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Role of Fractional Carbon Dioxide Laser in Treatment of Alopecia Areata: Review Article

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ABSTRACT

Background: The chronic inflammatory condition known as alopecia areata causes non-cicatricial hair loss. Ablative Fractional laser treatments as well as other laser therapies with various wave lengths have been used to treat AA.
Objective: The aim of the current review is to assess the efficacy and safety profile of fractional carbon dioxide (CO2) treatment in alopecia areata.
Development: CO2 lasers come in two varieties: nonfractionated and fractionated (both ablative and nonablative). In comparison to nonfractionated lasers, fractionated ablative and nonablative lasers offer a better safety profile. The two operating modes for this kind of laser are continuous and pulsed. Utilizing the continuous wave style consumes significantly more energy. Either a continuous wave or an intermittent wave can be selected for the pulse mode. The ultrapulsed mode, which has also enabled therapy with the greatest power, the least thermal damage, and hence the fewest side effects, is a final option.
Conclusion: Alopecia areata may respond well to treatment with fractional CO2 laser.
Keywords: Alopecia areata, fractional laser, fractional laser–assisted drug delivery, review, Zagazig University.

INTRODUCTION

The carbon dioxide laser was one of the earliest lasers to enter the market (CO2 laser). At Bell Labs in the US, Patel and colleagues created the CO2 laser in 1964. It was initially developed as a surgical laser due to its high-water absorption, but Professor Kaplan and his colleagues later looked into a variety of applications. The CO2 laser is extensively used in dermatology for both medicinal (such as the management of benign disorders like seborrheic keratosis) and cosmetic purposes. , warts, and skin nevi) and cosmetic (such as anti-aging) objectives (such as the correction of aesthetic flaws) objectives (ie, acne scars). In comparison to conventional therapy, the CO2 laser is more accurate, causes less bleeding and irritation, and promotes quicker recovery [(1)].

The CO2 laser has a wavelength of 10 600 nm. According to the principles of selective photothermolysis, the water that makes up more than 80% of the makeup of the skin is the specific chromophore that quickly absorbs the light that is emitted. Within 20 to 50 m of tissues, the CO2 laser's energy is practically completely absorbed, causing a fast heating that causes intracellular water to evaporate and causes the tissues to be destroyed [(2)].

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The two operating modes for this kind of laser are continuous and pulsed. Utilizing the continuous wave style consumes significantly more energy. Either a continuous wave or an intermittent wave can be selected for the pulse mode. The ultrapulsed mode, which has also enabled therapy with the greatest power, the least thermal damage, and hence the fewest side effects, is a final option [(2)].

1. Fractional photothermolysis

Fractional photothermolysis is a novel idea in skin laser therapy that aims to produce uniform thermal damage at a certain depth in the skin by inflicting small thermal wounds [(3)].

Comparatively to traditional ablative lasers, fractional lasers—both ablative and nonablative enable rapid healing since the intervening skin is left intact for the reparative process. The principle of fractional skin damage serves as the foundation for fractional laser therapy. reduced downtime, less side effects compared to standard ablative lasers, and more successful tissue regeneration compared to nonablative techniques are all advantages of this system [(4)].

2. Ablative Fractional Lasers (AFL)

The so-called microthermal zones (MTZs), created by the AFL, is minute columns of ablated tissue that run from the epidermis to the dermis while sparing the healthy tissue regions in between. The surrounding healthy skin cells encourage a process of rapid reepithelization in response to collagen degeneration and localised epidermic necrosis [(4)].

By reducing the side effects and difficulties that were previously expected because the classic ablative resurfacing did not employ to keep any healthy skin region, the AFL technology offers us a fresh perspective on facial resurfacing methods [(5)].

The Er:YAG (yttrium, aluminium, garnet) 2.940 nm and the recently developed Er: YSG (yttrium, sapphire, garnet) 2790 nm are additional ablative fractional laser types. Their object ives are the same, therefore the only differences are in the wavelength and water absorption

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coefficient. The amount of water in the tissue absorbs the emitting energy [6].

AFL is a safe and effective therapeutic option when taken properly, despite the possibility that side effects could be more severe than with NAFL. In contrast to NAFL, patients receiving treatment in AFL experience more pain and a longer downtime. Prolonged erythema, acneiform eruptions, milia development, Darker skin types almost often experience mild to moderate negative consequences, such as herpes simplex infection and postinflammatory hyperpigmentation (Fitzpatrick III-VI) [7].

3. Nonablative fractional Lasers (NAFLs)

This kind of laser employs water as the chromophore to coagulate several tissue columns that are separated by surrounding uncoagulated tissue, resulting in fractional photothermolysis. These coagulated tissue columns form what are referred to as microthermal zones, which pass through the epidermis and enter the deep dermis. Although the stratum corneum is continuous and physically intact, the epidermis has coagulated [8].

Because of the fractionated nature of the process, which includes 15–30% of the skin's surface area in each treatment session, healing is accomplished significantly more quickly.

The coagulated microthermal zones are surrounded by untreated tissue and a heat shock zone, which enables quick healing and remodelling of the treated portions. Greater patient tolerance and shorter downtime are both a result of the quicker healing time. Additionally, NAFL may have fewer negative side effects, such as erythema, edoema, discomfort, and post-inflammatory hyperpigmentation [9].

Numerous factors contribute to the lack of homogenous laser settings in clinical practise. Various laser practises among dermatologists may have an impact on the ultimate clinical outcomes, despite the fact that several clinical and histologic investigations have been published in the medical literature.

The quantity of laser passes provided, the amount of pulse or scan overlap, the extent to which partially dried tissue is removed completely or partially between each laser pass, preoperative planning, and after wound care, for instance, all affect clinical effect in addition to the laser parameters chosen [10]. A handpiece on the CO2 laser device beams tiny dots of light onto the skin. Depending on the model being used, the shot format (triangle, square, or round, for example), spot density, and spot diameter can all be adjusted. When employed in the standard mode, nonfractional, Having the lowest water absorption coefficient, it causes severe collateral thermal damage while maintaining perfect homeostasis [11].

Fractional carbon dioxide laser in treatment of alopecia areata

For years, it has been known that laser and light systems can be used to promote hair growth. There is only one report of fractional laser therapy being used successfully as a single treatment for AA [12]. It is assumed that the dermal heat generated by fractional laser therapy will promote hair regeneration. Fractional lasers function by delivering a topical steroid through the skin to the hair follicle via transepidermal medication delivery in addition to their direct therapeutic effect (TED). "Laser-assisted medication delivery" is a characteristic of fractional lasers that has been utilised to treat a number of dermatological disorders, including burn scars, skin cancers, and even inflammatory skin conditions like lichen planus. A novel idea in dermatological therapy is the fractional laser-assisted medication administration of corticosteroids for resistant AA [13].In a study of **Majid *et al.*** [14] about Fractional Carbon Dioxide Laser in Combination with Topical Corticosteroid Application in Resistant AA found that; Drugs can be delivered uniformly and under controlled conditions thanks to the channels created by MTZ production by fractional lasers. The channels are uniformly dispersed over the target area, which results in uniform drug deposition. By piercing the dermis up to 2-3 mm, the dermal papilla, which contains the capillaries that surround the hair germ cells, is where fractional lasers can deposit heat energy. According to some theories, fractional laser therapy causes T cells to die, boosts blood flow, and encourages telogen to anagen transitions. Fractional laser therapy was connected to an increase in the proportion of anagen hairs and hair regeneration in a mouse model study related to anagen induction attached to the Wnt/-catenin pathway. The synergistic effects of fractional laser and topical triamcinolone employed in this case series can be explained by the direct therapeutic effect of TED and fractional laser into the target hair follicles. These two systems might be in charge of encouraging hair growth in AA [14]. Numerous therapeutic indications have been treated with the TED technique using fractional lasers, including precancerous lesions, nonmelanoma skin malignancies, scars and keloids, dermatological illnesses, and aesthetic issues [15].

Triamcinolone can be given more evenly in the target area with this innovative technology using a fractional CO2 laser as TED system as opposed to a needle injection, which helps the therapeutic response. Additionally, using a fractional laser rather than numerous intradermal injection pricks would spare you the discomfort that comes with repeated injections. Reduced skin atrophy caused by topical triamcinolone is another potential benefit of employing fractional lasers. About 90% of the cases in this case series that were treated with a combination of CO2 fractional laser and topical triamcinolone showed a pretty strong therapeutic response [14].

CONCLUSION

By raising the skin's temperature, fractional laser therapy promotes the growth of new hair. Fractional lasers can be a successful therapy option for alopecia areata because they have both a direct and indirect therapeutic effect on the hair follicle.

DECLARATIONS

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