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STRIAE DISTENSAE: A LITERATURE REVIEW OF TREATMENT MODALITIES AND THEIR CLINICAL EFFICACY

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ABSTRACT

Background. Striae distensae, or stretch marks, are common linear dermal scars resulting from collagen and elastin disruption. They frequently affect women during puberty and pregnancy, as well as individuals experiencing rapid weight gain or endocrine disorders, and can substantially impair quality of life.
Aim. This review aimed to synthesize current literature on the pathophysiology, risk factors, and therapeutic options for striae distensae, with a focus on aesthetic medicine techniques such as laser therapies and microneedling.
Materials and Methods. Between March and June 2025, PubMed, PMC, and Google Scholar were systematically searched using the keywords "aesthetic medicine," "striae," "stretch marks," "laser therapy," and "microneedling." Studies reporting clinical efficacy, histological changes, and safety profiles were included.
Results. Topical agents (e.g., retinoids, Centella asiatica, and hyaluronic acid) produced modest improvements. Among aesthetic procedures, chemical peels, platelet rich plasma, microdermabrasion, carboxytherapy, and radiofrequency demonstrated variable success. Microneedling and fractional CO_2 laser treatments yielded the most pronounced results, especially in combination, achieving up to 60-70% improvement in early (striae rubrae) lesions. However, mature hypopigmented striae albae remained particularly resistant, with improvements typically below 30%. Adverse events-primarily transient erythema and post inflammatory hyperpigmentation-were more common in darker skin phototypes.
Conclusions. Complete elimination of stretch marks remains unachievable; nonetheless, combination based, individualized approaches can significantly enhance their appearance. There is a critical need for robust, large scale randomized trials employing standardized, objective assessments, long term follow up, and inclusion of diverse skin phototypes and patient reported outcomes to establish evidence based treatment protocols.

KEYWORDS

Striae, Stretch Marks, Aesthetic Medicine, Laser Therapy, Microneedling

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1. Introduction

Stretch marks are common and therapeutically challenging skin imperfections, presenting as linear lesions. Initially, they appear as reddish-purple striae (striae rubrae), elevated above the surface of the skin. This manifestation results from ruptured capillaries. As the condition progresses, the lesions become atrophic, taking on a color closer to the surrounding skin but appearing more hypopigmented, slightly shiny, and silvery-white in hue (striae albae). Microscopic examination of affected skin reveals significant thinning of the dermis, altered arrangement and reduced quantities of collagen, elastin, and blood vessels. These lesions resemble atrophic scars overlaid with an atrophic epidermis. Stretch marks are particularly prevalent in women and may be associated with both physical discomfort and psychological distress in affected individuals(Borrelli et al., 2021; Mustafa et al., 2025). Given their high incidence, there is ongoing research into novel treatment techniques. The aim of this paper is to review current literature on available therapeutic options, assess their effectiveness, and evaluate the safety of stretch mark treatments, especially within the context of aesthetic medicine.

2. Conditions Associated with Increased Risk of Stretch Marks

Stretch marks are frequently observed in pregnant women-affecting approximately 50-90% of this population-and during puberty, where they are noted in about 6-86% of adolescents. They also occur in 43% of individuals with obesity or rapid weight gain(Mendes et al., 2022). Genetic and ethnic predispositions significantly influence their development. Additionally, psychological factors may contribute to their appearance. Certain endocrine disorders are also linked to the formation of stretch marks. A primary example is Cushing's syndrome, which is characterized by excessive cortisol production and elevated levels in the bloodstream. In this condition, stretch marks exhibit a distinctive appearance that aids diagnosis-they tend to be broad, deep red, and typically localize on the abdomen, thighs, breasts, and upper arms. Similarly, prolonged use of exogenous glucocorticoids (both oral and topical) can lead to the formation of characteristic stretch marks. Clinical suspicion of hypercortisolism may arise not only from the presence of such stretch marks but also from associated features such as central obesity-manifesting as a "moon face" or "buffalo hump"-and muscle wasting in the limbs, leading to their slim(Lause et al., 2017). Stretch marks typically appear on the buttocks, thighs, abdomen, and breasts(Ud-Din et al., 2016).

3. Histological Features of Stretch Marks

In histopathological analysis of healthy skin, downward-extending epidermal projections (rete ridges) are visible, along with thin, randomly oriented collagen and elastin fibers in the papillary dermis. In contrast, the reticular dermis contains thick collagen bundles. In red stretch marks (striae rubrae), the dermis shows structural alterations in collagen, an abundance of thin elastin fibers in an edematous dermal matrix, and increased microvascularization, which contributes to their reddish appearance. In white stretch marks (striae albae), histology reveals epidermal atrophy with loss of rete ridges, densely packed collagen fibers aligned parallel to the dermoepidermal junction, similarly aligned elastin fibers, and reduced microcirculation, accounting for the white coloration of the lesions(Borrelli et al., 2021).

4. Prevention of Stretch Mark Formation

Numerous cosmetic products are available for home use to reduce the likelihood of developing these skin changes. A meta-analysis evaluated the effectiveness of several over-the-counter products in preventing stretch marks in pregnant women. The study assessed the use of Verum ointment, cocoa butter, and olive oil applied to the abdominal area. The results showed that Verum ointment was the most effective. It limited the incidence of stretch marks to 26% of users, compared to 62% in the placebo group. In the cocoa butter group, stretch marks appeared in 44% of users, versus 55% in the placebo group. Olive oil showed no statistically significant effect in preventing stretch marks compared to placebo(Ross et al., 2017). A larger meta-analysis of six randomized trials involving a total of 800 women also examined the preventive efficacy of these topical treatments. The findings indicated that their prophylactic effect was insufficient for reliably preventing stretch marks(Borrelli et al., 2021). Given the variability in outcomes across different studies, further research is necessary to determine which product, if any, is most effective in preventing the development of stretch marks.

5. Non-Aesthetic Medical Treatments for Stretch Marks

Once stretch marks have formed, patients often seek effective treatment options. A wide range of products is available on the market, each claiming to offer a solution to this common concern. In addition, therapeutic approaches involving aesthetic medicine are being explored. Among non-aesthetic options, various

topical strategies have been proposed, such as tretinoin, silicone gel, or formulations combining *Centella asiatica* with hyaluronic acid-known to improve collagen production and thereby enhance the appearance of stretch marks. Most methods aim to stimulate collagen synthesis and improve the pigmentation of lesions(Ross et al., 2017). However, results vary and monotherapy typically yields unsatisfactory outcomes. As a result, research increasingly focuses on combination therapies to maximize effectiveness. Treatment strategies described in the literature target multiple mechanisms involved in the pathology of stretch marks, including:

- Stimulating collagen production and fibroblast activity to improve tissue strength
- Reducing vascularization in red stretch marks (striae rubrae)
- Enhancing pigmentation in white stretch marks (striae albae)
- Diminishing skin laxity and wrinkle depth
- Improving skin elasticity and vascularization
- Promoting cellular proliferation
- Increasing skin hydration
- Exerting anti-inflammatory effects(Lokhande & Mysore, 2019).

Retinoids

Retinoids act primarily by increasing the concentration of transforming growth factor-beta (TGF-β), which may in turn enhance fibroblast activity in the extracellular matrix and boost collagen synthesis within the dermis. Theoretically, this can lead to reduced visibility of stretch marks(Ross et al., 2017). One randomized clinical trial involved the daily use of 0.1% tretinoin cream over six months. This study demonstrated a significant reduction in the length and width of stretch marks, with 80% of patients showing marked improvement in lesion appearance, compared to only 8% in the control group. However, despite these visible results, histopathological analysis did not reveal any significant changes in collagen or elastin content in the retinoid-treated group compared to controls(Kang, 1998).

Another randomized trial examined the effects of 0.025% tretinoin applied daily for seven months. In this case, three dermatologists independently assessed changes in tissue appearance after treatment. Two of the three were unable to identify any notable improvement, suggesting that if an effect occurred, it was minimal(Pribanich et al., 1994).

As these examples indicate, studies have investigated different concentrations of retinoids in treating stretch marks. The overall efficacy appears modest, and the limited number of high-quality publications highlights the need for further research - preferably with concurrent histological analysis of skin structure-to more accurately evaluate the therapeutic impact of retinoid use(Ross et al., 2017).

Silicone Gels

Silicone gels are commonly used in the treatment of scars(Ross et al., 2017). In a placebo-controlled study involving 20 volunteers, six weeks of silicone gel application resulted in increased type I collagen levels, improved skin elasticity, decreased melanin content, and reduced vascularity of treated lesions compared to placebo. However, further studies are required to determine whether the routine use of silicone gels for the treatment of stretch marks is justified(Ud-Din et al., 2013).

Subcision for Stretch Marks

Subcision has been explored as a surgical approach to reduce the visibility of stretch marks. This technique involves using a scalpel blade to sever fibrous attachments. Trials have demonstrated limited effectiveness. Additionally, the procedure carries risks, including scarring and, in some cases, reported necrosis in the treated area. This method is not recommended and is mentioned here to illustrate the extent of controversial attempts to address stretch mark-related skin defects(Ross et al., 2017).

Topical Use of Centella Asiatica and Hyaluronic Acid

Hyaluronic acid is well known for its moisture-retention properties, while *Centella asiatica* contains bioactive compounds that stimulate type I collagen production and support scar maturation. Although evidence is limited, one randomized trial assessed a topical cream combining both agents. The combination improved color, texture, and softness of the lesions. Due to scarce data, however, the overall efficacy in stretch mark therapy remains uncertain(Ross et al., 2017).

6. Aesthetic Medicine in the Treatment of Stretch Marks

Due to the limited efficacy of non-invasive methods, patients increasingly seek aesthetic procedures to treat stretch marks. Given the prevalence of this condition and its associated psychological impact, researchers continue to explore new techniques and therapeutic protocols in aesthetic medicine.

Chemical Peels

Chemical peels aim to exfoliate the epidermis and/or dermis in a controlled manner, regenerate the viable epidermal layers, and remodel the dermis(Ross et al., 2017). These procedures can cause irritation(Jaiswal & Jawade, 2024). A randomized trial evaluating six sessions of 70% glycolic acid applied to the thighs over six months found that the treatment significantly reduced stretch mark width and altered scar pigmentation. Specifically, it reduced redness in striae rubrae and increased melanin in striae albae(Mazzarello et al., 2012). Another study investigated the impact of up to eight applications of 50% trichloroacetic acid (TCA) peels, reporting a 60-75% improvement in lesion depth(Deprez, 2000).

Based on documented efficacy and relative safety the current recommendation includes the use of 70% glycolic acid and 35% TCA peels. Long-term effects beyond six months, however, require further investigation.

Platelet-Rich Plasma (PRP)

As the name suggests, PRP is plasma enriched with a high concentration of platelets, obtained by centrifuging whole blood. It stimulates collagen and elastin production and supports extracellular matrix remodeling. Studies have shown that PRP is more effective in treating white stretch marks than 0.05% retinoic acid, with over 85% of patients reporting improvement and satisfaction. It is associated with low risk of adverse effects and has demonstrated comparable efficacy to carboxytherapy for striae albae(Huang et al., 2022).

A comparative study between PRP (2 sessions at monthly intervals) and microneedling (4 sessions every 2 weeks) showed that both were effective with no statistically significant differences in stretch mark size or texture. Dermapen produced a statistically significant reduction in stretch mark width ($p < 0.001$). PRP was associated with greater pain, while Dermapen caused more erythema and hyperpigmentation(Mohamad et al., 2022). Although promising, current research on PRP for stretch marks remains limited and requires expansion.

Microdermabrasion

Microdermabrasion involves physical exfoliation using agents such as aluminum oxide or diamond-tipped heads. This technique removes the stratum corneum without affecting the dermis (unlike dermabrasion), enhancing skin texture, absorption capacity, and radiance. It also helps reduce fine lines, pigmentation, and pore size. The goal is to stimulate collagen and elastin production and promote skin regeneration(Ross et al., 2017).

A randomized trial with 68 patients showed that combining microdermabrasion with PRP produced superior results in a shorter time and with fewer sessions than either method alone. This combination improved the appearance of stretch marks and enhanced collagen and elastin production more effectively than monotherapy(Ibrahim et al., 2015). Another study indicated that microdermabrasion produced similar improvements to 0.05% tretinoin cream but was preferred by patients due to fewer side effects such as itching, peeling, and redness(Hexsel et al., 2014). Case series also support its efficacy. One involved five sessions using aluminum oxide and sodium chloride, resulting in a significant increase in type I collagen and clinical improvement in 50% of participants(Hexsel et al., 2014). Another case series showed up to 70% improvement after an average of 4.2 sessions, outperforming TCA peeling, which showed only a 15% improvement(M. A. Adatto & Deprez, 2003). These findings suggest that combining microdermabrasion with chemical peeling may yield better aesthetic outcomes. Nonetheless, data on microdermabrasion monotherapy remain limited, and further studies are needed to validate its effectiveness.

Carboxytherapy

Carboxytherapy is a procedure that involves injecting carbon dioxide (CO_2) into the skin and subcutaneous tissue. This technique utilizes the Bohr effect. Water molecules react with CO_2 to form carbonic acid, which lowers the pH of the surrounding tissues. The increased acidity facilitates the release of oxygen from hemoglobin, promotes vasodilation in the microcirculation, and enhances peripheral blood flow. Moreover, the mechanical effect of gas injection stretches the tissue, triggering a subclinical inflammatory response. This, in turn, activates macrophages, endothelial cells, and fibroblasts, leading to neovascularization and remodeling of the extracellular matrix.

Carboxytherapy is primarily used for skin revitalization. Its efficacy has also been demonstrated in the treatment of striae distensae (stretch marks)-improving skin elasticity, reducing the length and width of the lesions (visible results within one month of therapy), and unifying the coloration of the affected area with the surrounding healthy skin in nearly 80% of patients, resulting in a notable clinical improvement. The method appears to be more effective in treating red (early-stage) stretch marks than white (chronic) ones. Its effectiveness has been compared to that of fractional CO_2 laser therapy, with the advantage of avoiding post-inflammatory hyperpigmentation. Other studies have compared carboxytherapy to platelet-rich plasma (PRP), noting higher patient satisfaction with the former treatment. The most serious adverse event associated with carboxytherapy is hematoma formation, while more common side effects include bruising and temporary erythema at the injection site(Huang et al., 2022).

Microneedling

Microneedling, as the name suggests, involves the dense application of micro-punctures that penetrate the papillary dermis. This minimally invasive procedure induces a mild inflammatory response, which stimulates the production of collagen types I and III(Borrelli et al., 2021; Ross et al., 2017). The micro-injuries also cause minor vascular damage, releasing blood rich in growth factors, which further activates fibroblasts to produce collagen, elastin, and glycosaminoglycans. The resulting effects include improved skin firmness, accelerated regeneration, and enhanced microcirculation.

These effects make microneedling suitable for addressing wrinkles, skin laxity, atrophic scars, and acne scarring(Jaiswal & Jawade, 2024). It is also effective in the treatment of striae distensae(Jaiswal & Jawade, 2024; Mustafa et al., 2025; Ross et al., 2017). A key advantage of this method is its ability to rejuvenate skin while preserving the surrounding tissue. The treatment can be applied to nearly any area of the body, most commonly the face and neck. Due to its safety, efficacy, and broad applicability, microneedling is frequently chosen for various dermatological indications(Jaiswal & Jawade, 2024).

The formation of microchannels increases transdermal permeability, enhancing the absorption of topically applied substances such as vitamin serums or growth factors(Jaiswal & Jawade, 2024). Initially performed using dermal rollers, modern technologies now offer more sophisticated tools like automated pens and microneedling radiofrequency (RF) devices, which use thicker needles to deliver heat into deeper skin layers(Jaiswal & Jawade, 2024).

Studies have reported that patients perceive significant improvements in the appearance of stretch marks following microneedling. Compared to CO_2 laser treatment, in some studies greater patient satisfaction and superior clinical and histopathological outcomes have been observed(Khater et al., 2016). In a case series, even a single microneedling session was reported to improve skin texture and reduce laxity, while another series reported that three monthly sessions produced significant clinical improvement in 7 out of 16 patients(Park et al., 2012).

A meta-analysis assessing the efficacy, safety, and patient satisfaction with microneedling for treating striae distensae found that both dermarollers and fractional microneedling RF devices-which combine microneedling with bipolar RF-produced favorable outcomes. Across six randomized controlled trials, more than 70% of patients experienced noticeable improvement. Although the group treated with microneedling had a higher proportion of individuals rated as having “best improvement” compared to those treated with CO_2 lasers, the difference was not statistically significant. The results suggest that both methods are comparably effective. Additionally, no significant differences were found in patient satisfaction or reduction in striae width between the two methods. However, patients undergoing microneedling reported fewer incidents of hyperpigmentation. The highest satisfaction score - “satisfied” - was recorded in 38% of the microneedling group. This lower risk of pigmentation disorders may be attributed to the absence of thermal damage in microneedling. Still, these findings were not analyzed in the context of Fitzpatrick skin types, which could affect the outcomes since types III-V are more prone to hyperpigmentation(Mustafa et al., 2025).

Some evidence suggests that combining fractional microneedling RF with fractional CO_2 laser therapy yields better and faster results in treating white stretch marks than either technique alone(Borrelli et al., 2021). Observational studies also highlight the effectiveness of microneedling RF in treating both red and white striae across different anatomical areas and skin phototypes(Borrelli et al., 2021).

Combination therapies involving microneedling with PRP or topical agents like retinoids are also being explored(Jaiswal & Jawade, 2024). Home-use dermarollers are available, although concerns remain regarding sterility and the ability to control needle depth(Borrelli et al., 2021).

Post-treatment, redness may persist for several days. Mild edema or temporary pigmentation (especially in darker skin types) may also occur, typically resolving within a few weeks. Infection or allergic reactions are

possible, though rare. The procedure is usually preceded by topical anesthesia to minimize discomfort and followed by the application of soothing agents to aid healing and cool the skin(Jaiswal & Jawade, 2024).

While current literature supports the potential of microneedling in striae treatment, more objective studies are needed, as many existing analyses rely on subjective patient assessments. The absence of thermal damage-and consequently, the lower risk of complications such as pain, edema, and pigmentation-along with the low cost, quick healing, and suitability for large treatment areas make microneedling an attractive option(Borrelli et al., 2021).

Radiofrequency (RF)

Radiofrequency (RF) therapy utilizes electromagnetic waves to heat the deeper layers of the skin. This thermal effect causes contraction of collagen fibers and stimulates the production of collagen and elastin. As a result, RF enhances skin firmness and rejuvenation. It is also applied in body contouring, as well as in reducing scars and striae distensae(Borrelli et al., 2021). The treatment is non-ablative. Initially, monopolar RF systems were available. Nowadays, more advanced fractional RF devices enable targeted energy delivery to deeper layers with minimal epidermal disruption(Ross et al., 2017).

A 2022 prospective study evaluated the safety and efficacy of fractional RF for treating stretch marks. Patients underwent a minimum of four sessions spaced four weeks apart. Three-dimensional imaging of the treated areas revealed a 19.1% reduction in striae volume, 14.3% reduction in erythema, and 11.2% reduction in pigmentation after four months. No significant adverse events were reported, and patient satisfaction was high(M. Adatto, 2023).

Haishan et al. published a meta-analysis evaluating various treatment modalities for striae, identifying bipolar RF combined with topical tretinoin as yielding the most favorable outcomes and highest patient satisfaction than using each of these methods separately. Monotherapy with RF was slightly less effective, while tretinoin alone showed the least benefit(Lu et al., 2020). Similarly, combining microneedling RF with fractional CO_2 laser resulted in superior outcomes compared to either method used independently(Fatemi Naeini et al., 2016).

Another study combining monopolar RF and pulsed dye laser (PDL) reported minor reductions in striae width, with histological analysis revealing increased collagen in 66% and elastin in 100% of cases(SUH et al., 2007). Additional studies highlight promising results when combining RF with autologous PRP(Ross et al., 2017).

Importantly, RF appears safe for patients with higher Fitzpatrick skin types (IV and V), who are generally more prone to post-inflammatory pigmentation changes(Borrelli et al., 2021; Ross et al., 2017). Literature suggests minimal pigmentation alterations in these groups, making RF a suitable option. However, long-term data on RF treatment for striae distensae are lacking. Therefore, further research is required to determine its sustained effects and overall efficacy.

Incoherent Light Sources

Certain types of incoherent light sources are used in skin rejuvenation, the treatment of discolorations, and telangiectasia. They function via photobiomodulation and stimulation of collagen production in the dermis. However, repeated treatments are necessary to achieve a noticeable effect. Examples of such devices include infrared light devices, IPL (Intense Pulsed Light), and ultraviolet light-emitting devices(Ross et al., 2017). These will be briefly discussed in this subsection.

a. IPL (Intense Pulsed Light)

Three case series demonstrate IPL's effectiveness in reducing the length, width, and number of striae, improving skin elasticity, and histologically increasing both the amount and quality of collagen in affected skin. Additionally, reductions in erythema and pigmentation have been reported. Nevertheless, the limited number of available publications necessitates further research to evaluate the usefulness of this method in treating striae(Ross et al., 2017).

b. Infrared Light-Emitting Devices

A case series has been reported involving the use of infrared light-emitting devices for treating striae. The study was based on a series of four treatments performed every 15 days, using infrared light in the ranges of 800-1800 nm, 500-800 nm, and 600-1000 nm. 3D image evaluations showed an improvement in the appearance of striae. However, due to limited study availability and the lack of quantitative outcome assessment, this method cannot currently be considered a recommended therapeutic option(Trelles et al., 2008).

c. Ultraviolet Light Devices

Available data indicate temporary improvements in striae appearance following the use of ultraviolet (UVA and UVB) light. After treatment, 5 out of 9 patients (55%) experienced complete repigmentation of lesions at some point. However, this effect was temporary, with pigmentation returning to baseline shortly after therapy. Additionally, over 50% of patients developed post-inflammatory hyperpigmentation following treatment(Sadick et al., 2007).

Lasers

Lasers are widely utilized in the treatment of striae distensae (stretch marks). They are generally categorized into ablative and non-ablative types. Both categories have shown efficacy in treating stretch marks with better results after ablative lasers. Another classification divides lasers into full-field (which thermally ablate the entire skin surface) and fractional lasers (which target microscopic columns of skin while leaving surrounding areas intact, thus serving as a source of nutrients and promoting faster healing). Fractional lasers are more frequently selected due to their favorable safety profile and effective clinical results. The primary mechanism of laser therapy in this context is the stimulation of collagen synthesis via controlled thermal injury to the dermis(Borrelli et al., 2021).

Non-Ablative Lasers

Non-ablative lasers emit coherent and narrow-band wavelengths that generate heat without ablating the skin. This promotes collagen formation and subsequent tissue remodeling(Borrelli et al., 2021).

a. Xenon-Chloride (XeCl) 308 nm Excimer Laser

The excimer laser, typically used in treating depigmented lesions in vitiligo, psoriatic plaques, and hypopigmented scars, induces collagen and elastin production through micro-injury to the skin(Ross et al., 2017). A randomized controlled trial evaluated the efficacy of 308 nm XeCl excimer lasers in treating stretch marks. The study showed improved pigmentation after nine treatment sessions; however, the results were temporary, with pigmentation reverting to baseline within six months(Alexiades-Armenakas et al., 2004). This suggests that consistent use is necessary to maintain clinical benefits. Parameters that could ensure long-term results are still being explored. Moreover, the excimer laser is generally not effective in improving scar texture or reducing erythema(Ross et al., 2017).

b. Pulsed Dye Lasers (PDL) - 585 and 595 nm

Pulsed dye lasers at 585 and 595 nm stimulate the synthesis and reorganization of collagen and elastin, while also targeting hemoglobin in blood vessels. However, their efficacy is limited in treating striae albae. Observational studies indicate some benefit from using 585 nm PDL for stretch marks, but the treatment may paradoxically induce new striae or post-inflammatory hyperpigmentation. This risk is particularly relevant in individuals with darker skin types (Fitzpatrick types IV-VI), due to higher melanin absorption(Borrelli et al., 2021; Ross et al., 2017).

Case series using PDL have reported varied results. One study noted visible fading of lesions over six months(McDANIEL et al., 1996), while another demonstrated erythema and lesion size reduction after two sessions spaced six weeks apart. Conversely, some reports suggest a lack of efficacy in treating stretch marks. While PDL helps with erythema reduction and possibly collagen remodeling, its impact on scar architecture remains inconclusive, necessitating further clinical studies(Ross et al., 2017).

c. Long-Pulsed Nd:YAG (1064 nm)

A randomized trial evaluated the efficacy of long-pulsed Nd:YAG (1064 nm) and variable square pulse Er:YAG (2940 nm) lasers in both striae rubrae and albae. Both lasers achieved moderate improvement in red striae, but yielded only mild improvement in white striae(Gungor et al., 2014). A separate case series noted visible improvement in red striae after an average of 3.45 sessions, with 55% of patients and 40% of physicians rating the results as excellent(GOLDMAN et al., 2008). However, detailed treatment protocols and objective outcome measures are lacking, highlighting the need for further studies to validate the effectiveness of Nd:YAG lasers in both red and white stretch marks(Ross et al., 2017).

d. Diode Laser (1450 nm)

A controlled trial evaluated the use of a 1450 nm diode laser in stretch mark treatment over three sessions. The results were underwhelming, showing no significant improvement. Additionally, post-inflammatory hyperpigmentation occurred in 64% of patients(Borrelli et al., 2021).

e. Erbium:Glass Lasers (1410, 1450, 1540, and 1550 nm)

Various wavelengths of Er:Glass lasers have been evaluated. The 1550 nm wavelength is commonly used as a non-ablative option. Preclinical studies suggest its efficacy may be linked to modulation of metalloproteinase and interleukin expression, indicating its potential for skin rejuvenation and remodeling(Borrelli et al., 2021).

A randomized clinical study using a 1450 nm non-ablative continuous laser involved 11 patients treated at 4, 8, or 12 J/cm² energy levels over three sessions in 18 weeks. No significant improvement was observed at a two-month follow-up, and post-inflammatory hyperpigmentation was reported in 64% of subjects(Tay et al., 2006). Case series involving fractional Er:Glass lasers at 1410, 1540, and 1550 nm showed better results compared to 1450 nm, with the 1540 nm wavelength appearing most effective. Statistically insignificant yet favorable differences were noted after six treatment sessions at 3-6 week intervals(Ross et al., 2017; Wang et al., 2016). Studies suggest that 2-4 sessions may be needed to see improvement with the 1540 nm wavelength, whereas 3-8 sessions are required for 1550 nm. Further trials are required to identify the most effective wavelength and standardize treatment protocols(Ross et al., 2017).

Comparative studies have shown that 1500 nm non-ablative glass lasers are better tolerated than CO_2 lasers, with less pain, reduced post-treatment erythema, and lower risk of hyperpigmentation. Both Er:Glass and Nd:YAG 1064 nm lasers show similar efficacy in reducing striae density, but the lower cost of Er:Glass gives it an economic advantage(Borrelli et al., 2021).

f. Copper Bromide (CuBr) Laser - 577 nm

The 577 nm CuBr laser is not widely used clinically but has been studied in case series on 15 patients with histological evaluations. Complete improvement was reported in five patients, while 50-90% improvement was observed in ten patients(Longo et al., 2003).

Ablative Lasers

Ablative lasers act more aggressively than non-ablative ones, physically removing the epidermis and part of the dermis to stimulate collagen and elastin remodeling(Borrelli et al., 2021; Ross et al., 2017). Special caution is advised in individuals with darker skin types due to a significantly higher risk of post-inflammatory hyperpigmentation(Ross et al., 2017).

a. CO_2 Laser

The 10,600 nm CO_2 laser is currently the most commonly used ablative laser for stretch mark treatment(Borrelli et al., 2021). It delivers concentrated thermal energy to specific skin layers, sometimes causing controlled thermal injury(Jaiswal & Jawade, 2024; Ross et al., 2017). The fractional CO_2 laser (Fr CO_2, 10,064 nm) is especially popular for its ability to enhance collagen production and remodel the extracellular matrix by activating fibroblasts(Mustafa et al., 2025). CO_2 lasers have shown superior efficacy (72%) and higher patient satisfaction (58%) compared to other modalities(Lu et al., 2020).

A randomized controlled study of 22 patients compared outcomes after three treatments spaced four weeks apart using a 10,600 nm CO_2 laser (40-50 mJ, 75-100 spots/cm²) versus a non-ablative fractional Er:Glass laser (1550 nm, 50 mJ, 100 spots/cm²). The CO_2 laser showed a significantly greater reduction in stretch mark length and width(Yang & Lee, 2011). Other studies indicate enhanced outcomes when combining fractional CO_2 and pulsed dye lasers (PDL) compared to either modality alone(Borrelli et al., 2021).

Case series also support the effectiveness of CO_2 lasers. One series reported 58.4% of patients achieving 50-100% improvement, with 7.4% exceeding 75% improvement. Mild, transient post-inflammatory hyperpigmentation was noted in some cases(Lee et al., 2010; Ross et al., 2017). Another case series described the use of succinylated atelocollagen in conjunction with CO_2 laser, demonstrating further enhancement in appearance(Nouri et al., 1999; Ross et al., 2017).

A meta-analysis evaluated the efficacy, safety, and patient satisfaction of fractional CO_2 laser (Fr CO_2, 10,064 nm) across six RCTs. Over 70% of patients showed clinically significant improvement in dermatological assessment(Mustafa et al., 2025). While fewer patients achieved “maximum improvement”

compared to microneedling, the difference was not statistically significant. Both therapies had comparable clinical efficacy and patient satisfaction levels. The highest proportion (25%) of patients treated with CO_2 lasers fell into the "slightly satisfied" category. However, CO_2 lasers were associated with a significantly higher incidence of post-inflammatory hyperpigmentation, making microneedling a safer choice for Fitzpatrick skin types IV-V(Mustafa et al., 2025).

Further studies compared CO_2 laser results with chemical peels (glycolic acid), showing superior outcomes with laser therapy(Borrelli et al., 2021). Another RCT demonstrated better aesthetic improvement with five sessions of CO_2 laser over five months versus ten IPL sessions(Borrelli et al., 2021). Combining IPL and CO_2 laser has shown enhanced efficacy compared to CO_2 monotherapy(Naeini et al., 2014; Ross et al., 2017). A clinical trial on 20 patients found that both CO_2 laser and platelet-rich plasma injections improved white stretch marks. Only the CO_2 group showed histopathological improvement via increased fibronectin expression. Both methods had minimal adverse effects(Borrelli et al., 2021).

In conclusion, CO_2 lasers improve the appearance and structure of stretch marks, although risks such as edema, pain, erythema, hyperpigmentation, and infection must be considered(Borrelli et al., 2021). The majority of studies support CO_2 laser superiority over alternative therapies. However, microneedling remains a safer and often preferred option. Further research is necessary to refine laser parameters for optimal results while minimizing adverse effects.

Erbium:YAG Laser (Er:YAG) 2940 nm

Another type of ablative laser utilized in the treatment of striae is the Erbium:YAG (Er:YAG) laser. Similar to the CO_2 laser, it is employed for stretch mark therapy and shares associated risks such as post-inflammatory hyperpigmentation and a longer recovery period, factors that limit its use frequency(Borrelli et al., 2021). One study demonstrated that patients rated treatment outcomes with the Er:YAG laser more favorably compared to PDL(Gauglitz et al., 2014). It is effective in reducing the width of stretch marks, comparable to fractional microneedling radiofrequency. It also increases epidermal thickness; however, the magnitude of this improvement is statistically significantly lower than that achieved with FMR, as evaluated by optical coherence tomography (OCT)(Nada et al., 2021).

7. Fillers as a Potential Treatment for Striae?

A 2023 systematic review indicated that filler injections, whether as monotherapy or in combination therapies, may be effective in treating striae with minimal adverse effects. The most favorable method in terms of safety was the combination of calcium hydroxyapatite (CaHA) with microfocused ultrasound with visualization (MFU-V). Nevertheless, further research is necessary to determine the most effective filler material and to compare this treatment modality with other established techniques(Alsharif et al., 2023).

8. Emerging Techniques in Striae Management

New treatment strategies are being investigated to assess the efficacy and safety of combining topical beta-glucan with nanofractional radiofrequency. Nanofractional RF allows precise control over the pattern and density of heated skin zones using microneedle-like pins that deliver energy directly to the skin through fractional exposure. In a study involving patients with mature (white) striae, no adverse effects were observed. The most favorable results were achieved when beta-glucan was applied twice daily and combined with nanofractional RF therapy in three sessions spaced four weeks apart(Shu et al., 2023).

9. Comparison of Various Treatment Modalities

A study conducted in 2018 among female participants compared the efficacy of carboxytherapy using CO_2 injections, intradermal PRP injections, and tripolar radiofrequency in treating striae. All three methods demonstrated effectiveness in both clinical and histopathological assessments for both red and white striae, showing improvements in size and texture. No statistically significant differences were observed between groups in terms of objective outcomes. However, significantly higher patient satisfaction was noted following carboxytherapy (80%) and RF (93.33%) compared to PRP (53.33%). While satisfaction levels did not differ significantly between CO_2 and RF, PRP was associated with more frequent adverse effects such as pain and bruising, though these were generally well-tolerated. Additionally, there was no significant difference in the effectiveness of carboxytherapy and tripolar RF based on location or maturity of the striae. Notably, PRP was more beneficial when used on the torso for red striae, where it improved striae texture(Ahmed & Mostafa, 2019).

Another publication compared PRP with fractional CO_2 laser and radiofrequency (CO_2/RF), as well as a combination of both. All approaches were effective, albeit to varying degrees. The best outcomes were observed in the combination group (PRP + CO_2/RF), which uniquely demonstrated histopathological increases in collagen and decreases in elastin. In contrast, monotherapies led to a reduction in both collagen and elastin. Clinically, the combined therapy resulted in mild improvement in 44% of participants, moderate in 33%, and marked in 23%. The CO_2/RF group showed mild, moderate, and marked improvements in 22%, 55.5%, and 22.5% of patients, respectively. PRP monotherapy resulted in mild improvement in 22%, moderate in 55%, and significant improvement in only 23%(Sany et al., 2022).

A meta-analysis found no statistically significant differences in treatment outcomes or patient self-assessments between FMR and fractional CO_2 laser therapy. However, post-inflammatory hyperpigmentation occurred significantly more often following laser treatment(Aktoz & Yilmaz, 2024). Further studies comparing each modality individually and in combination, using patient and dermatologist assessments via the Visual Analog Scale (VAS), skin imaging, and ultrasound, revealed superior results with combination therapy. Dermatologists rated the combined approach at 6.1, versus both approaches separately: 4.3 for FMR and 5.1 for CO_2. Patients' assessments were even higher for the combined therapy (6.3) compared to 5.1 for FMR. The combination method also significantly increased dermal thickness and density on ultrasound but was associated with higher melanin and redness levels than FMR alone. These findings suggest that the most optimal treatment strategy may be a combination of fractional CO_2 laser and microneedling radiofrequency, keeping in mind the potential risk of hyperpigmentation(Seong et al., 2021).

Another study compared the clinical and histopathological results of 0.1% tretinoin cream versus a combined FMR and CO_2 laser protocol for treating white striae in patients with Fitzpatrick skin types IV and V. The combination technique led to universal post-inflammatory hyperpigmentation and a clinically significant reduction in striae size. Histopathological analysis showed a greater percentage change in collagen content post-treatment compared to tretinoin cream alone. Notably, two out of eleven patients using tretinoin cream experienced irritation(Listiawan et al., 2021).

10. Recommended Management Approach for Striae Distensae

When a patient presents with striae distensae, a thorough medical history must first be taken. This should include evaluation of potential underlying causes such as endocrine disorders (e.g., Cushing's syndrome), genetic conditions (e.g., Marfan syndrome), and possible drug-related factors (e.g., prolonged topical corticosteroid use, indinavir). It is also essential to ensure that the patient's expectations are realistic. Additional considerations include their occupation, clothing preferences, cost-to-benefit ratio, quality of life impact, and Fitzpatrick skin type classification. A clinical assessment should determine the type of striae present-whether erythematous or hypopigmented. In rare cases, histopathological analysis may be performed.

Depending on the maturity of the striae, Lokhande et al. recommend tailored treatment strategies. For erythematous striae, topical moisturizers and tretinoin are suggested, followed by vascular laser treatments such as pulsed dye laser (PDL), and subsequently fractional Er:YAG laser. Platelet-rich plasma can also be included. For patients with limited financial resources, dermarolling combined with microdermabrasion and PRP is a more economical alternative. In contrast, when treating striae albae, the initial approach should involve fractional Er:YAG or CO2 lasers, or excimer lasers. Microneedle radiofrequency and PRP are advised as adjunct therapies. If these options are unaffordable, the same regimen as used for erythematous striae may be applied, with the addition of chemical peels for enhanced results(Lokhande & Mysore, 2019).

Discussion

Striae distensae, though medically benign, pose a significant cosmetic and psychological burden for many individuals-particularly women. Their multifactorial etiology, involving mechanical stretching, hormonal imbalances, genetic predisposition, and altered dermal structure, makes prevention and treatment especially complex. Despite decades of research, there is still no universally effective therapy that consistently restores skin appearance to pre-lesional condition.

Topical agents such as tretinoin, Centella asiatica, and hyaluronic acid have demonstrated mild to moderate efficacy, particularly in early stages of striae formation. However, their impact is limited, and results often fall short of patient expectations. Aesthetic medicine has brought new possibilities, with procedures such as microneedling, platelet-rich plasma (PRP), fractional CO_2 laser therapy, and radiofrequency yielding promising outcomes. Studies indicate that combination therapies targeting both dermal remodeling and vascular components-such as fractional CO_2 laser with PRP or microneedling radiofrequency-tend to produce

superior results compared to monotherapy. Still, the cost, the need for multiple sessions, and the potential for adverse effects (including hyperpigmentation and prolonged erythema) remain notable challenges. These limitations are especially relevant for patients with darker skin types (Fitzpatrick IV-VI), who are at higher risk for pigmentary complications.

Moreover, most clinical studies suffer from methodological limitations. Many rely on subjective assessments by clinicians or patients, lack standard outcome measures, and often involve small sample sizes. This makes it difficult to compare results across different studies or to formulate evidence-based guidelines. Objective evaluation tools-such as high-resolution skin imaging and optical coherence tomography-are rarely used but could significantly enhance the quality of clinical data.

Another important aspect is the mismatch between patient expectations and realistic treatment outcomes. Since complete removal of striae is not currently achievable, clinicians must carefully manage expectations and tailor treatment plans to each individual's needs, striae maturity, skin type, and financial capacity.

Future research should focus on optimizing treatment protocols, exploring new technologies (e.g., nanofractional RF, novel fillers), and conducting large-scale randomized controlled trials with long-term follow-up. Development of standardized grading scales for striae severity and response to therapy would also improve the comparability and reproducibility of findings.

In summary, while aesthetic treatments for striae distensae have evolved considerably, there remains a pressing need for innovation, standardization, and personalization in therapeutic approaches. Multimodal strategies currently offer the best outcomes, but further scientific rigor is essential to validate and refine these interventions.

Conclusions

Striae distensae are a common dermatological concern, especially among young women, and can significantly impact self-esteem and quality of life. Although many preventive and therapeutic options exist, none guarantees complete resolution of lesions. White stretch marks (striae albae) are particularly resistant to treatment, whereas red ones (striae rubrae) tend to respond better.

Current evidence supports the use of combination therapies-such as fractional CO_2 lasers, microneedling, platelet-rich plasma (PRP), and radiofrequency-as the most effective strategies for visible improvement. However, these procedures often involve high costs, require multiple sessions, and carry the risk of side effects like post-inflammatory hyperpigmentation, especially in individuals with darker skin types.

Most available studies rely on subjective evaluations and lack standardization in treatment protocols and outcome assessment. Thus, there is a strong need for high-quality, objective clinical trials involving diverse populations and longer follow-up periods. When planning treatment, clinicians must consider the type and maturity of striae, patient skin phototype, aesthetic expectations, and willingness to accept downtime. Effective communication about realistic outcomes is crucial, as is a personalized approach to therapy selection.

Despite advances in aesthetic dermatology, stretch mark treatment remains challenging. Future research should aim to refine existing techniques, explore novel therapies, and develop standardized, evidence-based guidelines.

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