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Contraindications of Using Fractional CO_2 Laser in the Treatment of Aesthetic Disorders: A Narrative Review

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Abstract

Introduction: Despite its proven efficacy, the use of fractional CO_2 laser therapy is not without risks. Several complications and adverse effects may occur following its application. However, it is widely understood that if the procedure's contraindications are properly observed, such adverse events can be prevented. Therefore, specific contraindications must be carefully evaluated to ensure patient safety and optimal outcomes. **Objective**: To describe the contraindications regarding the use of fractional CO_2 laser techniques applied to the treatment of aesthetic disorders, with the purpose of ensuring a safe and effective procedure, while preventing complications during and after treatment. **Methodology**: This study is characterized as exploratory research presented through a narrative review, aiming to highlight the need and importance of rigorous patient selection for the treatment of aesthetic and functional disorders using fractional CO_2 laser. **Results**: The most frequently cited contraindications in the reviewed literature include pigmentary disorders and high phototypes, active autoimmune diseases, active inflammatory skin conditions and acne, photosensitivity, pregnancy or breastfeeding, history of keloids or hypertrophic scars, active infections in the treatment area, previous ablative

laser treatment in the same area, use of isotretinoin in the past year, and use of anticoagulants. **Conclusion**: Careful patient selection based on awareness of contraindications and individualized therapeutic planning emerges as the foundation for maximizing the benefits of fractional CO_2 laser and minimizing associated risks, thereby ensuring quality and safety for patients seeking this therapeutic resource.

Keywords

Fractional CO_2 Laser, Carbon Dioxide Laser, Contraindications, Aesthetic Medicine

1. Introduction

Laser resurfacing technology has benefited from numerous advances in recent decades, beginning with the use of continuous-wave carbon dioxide (CO_2) lasers in the 1980s. By the 1990s, the establishment of pulsed energy delivery in CO_2 lasers became popular, improving precision and depth in cutaneous ablation while reducing adverse event rates. A further refinement in skin resurfacing occurred in the early 2000s with the advent of fractional CO_2 lasers. This less destructive modality further reduced the incidence of adverse events and enhanced therapeutic control, while seemingly delivering results similar to those of non-fractional techniques [1].

Fractional CO_2 laser is an effective treatment for many skin conditions, particularly acne scars and facial rejuvenation [2]-[5]. It works by stimulating dermal collagen regeneration and improving skin texture, with noticeable results after multiple sessions [6]-[8]. Additionally, fractional laser has shown high applicability in the treatment of stretch marks [9] [10], onychomycosis [11] [12], vaginal conditions [13] [14], alopecia [15] [16], keloid and hypertrophic scars [17], among other conditions.

Despite its efficacy, that laser therapy is not risk-free. Numerous authors have reported various complications and adverse effects following its use [18] [19]. However, there is consensus that many of these issues could have been avoided if proper contraindications had been respected. Therefore, these contraindications must be carefully evaluated to ensure patient safety and achieve great results. In this context, careful patient selection and individualized treatment protocols are crucial to achieving complication-free outcomes [20].

Contraindications to fractional CO_2 laser treatments might be categorized as absolute or relative [21] [22]. Absolute contraindications include the use of isotretinoin within the last six months, active bacterial or viral cutaneous infections in the treatment area, and ectropion (following infraorbital resurfacing) [22]. In contrast, relative contraindications with less than 50% consensus among professionals include a track record of non-absorbable threads, papular or eczematous skin, and a tendency or hereditary predisposition to poor wound heal-

ing [21].

It is important to note that relative contraindications involve conditions that may not fully disqualify a patient from treatment but do require thorough evaluation. Hence, comprehensive pre-treatment assessment is essential to identify such limiting conditions, mitigate potential complications and adverse outcomes, and adapt the treatment plan to the patient's individual needs. Presently, the topic of contraindications in fractional CO_2 laser treatment is of growing relevance due to the increasing demand for aesthetic procedures and the diverse profiles of patients seeking them.

Understanding the contraindications for this laser therapy is vital for practitioners to ensure patient safety while optimizing treatment outcomes. As aesthetic treatments become more widespread, careful consideration of these factors will help to avoid risks and enhance the overall effectiveness of laser-based procedures. Therefore, this study aimed to describe the contraindications surrounding the use of fractional CO_2 laser techniques in the treatment of aesthetic disorders, with the goal of ensuring safe and effective practice, avoiding adverse events both during and after treatment.

2. Methodology

This study is characterized as exploratory research presented through a narrative review, with the objective of highlighting the need and/or importance of the rigorous selection of patients initially indicated for the treatment of aesthetic and functional disorders using fractional CO_2 laser. The review examined scientific articles published and available in the following databases: MEDLINE (Medical Literature Analysis and Retrieval System Online), PubMed (National Library of Medicine), SCIELO (Scientific Electronic Library Online), LILACS (Literature in Latin America and the Caribbean in Health Sciences), and Google Scholar.

As inclusion criteria, sources were selected that mentioned exclusion criteria in clinical studies or specific contraindications for the use of fractional CO_2 laser for the treatment of various aesthetic and/or functional skin disorders. Sources were excluded if they lacked an abstract, were not published in scientific journals, did not address the subject of the study, or failed to provide reliable data for analysis.

The literature review was conducted in Portuguese, English, Spanish, and Italian, using the following descriptors: laser, fractional CO_2, carbon dioxide, contraindications.

The literature search was conducted between October 2024 and January 2025, with the final search completed on January 10, 2025. The following descriptors and Boolean operators were used: ("fractional CO2 laser" OR "carbon dioxide laser" OR "laser resurfacing") AND ("contraindications" OR "exclusion criteria" OR "complications"). The study selection process—including the number of records identified, screened, excluded, and ultimately included—is illustrated in the flow chart shown in **Figure 1**.

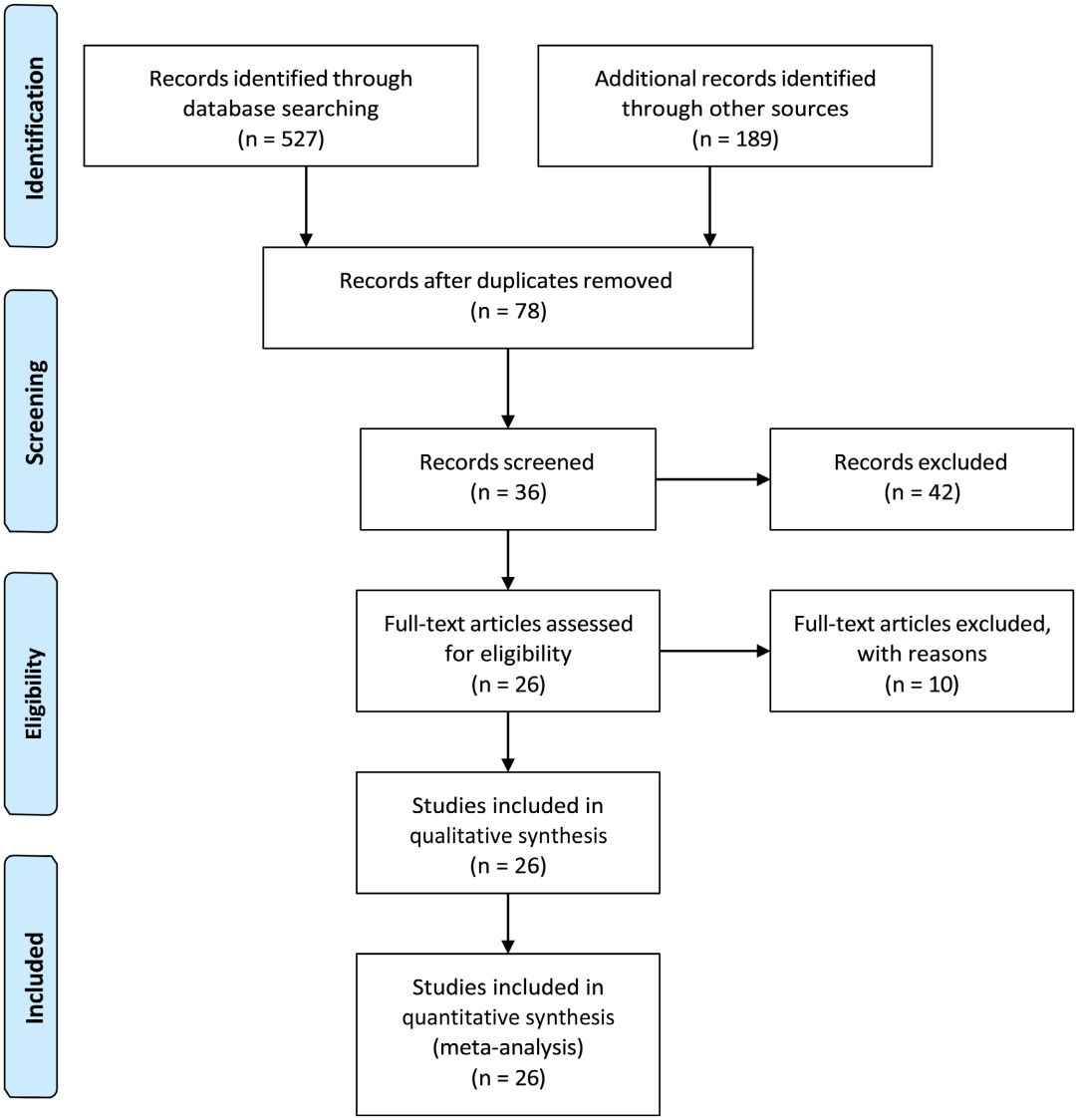

Figure 1. Flow chart of literature search and selection criteria.

3. Results and Discussion

3.1. Main Physiological Actions of Fractional CO_2 Laser

The treatment of aesthetic and functional disorders with fractional CO_2 laser has shown significant efficacy, based on biophysical principles that promote tissue renewal and stimulation of essential components of the extracellular matrix. This procedure can induce physiological effects that are crucial to the results delivered by fractional CO_2 laser therapy. A thorough understanding of its mechanisms of action such as fractional photothermolysis, collagen stimulation and remodeling, and tissue ablation, is essential to optimize therapeutic outcomes and minimize the risk of complications [1]-[4] [10] [13]-[16] [19] [20].

3.1.1. Fractional Photothermolysis

The concept of fractional photothermolysis (FP) introduced in 2004 [23], is the

cornerstone of fractional CO_2 laser action on the skin. This mechanism is based on the emission of light beams that create microscopic treatment zones (MTZs) in the epidermis and dermis, while leaving surrounding tissue intact [1] [2]. Its fractional approach is key to the safety and efficacy of the treatment, as the *islands* of untreated tissue act as reservoirs of viable cells, accelerating the healing process and reducing recovery time and adverse effects compared to traditional ablative lasers [1] [5]. This technique revolutionized laser resurfacing by creating microscopic zones of thermal damage in the skin, while preserving adjacent tissue [23] [24].

The MTZs are characterized by microscopic columns of thermal injury penetrating the epidermis and dermis, with diameters ranging from 100 to 160 μm and depths between 300 and 700 μm, depending on the energy settings used (**Figure 2**). The density of these zones is adjustable, typically delivering around 2000 MTZs/cm^2, covering approximately 15% to 25% of the skin surface area per treatment session [23].

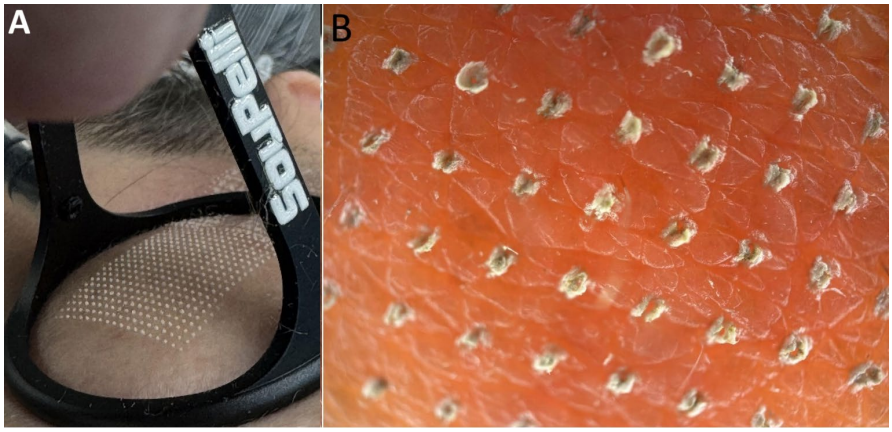

Figure 2. Formation of MTZs on the skin surface with the use of fractional CO_2 laser A; Dermatoscopic image showing microzones of thermal injury magnified 400× B.

The fractional CO_2 laser with a wavelength of 10600 nm, is highly absorbed by the water present in tissues. Upon reaching the skin, laser energy is rapidly converted into heat, resulting in the instantaneous vaporization of intracellular and extracellular water which leads to precise tissue ablation within the MTZs [24]. The resulting dermo epidermal debris is eliminated through a trans epidermal elimination process [23]. The ablation induces a controlled inflammatory response and activation of fibroblasts, which are essential for subsequent neocollagenesis and tissue remodeling [25]. The presence of unaffected tissue between MTZs allows for rapid reepithelialization and healing, minimizing downtime and the complications typically associated with conventional ablative lasers [23] [26].

The depth and density of MTZs can be adjusted to allow customization of treatment according to skin condition and therapeutic goals. The precision of thermal injury delivered by fractional technology enables the treatment of various aesthetic concerns, such as pigmentation, stretch marks, cellulite, and scarring, providing effective tissue resurfacing with an improved safety profile [25].

During the fractional CO_2 laser procedure, as temperatures can exceed 200˚C when the laser beam contacts the skin (**Figure 3**), cooling systems are commonly used to reduce discomfort and improve patient tolerance during the session [3] [5] [23] (**Figure 4**). However, some authors [26] note that skin temperature directly affects MTZ dimensions. A positive linear correlation was reported between skin surface temperature and the diameter and area of MTZs. For example, reducing skin temperature from 45˚C to 0˚C can decrease MTZ diameter by 58% and area by 148%. This suggests that while skin cooling enhances patient comfort, it may also reduce MTZ size and thus the treatment's effectiveness, if energy parameters are not adequately adjusted.

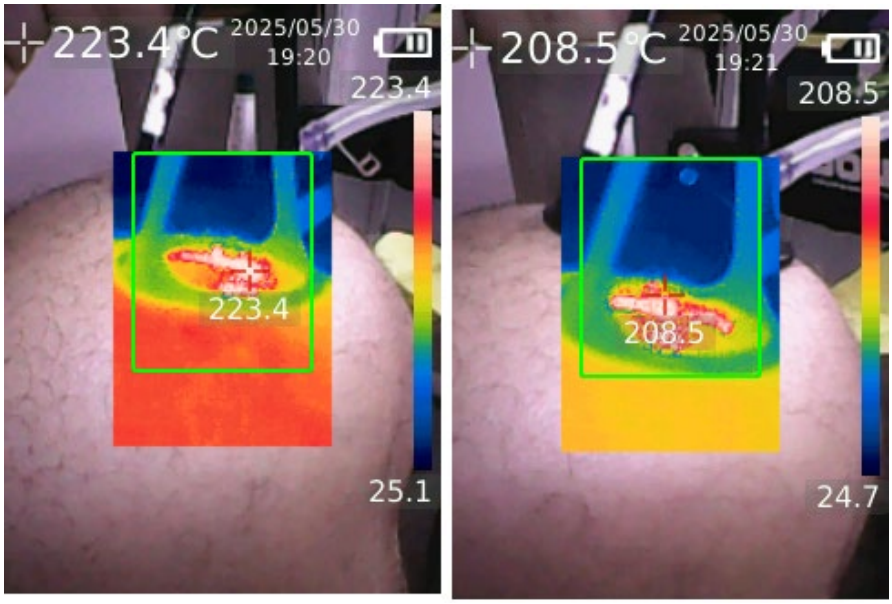

Figure 3. Thermographic images showing the exact moment the fractional CO_2 laser beam contacts the skin, raising temperatures above 200˚C.

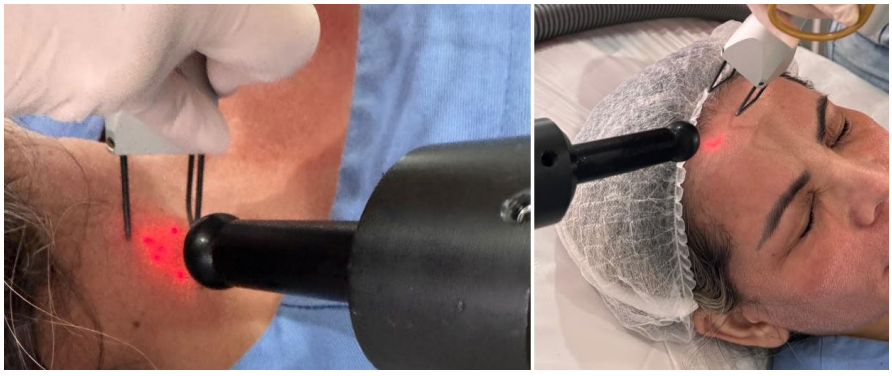

Figure 4. Cooling system used to reduce discomfort during fractional CO_2 laser application.

Skin hydration is another factor that influences laser-tissue interaction. Water is the primary chromophore for CO_2 lasers, and variations in skin water content can affect the dimensions of microscopic thermal injury channels. It has been

found that hyperhydration may reduce the depth of both microscopic ablation zones (MAZs) and MTZs, while dehydration can result in even greater reductions. This highlights the importance of considering skin hydration status to optimize treatment outcomes and minimize unwanted effects [27].

In our clinical practice, we implemented skin preparation protocols prior to fractional CO_2 laser treatment, which include adjusting the skin's hydration status, among other factors, to enhance treatment efficacy.

3.1.2. Collagen Stimulation and Tissue Remodeling

One of the main benefits of fractional CO_2 laser therapy is the ability to stimulate collagen production and promote subsequent tissue remodeling. For this reason, it is widely used in skin rejuvenation procedures due to its capacity to induce neocollagenesis and structural reorganization of the skin [23] [28]. The heating of deeper skin layers—caused by the absorption of laser energy by tissue water—triggers a cascade of biological events that culminate in neocollagenesis and the reorganization of existing collagen and elastin fibers. This collagen stimulation process may last for several months after treatment, resulting in progressive improvements in skin texture, reduction of wrinkles, decreased sagging, and attenuation of scars and enlarged pores [1]-[4] [7] [9] [10] [25] [29].

Thus, the thermal injury induced by the laser, although microscopic, initiates a wound-healing response that leads to new collagen formation and the restructuring of existing fibers [23].

Tissue remodeling is mediated by the activation of fibroblasts and the synthesis of collagen, elastin, and other extracellular matrix proteins [23]. The penetration depth of the fractional CO_2 laser, which exceeds that of other ablative lasers such as Er:YAG, enables a more significant thermal effect in the dermis, which is crucial for dermal remodeling and achieving long-lasting aesthetic results [28].

The formation of new collagen fibers, especially type III collagen, is a wound healing response induced by fractional laser treatments and contributes significantly to tissue restructuring and long-term skin rejuvenation [25]. Immediate collagen contraction observed during the procedure due to thermal heating, also contributes to a skin-tightening effect. The fractional CO_2 laser technology optimizes the healing response and collagen production by creating dermo-epidermal coagulation columns without fully ablating the skin surface, what makes it a valuable tool for facial rejuvenation and the treatment of various dermatological conditions [25] [30].

Histological studies in animal models demonstrate that treatment with fractional CO_2 laser leads to collagen coagulation and increased tensile strength of irradiated skin. The extent of collagen coagulation is directly proportional to the number of laser pulses applied, indicating that multiple pulses can enhance tissue remodeling [28].

3.1.3. Tissue Ablation

Tissue ablation is one of the fundamental principles of fractional CO_2 laser ther-

apy and refers to the precise removal of superficial skin layers through tissue vaporization (which results in post-treatment exfoliation). When its energy is absorbed by the skin, due to the laser's high affinity for water, the intracellular and extracellular water boils causing vaporization of the irradiated tissue [24] [25] [31]. This effect is responsible for creating ablative microchannels and is essential for skin resurfacing, allowing the leveling of wrinkles, scars, and other irregularities on the skin surface [29].

The microchannels formed by the fractional CO_2 laser can be created with precise width, spacing, and depth at the moment of delivery [32]. The use of short pulses ensures highly selective tissue vaporization, limiting penetration and minimizing residual thermal damage to adjacent areas [24]. Thus, the depth of ablation can be precisely controlled, giving the fractional CO_2 laser the ability to treat both superficial and deeper lesions, depending on the device's configuration and the clinical need. Removal of damaged tissue (post-treatment exfoliation) (**Figure 5**) stimulates the regeneration of a new, healthier skin layer with improved quality, contributing to enhanced texture and overall appearance.

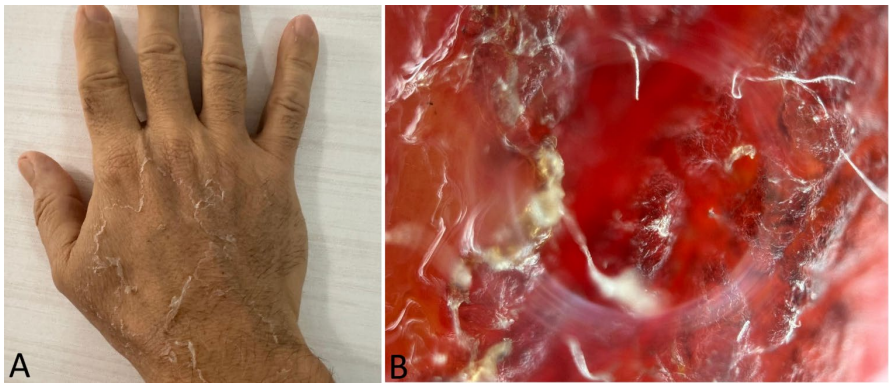

Figure 5. Post-treatment skin exfoliation after CO_2 laser application to aging hands A; Dermatoscopic image showing elimination of damaged tissue B.

Although the fractional CO_2 laser is an ablative modality, the fractioning of the light beam minimizes collateral thermal damage and accelerates recovery, as untreated areas adjacent to the ablative microchannels serve as container of viable cells that promote reepithelialization [29].

Tissue ablation, together with photothermolysis and collagen stimulation forms the triad of action responsible for the therapeutic effects of fractional CO_2 laser, making it a safe and effective tool for skin rejuvenation when proper indications and contraindications are strictly followed [18]. However, tissue ablation is not exempt from complications and potential adverse effects. Common side effects include erythema, swelling, exudation, crusting, and pruritus; more serious complications, although rare, may include bacterial, viral or fungal infections, persistent hyperpigmentation or hypopigmentation, and hypertrophic or keloid scarring. The depth of ablation and the intensity of thermal damage are critical factors influencing the incidence and severity of these adverse outcomes. Therefore, rig-

orous patient selection, appropriate skin preparation before treatment, and adequate post-procedure care are essential to optimize results and minimize the risks associated with fractional CO_2 laser ablation [18] [31] [33].

3.2. Contraindications

The use of fractional CO_2 laser has become well established as an effective tool in various aesthetic procedures, including facial rejuvenation, treatment of acne scars, stretch marks, vulvar laxity, and pigmentary alterations. However, despite its benefits, contraindications must be rigorously observed to prevent clinical complications. Studies have demonstrated that careful patient selection is fundamental to minimizing risks and ensuring safe and effective outcomes [24] [34] [35].

Contraindications may involve systemic factors such as active autoimmune diseases, use of immunosuppressive or anticoagulant medications, as well as specific dermatological conditions similarly active infections, scarring disorders, or high phototypes with a history of post-inflammatory hyperpigmentation. Additionally, physiological states such as pregnancy and breastfeeding are traditionally excluded from clinical protocols due to the absence of safety studies in these populations.

Based on recent literature, **Table 1** summarizes the main contraindications to the use of fractional CO_2 laser, highlighting the most frequently reported factors among the reviewed authors.

3.2.1. Pigmentary Disorders and High Phototype

The use of fractional CO_2 laser is associated with adverse effects and post-inflammatory hyperpigmentation (PIH) was the most frequently reported complication, affecting up to 13% of patients. Although in most cases this pigmentary change tends to resolve spontaneously within approximately one week, its incidence is significantly higher in individuals with darker phototypes [36]. Despite the efficacy of CO_2 laser in scar prevention in darker skin types, concerns remain regarding possible pigmentary and histological changes resulting from the procedure [37].

In patients with higher phototypes, hyperpigmentation may persist for several weeks, which makes it essential to address this risk clearly during the pre-treatment consultation [22] [24]. Given the high susceptibility to PIH, therapeutic indication of laser treatment in these populations should be approached with caution [9].

In our clinical practice, we emphasized the importance of adopting strict photoprotection protocols, the use of topical depigmenting agents beforehand, and ongoing clinical follow-up in the post-laser period. Additionally, it is recommended that clinicians register in the medical record all identified risk factors during the initial consultation, such as a history of melasma, hormone use, and recent sun exposure. Regular outpatient follow-up, particularly in the first four weeks, allows for early intervention in emerging cases of hyperpigmentation,

Table 1. Potential contraindications and exclusion criteria of published studies on the use of fractional CO_2 laser in the treatment of aesthetic dysfunctions.

CONTRAINDICATIONS	REFERENCES
1. Pigmentation disorder and high phototype	Nepomuceno and Silva [9]; Krupashankar [22]; Alcolea *et al.* [24]; Ansari [36]; Darwish *et al.* [37]; Ghani [38].
2. Active autoimmune disease	Beutler *et al.* [34]; EL-Domyati *et al.* [35]; Campos and Gontijo [39]; Zhou *et al.* [40].
3. Active inflammatory skin diseases and/or active acne	Beutler *et al.* [34]; Trelles [41].
4. Photosensitivity	EL-Domyati [35]; Makboul *et al.* [42].
5. Pregnancy or lactation	Alcolea *et al.* [24]; Beutler and Beutler [34]; EL-Domyati [35]; Ghani [38]; Campos and Gontijo [39]; Zhou *et al.* [40]; Makboul *et al.* [42]; Bjorn [43]; Di Nonato [44]; Khan [45]; Bretas *et al.* [46].
6. History of keloid or hypertrophic scarring	Xu and Deng [3]; Tehranchinia *et al.* [10]; Wu, *et al.* [15]; Apfelberg [18]; Beutler *et al.* [34]; El-Domyati [35]; Ghani [38]; Campos and Gontijo [39]; Bjorn [43]; Khan [45]; Krishna *et al.* [47]; Behrangi *et al.* [48]; Younes *et al.* [49]; Eiazhary *et al.* [50]; Tawaranurak *et al.* [51].
7. Active infection in the treated area	Wu *et al.* [4]; Apfelberg [18]; Beutler *et al.* [34]; Krishna *et al.* [37]; Campos and Gontijo [39]; Khan *et al.* [45]; Krupashankar [22]; Xu [52]; Zhou *et al.* [53].
8. Previous treatment with ablative laser in the same area	Makboul *et al.* [42]; Bjorn [43].
9. Use of anticoagulants	Wu *et al.* [4]; Campos and Gontijo [39].
10. Use of isotretinoin in the last year	Campos and Gontijo [39]; Makboul *et al.*,[42]; Bjorn [43]; Bretas *et al.* [46].
11. Recent or planned sun exposure (before/after treatment)	Yumeen, and Khan, [54]; Levy *et al.* [55].
12. Active herpes simplex	Yumeen, and Khan [54]; Levy *et al.* [21]; Tannous [55].
13. Active Oncological Disease or Severe Immunosuppression	Yumeen and Khan [54]; Proietti *et al.* [56].
14. Patients with systemic impairments	Carniol *et al.* [57]; Metelitsa and Alster [58].
15. Vitiligo and psoriasis.	Yumeen and Khan, [54]; Ramsdell [19].
16. Allergy or sensitivity to anesthetics.	Leszczynski [17], Tawaranurak [51].
17. Hormonal changes and puberty period.	Souza [60]; Dakhil [61].

Source: Data from bibliographic research (2025).

which may prevent permanent sequelae.

Among ablative devices, the CO_2 laser is associated as having the highest rates of adverse events, with reported incidences reaching up to 64.5%. In contrast, the Erbium laser has been suggested as a safer alternative for darker skin types [38].

Based on our clinical practice, we emphasize the importance of adopting strict photoprotection protocols, the use of topical depigmenting agents when indicated, and continuous clinical follow-up during the post-laser period. We also recommend documenting, in the medical record, risk factors identified during the

initial consultation, such as a history of melasma, hormone use, and recent sun exposure. Regular outpatient follow-up, especially within the first four weeks, allows for early intervention in cases of emerging hyperpigmentation, thereby reducing the risk of persistent sequelae.

This approach aligns with the "Expert Consensus" on clinical recommendations for fractional ablative CO_2 laser treatment for facial skin rejuvenation published in 2024 [21], which proposed specific protocol adjustments for darker skin types, including more conservative laser parameters and stricter photoprotection, to minimize the risk of post-inflammatory hyperpigmentation.

3.2.2. Active Autoimmune Disease

Although there is no explicit prohibition against the use of laser therapy in individuals with active autoimmune diseases, several authors have emphasized the importance of exercising caution in the presence of clinical conditions that may impair wound healing or negatively modulate the inflammatory response [39].

Autoimmune pathologies and endocrine dysfunctions are known to adversely affect both the safety and efficacy of laser therapies [34]. In this context, connective tissue disorders and systemic diseases such as *diabetes mellitus* and anemia are frequently associated with altered tissue responses, which may negatively impact clinical outcomes [35]. Additionally, the systematic exclusion of patients with systemic lupus erythematosus from clinical protocols involving laser therapy reinforces the cautious approach regarding the use of this technology in cases of significant autoimmune activity [40].

In cases of active autoimmune disease, a multidisciplinary evaluation and strict control of the systemic condition are essential to prevent exacerbations and ensure patient safety during the laser procedure.

3.2.3. Active Inflammatory Skin Diseases and/or Active Acne

Cases of active inflammatory acne, as well as other inflammatory dermatoses, have been widely used as exclusion criteria in clinical studies assessing the safety and efficacy of fractional CO_2 laser treatment [41]. Additionally, reports of acne exacerbation following the application of fractional lasers suggest an increased risk of complications in skin with ongoing inflammatory processes, reinforcing the need for caution when considering the procedure in such cases [34].

The presence of active inflammatory skin diseases or active acne may require prior treatment of these conditions and resolution of the inflammatory state before performing the laser procedure, in order to prevent complications and optimize outcomes [38].

3.2.4. Photosensitivity

Photosensitivity has been considered an exclusion criterion in clinical studies involving the use of fractional CO_2 laser, due to the potentially high risk of adverse skin reactions when exposed to intense thermal and/or light energy [42]. Similarly, patients undergoing treatment with systemic retinoids have also been excluded from such protocols, indicating an additional concern regarding pharma-

cologically induced photosensitivity and its possible implications for the healing process and the post-laser inflammatory response [35].

In this context, it is advisable to thoroughly investigate the patient's recent medication history, including the use of photosensitizing antibiotics, general retinoids, anti-inflammatory drugs, and diuretics. This screening should be part of the initial anamnesis and recorded in the medical chart, ideally with the patient's assistance, who may provide medication leaflets, prescriptions or photographs of the products used. Furthermore, to make treatment achievable, a safe suspension of photosensitizing agents may be implemented with a minimum lead time of 15 to 30 days, depending on the specific drug, but always under the prescribing physician's authorization.

In our clinical practice, we advise patients with photosensitivity to avoid intense sun exposure and to use broad-spectrum sunscreen rigorously before and after treatment. Additionally, we prioritize, whenever possible, performing the fractional CO_2 laser procedure during periods of lower solar radiation.

It is important to emphasize that failure to identify drug-induced photosensitivity is one of the primary risk factors for burns and abnormal scarring in outpatient settings. Therefore, a thorough evaluation regarding the recent or ongoing use of photosensitizing medications is strongly recommended.

3.2.5. Pregnancy or Breastfeeding

The application of fractional CO_2 laser therapy in pregnant or breastfeeding women is widely discouraged, primarily due to the lack of robust clinical evidence attesting to its safety in this population. For this reason, pregnancy and lactation are frequently used as exclusion criteria in clinical studies on the subject [35] [40] [43] [44].

The hormonal and physiological changes characteristic of pregnancy, as well as the cutaneous modifications that occur during this period, may result in unpredictable therapeutic responses including a higher risk of pigmentary disorders, abnormal wound healing and possible indirect systemic effects [38] [39] [42] [45].

Given the absence of scientific consensus and in accordance with the precautionary principle, the use of fractional CO_2 laser is not recommended during pregnancy and lactation, with the goal of safeguarding maternal and fetal well-being [24] [34] [46].

3.2.6. History of Keloids and/or Hypertrophic Scars

Individuals with a history of keloids or hypertrophic scars require careful clinical evaluation before undergoing fractional CO_2 laser treatment due to the increased risk of elevated scarring and excessive fibrosis development [18] [39] [43]. A predisposition to abnormal wound healing necessitates caution when defining therapeutic parameters and may justify the adoption of personalized protocols or contraindication of the procedure altogether depending on such cases [10] [34] [38].

Reports of recurrence or worsening of pre-existing keloids highlight the importance of rigorous screening and the use of combined therapeutic strategies

aimed at mitigating the associated risks [3] [15] [35] [45] [47].

Corticosteroids are commonly used to control inflammation and reduce the volume of hypertrophic scars. One of the most frequent treatments for these scars is intralesional steroid injection, which inhibits alpha-2-macroglobulin and subsequently leads to collagen breakdown. This approach helps to reduce the recurrence of keloids and hypertrophic scars [48].

In patients with a history of keloids or hypertrophic scars, we consider it important to perform test spots in discreet areas and to use prophylaxis with intralesional antikeloid medications or other adjuvant therapies, in order to mitigate the risk of abnormal scar formation.

Some authors have reported that the application of topical or intralesional triamcinolone acetonide following fractional CO_2 laser treatment can prevent keloid recurrence [48]-[51]. In our clinical practice, we also used intralesional triamcinolone acetonide immediately after fractional CO_2 laser therapy to avoid recurrences and ensure favorable outcomes (**Figure 6**).

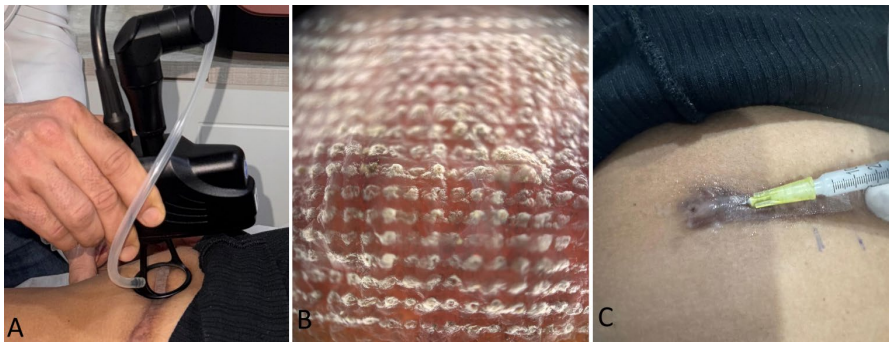

Figure 6. Keloid scar treatment using fractional CO_2 laser A; Dermatoscopic image showing MTZs over keloid tissue B; Application of triamcinolone acetonide immediately after CO_2 laser treatment.

3.2.7. Active Infection in the Treated Area

The presence of an active infection in the treatment area constitutes an absolute contraindication to the application of fractional CO_2 laser, as it may spread the infection, hinder tissue regeneration, and increase the risk of inflammatory and scarring complications [18] [22] [39] [52].

In this regard, the literature recommends postponing the procedure until complete resolution of the infectious condition as a strategy to promote greater safety and optimize therapeutic outcomes [34] [53]. The implementation of thorough screening to rule out active infections prior to intervention is strongly emphasized across studies and is considered an essential step for preventing adverse effects and achieving more favorable clinical results [4] [45] [47].

3.2.8. Previous Ablative Laser Treatment in the Same Area

Patients who have undergone previous ablative laser treatment in the same area have been excluded from clinical studies, which suggests contraindication due to the increased risk of complications and tissue fragility [42] [43].

It is also important to note that this contraindication may extend to chemical peels with high ablative potential applied to the skin.

We consider that a careful assessment of the skin's health status, combined with the time elapsed since the last ablative treatment, is essential to avoid excessive damage and ensure proper tissue recovery following fractional CO_2 laser treatment.

3.2.9. Use of Anticoagulants

The use of anticoagulants is associated with an increased risk of bleeding, hematoma formation, and impaired wound healing. Although not always listed as an absolute contraindication to fractional CO_2 laser, the literature emphasizes the need for caution when treating such cases [4] [39].

Additionally, patients on continuous anticoagulant therapy may experience prolonged recovery times, which demands a thorough clinical evaluation prior to the procedure to individually balance risks and benefits.

We advise patients who are using anticoagulants to seek an evaluation of their medication dosage with their attending physician prior to the procedure, in order to assess potential risks of bleeding and severe bruising, particularly when fractional CO_2 laser is performed with advanced or aggressive protocols, which typically reach the dermis and may cause bleeding.

3.2.10. Use of Isotretinoin in the Past Year

Recent use of isotretinoin is considered a relative contraindication to the application of fractional CO_2 laser, due to its negative impact on skin regeneration and the increased risk of hypertrophic scarring or fibrosis [39] [42] [46].

Given these potential adverse effects, authors have recommended a minimum waiting period of six to twelve months after completing isotretinoin therapy before performing ablative procedures, with the aim of minimizing the likelihood of abnormal scarring responses [43].

In the event of an indication for laser treatment immediately after the safety interval, we consider it prudent to use more conservative dosimetric parameters in order to reduce the risk of exacerbated scarring responses, since in our clinical practice we have observed patients who still exhibited symptoms related to isotretinoin use even after the twelve-month interval.

3.2.11. Recent or Planned Sun Exposure (Before/After the Procedure)

Still clinically important, intense sun exposure is a relative, contraindication for resurfacing procedures with fractional CO_2 laser, particularly in the weeks preceding or following treatment. Ultraviolet radiation can trigger a cutaneous inflammatory response, increasing the risk of post-inflammatory hyperpigmentation (PIH), especially in individuals with Fitzpatrick skin types III to VI [54].

Clinical evidence links recent or excessive sun exposure prior to treatment with a higher incidence of pigmentary alterations, which is why 67% of specialists interviewed in a consensus study on fractional CO_2 laser [55] recommended strict sun avoidance.

Regarding the clinical consensus on fractional CO_2 laser practice, the ideal interval for sun abstinence remains controversial: 47% of professionals suggested avoiding direct radiation for 2 to 4 weeks, while 41% recommended 1 to 2 weeks. Despite differing timelines, there is agreement on the necessity of initiating a broad spectrum photoprotection protocol at least four weeks prior to the intervention to reduce the risk of PIH [55].

Patients with higher epidermal melanin density are more prone to pigmentation after laser treatment if exposed to sunlight during the healing phase, which may compromise aesthetic outcomes [54]. Additionally, individuals who easily tans should avoid direct sun exposure for at least four to six weeks before and after the procedure to support reepithelialization and reduce UV-induced inflammation [56].

3.2.12. Active Herpes Simplex

The presence of an active herpes simplex virus (HSV) infection becomes an absolute contraindication for fractional CO_2 laser resurfacing, given the high probability of viral reactivation, local or systemic spread and the potential formation of permanent scars [55] [56].

Due to the widespread seroprevalence of HSV in the adult population, it is recommended that all candidates be thoroughly screened for previous herpes episodes and undergo mandatory antiviral prophylaxis, even in the absence of active lesions. The prophylactic regimen should begin the day before, or at the latest on the day of the procedure and is considered standard practice in clinical dermatology [55].

When active herpetic infection is present, treatment must be postponed, as the thermal injury from the laser compromises the epidermal barrier, facilitating viral replication and dissemination. This may lead to delayed healing, intense pain, and the risk of long-lasting aesthetic sequelae [54]. Therefore, both the presence of active lesions and the absence of prophylaxis constitute temporary exclusion criteria for fractional CO_2 laser procedures. The strict implementation of these preventive measures is essential to ensure patient safety and the therapeutic success of the procedure.

3.2.13. Active Oncologic Disease or Severe Immunosuppression

The presence of severe immunosuppression or active malignant neoplasia requires a careful evaluation prior to the indication of fractional CO_2 laser resurfacing, as these conditions may significantly impair the inflammatory response and healing process, increasing the risk of infection, delayed reepithelialization, and unsatisfactory aesthetic outcomes [57].

Patients with a history of radiotherapy, extensive burns, or autoimmune diseases often present with alterations in cutaneous appendages that hinder tissue regeneration following the procedure, thus raising the likelihood of scarring complications [54]. Considering this scenario, the indication of fractional laser in individuals with active cancer or immunosuppressive conditions must be highly in-

dividualized, considering the general clinical status, the degree of immunocompromise, and the potential risks involved in tissue healing [54] [57].

We emphasize that risk mitigation in these patients requires a thorough multidisciplinary evaluation, involving the attending physician responsible for managing the underlying disease. We recommend that laser treatment be considered only under conditions of clinical stability, with laboratory tests consistent with adequate immune function and absence of active infections. When therapy is authorized, we prioritize more conservative parameters and establish intensive outpatient follow-up in the post-procedure period, in order to enable early intervention in the event of any signs of complications.

3.2.14. Patients with Systemic Impairments

Patients with chronic or unstable systemic conditions require special caution when being considered for fractional CO_2 laser resurfacing, as they may present with impaired wound healing, increased susceptibility to complications, and lower tolerance to the physiological stress induced by the procedure.

Certain collagen disorders, such as systemic lupus erythematosus and scleroderma, are considered relative contraindications because they negatively affect dermal repair mechanisms, promoting the formation of atrophic or dysplastic scars and potentially exacerbating pre-existing inflammatory processes [58]. Furthermore, individuals with severe valvular heart disease may exhibit limited hemodynamic resilience in response to the systemic inflammatory reaction induced by the laser, which justifies prior cardiologic evaluation and if necessary, adjustments to treatment parameters [59].

Thus, the indication of fractional CO_2 laser for patients with relevant systemic impairments must be preceded by a careful risk-benefit analysis, considering the individual's clinical condition and regenerative capacity to ensure treatment safety and efficacy.

3.2.15. Vitiligo and Psoriasis

Patients with vitiligo, psoriasis, or other dermatoses susceptible to the Koebner phenomenon must be carefully evaluated before undergoing fractional CO_2 laser resurfacing, as the thermal trauma induced by the procedure may trigger the appearance of new lesions in the treated areas [19] [54].

The risk of Koebnerization, a process in which cutaneous microtrauma induces lesions characteristic of the underlying disease, is well documented, particularly during active phases of vitiligo and psoriasis [19].

Additionally, inflammatory or autoimmune conditions that impair cutaneous appendages can interfere negatively with tissue regeneration, constituting relative contraindications or requiring adjustments to the therapeutic plan [54]. In such cases, it is recommended to postpone laser treatment in patients with active manifestations of these dermatoses or to avoid it altogether in individuals with a significant personal or family history, in order to reduce the risk of clinical exacerbation and preserve the expected aesthetic results.

3.2.16. Allergy or Sensitivity to Anesthetics

It is known that the perception and duration of pain during fractional CO_2 laser treatment vary according to the parameters used [3]. For this reason, the use of topical anesthetics combined or not with analgesics, is recommended to ensure greater comfort during the procedure [59].

However, if the patient has a history of allergy or hypersensitivity to local anesthetics such as lidocaine, tetracaine, or topical combinations (e.g., EMLA), the procedure becomes contraindicated, as it will not be possible to provide adequate pain control [17] [51].

It is also worth noting that the use of injectable anesthetics during fractional CO_2 laser application (e.g., facial nerve blocks) may further complicate anaphylactic symptoms in patients prone to such reactions.

3.2.17. Hormonal Changes and Puberty

Changes in estrogen, androgen, and glucocorticoid levels negatively affect fibroblast activity by promoting a catabolic state that reduces collagen production in the dermal matrix. This condition contributes to the development of new stretch marks. For this reason, the use of CO_2 laser for therapeutic treatment of stretch marks is considered a relative contraindication during pregnancy and the immediate postpartum period, with treatment recommended only after hormonal levels have stabilized.

Similarly, puberty also represents a relative contraindication due to the intense and unstable hormonal fluctuations typical of this developmental phase [60].

Moreover, there is evidence suggesting that the risk of post-inflammatory hyperpigmentation (PIH) may be increased when CO_2 laser is applied during the menstrual cycle, possibly due to heightened inflammatory activity associated with hormonal fluctuations during this period [61]. Thus, we recommend, whenever possible, scheduling the procedure outside the menstrual period as a way to mitigate the risk of post-inflammatory hyperpigmentation associated with hormonal fluctuations.

3.3. Classification of Contraindications: Absolute and Relative

The classification of a contraindication as "absolute" or "relative" is based on its severity and the feasibility of safe clinical management. Absolute contraindications are those that present a high and imminent risk of serious adverse events, such as systemic infections, impaired wound healing, or exacerbation of severe diseases, making the procedure prohibitive regardless of the clinical context. Relative contraindications, on the other hand, correspond to conditions that do not entirely preclude treatment but require careful evaluation, adjustments in technical parameters, or specific preventive interventions to mitigate risks [21] [22].

This classification is supported by guidelines such as those published by Krupashankar (2008) [22], which clearly outlined the contraindications to CO_2 laser based on risk and clinical management. Furthermore, a recent international expert consensus published in 2024 [21] reinforced the distinction between these

categories for the safe use of fractional ablative CO_2 laser, particularly in facial rejuvenation.

Although Table 1 presents a comprehensive compilation of the main contraindications described in the literature, it is essential to deepen this analysis by distinguishing between conditions that definitively preclude the procedure and those that merely require cautious handling. This classification is particularly relevant in clinical practice, as it contributes to safer and more individualized decision-making based on the risk-benefit assessment of each case. In this regard, Table 2 summarizes the contraindications categorized according to their severity and clinical management feasibility, based on the consensus from the reviewed studies.

Table 2. Classification of Contraindications to the Fractional CO_2 Laser Use in Absolute and Relative Terms, according to the Specialized Literature, Based on Severity and Clinical Management Feasibility

CLASSIFICATION	CLINICAL CONDITIONS
Absolute	- Active infection in the treated area
	- Active herpes simplex
	- Recent use of isotretinoin (within 6 - 12 months)
	- Active oncologic disease
	- Severe immunosuppression
	- Active autoimmune disease
Relative	- Use of anticoagulants
	- Pigmentary disorders and high phototype
	- Active inflammatory acne or dermatitis
	- Pregnancy or breastfeeding
	- History of keloids or hypertrophic scars
	- Recent or planned sun exposure
	- Previous ablative laser treatment in the same area
	- Vitiligo or psoriasis
	- Chronic systemic impairments
	- Allergy or sensitivity to anesthetics
	- Hormonal changes and puberty

Source: Compiled by the authors based on the findings discussed in this review (2025).

4. Limitations

This review presents some important limitations. As it is a narrative review, it is subject to selection bias and did not include a formal assessment of the methodological quality of the studies. The heterogeneity in study designs and in the reporting standards of the included articles made direct comparisons and consistent synthesis of findings difficult. Furthermore, much of the available literature on contraindications to fractional CO_2 laser is based on expert opinion, small case series, or retrospective analyses, with a limited number of high-level evidence

studies. These factors should be taken into account when interpreting the results and applying them in clinical practice.

5. Conclusions

Fractional CO_2 laser is an effective technology for treating different aesthetic disorders, acting through fractional photothermolysis, collagen stimulation, and tissue ablation. However, the safety and effectiveness of the treatment depend critically on the thorough assessment of contraindications, which may be either absolute or relative. A deep understanding of these contraindications, along with careful patient selection, is essential to optimize outcomes and minimize the risks of complications, thus ensuring the safety and success of aesthetic procedures involving fractional CO_2 laser.

In summary, the safe and effective application of fractional CO_2 laser in aesthetic procedures is not limited to the practitioner's technical skill but also depends on their ability to perform a comprehensive medical history and physical examination, identifying any factors that could compromise the safety or results of the treatment. We concluded, therefore, that the careful selection of patients, based on knowledge of contraindications and the individualization of the therapeutic plan, emerges as the cornerstone for maximizing the benefits of fractional CO_2 laser therapy and minimizing its associated risks, thereby ensuring both quality and safety for those seeking the benefits of this therapeutic resource.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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