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Fundamentals and clinical applications of the fractional CO_2 Laser Microcoring Mode for Treating Aesthetic Disorders

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Abstract

Fractional CO_2 laser therapy has become established as an effective tool for the treatment of aesthetic disorders, promoting tissue regeneration with reduced recovery time. A specific mode, commercially referred to in Brazil as *Microcoring*, has gained popularity due to its predominantly superficial action, although the term originally described a different, non–laser-based technique. The application of the superficial mode aims to combine aesthetic efficacy with reduced tissue aggressiveness and minimal downtime. To critically analyze the technical fundamentals, biological mechanisms and clinical evidence supporting the use of this kind of laser in the treatment of aesthetic disorders, an integrative narrative literature review was conducted, encompassing publications from 2006 to 2025 indexed in PubMed, Scopus, Web of Science, and Google Scholar. Studies addressing the aesthetic use of fractional CO_2 laser therapy with descriptions of technical parameters and clinical outcomes were included. After screening, 16 studies were selected for qualitative descriptive analysis. The *Microcoring* mode promotes superficial ablation of the epidermis and papillary dermis with controlled penetration, favoring quick re-epithelialization and collagen remodeling. Studies demonstrated significant improvement in fine wrinkles, superficial scars, irregular skin texture, and enlarged pores, with high patient satisfaction rates and reduced recovery time. The combination with the deep mode (fusion mode) proved effective in the management of more complex conditions. Clinical and histological evidence supports the safety of this approach, including higher skin phototypes, when appropriately parameterized. Finally, *microcoring* mode of fractional CO_2 laser therapy represents an effective and safe alternative for treating superficial aesthetic disorders, offering advantages such as reduced downtime and lower intraoperative discomfort. However, greater technical standardization, scientific validation, and regulation of terminology are required to ensure reproducibility and promote international recognition of this practice.

Keywords: Fractional CO_2 laser; Active FX; Acu Pulse; Microcoring; Micro-coring; Ultra Pulse

1. Introduction

The use of fractional CO_2 lasers has become established as one of the most effective strategies for the treatment of cutaneous aesthetic disorders and scars due to their ability to generate microscopic thermal zones (MTZs) that induce

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dermal remodeling with reduced aggressiveness when compared with fully ablative systems [1–3]. Fractional lasers have gained prominence by combining high clinical efficacy with a shorter recovery period. This therapeutic modality may act selectively by creating controlled microthermal injuries, thereby triggering a more efficient tissue regeneration process in the skin, resulting in significant clinical improvement with reduced downtime [2,4]. In this way, this technology overcomes some limitations associated with non-ablative methods, particularly regarding depth of penetration and the effectiveness of the therapeutic response [5].

Within this context, fractional CO_2 laser devices with a more superficial mode of action emerged. In 1998, the UltraPulse Encore system was introduced, whose ActiveFX mode promoted more superficial tissue ablation [1]. In the early 2000s, the AcuPulse™ platform, approved by the U.S. Food and Drug Administration (FDA) was launched with the Superficial™ Mode — both devices manufactured by Lumenis Inc. (Santa Clara, CA, USA) [6]. In Brazil, this mode of superficial thermal ablation became commercially known as Microcoring and has gained increasing attention due to its precise and predominantly epidermal action. However, the popularization of the term Microcoring in association with fractional CO_2 laser technology has been accompanied by a conceptual misunderstanding. According to some authors [7,8], the terms microcoring or coring originally refer to a dermal microdrilling technique designed to extract skin cores small enough to allow scarless healing. The device used for dermal microcoring employs hollow hypodermic needles to remove small micron-sized cores of skin. Its application has been reported in the treatment of skin laxity, rhytides and acne scars, but it has not traditionally been associated with fractional CO_2 laser devices.

According to some authors [6], the AcuPulse™ platform allows the use of both the traditional deep mode (so-called spot ablation) and the superficial mode (ablation in a spiral or vortex pattern), either separately or in combination — an approach currently adopted by several devices marketed in Brazil. The action of the called Microcoring mode in fractional CO_2 lasers is typically characterized by a larger epidermal lesion with a spiral or vortex configuration (Figure 3). It measures approximately 1.3 mm, when compared with the traditional deeper ablation mode of fractional CO_2 lasers (approximately 0.12 mm). This mode can selectively vaporize the epidermis and part of the papillary dermis with minimal penetration depth, thereby favoring accelerated re-epithelialization and potentially reducing the risk of adverse effects.

Evidence indicates that by operating with high fluence and dense coverage, the superficial mode can promote effective epidermal renewal at controlled depths (10–300 µm), stimulating growth factors secreted by keratinocytes to repair laser-induced thermal damage. This mode is particularly indicated for fine wrinkles and pigmentary alterations, offering quick recovery and a low risk of post-inflammatory hyperpigmentation [9]. Authors [6] have demonstrated that the combination of superficial and deep modes might promote effective epidermal and dermal remodeling with minimal adverse events. Clementoni et al. [10] evaluated this exact scenario by employing a multimodal fractional laser with dual superficial and deep capabilities and reported a mean improvement in deep wrinkles and melanin variation six months after treatment.

These findings emphasize the importance of understanding the specific characteristics of the different emission modes—superficial, deep, and combined—within the therapeutic context of ablative lasers, in order to optimize clinical outcomes and minimize adverse effects. Nevertheless, gaps remain in the understanding of the specific biological mechanisms activated by each emission mode, particularly the Microcoring mode, since due to its superficial action, may present limitations in the treatment of deeper conditions such as scars and deep wrinkles.

Given the above, the main question guiding this study is: What are the technical–biological mechanisms and clinical impacts associated with the Microcoring mode of the fractional CO_2 laser, when applied alone or in combination with the traditional deep mode, when treating selected aesthetic disorders? The rationale for this investigation lies in the lack of consolidated evidence supporting the commercial protocols currently used in Brazil, particularly regarding safety, efficacy, and reproducibility of clinical outcomes. Accordingly, the objective of this study is to critically analyze the technical foundations, biological mechanisms, and available clinical evidence supporting the use of the superficial mode of the fractional CO_2 laser—commercially referred to as Microcoring in Brazil—regarding the management of aesthetic disorders.

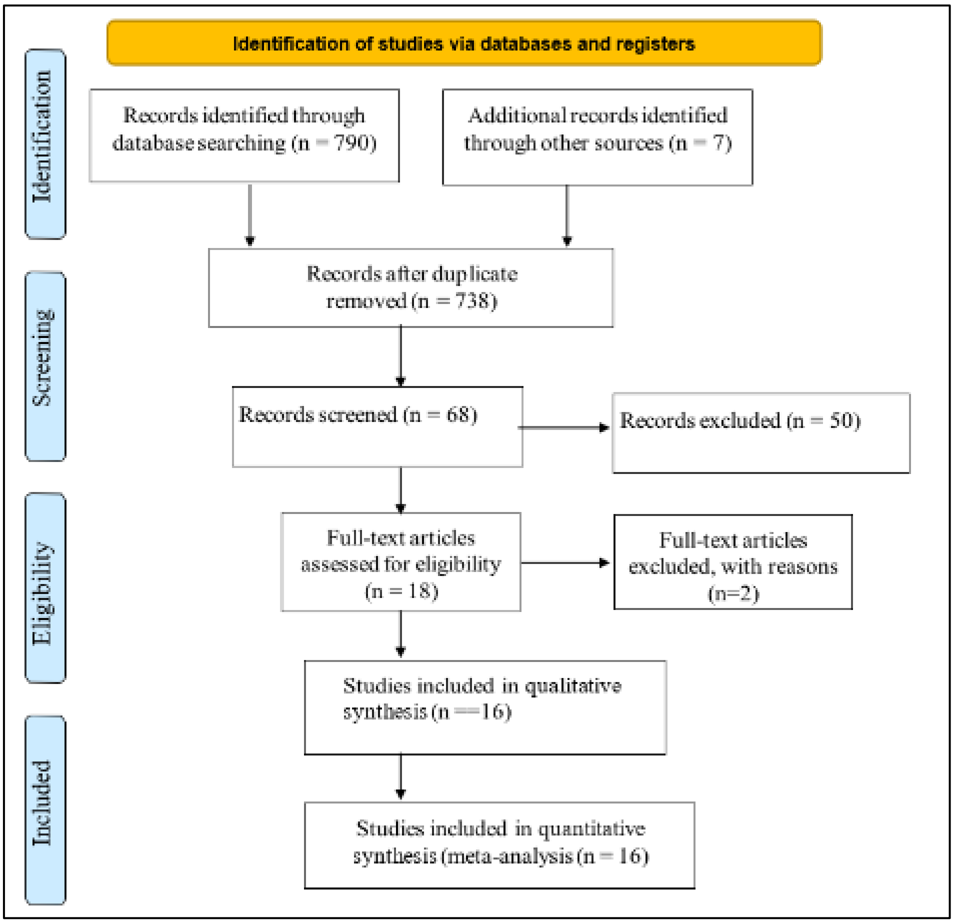
2. Material and methods

This study was conducted as an integrative narrative literature review aimed at gathering, analyzing, and synthesizing scientific evidence related to the proposed topic. A systematic bibliographic search was performed in PubMed, Scopus, Web of Science, Google Scholar, and SciELO databases. Descriptors were combined using the Boolean operators AND and OR. The search terms included “CO_2 fractional laser,” “fractional carbon dioxide laser,” “ActiveFX,” “AcuPulse,” “Microcoring,” “Micro-coring,” and “UltraPulse”.

The adopted time frame covered publications from 2006 to 2025, with priority given to systematic reviews randomized controlled clinical trials, controlled clinical studies, and technical validation articles of laser devices. In addition, official technical materials such as white papers, manufacturer manuals, and operational protocols were considered, particularly those published by Lumenis Ltd. (Santa Clara, CA, USA) regarding the AcuPulse™ and ActiveFX™ platforms, if they were widely cited and demonstrated scientific relevance.

The initial search approached 797 records. After manual removal of duplicates (n = 59), records clearly outside the thematic scope such as patents, presentations, non-scientific documents, technical materials lacking scientific validation, and studies unrelated to the use of fractional CO_2 lasers in aesthetic disorders, were excluded prior to formal screening. After this step, 68 records remained for title and abstract screening. During this phase, 50 records were excluded for failing to meet the predefined inclusion criteria, resulting in 18 studies selected for full-text review. All full texts were retrieved and assessed for eligibility, with two additional articles excluded at this stage. Consequently, 16 studies fully met the eligibility criteria and were included in the final analysis.

Identification processes, screening, eligibility assessment and inclusion of studies were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines, adapted to the design of an integrative narrative review to ensure transparency, traceability, and methodological clarity. The stages and corresponding numbers at each phase of the process are presented in the flowchart shown in Figure 1. Data analysis was performed using a qualitative descriptive approach, with extraction and synthesis of information related to technical application parameters, mechanisms of action, clinical indications, therapeutic outcomes, and reported limitations.



Source: Search data, 2025.

Figure 1 Flowchart of the methodological stages

3. Results and discussion

3.1. Fractional CO_2 Laser and Its Applicability in Aesthetic Disorders

Fractional ablative carbon dioxide (CO_2) lasers are recognized as one of the most significant advances in the field of aesthetic dermatology, with well-documented efficacy in the treatment of fine wrinkles, skin rejuvenation, atrophic scars, and dyschromias [3,4,11,12]. By creating microscopic thermal zones (MTZs) (Figure 2), this technology stimulates both epidermal and dermal regeneration promoting collagen synthesis and remodeling skin texture [13]. When compared with non-ablative lasers, fractional CO_2 systems produce faster and more notable clinical results while requiring fewer treatment sessions. This balance between high therapeutic efficacy and reduced recovery time justifies their widespread adoption in clinical practice, particularly for facial treatments and in sensitive anatomical areas [1].

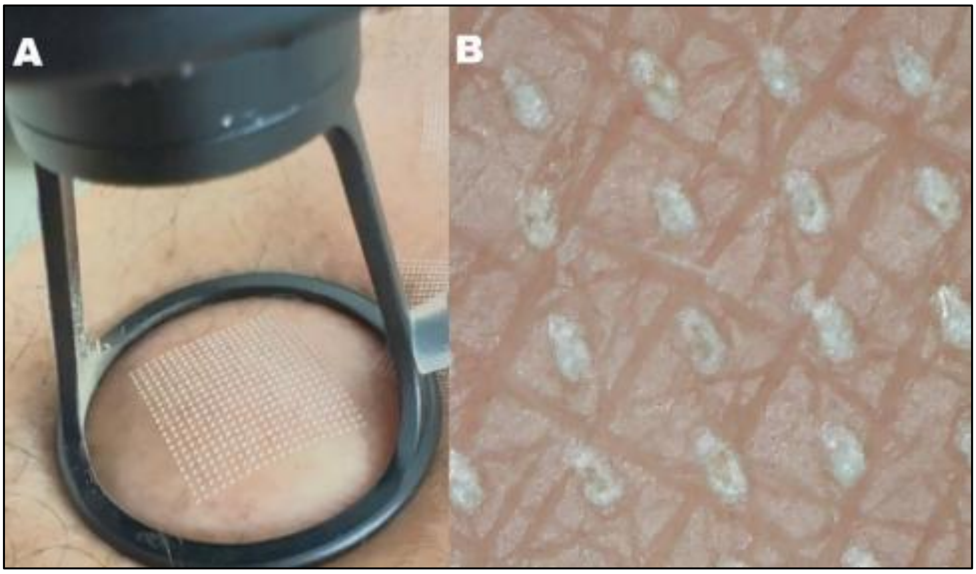


Figure 2 Microscopic thermal zones (MTZs) immediately after application of the fractional CO_2 laser (Vivaderm Smart™, Soupelli, Brazil): (A) macroscopic view; (B) dermoscopic view

Gold and Biron [6] demonstrated substantial improvements in skin texture and pigmentation, even after single treatment sessions. The authors applied a multimodal approach combining deep treatment (energies ranging from 5 to 20 mJ and density of 5–15%) with superficial treatment (energies between 50 and 170 mJ and density of 40–60%). This strategy proved effective not only in achieving clinical improvement but also in reducing adverse effects such as post-inflammatory hyperpigmentation (PIH). Corroborating these findings, Clementoni et al. [10] reported objective improvements of up to 42% in wrinkle depth and 40% in skin texture and pigmentation using fractional CO_2 laser in a multimodal protocol (deep + superficial microcoring). The applied protocol utilized energies between 10 and 20 mJ and ablation densities of 5–20% for the deep component, and energies between 80 and 130 mJ with densities of 40–60% for the superficial component. The observed effectiveness was attributed to uniform coverage and precise fluence control, confirming the method's potential for superficial epidermal and dermal remodeling.

Supporting these data, a systematic review conducted by some authors [14] reported that fractional CO_2 laser treatment yields higher patient satisfaction rates compared with other *resurfacing* technologies, such as intense pulsed light (IPL) and fractional radiofrequency. This superiority is reflected not only in clinical improvement but also in faster recovery and a lower incidence of persistent adverse effects.

Regarding the clinical applicability of fractional CO_2 lasers, there is consensus in the literature on the need for individualized technical parameters, considering the type of lesion and its anatomical location [6,10,15]. Accordingly, a detailed treatment plan may be developed based on wrinkle topography, allowing differentiation between deep and superficial treatments for specific areas such as the perioral region, cheeks, and periorbital area [10]. The shape and width of the laser scanning area (e.g., circular, square, triangular) can also be adjusted according to the anatomical region and patient-specific needs [15].

Although there is no explicit consensus on the strict individualization of parameters for darker skin phototypes (IV–VI), post-inflammatory hyperpigmentation (PIH) remains a relevant concern in patients with darker skin tones. In this context, patients with Fitzpatrick phototype VI and a history of PIH were excluded from a study evaluating combined superficial and deep modes of fractional CO_2 laser treatment [6].

According to some authors [15], appropriate selection of laser parameters such as fluence and density is recommended to reduce the risk of PIH and other adverse effects. Consequently, non-ablative lasers which do not induce abnormal pigmentation have been suggested as more suitable for patients with darker skin tones, given the higher risk associated with ablative lasers [1]. However, a systematic review analyzing 1,093 patients [14] suggested that, excluding transitory events, ablative lasers were associated with fewer overall complications (2.56%) compared with non-ablative lasers (7.48%). Most treatment-related adverse events including PIH, were transitory and resolved spontaneously. Therefore, although ablative lasers act on deeper skin layers and carry greater potential for tissue damage, this study emphasized that clinical success depends primarily on appropriate parameter selection and careful patient assessment.

Direct comparisons between technologies further emphasize the superiority of fractional CO_2 lasers. A meta-analysis indicated that fractional CO_2 laser treatment is more effective than fractional Er:YAG laser for atrophic acne scars, with a favorable odds ratio (OR = 1.81). And a shorter mean duration of erythema (approximately 2.1 days), although it is associated with greater procedural discomfort [16]. Additionally, clinical studies have demonstrated that combining fractional CO_2 laser treatment with hyaluronic acid–based dressings significantly reduced clinical scar scores, crust formation, and the incidence of hyperpigmentation, while maintaining high levels of patient satisfaction [17].

Given this, such findings indicate that the versatility of fractional CO_2 laser technology allows customizing the treatment protocols based on MTZ density, depth of action, and the specific aesthetic disorder being treated. This adaptability is widely recognized as essential for optimizing therapeutic outcomes and minimizing risks, thereby consolidating fractional CO_2 laser technology as an essential tool in contemporary aesthetic dermatology practice.

3.2. Emergence and rise of fractional CO_2 laser devices with the Microcoring (superficial mode) in Brazil

In 1998, Lumenis Inc. released the UltraPulse Encore™, which featured an advanced fractional CO_2 laser system with three distinct laser energy delivery modes. The first mode, ActiveFX, generated a spiral-shaped thermal lesion with a tissue ablation size of approximately 1.3 mm, resulting in more superficial ablation (Figure 3). This mode proved useful for the treatment of fine wrinkles, actinic keratosis, and similar conditions and corresponds to what is commercially referred to in Brazil as *Microcoring*. The second mode, DeepFX, concentrated laser energy into a spot size of approximately 0.12 mm, enabling deep ablation that was effective for the treatment of deep rhytides.

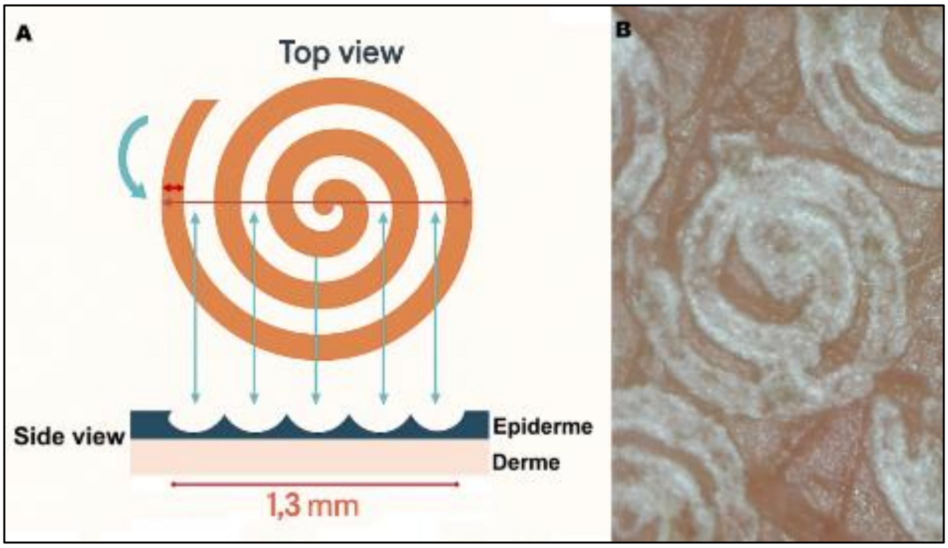


Figure 3 (A) Schematic representation of energy delivery in a spiral (or vortex) pattern characteristic of the superficial mode of the AcuPulse™ fractional CO_2 laser, shown in top and lateral views (adapted from Gold and Biron, 2022 [6]); (B) Dermoscopic image showing a superficial fractional CO_2 laser–induced skin lesion in a spiral configuration, characterizing the so-called Brazilian *microcoring*, produced by the Vivaderm Smart™ device (Soupelli, Brazil)

This mode might achieve tissue ablation depths of up to 2 mm. The third mode, known as TotalFX, combined the ActiveFX and DeepFX modes simultaneously and was indicated for the treatment of scars and rhytides [1]. Subsequently, on October 1, 2009, during the American Society for Dermatologic Surgery (ASDS) annual meeting, Lumenis Inc. introduced the AcuPulse™ Fractional CO_2 Laser system, marking the entry of a new generation of ablative fractional lasers into the global aesthetic market [18]. In an effort to simplify the delivery of both superficial and deep therapies using a single device, the AcuPulse™ was presented as a fractional ablative laser system able to perform both superficial and deep ablation through a single handpiece that sequentially delivers the two types of ablation [6].

Although the term *Microcoring* does not appear in official technical documentation from Lumenis Ltd., it has been commercially adopted by Brazilian professionals and companies to refer to the superficial mode of the fractional CO_2 laser due to its predominantly epidermal action and reduced tissue aggressiveness (Figure 4). This popular designation gained traction based on clinical perceptions of aesthetic efficacy combined with less tissue damage and enhanced heating potential when used simultaneously with the deep mode.

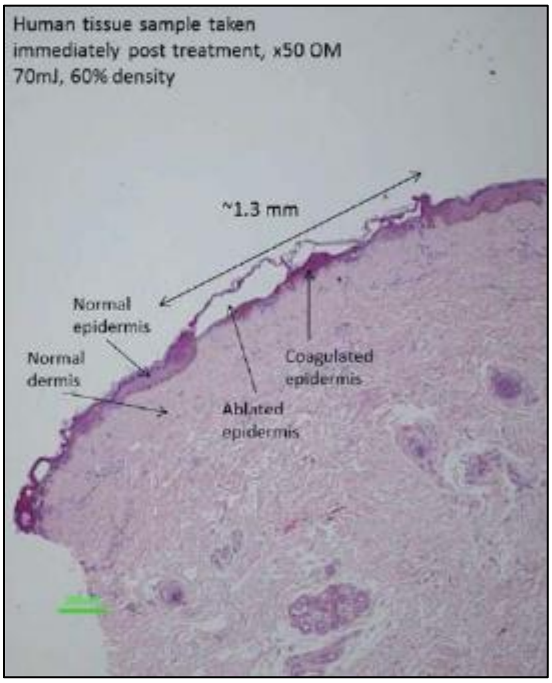


Figure 4 Example histologies demonstrating the uniformity, diameter and tissue affect of the superficial mode (x50 OM) with *AcuPulse™* carbon dioxide laser device (Lumenis Ltd, Santa Clara, CA). (Source: Gold & Biron, 2012[6])

Adopting the superficial mode of fractional CO_2 laser in Brazil (*Microcoring*) was driven by the release of Hybrid CO2™ device (Laser Medical Group – LMG®, Brazil), which produces a superficial thermal lesion pattern in the shape of a ring or circle. This device also allows the use of two superficial thermal lesion configurations: the formation of a single ring or two concentric rings (Figure 5). In addition to the post-launch dissemination of the LMG® device, studies published in 2012 [6,10] reported favorable clinical outcomes using the superficial mode alone in patients with more sensitive skin phototypes, although demonstrating a different lesion pattern. These findings state as a reference for the local adaptation of the *Microcoring* concept, despite the absence of formal regulation or standardized nomenclature. In parallel, reports from professional practice, technical materials used in courses and training programs also contributed to its dissemination throughout Brazil, as well as the introduction of other devices incorporating this technology.

Another relevant piece of evidence was provided by a study conducted in Brazil that evaluated combined protocols using deep (DeepFX) and superficial (ActiveFX) modes, demonstrating high clinical efficacy and acceptable safety in patients with Fitzpatrick phototypes III to V. The results showed improvements exceeding 50% in skin rejuvenation among treated individuals, with transitory hyperpigmentation but high levels of patient satisfaction. This experience reinforces the safety of protocols incorporating the superficial mode in pigmented skin when applied under well-controlled technical criteria and served as a background to the expansion of isolated *Microcoring* mode use in aesthetic treatments across the country [19].

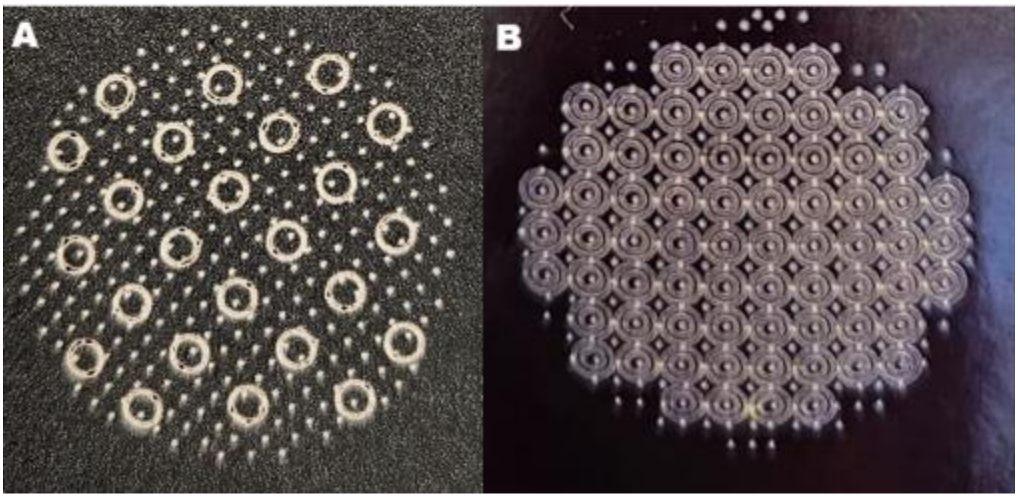


Figure 5 Visualization of the thermal lesion pattern with a ring or circular appearance generated by the superficial microcoring mode of a fractional CO_2 laser using the Hybrid CO2™ system (Laser Medical Group – LMG®, Brazil): (A) formation of single circles; (B) formation of concentric circles (courtesy of Cynthia Chermouth, Rio de Janeiro, Brazil)

Despite these advances, there remains a scarcity of formal scientific literature addressing the standardization of technical parameters for the use of the superficial mode. Either alone or in combination with the deep mode of fractional CO_2 laser adapted to the Brazilian therapeutic context. Moreover, there are few comparative studies evaluating different skin phototypes or cutaneous conditions treated with specific standardized protocols.

Finally, although *Microcoring* is a Brazilian commercial designation, it is noteworthy that the term reflects a practice grounded in the technical principles of the Superficial/ActiveFX mode of the AcuPulse™ system disseminated in the early 2000s. However, currently it is possible to find other devices manufactured in Europe and Asia also incorporate superficial fractional CO_2 laser modes. One example is the CO2RE™ system, launched in 2010 by Candela Corporation (Israel), which features a superficial fractional CO_2 mode that produces a circular or annular thermal lesion pattern (Figure 6), differing from the previously described spiral configuration. Authors [20] used the CO2RE™ system to treat vulvar lichen sclerosus employing the fusion mode (superficial plus deep) and reported significant improvement across all clinical signs as well as in the quality of life of treated patients.

From Asia, the *eCO2* system manufactured by Cynosure Lutronic Corporation (Goyang, Korea) demonstrated efficacy and safety in a single treatment session for acne scars and enlarged facial pores in 2022 [21]. A new version was released in 2025 (eCO2 3D™), introducing a superficial lesion mode using wider laser beams (0.5 mm) that reaches a shallower depth (160 µm), thereby enabling greater precision in superficial ablation with minimal lateral thermal diffusion. Although no studies were identified that specifically addressed the use of this superficial application mode, authors [22] reported that the deep mode of the eCO2 3D™ when operated at 40 W, provides greater precision, deeper dermal penetration and reduced thermal diffusion compared with operation at 30 W.

The use of the superficial mode of fractional CO_2 laser in Brazil continues to expand based on protocols inspired by international evidence. Nevertheless, the need for standardized parameters and controlled studies adapted to the Brazilian population remains as an open opportunity.

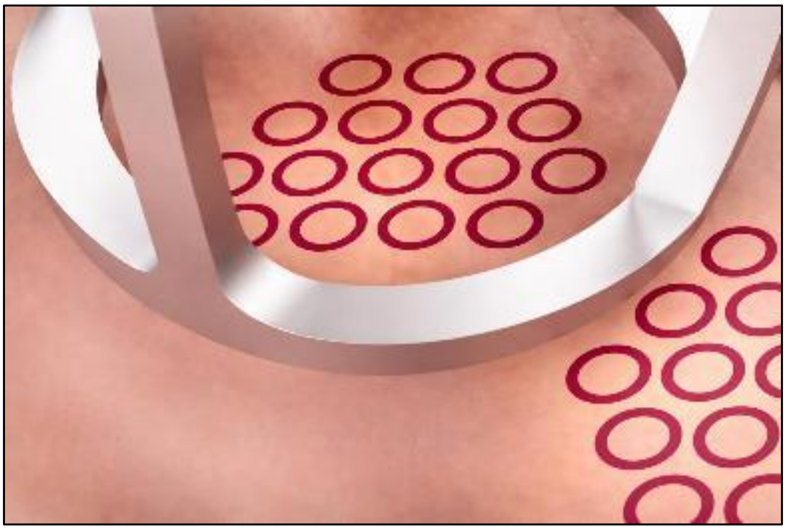


Figure 6 Schematic representation of the circular configuration from the superficial thermal lesion produced by the CO2RE™ system (Candela Corporation, Israel)

3.3. Fundamentals, Effects, and Outcomes of the Superficial Action of the Fractional CO_2 Laser – the Microcoring Mode

The superficial mode known in Brazil as *Microcoring* consists of a fractional ablative CO_2 laser protocol designed to promote broad superficial ablation with controlled penetration depths ranging from 150 to 200 μm, targeting conditions localized in the epidermis and the superficial papillary dermis [1].

Histological studies have demonstrated the formation of wide and shallow craters with limited zones of lateral coagulation, without penetration into the deeper dermis. However, at higher fluence settings, these thermal effects may extend through the epidermal basement membrane into the papillary dermis. Evidence of apoptosis has been noticed in the epidermis and superficial papillary dermis, with preservation of deeper skin layers [23]. This thermal pattern favors the regeneration of type I and type III collagen, promoting safe clinical outcomes even in sensitive skin types [24].

Adjustment of device modulation parameters depends on the specific clinical indication. The study by Jung et al. [21] demonstrated clinical improvement in acne scars and enlarged facial pores: four out of ten patients showed 51–75% improvement using a low-fluence/high-density configuration, while five out of ten patients achieved improvements greater than 76% with a high-fluence/low-density configuration. At the histopathological level, the formation of necrotic columns in the epidermis and upper dermis was observed. Still, the presence of these histological changes, along with the observed clinical improvement, suggests an active process of tissue remodeling.

Clinically, superficial ablative fractional CO_2 laser systems demonstrated excellent outcomes in the treatment of several skin conditions, including solar lentigines [1,10,14], superficial acne scars [1,6,25], enlarged pores [21], fine periorbital wrinkles [1,6,10,26], and irregular skin texture [1,6].

Clinical studies evaluating the effects of fractional CO_2 laser treatment across different skin phototypes have shown efficacy and safety in patients with Fitzpatrick phototypes II or III [10], phototypes III to V [19], as well as in Asian populations [6,25].

In such kind of procedure, downtime is defined as the period of edema and erythema limiting social activities. So, the average downtime reported in studies using the superficial mode of fractional CO_2 laser devices ranged from 3 to 5 days, with crust resolution occurring in approximately 4.9 ± 1.1 days [10,25,26]. When the aesthetic condition is confined to the epidermis or superficial dermis, the isolated use of the superficial mode of fractional CO_2 laser has proven to be effective and safe with accelerated recovery, representing a relevant option for clinics which prioritize aesthetic outcomes with reduced risk and minimal downtime [25]. In addition, high patient satisfaction rates have been consistently reported, with 87.5% of patients in a study indicating that they would recommend this type of laser treatment [10].

In our clinical practice, we commonly used a fusion approach, combining the superficial (Microcoring) and deep modes in a single session to integrate superficial ablation with deep dermal remodeling. In Figures 7 to 11, we presented selected treatment outcomes from this combined approach.

Figure 7 Facial rejuvenation. The fusion mode was applied to the lower eyelids and the midface in a single treatment session. The protocol included a superficial *Microcoring* mode set at 20 W with an inter spot distance of 2 mm, and a deep mode set at 22 W with an inter spot distance of 0.8 mm, a pulse duration of 1 ms, and overlap level 1 (Vivaderm Superpulsado™, Soupelli, Brazil)

Figure 8 Periorbital rejuvenation. The fusion mode was applied to both the upper and lower eyelids in a single treatment session. The protocol included a superficial *Microcoring* mode set at 18 W with an inter spot distance of 1.2 mm, and a deep mode set at 20 W with an inter spot distance of 0.8 mm, a pulse duration of 1 ms, and overlap level 1 (Vivaderm Smart™, Soupelli, Brazil)

Figure 9 Forehead scar treatment. The fusion mode was applied in a single session. The protocol included a superficial *Microcoring* mode set at 9 W with an inter spot distance of 2 mm, and a deep mode set at 12 W with an inter spot distance of 1 mm, a pulse duration of 1.6 ms, and overlap level 2 (Vivaderm Ultrapulsado™, Soupelli, Brazil)

Figure 10 Vulvar rejuvenation. The fusion mode was applied throughout the labia majora and mons pubis in a single treatment session. The protocol included a superficial *Microcoring* mode set at 16 W with an inter spot distance of 2 mm, and a deep mode set at 20 W with an interspot distance of 1 mm, a pulse duration of 1 ms, and overlap level 1 (Vivaderm Superpulsado™, Soupelli, Brazil)

Figure 11 Vulvar rejuvenation. The fusion mode was applied throughout the labia majora and mons pubis in a single treatment session. The protocol consisted of a superficial *Microcoring* mode set at 16 W with an inter spot distance of 1.2 mm, and a deep mode set at 20 W with an inter spot distance of 1 mm, a pulse duration of 1 ms, and overlap level 1 (Vivaderm Smart™, Soupelli, Brazil)

4. Conclusion

The reviewed clinical and histological data support *Microcoring* mode's efficacy in the treatment of superficial aesthetic disorders. The combination of moderate fluence, high density, and a wide spot size enabled satisfactory clinical outcomes with a low incidence of adverse effects.

Brazilian literature lacks controlled studies specifically addressing the isolated use of the *Microcoring* mode across different skin types and aesthetic pathologies. Also, the absence of standardized protocols - regarding power, energy, density, pulse duration, stacking, or overlap may lead to variability in outcomes. Furthermore, the adoption of a commercial nomenclature *Microcoring* that is not formally recognized in international literature may compromise scientific consistency and limit integration with global databases.

Thus, the conduction of randomized and standardized clinical studies evaluating the superficial mode alone or in combination with the deep mode is strongly recommended. The validation of evidence-based protocols will enhance safety, efficacy, and reproducibility.

Finally, the regulation and standardization of technical and commercial terminology may facilitate greater uniformity and international scientific recognition of this modality.

Compliance with ethical standards

Disclosure of Conflict of interest

The authors declare no conflicts of interest.

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