

Striae distensae: What's new at the horizon?

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Abstract

Striae distensae, commonly known as stretch marks, are benign skin lesions associated with considerable cosmetic morbidity. Despite considerable investigations into their origins, the pathogenesis of striae distensae remains unknown. Currently, there is no treatment which consistently improves the appearance of striae. With a high incidence and unsatisfactory treatments, stretch marks remain an important target of research for an optimum consensus of treatment. The aim of present article is to appraise the readers with various newer treatment options in the management of this difficult condition.

Keywords: Striae distensae, stretch marks, cosmetic

Introduction

Striae distensae, or stretch marks, are linear scars in the dermis which arise from rapid stretching of the skin over weakened connective tissue. It is a common skin condition that rarely causes any significant medical problems but is often a significant source of distress to those affected. Striae distensae were described as a clinical entity hundreds of years ago, and the first histological descriptions appeared in the medical literature in 1889.¹ With a high incidence and unsatisfactory treatments, stretch marks remain an important target of research for an optimum consensus of treatment. These appear initially as red, and later, as white lines on the skin, representing scars of the dermis, and are characterized by linear bundles of collagen lying parallel to the surface of the skin, as well as eventual loss of collagen and elastin. The estimated prevalence of striae distensae range from 50 to 80%.^{2,3} The anatomical sites affected vary, with areas commonly affected including the abdomen, breasts, thighs and buttocks.⁴ The three maturation stages of striae include the acute stage (striae rubra) characterized by raised, erythematous striae, the sub-acute stage characterized by purpuric striae, and the chronic stage (striae alba), characterized by white or hypo-pigmented, atrophied striae.⁵ Although stretch marks are only harmful in extreme cases, even mild stretch marks can cause distress to the bearer⁶ (Table 1).

Aetiology

Striae may result from a number of causes, including, but not limited to, rapid changes in weight, adolescent growth spurts, corticosteroid use or Cushing Syndrome, and generally appear on the buttocks, thighs, knees, calves, or lumbosacral area.⁷ In addition, approximately 90% of all pregnant women develop stretch marks either on their breasts and/or abdomen by the third trimester.⁸ Genetic predisposition is also presumed, since striae distensae have been reported in monozygotic

twins.^{9,10} There is decreased expression of collagen and fibronectin genes in affected tissue.¹¹ The role of genetic factors is further emphasised by the fact that they are common in inherited defects of connective tissue, as in Marfan's syndrome.^{12,13} Obesity and rapid increase or decrease in weight have been shown to be associated with the development of SD.¹⁴ Young male weight lifters develop striae on their shoulders.¹⁵ Striae distensae also occurs in cachetic states, such as tuberculosis, typhoid and after intense slimming diets.¹⁶ Rare etiologies include human immunodeficiency virus positive patients receiving the protease inhibitor indinavir and chronic liver disease.^{13,15} A case of idiopathic striae was also reported.¹⁷

Rosenthal¹⁸ proposed four aetiological mechanisms of striae formation: insufficient development of tegument, including elastic properties deficiency; rapid stretching of the skin; endocrinal changes; and other causes, possibly toxic.

Pathogenesis

The pathogenesis of striae is unknown but probably relates to changes in the components of extracellular matrix, including fibrillin, elastin and collagen.¹⁹ There has been emphasis on the effects of skin stretching in the pathogenesis of striae because the lesions are perpendicular to the direction of skin tension.²⁰ A possible role of glucocorticoids in the pathogenesis of striae has been suggested because of an increase in the levels of steroid hormones and other metabolites found in patients exhibiting striae.²¹ There are studies suggesting the role of fibroblasts in the pathogenesis of striae. Compared to normal fibroblasts, expression of fibronectin and both type I and type III procollagen were found to be significantly reduced in fibroblasts from striae, suggesting that there exists a fundamental aberration of fibroblast metabolism in striae distensae.²²

Table 1: Histological comparisons between striae rubrae and striae albae

Epidermis	Oedema Increased melanocytes	Epidermal atrophy Loss of rete ridges Decreased melanocytes
Papillary dermis	Dilatation of blood vessels	No vascular reaction
Reticular dermis	Structural alteration of collagen fibres Reduced and reorganized elastic fibres Fine elastic fibres in dermis	Densely packed collagen parallel to skin surface. Thick elastic fibres in dermis
Inflammatory cells	Lymphocytes and fibroblasts	Eosinophils

Table 2: Visual scoring systems for the assessment of striae distensae

Davey method	Used for evaluating striae rubrae and albae. Divide the abdomen into quadrants using midline vertical and horizontal lines. Each quadrant given a score (0 no SD; 1 moderate number of SD; 2 many SD). Score given out of 8.
Atwal score	Used for evaluating striae rubrae and albae. Six sites chosen (abdomen, hips, breasts, thigh/buttocks). Each site given a maximum score of six. Total score out of 24. Score 0–3 for the presence of striae (0 no SD; 1 < 5 SD; 2 5–10 SD; 3 > 10 SD). Score 0–3 for the presence of erythema (0 no erythema; 1 light red/pink; 2 dark red; 3 purple).

Pathological aspects

The earliest pathological changes are subclinical to be detected by electron microscopy only. These changes include mast cell degranulation and the presence of activated macrophages in association with mid-dermal elastolysis.²³ When the lesions become clinically visible, collagen bundles start showing structural alterations, fibroblasts become prominent, and mast cells are absent.²³ On light microscopic examination, inflammatory changes are conspicuous in the early stage, with dermal oedema and perivascular lymphocytic cuffing.²⁴ In later stages, there is epidermal atrophy, loss of rete ridges and other appendages including hair follicles are absent.²⁵

Evaluation of striae distensae

Approaches to evaluating SD severity visually include the Davey²⁶ and Atwal scores,²⁷ although these have not been validated specifically for SD. An objective evaluation of SD may be carried out using skin topography, imaging devices including three-dimensional (3D) cameras, reflectance confocal microscopy and epiluminescence colorimetry.^{28,29,30}

Management

Striae distensae (striae alba) is a very challenging cosmetic problem for dermatologists to treat. Various modalities of treatment have been tried. Although therapeutic strategies are numerous, there is no treatment which consistently improves the appearance of striae and is safe for all skin types.³¹ Weight loss by diet alone or a combination of diet and exercise do not change the degree of striae distensae.³²

Topical treatments

Topical tretinoin (0.1%) ameliorates striae and the improvement may persist for almost a year after discontinuation of

therapy.³³ More recently, tretinoin has been shown to improve the clinical appearance of stretch marks during the active stage (striae rubra), although with not much effect during the mature stage (striae alba).³⁴ Some of the studies have proven the inefficacy of the vitamin A derivative in the treatment of SD, but most of the patients included in these early studies presented with old lesions that had evolved into whitish atrophic scars.³⁵ A study comparing topical 20% glycolic acid and 0.05% tretinoin versus 20% glycolic acid and 10% L-ascorbic acid, found that both regimens improved the appearance of striae alba.³⁶

Hydrant Creams: 1) Trofolastin (a cream containing Centella asiatica extract, vitamin E, and collagen-elastin hydrolysates). The exact mechanism of action was identified as the stimulation of fibroblastic activity³⁷ and an antagonistic effect against glucocorticoids.³⁸ 2) Verum (a cream containing vitamin E, panthenol, hyaluronic acid, elastin and menthol). The results suggest that the product may show the benefit of massage alone.³⁹ 3) Alphastrin (a cream composed of hyaluronic acid, allantoin, vitamin A, vitamin E, and dexpanthenol). Only one study was conducted, which concluded that the product markedly lowered the incidence of stretch mark development after pregnancy.⁴⁰

Glycolic acid (GA): The exact mechanism of action of GA in the management of striae distensae is still unknown because, although GA is reported to stimulate collagen production by fibroblasts and to increase their proliferation in vivo and in vitro, which may be useful for the treatment of stretch marks.^{41,42} A study comparing topical 20% glycolic acid and 0.05% tretinoin versus 20% glycolic acid and 10% L-ascorbic acid, found that both regimens improved the appearance of striae alba.⁴³

Trichloroacetic acid (TCA; 10–35%): It has been used for many years as a treatment option for striae distensae and is repeated at monthly intervals with reported improvement in texture and color of marks.⁴⁴

Other topical products: Several oils have been used in the prevention of SD. A non-randomized, comparative study investigated the effect of almond oil in the prevention of SD in which they noted significant differences in the frequency of SD between the groups (almond oil and massage 20%, almond oil alone 38.8%, control 41.2%).⁴⁵

Overall, there is limited evidence for the efficacy of topical therapy for the treatment of SD.

Microdermabrasion

Microdermabrasion may improve many skin problems including acne scars, skin texture irregularities, mottled pigmentation and fine wrinkles. Karimipour et al reported that microdermabrasion induces epidermal signal transduction pathways associated with remodelling of the dermal matrix.⁴⁶ However, studies documenting the efficacy of microdermabrasion in treatment of striae are lacking. Published in 1999, a book on microdermabrasion written by a French dermatologist, Francois Mahuzier, and translated to English, has a chapter "Microdermabrasion of stretch marks".⁴⁷ The author states that 10-20 sessions of microdermabrasion at an interval of not less than 1 month, each session resulting in bleeding points, provide satisfactory results. The author concludes that, "microdermabrasion is the only effective treatment of stretch marks today."

Lasers

Lasers have recently become a popular therapeutic alternative to ameliorate and improve the appearance of stretch marks. Most commonly used lasers used include pulsed-dye laser (PDL), short-pulse carbon dioxide and erbium-substituted yttrium aluminium garnet (YAG), neodymium-doped YAG (Nd:YAG), diode, and Fraxel.

Pulsed dye laser: The dilated blood vessels render the striae rubrae a good candidate for PDL.⁴⁸ The 585-nm pulsed dye laser has a moderate beneficial effect in the treatment of striae rubra.⁴⁹ To evaluate the effectiveness of the 585-nm flashlamp-pumped pulse dye laser in treating cutaneous striae, 39 striae were treated with four treatment protocols.⁵⁰ Subjectively, striae appeared to return toward the appearance of normal skin with all protocols. Objectively, shadow profilometry revealed that all treatment protocols reduced skin shadowing in striae. Laser treatment of SD should be avoided or used with great caution in darker skin types (IV–VI), because of the possibility of pigmentary alterations after treatment.⁵¹

Excimer laser: Studies have shown temporary repigmentation and improvement of leukoderma in SD with excimer laser,

although it failed to show any improvement in skin atrophy.^{52,53} To evaluate the true efficacy of the 308-nm excimer laser for darkening striae alba, 10 subjects were treated using the excimer laser on the white lines of striae, while the normal skin near to and between the lines was covered with zinc oxide cream. The results of this study showed the weakly positive effect of the 308-nm excimer laser in the repigmentation of striae alba.⁵⁴

Copper Bromide laser: copper-bromide laser (577-511 nm) has been used for stretch marks. A clinical study was conducted in 15 Italian women with stretch marks, treated with the CuBr laser (577-511 nm) and followed-up for 2 years.⁵⁵ The results of the study concluded that the copper-bromide laser was effective in decreasing the size of the SD and there were some pathogenic considerations that justified the use of this laser.

1,450-nm Diode Laser: The non-ablative 1,450-nm diode laser has been shown to improve atrophic scars and may be expected to improve striae. To evaluate the efficacy of the 1,450-nm diode laser in the treatment of striae rubra and striae alba in Asian patients with skin types 4-6, striae on one half of the body in 11 patients were treated with the 1,450-nm diode laser with cryogen cooling spray with the other half serving as a control.⁵⁶ None of the patients showed any noticeable improvement in the striae on the treated side compared to baseline and to the control areas. The study concluded that the non-ablative 1,450-nm diode laser is not useful in the treatment of striae in patients with skin types 4, 5, and 6.

1,064-nm Nd:YAG Laser: A study was aimed to verify the efficacy of this laser in the treatment of immature striae in which 20 patients with striae rubra were treated using the 1,064-nm long-pulsed Nd:YAG laser.⁵⁷ A higher number of patients (55%) considered the results excellent when compared to the same assessment made by the doctor (40%).

Intense Pulsed Light: In order to assess the efficacy of IPL in the treatment of striae distensae, a prospective study was carried out in 15 women, all of them having late stage striae distensae of the abdomen.⁵⁸ All the study subjects showed clinical and microscopical improvement after IPL. It seems to be a promising method of treatment for this common problem with minimal side-effects, a wide safety margin and no downtime.

Fractional Photothermolysis: To determine the efficacy of fractional photothermolysis in striae distensae, 22 women with striae distensae were treated with two sessions each of fractional photothermolysis at a pulse energy of 30 mJ, a density level of 6, and eight passes at intervals of 4 weeks and response to treatment was assessed by comparing pre- and post-treatment clinical photography and skin biopsy samples.⁵⁹ Six of the 22 patients (27%) showed good to excellent clinical improvement from baseline, whereas the other 16 (63%) showed various degrees of improvement. This study concluded that Fractional

photothermolysis may be effective in treating striae distensae, without significant side effects.

Ablative 10,600-nm carbon dioxide fractional laser: Ablative 10,600-nm carbon dioxide fractional laser systems (CO₂ FS) have been used successfully for the treatment of various types of scars. To assess the therapeutic efficacy of CO₂ FS for the treatment of striae distensae, 27 women with striae distensae were treated in a single session with a CO₂ FS and clinical improvement was assessed by comparing pre- and post-treatment clinical photographs and participant satisfaction rates.⁶⁰ The evaluation of clinical results 3 months after treatment showed that two of the 27 participants (7.4%) had grade clinical 4 improvement, 14 (51.9%) had grade 3 improvement, nine (33.3%) had grade 2 improvement, and two (7.4%) had grade 1 improvement. None of the participants showed worsening of their striae distensae. To assess and compare the efficacy and safety of nonablative fractional photothermolysis and ablative CO(2) fractional laser resurfacing in the treatment of striae distensae, 24 ethnic South Korean patients with varying degrees of atrophic striae alba in the abdomen were enrolled in a randomized blind split study and were treated with 1,550 nm fractional Er:Glass laser and ablative fractional CO(2) laser resurfacing.⁶¹ These results of the study support the use of nonablative fractional laser and ablative CO(2) fractional laser as effective and safe treatment modalities for striae distensae of Asian skin with neither treatment showing any greater clinical improvement than the other treatment.

UVB/UVA1 Combined Therapy: Besides lasers, light sources emitting ultraviolet B (UVB) irradiation have been shown to repigment striae distensae. A study was conducted on 9 patients with mature striae alba who received 10 treatment sessions, and biopsies were taken at the baseline and end of the study.⁶² At the end of the study, all patients reported some form of hyperpigmentation that was transient and did not affect any surrounding tissues. No changes were seen on biopsy to indicate an effective remodelling collagen effect of the device, although it needs further assessment. Another study was conducted to analyse the histologic and ultrastructural changes seen after UVB laser- or light source-induced repigmentation of striae distensae in which analyses of biopsied skin after treatment with both the UVB laser and light source showed increased melanin content, hypertrophy of melanocytes, and an increase in the number of melanocytes in all patients.⁶³

Radiofrequency devices: RF devices are based on the principle of heat generation that occurs in response to poor electrical conductance according to Ohm's law (heat generation is directly correlated with tissue resistance). The heat that is generated is sufficient to cause thermal damage to the surrounding connective tissue,⁶⁴ which is responsible for the partial denaturation of pre-existing elastic fibers and collagen bundles.⁶⁵ Initial collagen denaturation within thermally modified deep tissue is thought to represent the mechanism for immediate tissue contraction; subsequent neocollagenesis

further tightens the dermal tissue and reduces striae.⁶⁶ The efficacy and safety of combination therapy with fractionated microneedle radiofrequency (RF) and fractional carbon dioxide (CO₂) laser in the treatment of striae distensae has been evaluated revealing that this combination therapy is a safe treatment protocol with a positive therapeutic effect on striae distensae.⁶⁷ A recent study evaluating the effectiveness of a RF device in combination with PDL subjected 37 Asian patients with darker skin tone with SD to a baseline treatment with a RF device and PDL.⁶⁸ All histological evaluations demonstrated an increase in the amount of collagen fibers, and six of the nine specimens showed an increase in the number of elastic fibers. TriPollar RF device appears to be a promising alternative for the treatment of striae distensae in skin phototypes IV-V.⁶⁹

Needling therapy:

To evaluate the effectiveness and safety of a disk microneedle therapy system (DTS) in the treatment of striae distensae, 16 Korean volunteers with striae distensae alba or rubra were enrolled which received three treatments using a DTS at 4-week intervals.⁷⁰ Marked to excellent improvement was noted in seven (43.8%) patients, with minimal to moderate improvement in the remaining nine. This study revealed that Disk microneedle therapy system (DTS) can be effectively and safely used in the treatment of striae distensae without any significant side effects. Another study assessed and compared the efficacy and safety of needling therapy versus CO₂ fractional laser in treatment of striae and the results supported the use of microneedle therapy over CO₂ lasers for striae treatment.⁷¹

Platelet-rich plasma:

Platelet-rich plasma has these wound-healing properties, affecting endothelial cells, erythrocytes, and collagen,⁷² which potentially aids in the healing of the localized chronic inflammation believed to be a factor in the aetiology of striae distensae. Platelet-rich plasma is well tolerated by the patients and is a safe and cost effective treatment option for striae distensae.

Platelet-rich plasma alone is more effective than microdermabrasion alone in the treatment of striae distensae, but it is better to use the combination of both for more and rapid efficacy.⁷³

The plasma fractional radiofrequency and transepidermal delivery of platelet-rich plasma using ultrasound has also been found to be useful in the treatment of striae distensae.⁷⁴

Since thermal damage from intradermal RF has characteristics similar to those of many wounds, combination treatment with intradermal RF and autologous PRP would eventuate in enhanced localized collagen neogenesis and redistribution. In one of the studies, three sessions of intradermal RF were used combined with autologous PRP administered once every four

weeks.⁷⁵ All of the participants showed satisfactory changes and no patient was reported to show no improvement.

Transepidermal retinoic acid:

Transepidermal retinoic acid delivery using ablative fractional radiofrequency associated with acoustic pressure ultrasound has also been used for the treatment of stretch marks.⁷⁶

Conclusion

Striae distensae are an extremely common, therapeutically challenging form of dermal scarring. Adequate scientific knowledge and the evidence behind both preventative and therapeutic agents are vital in order to understand striae and to offer patients the best therapeutic options. The treatment of this cosmetically distressing condition has been disappointing and there is no widely accepted surgical procedure for improving the appearance of stretch marks. Laser therapy has been advocated as a treatment for striae distensae.

Competing Interests

None declared

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