Striae Distensae: An Updated Evidence-Based Review of Medical and Procedural Management

Amany Nassar, Basma Hamed Ibrahim, Elsayed Mohamed Galal Khater

Dermatology, Venereology and Andrology Department, Faculty of Medicine, Zagazig University,
Corresponding Author: Basma Hamed Ibrahim

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Abstract

Background: Striae distensae (SD), commonly known as stretch marks, are frequent dermal lesions characterized by linear atrophy resulting from connective tissue damage. They commonly occur during pregnancy, puberty, rapid weight change, endocrinopathies, and prolonged corticosteroid exposure. Although benign, striae distensae are often associated with significant cosmetic concern and psychological distress, leading to a high demand for effective treatments. Historically, management outcomes have been inconsistent, reflecting incomplete understanding of pathophysiology and variable quality of clinical evidence. In recent years, advances in laser technologies, energy-based devices, and combination treatment protocols have expanded therapeutic options and renewed clinical interest.

Aim: This review aims to provide an updated, evidence-based overview of the medical and procedural management of striae distensae, integrating current understanding of pathophysiology with available therapeutic modalities. Emphasis is placed on differentiating management strategies according to disease stage (striae rubrae versus striae albae), evaluating the strength of clinical evidence, and highlighting practical considerations for individualized patient care.

Methods and Scope: A comprehensive review of the literature was conducted focusing on randomized controlled trials, systematic reviews, consensus guidelines, and well-designed observational studies evaluating topical agents, injectable therapies, laser and light-based treatments, radiofrequency, microneedling, and combination approaches. Both efficacy and safety profiles were considered, with attention to skin phototype and patient-reported outcomes.

Conclusion: The management of striae distensae remains challenging, with no universally curative therapy. Early intervention during the inflammatory stage offers better outcomes, particularly with topical retinoids and vascular-targeting lasers. In mature striae, fractional lasers, microneedling, and radiofrequency-based devices demonstrate modest but clinically meaningful improvements, especially when used in combination protocols. Current evidence supports a stage-based, multimodal treatment approach tailored to individual patient characteristics. However, heterogeneity in study design and outcome measures continues to limit definitive conclusions. Further high-quality, standardized clinical trials are required to establish optimal treatment algorithms and long-term efficacy.

Keywords: *Striae Distensae, Management, Updated*

Introduction

Striae distensae (SD), commonly known as stretch marks, are acquired dermal lesions characterized by linear atrophy of the skin resulting from connective tissue damage. Clinically, they initially present as erythematous or violaceous bands known as striae rubrae, which gradually evolve into hypopigmented, atrophic, and wrinkled lesions referred to as striae albae. These lesions typically involve areas subjected to mechanical stretching, including the abdomen, breasts, thighs, buttocks, and shoulders. Although striae distensae are medically benign, they are frequently associated with significant cosmetic concern and psychological distress, prompting many affected individuals to seek dermatologic care [1].

Histologically, striae distensae represent a form of dermal scarring rather than simple skin stretching. Microscopic examination reveals epidermal thinning with flattening of rete ridges, marked disruption of collagen bundles, and fragmentation and reduction of elastic fibers within the dermis. Ultrastructural studies have demonstrated decreased fibrillin microfibrils and altered elastin organization, supporting the concept that impaired extracellular matrix integrity plays a central role in lesion development. These structural changes closely resemble those observed in atrophic scars, reinforcing the classification of striae distensae as a specialized form of dermal atrophy [2].

The pathogenesis of striae distensae is multifactorial, involving mechanical, hormonal, and genetic influences. Mechanical stretching alone is insufficient to explain lesion formation, as not all individuals exposed to similar stress develop striae. Hormonal factors, particularly glucocorticoids, estrogens, and relaxin, are believed to impair fibroblast proliferation and collagen synthesis, thereby reducing dermal tensile strength. Genetic predisposition is supported by familial clustering and ethnic variability, although specific susceptibility genes remain incompletely defined [3].

Despite their high prevalence, the management of striae distensae remains challenging and often unsatisfactory. Numerous topical agents and procedural interventions have been proposed, yet most demonstrate variable efficacy with modest clinical improvement. Treatment outcomes depend heavily on lesion stage, anatomical location, skin phototype, and treatment modality. Furthermore, many published studies are limited by small sample sizes, lack of standardized outcome measures, and short follow-up durations, making direct comparison between therapies difficult [4].

Aim and Research Gap

The aim of this review is to provide an updated, evidence-based analysis of the current medical and procedural management options for striae distensae, with particular emphasis on stage-specific and combination treatment strategies. A critical appraisal of the existing literature is undertaken to identify therapies supported by the strongest evidence while highlighting limitations and unmet needs. The persistent lack of standardized assessment tools, long-term outcome data, and high-quality randomized controlled trials represents a significant research gap that must be addressed to establish optimized, reproducible treatment algorithms for clinical practice [5].

Pathophysiology of Striae Distensae

Striae distensae develop as a result of complex structural and functional alterations within the dermis, rather than simple overstretching of the skin. Early lesions are characterized by an inflammatory component with vascular dilation, which explains the erythematous or violaceous appearance of striae rubrae. During this stage, increased mast cell activity and dermal edema have been observed, suggesting an active inflammatory process that precedes irreversible connective tissue damage. This early inflammatory milieu represents a potential therapeutic window, during which interventions may yield more favorable outcomes [6].

At the cellular level, fibroblast dysfunction plays a central role in the development of striae distensae. Fibroblasts within affected skin demonstrate reduced proliferative capacity and impaired synthesis of collagen and elastin fibers. Studies have shown a decrease in type I collagen with relative preservation or increase of type III collagen, resulting in weaker and disorganized dermal architecture. These alterations compromise tensile strength and elasticity, predisposing the skin to tearing under mechanical stress [7].

Elastic fiber abnormalities are a hallmark of striae distensae and contribute significantly to their

irreversible nature. Ultrastructural analyses reveal fragmented, thinned, and sparsely distributed elastic fibers, along with a reduction in fibrillin-rich microfibrils. These changes disrupt the elastic recoil properties of the skin and closely resemble those seen in other forms of dermal atrophy. Once established, these elastic fiber defects are poorly reversible, which explains the limited efficacy of many therapeutic modalities in mature striae albae [8].

Hormonal influences are strongly implicated in the pathogenesis of striae distensae. Glucocorticoids, whether endogenous or exogenous, inhibit fibroblast activity, suppress collagen synthesis, and enhance collagen degradation by upregulating matrix metalloproteinases. Additionally, estrogens and relaxin may alter dermal ground substance and reduce skin tensile strength, particularly during pregnancy and puberty. These hormonal effects act synergistically with mechanical stretching to accelerate dermal breakdown [9].

Genetic susceptibility further modulates individual risk for developing striae distensae. Familial clustering, ethnic variability, and differential prevalence among individuals exposed to similar mechanical and hormonal conditions suggest an inherited component. Polymorphisms affecting connective tissue metabolism, hormonal receptors, or extracellular matrix regulation have been proposed, although definitive genetic markers remain elusive. Understanding these genetic contributions may ultimately guide personalized prevention and treatment strategies [10].

Clinical Classification and Natural History of Striae Distensae

Clinically, striae distensae are broadly classified according to their stage of evolution into striae rubrae and striae albae. Striae rubrae represent the early inflammatory phase and are characterized by erythematous to violaceous linear lesions that may be slightly raised and occasionally pruritic. The coloration reflects underlying vascular dilation and increased blood flow within the dermis. At this stage, the epidermis remains relatively preserved, and the dermal changes, although active, are potentially more responsive to therapeutic intervention, making early diagnosis clinically significant [11].

As striae distensae mature, they progress into striae albae, which represent the chronic, atrophic stage of the disease. Striae albae appear as hypopigmented or pearly-white, depressed, and wrinkled bands with a cigarette-paper–like texture. Histologically, this stage is marked by epidermal thinning, loss of rete ridges, dense collagen realignment, and severe elastic fiber disruption. The absence of inflammation and vascularity at this stage explains the reduced responsiveness of striae albae to most treatment modalities [12].

Intermediate and variant forms of striae have also been described, reflecting gradual transition rather than an abrupt stage change. In some individuals, lesions may display mixed features, with residual erythema or hyperpigmentation persisting alongside atrophic changes. In darker skin phototypes, striae may appear hyperpigmented or hypopigmented rather than erythematous, which can obscure early recognition of the rubra stage. These variations underscore the importance of individualized clinical assessment rather than strict reliance on color alone [13].

The natural history of striae distensae is generally one of permanence, with spontaneous regression being uncommon. While striae rubrae may gradually fade in color over months to years, complete resolution rarely occurs, and most lesions eventually evolve into striae albae. Factors such as ongoing mechanical stress, hormonal exposure, and genetic predisposition influence both progression and severity. Importantly, once mature atrophy is established, structural restoration of normal dermal architecture remains largely unattainable with current therapies [14].

Understanding the clinical classification and natural course of striae distensae is essential for realistic patient counseling and therapeutic planning. Early-stage lesions should be identified promptly, as interventions initiated during the rubra phase are associated with superior outcomes compared to treatment of mature striae. This stage-based framework provides the foundation for selecting appropriate medical and procedural management strategies, which are discussed in subsequent sections [15].

Medical (Topical and Injectable) Management of Striae Distensae

Topical therapies remain the most commonly prescribed first-line treatments for striae distensae, particularly during the early inflammatory stage. Among these, topical retinoids have been the most extensively studied and are supported by moderate clinical evidence. Tretinoin stimulates fibroblast

proliferation, enhances collagen synthesis, and promotes epidermal turnover, leading to partial improvement in striae rubrae. Clinical trials have demonstrated reduction in lesion length and width with regular use; however, efficacy is limited in mature striae albae, and treatment is frequently associated with irritation, erythema, and scaling, limiting patient adherence [16].

Various topical formulations containing hyaluronic acid, centella asiatica extract, silicone gels, and vitamin C have been marketed for the prevention and treatment of striae distensae. These agents are believed to improve hydration, support dermal repair, and enhance collagen production. While some studies suggest mild improvement in skin texture and elasticity, the overall quality of evidence remains low, with many trials lacking proper controls or objective outcome measures. Consequently, these agents may be considered adjunctive therapies rather than definitive treatment options [17].

Topical corticosteroids are contraindicated in the management of striae distensae, as prolonged use is a well-established causative factor in lesion development. Corticosteroids suppress fibroblast activity and collagen synthesis, exacerbating dermal atrophy and promoting irreversible structural damage. Patient education regarding appropriate steroid use, particularly in intertriginous and cosmetically sensitive areas, is essential for prevention and avoidance of iatrogenic striae [18].

Injectable therapies have gained attention as minimally invasive options for striae distensae, particularly in combination treatment protocols. Platelet-rich plasma (PRP) has been proposed to enhance dermal remodeling through the release of growth factors that stimulate fibroblast proliferation and angiogenesis. Preliminary studies suggest modest improvement in skin texture and elasticity, especially when PRP is combined with microneedling or laser therapy. However, heterogeneity in preparation methods and treatment protocols limits definitive conclusions regarding its standalone efficacy [19].

Mesotherapy using compounds such as hyaluronic acid, vitamins, amino acids, and growth factors has also been explored in the treatment of striae distensae. The proposed mechanism involves stimulation of dermal regeneration and improved hydration through intradermal delivery. While some uncontrolled studies report subjective improvement, robust randomized controlled trials are lacking, and current evidence does not support routine use of mesotherapy as monotherapy. Further standardized studies are required to establish its role in evidence-based management [20].

Laser and Light-Based Therapies in Striae Distensae

Laser and light-based therapies represent a major advancement in the management of striae distensae, particularly for patients seeking procedural intervention after failure of topical treatments. The therapeutic rationale is based on selective photothermolysis and controlled dermal injury, which stimulate neocollagenesis and dermal remodeling. Treatment response is highly dependent on lesion stage, wavelength selection, energy parameters, and skin phototype, making careful patient selection essential for optimal outcomes [21].

Vascular lasers, particularly pulsed dye laser (PDL), have demonstrated the greatest efficacy in early-stage striae rubrae. By targeting oxyhemoglobin, PDL reduces erythema through vascular photocoagulation while simultaneously inducing collagen remodeling. Clinical studies have shown significant improvement in color and modest improvement in texture when treatment is initiated during the inflammatory phase. However, PDL is less effective for mature striae albae and may be associated with transient purpura and post-inflammatory pigmentary changes, especially in darker skin phototypes [22].

Fractional non-ablative lasers, such as 1540-nm and 1550-nm erbium-doped fiber lasers, have been widely studied for striae distensae. These devices create microscopic zones of thermal injury within the dermis while sparing the epidermis, promoting collagen synthesis with minimal downtime. Non-ablative fractional lasers have demonstrated modest but consistent improvement in both striae rubrae and albae, with favorable safety profiles. Multiple treatment sessions are typically required, and results are gradual rather than dramatic [23].

Ablative fractional lasers, including fractional carbon dioxide (CO_2) and erbium:YAG lasers, produce more pronounced dermal remodeling by creating vertical columns of ablation and coagulation. These devices have shown superior improvement in skin texture, atrophy, and overall appearance of mature striae albae compared with non-ablative modalities. However, the increased efficacy is balanced by longer

downtime, higher risk of adverse effects, and greater technical demand, particularly in patients with darker skin types where post-inflammatory hyperpigmentation remains a concern [24].

Other light-based modalities, such as intense pulsed light (IPL) and excimer laser therapy, have been investigated with variable success. IPL may improve pigmentation and erythema in selected cases, but its lack of specificity limits consistent dermal remodeling. Overall, laser and light-based therapies are best utilized as part of a multimodal, stage-based approach rather than as standalone treatments. Ongoing refinement of protocols and combination strategies continues to shape their role in evidence-based management [25].

Radiofrequency and Microneedling-Based Therapies

Radiofrequency (RF) and microneedling-based treatments have emerged as valuable modalities for the management of striae distensae, particularly in patients with mature striae albae and those with darker skin phototypes. These technologies induce controlled dermal injury through thermal or mechanical stimulation, promoting collagen denaturation, fibroblast activation, and subsequent neocollagenesis without relying on chromophore-specific targets. Their relative safety across a wide range of skin types has contributed to increasing clinical adoption [26].

Non-ablative radiofrequency devices deliver heat to the dermis, leading to immediate collagen contraction and delayed remodeling through fibroblast stimulation. Clinical studies have reported improvement in skin laxity, texture, and atrophy associated with striae distensae following multiple RF treatment sessions. While improvements are generally modest, RF therapy offers the advantages of minimal downtime and low risk of pigmentary complications, making it suitable for patients seeking gradual improvement with minimal interruption to daily activities [27].

Fractional microneedle radiofrequency (MNRF) combines mechanical microneedling with targeted RF energy delivery directly into the dermis. This approach allows for precise thermal injury at adjustable depths, enhancing collagen and elastin regeneration while sparing the epidermis. Evidence suggests that MNRF may provide superior improvement in striae albae compared with microneedling alone, particularly in terms of texture and depth reduction. Treatment-related adverse effects are typically mild and transient, including erythema and edema [28].

Microneedling without energy delivery, also known as percutaneous collagen induction therapy, has been utilized as a low-cost, minimally invasive option for striae distensae. By creating microchannels in the skin, microneedling stimulates wound healing pathways and collagen production. Clinical trials have demonstrated moderate improvement in lesion appearance, especially when combined with topical agents such as platelet-rich plasma or retinoids. However, results are operator-dependent and require multiple sessions to achieve visible improvement [29].

Overall, radiofrequency and microneedling-based therapies are most effective when incorporated into combination treatment protocols tailored to lesion stage and patient characteristics. While these modalities do not restore normal dermal architecture, they offer meaningful aesthetic improvement with favorable safety profiles. Continued research is needed to standardize treatment parameters and establish long-term efficacy in diverse patient populations [30].

Combination Therapies and Multimodal Treatment Strategies

The recognition that striae distensae represent a multifactorial dermal disorder has led to increasing interest in combination and multimodal treatment approaches. Monotherapy often yields limited improvement, particularly in mature lesions, whereas combining medical and procedural modalities can target multiple pathogenic mechanisms simultaneously. Combination strategies aim to enhance dermal remodeling, improve texture and pigmentation, and maximize clinical outcomes while minimizing treatment-related adverse effects [31].

One of the most commonly employed combination approaches involves fractional laser therapy combined with adjunctive topical or injectable agents. Fractional lasers create microthermal zones that enhance transdermal delivery of topical agents such as retinoids, hyaluronic acid, or growth factor–containing formulations. This synergistic effect may amplify collagen synthesis and accelerate tissue repair. Clinical studies suggest that such combinations result in greater improvement compared with laser treatment alone,

although standardized protocols remain lacking [32].

The combination of microneedling with platelet-rich plasma (PRP) has gained popularity due to its theoretical regenerative benefits. Microneedling induces controlled dermal injury, while PRP supplies autologous growth factors that promote angiogenesis and fibroblast activity. Several studies report improved skin texture, elasticity, and patient satisfaction with this combination, particularly in striae albae. However, variability in PRP preparation methods and outcome assessment limits direct comparison across studies [33].

Radiofrequency-based therapies are frequently combined with microneedling or laser modalities to enhance dermal remodeling. Fractional microneedle radiofrequency followed by non-ablative fractional laser treatment has been proposed as a sequential approach to address both dermal depth and surface texture. Early evidence indicates additive benefits with acceptable safety profiles, especially in patients with darker skin phototypes who are at higher risk for pigmentary complications from ablative lasers [34].

Despite promising outcomes, combination therapies present challenges related to cost, treatment burden, and lack of consensus on optimal sequencing and intervals. Current evidence supports an individualized, stage-based approach rather than a uniform protocol. High-quality randomized controlled trials comparing combination regimens with monotherapies are needed to define best practices and establish evidence-based algorithms for the management of striae distensae [35].

Special Considerations: Skin Phototype, Pregnancy, and Safety

Skin phototype is a critical factor influencing both treatment selection and risk of adverse effects in patients with striae distensae. Individuals with darker skin phototypes (Fitzpatrick IV–VI) are at increased risk of post-inflammatory hyperpigmentation and dyschromia following energy-based procedures, particularly ablative lasers. Consequently, non-ablative fractional lasers, radiofrequency-based devices, and microneedling techniques are generally preferred in this population due to their lower chromophore dependence and favorable safety profiles. Careful parameter selection, test spots, and appropriate post-procedure photoprotection are essential to minimize complications and optimize outcomes [36].

Pregnancy represents a unique clinical scenario in which both prevention and treatment of striae distensae require special consideration. While numerous topical agents are marketed for prevention during pregnancy, robust evidence supporting their efficacy remains limited. Importantly, topical retinoids and most procedural interventions are contraindicated during pregnancy due to potential teratogenicity or lack of safety data. Management during this period should focus on patient education, reassurance, and postponement of active treatment until the postpartum period, when a wider range of therapeutic options becomes available [37].

Safety considerations are paramount when selecting treatment modalities for striae distensae, as most interventions offer cosmetic rather than medical benefit. Common adverse effects associated with topical therapies include irritation, erythema, and contact dermatitis, which may limit adherence. Procedural treatments may result in transient erythema, edema, purpura, or crusting, with more serious complications such as scarring or pigmentary alteration occurring infrequently when procedures are performed by experienced clinicians using appropriate protocols [38].

Patient expectations and psychological factors must also be addressed as part of comprehensive management. Unrealistic expectations regarding complete resolution of striae distensae can lead to dissatisfaction despite objective improvement. Clear counseling regarding achievable outcomes, need for multiple sessions, and the likelihood of partial rather than complete improvement is essential. Incorporating patient-reported outcome measures into clinical assessment can enhance satisfaction and guide shared decision-making [39].

Overall, individualized treatment planning that accounts for skin phototype, physiological status, safety considerations, and patient expectations is critical to successful management of striae distensae. Adherence to evidence-based practices and cautious application of emerging technologies will help balance efficacy with safety in diverse patient populations [40].

Future Directions, Limitations of Current Evidence, and Conclusion

Despite significant advances in procedural dermatology, the management of striae distensae continues to

be limited by incomplete understanding of disease mechanisms and inconsistent clinical outcomes. One of the major limitations of current evidence is the heterogeneity of published studies, with wide variability in patient selection, lesion stage, treatment protocols, outcome measures, and follow-up duration. The lack of standardized, validated scoring systems for assessing striae severity and treatment response further complicates comparison between studies and weakens the strength of clinical recommendations [41].

Emerging research is increasingly focused on regenerative and biologic approaches aimed at restoring dermal architecture rather than simply improving surface appearance. Novel strategies under investigation include stem cell–based therapies, exosome-rich formulations, and advanced bioactive compounds designed to enhance fibroblast function and extracellular matrix synthesis. While preliminary data are promising, these modalities remain largely experimental, and robust clinical trials are required before they can be integrated into routine clinical practice [42].

Another important future direction is the development of standardized, stage-based treatment algorithms that incorporate lesion age, skin phototype, anatomical site, and patient-specific risk factors. Personalized treatment planning supported by objective assessment tools and patient-reported outcome measures may improve both clinical efficacy and patient satisfaction. Additionally, long-term follow-up studies are needed to evaluate the durability of treatment responses and the potential need for maintenance therapy [43].

From a clinical perspective, prevention remains an area of unmet need. Although numerous topical agents are widely used for prophylaxis, particularly during pregnancy, high-quality evidence supporting their effectiveness is limited. Improved understanding of genetic susceptibility and molecular pathways involved in dermal resilience may eventually enable targeted preventive strategies for high-risk individuals. Until such data are available, patient education and realistic counseling remain central to management [44,45].

Conclusion

Striae distensae are common, multifactorial dermal lesions that pose a persistent therapeutic challenge in dermatologic practice. Current evidence supports a stage-based, multimodal management approach, with early intervention offering superior outcomes compared with treatment of mature lesions. Topical retinoids and vascular lasers are most effective in early striae rubrae, while fractional lasers, radiofrequency, microneedling, and combination therapies provide modest but meaningful improvement in striae albae. No single therapy achieves complete resolution, underscoring the importance of individualized treatment planning and realistic patient expectations. Future research focusing on standardized outcome measures, regenerative therapies, and long-term efficacy is essential to advancing evidence-based management of striae distensae

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