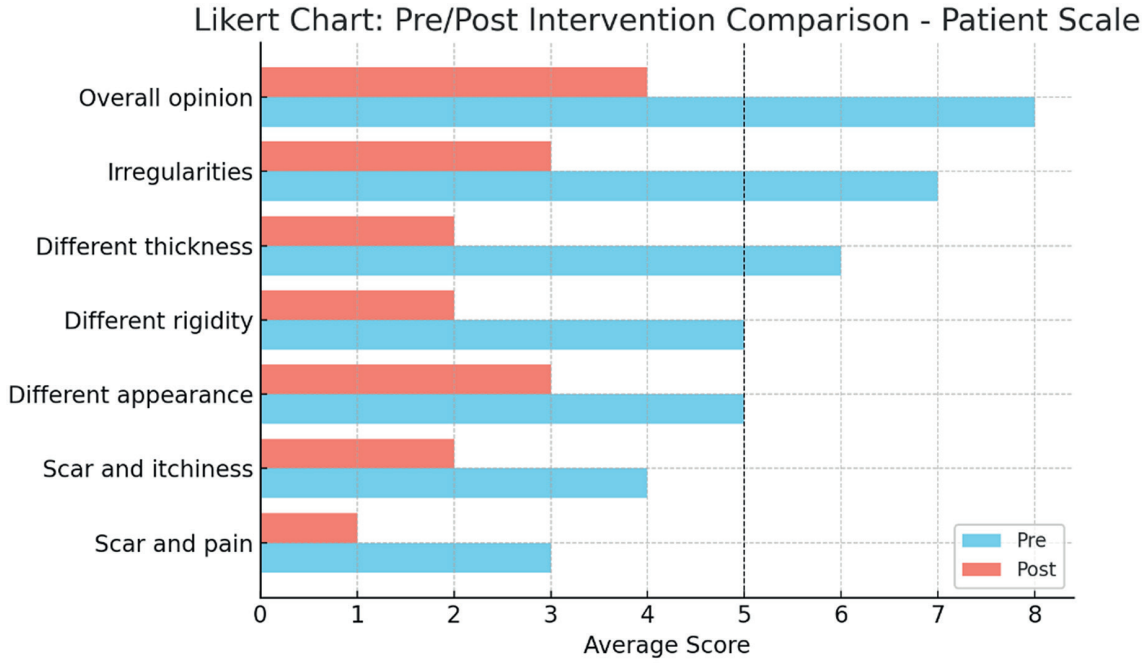

Figure 17. The Likert graph comparing the data filled in by patients on the POSAS Scale pre- and post-surgery clearly highlights the effectiveness of the treatment on scars.

intervention to improve wound healing during the initial phase of the scar formation process or to combat scar formation. formation of hypertrophic or keloid scars. The future role of laser therapy for the treatment of hypertrophic scars and keloids depends, however, on future prospective and controlled research. Since responsible treatment is effective and safe and offers the treating physician maximum control throughout the treatment, future research should focus on treatment methodology and finding the optimal laser settings for each indication.

Fractional laser devices treat scars with fewer side effects and less downtime than traditionally ablative CO_2 lasers. By leaving tissue unharmed around each microscopic channel or heat zone, the intact dermis heals faster around these columns, stimulating gradual collagen remodeling. Extensive literature now supports fractional ablative CO_2 laser treatment to successfully correct scars.

Although most studies focus on mature scars, present months to years after surgery or trauma, the most recent investigations demonstrate the effectiveness of early revision, i.e. performed within the first weeks after surgery. For optimal aesthetic and functional results, different treatment modalities can be combined to provide synergistic effects. The combined approach to different treatment modalities can offer superior benefits compared to the use of a single technology. This principle is based on the idea that different treatments can act on complementary aspects of the skin and scars, thus providing an overall more effective and harmonious result. In our study, we chose to exploit the combined power of the fractional CO_2 laser and Erbium Glass.

While the fractional CO_2 laser is known for its ability to stimulate skin renewal and collagen production, Erbium Glass is effective in superficial remodeling and in reducing patient discomfort caused by inflammation. The combination of these two technologies called YouLaser "mixed technology" has made it possible to obtain both aesthetic and functional results of high quality, exploiting the synergistic effects of the two lasers to offer patients a complete and advanced treatment. Our best results in scar management have been achieved by starting treatment 2-3 months after surgery, a period that seems to be ideal for effectively intervening on the evolving scar. According to the results of this study, early intervention on recent scars is valid because it guarantees preventive activity on the lesions, blocking the pathological evolution of the scars. This is confirmed by the fact that one year after the surgery none of them had a pathological course in the hypertrophic or keloid sense. All the treated scars showed a progressive improvement both from a symptomatic and aesthetic point of view as demonstrated by the photographic images and the scores of the completed POSAS scale. These encouraging results motivate us to move forward and invest in further studies to verify the long-term effectiveness of the treatment and consolidate our findings.

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