

ORIGINAL ARTICLE

High-resolution epiluminescence colorimetry of striae distensae

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Keywords

ethnicity, striae albae, striae caeruleae, striae distensae, striae nigrae, striae rubrae, typology

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Abstract

Background Colours of striae distensae are often different from that of the surrounding skin. A close look using dermoscopy discloses distinct patterns of melanized networks at these sites. The aim of the study was to design a method of high-resolution analytical analysis of the skin colours using the combination of photographic dermoscopy and small field reflectance colorimetry.

Methods Clinical photographs were taken from striae distensae and their surrounding skin using a Dermaphot® (Heine Optotechnik, Hersching, Germany). A final magnification of 125× was obtained on paper photographs. The reflectance colorimeter Visi-Chroma VC-100 (Biophotonics, Lessines, Belgium) was used to measure colours of the pigmentary networks in the L*a*b* system. Differential colour parameters (ΔE^*_{ab} , ΔL^* , Δa^* , Δb^*) were calculated for each case between the lesional and the surrounding normal skin, and between the melanized reticulated pattern and the enclosed lighter areas.

Results Objective colorimetric assessments distinguished four distinct types, namely striae albae, striae rubrae, striae caeruleae and striae nigrae. The latter peculiar hyperpigmented type of striae distensae was specifically identified by epiluminescence examination in dark-skinned subjects. The fine-melanized honeycomb network present on the adjacent intact skin was reshaped inside striae in a streaky pattern perpendicular to the striae axis. Strong linear correlations were found between all combinations of ΔL^* and Δb^* evaluating colours of the reticulated and the honeycomb alveolar patterns both inside and outside the striae distensae. By contrast, no correlations were found between Δa^* and the other colorimetric parameters.

Conclusion The direct and/or indirect influences of melanocyte mechanobiology appear to have a prominent effect on the various colours of striae distensae.

Introduction

In the vernacular, striae are referred to as stretch marks. They are a common finding on the abdomen, hips, thighs and breasts. Setting aside hereditary factors, the combination of endocrine changes and mechanical stretching of the skin is responsible for most striae distensae.¹⁻⁵ Skin is normally submitted to various intrinsic and external mechanical tensions. The natural intrinsic ones determine the orientation of the Langer's lines when the body is lying down.⁶ Other tension lines with different orientations appear when the body posture changes. In particular, the relaxed skin

tension lines⁷ are of particular interest in skin physiopathology.⁶ Force transductions affect the structure of the dermis⁶ and the functions of different cell lineages as well.⁸⁻¹¹ Striae are largely parallel to the relaxed tension lines that show the orientation of minimal skin extensibility.¹²⁻¹⁴ They result from a failure of the skin to elongate under low-intensity forces, with ultimate brittleness of the dermis. Alterations in the matrix structure are present.¹⁵⁻¹⁷ Once established, the resistance to stretch deformation is still solicited to sustain the permanent natural tensions.¹³

Striae distensae often show variations in colours compared with the normal-looking surrounding skin.¹ Little is

stated concerning the cause of the occasional tinting of these lesions, except that early lesions may be temporarily coloured red or purple, and then later become white. Hypercorticism of endogenous or exogenous origin may produce blue striae.^{1,2} These colours are not uniform, but rather represent a combination of peculiar darker networks on a lighter background.² These differences have not been studied thoroughly so far. Striae distensae are commonly classified as striae rubrae in their early erythematous stage and striae albae in their late whiter stages.^{1-3,18} The denomination-coloured striae was also used as synonym for striae rubrae.^{1,2} We also described other types of striae distensae that appear darker because of increased melanization.² The names striae caeruleae (blue) and striae nigrae (black) were proposed to describe them.

The aim of this study was to develop a new analytical method based on high-resolution epiluminescence colorimetry (HREC). This approach was used to scrutinize and compare the networks and patterns of skin pigmentation inside striae distensae and the surrounding skin.

Patients and methods

Striae distensae of the abdomen were observed using dermoscopy in a series of 22 subjects (14 women and 8 men) of different ethnicities attending a dermatologic clinic. Their ages ranged from 22 to 39 years. Epiluminescence observations under oil immersion were performed as recommended for examining melanocytic neoplasms. Photographs were taken using a Dermaphot® (Heine Optotechnik, Hersching, Germany). Representative portions of striae distensae and of the adjacent normal-looking skin were present on each photograph printed under a 10.25 linear magnification. Skin colour was measured on the darker network and the lighter background (fig. 1) in both striae distensae and their surrounding skin.

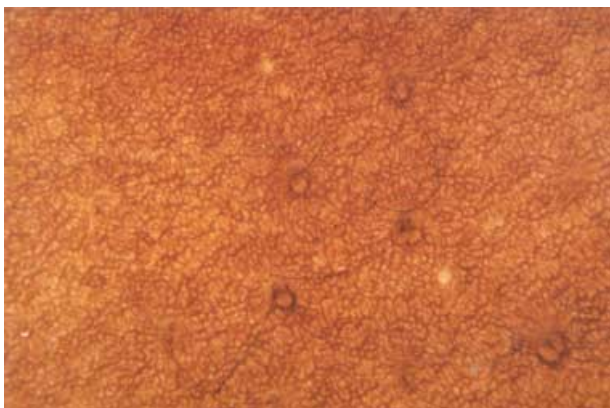


fig. 1 Normal honeycomb pattern of the melanotic network seen by dermoscopy.

Comparative reflectance colorimetric assessments were performed on the photographs using a Visi-Chroma® VC-100 (Biophotonics, Lessines, Belgium). This computer-assisted device allows to measure colours on very small and delimited areas defined by the observer.^{19,20} Measurements were performed in the CIELAB system with L*a*b* notifications.²¹ Value L* is expressed on a scale ranging from 0 for black to 100 for white. Values a* and b* indicate two colour axes, with a* being the red (0 to 100), green (0 to -100) axis and b* the yellow (0 to 100), blue (0 to -100). Differences in colours can be calculated by a subtraction (Δ) between two figures of the same colorimetric value (ΔL^* , Δa^* , Δb^*). Any positive Δ value indicates that the corresponding colour is more pronounced on the target area than on the reference area. For instance, a positive Δa^* means that the skin is more red. The overall difference in colour is given by ΔE^*_{ab} following:

$$\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{0.5}$$

Differential intraindividual colorimetric values were calculated between pairs of the four representative structures (darker network and lighter background) both present inside and outside the striae distensae. Colour differentials were calculated between the lighter alveolae and the darker networks both inside and outside the striae distensae. Colour differentials were also calculated for each of the darker networks and lighter alveolae between the inside and outside of the striae distensae. Correlations between the colorimetric assessments were searched using the Spearman test with calculation of the coefficient r .

Results

Striae distensae were clearly identified by dermoscopy. This method of examination revealed different patterns of melanin networks on normal-looking skin and striae distensae. These patterns were largely dependent on skin typology. Normal skin of subjects of darker complexion showed a prominent and evenly patterned honeycomb network made of thin and brown lines delimiting polygonal lighter areas (fig. 1). The size of the honeycomb alveolae varied by a factor of 3, reaching 1.2 mm² in average. This pattern was less prominent, disrupted or almost absent in subjects of lighter complexion.

The honeycomb melanotic network of normal skin was always altered in striae distensae. Four main basic dermoscopic aspects were identified and correlated with colorimetric evaluations (fig. 2). They were conveniently classified as striae albae (white), striae rubrae (red), striae caeruleae (blue) and striae nigrae (black). The global colour differences between striae distensae and the surrounding skin ranged from discrete ($\Delta E^*_{ab} = 4.4$) to

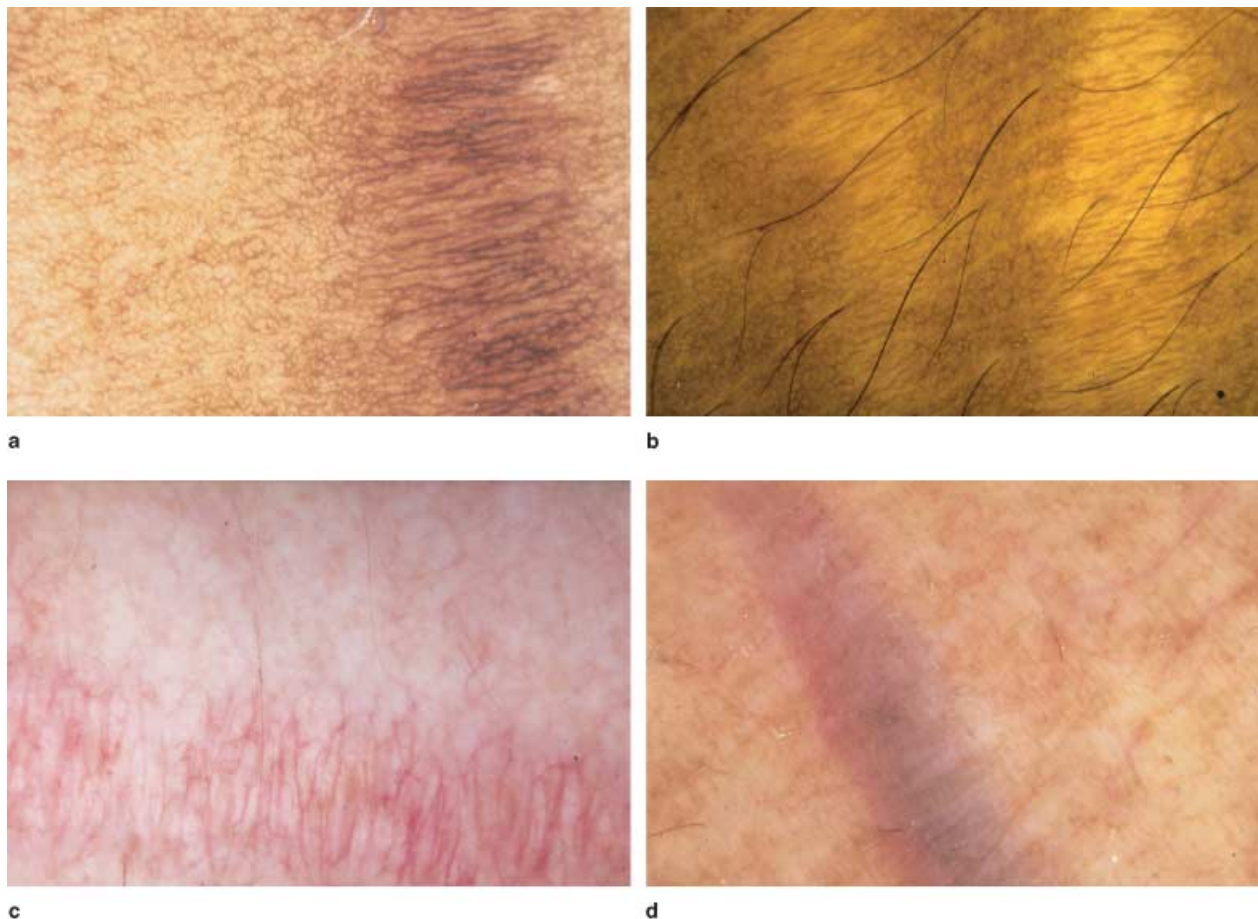


fig. 2 Dermoscopic aspects of striae distensae. (a) Stria nigra, (b) stria alba, (c) stria rubra, (d) stria caerulea.

prominent ($\Delta E^*ab = 30.7$). These differences were because of variable combinations of alterations in L^* , a^* and b^* . Striae nigrae were also characterized by a marked reduction in both values L^* and b^* . They exhibited a prominent streaky melanotic pattern that appeared to be in continuity with the honeycomb melanotic network of the adjacent normal skin (fig. 2a). Striae albae were characterized by the combination of increased L^* value and decreased a^* value. Dermoscopy showed a whitish foggy aspect with only discrete structures (fig. 2b). Striae rubrae exhibited a marked increase in value a^* . Under dermoscopy, they showed a faint to pronounced streaky pattern of dilated vessels orientated at right angle to the axis of the striae (fig. 2c). Striae caeruleae showed transversal bluish striations (fig. 2d) with reduction in the L^* and b^* values.

Colour differentials were calculated between the alveolar spaces and the reticulated networks both in the striae distensae and the surrounding normal-looking skin. Positive linear correlations were found between ΔL^* ($r = 0.85$) of

the two examined areas (fig. 3a), and between Δb^* ($r = 0.95$) of the same sites (fig. 3b). By contrast, Δa^* on both sites were not correlated ($r = -0.42$) (fig. 3c).

Colour differentials were also measured between the striae distensae and the surrounding skin both on the reticulated networks and in the alveolar spaces. Positive linear relationships were found between the corresponding ΔL^* ($r = 0.97$) (fig. 4a) and Δb^* ($r = 0.98$) (fig. 4b), but not for Δa^* ($r = -0.13$) (fig. 4c).

Discussion

Striae distensae result from the action of intrinsic stretching forces acting on a weakened connective tissue.¹⁻⁵ Several striae-prone conditions have been identified including puberty, gestation, obesity, Cushing's syndrome and prolonged corticotherapy. Dermal cells under specific hormonal, metabolic and tensile loads respond by feedback mechanisms and transduce the information into biochemical signals.²²⁻²⁵ They can shift their synthetic activities of

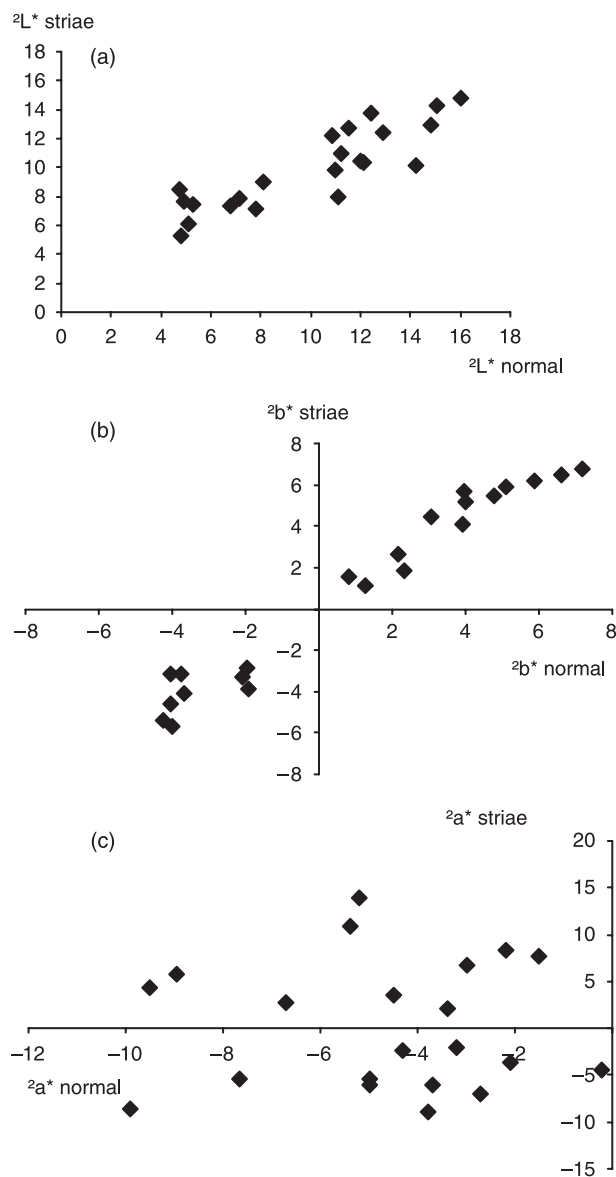


fig. 3 Scatterplots between colour differentials comparing the honeycomb alveolae and their reticulated borders in striae distensae and the surrounding skin. (a) Differentials in L*, (b) differentials in b*, (c) differentials in a*.

cytokines and components of the extracellular matrix. Once the resistance of the fibre network is weakened, the intrinsic mechanical loading changes and leads to the activation of secondary messengers that likely affect genetic expression and cell growth. The microvasculature and the epidermis including keratinocytes and melanocytes are also under the influence of mechanobiology. In striae distensae, both stretching forces and release of cytokines participate in this process.

This study encompassed the four previously identified types of striae distensae according to their colours relative

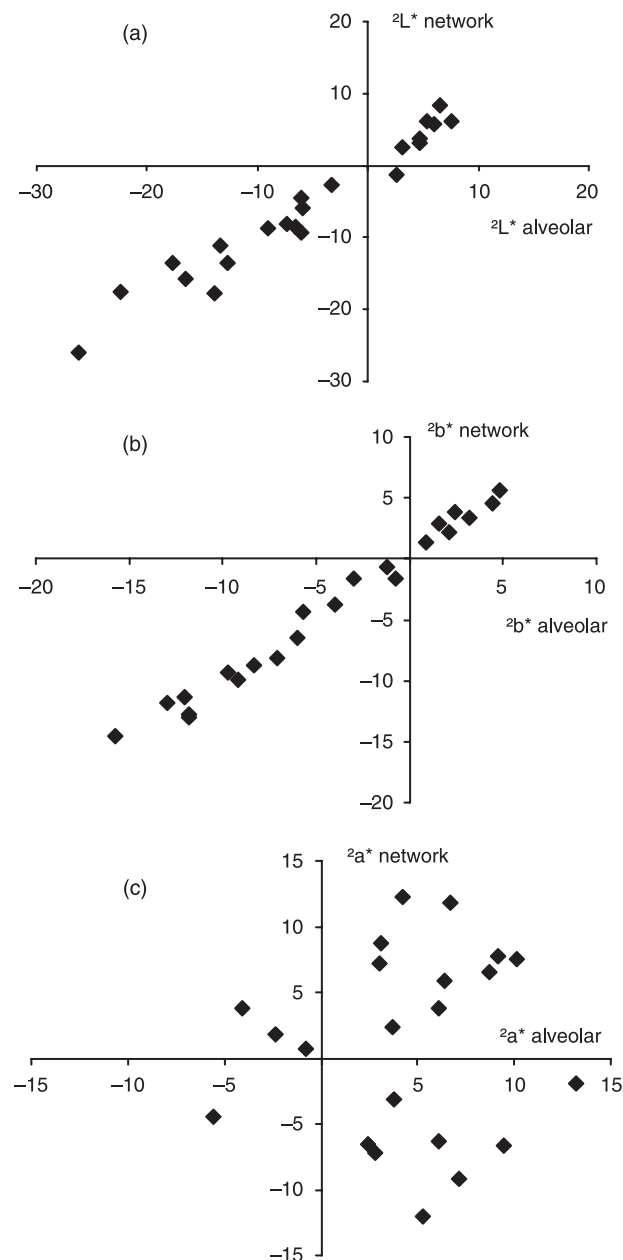


fig. 4 Scatterplots between colour differentials comparing the striae distensae and the normal skin both in the honeycomb alveolae and their reticulated border. (a) Differentials in L*, (b) differentials in b*, (c) differentials in a*.

to the normal-looking adjacent skin.² They can be tentatively interpreted as different stages of evolution in part under typology dependence. Striae rubrae appeared as the earliest recognizable stage. The diffuse erythema almost restricted to the limits of striae distensae corresponded to vasodilation perhaps associated with angiogenesis. Striae nigrae were an ethnicity-linked aspect. They corresponded to a marked increase in the melanin load, particularly

prominent in the stretched reoriented rete ridges. At this stage, erythema was also present. Thus, striae nigrae might represent a superimposed aspect of striae rubrae in some dark-skinned subjects. This aspect is reminiscent of pigmented lesions in focal dermal hypoplasia.²⁶ As intrinsic skin tensions being different in striae distensae compared with the surrounding normal skin, epidermal melanization might be modulated differently in these sites. Thus, this aspect might be the expression of some direct or indirect mechanobiological influence on melanocytes. The melanization might result from mechanical forces applied to the melanocyte itself,¹⁰ but biochemical signals arising from other stretch-activated skin cells can play a role,²⁷ as suggested by the fact that increased melanogenesis was associated with remodelling of the rete ridges. Some cytokines, such as the stem cell factor and hepatocyte growth factor, may indeed be released by dermal cells and induce epidermal hyperpigmentation. Striae caeruleae appeared similar as striae nigrae, although lighter in complexion. Striae albae combined the absence of erythema and a decrease in the melanin load. They represent the late stage of stabilized striae distensae when there is no more stimulation of the vasculature and of the epidermal melanin units.

One fascinating and yet undescribed aspect of colours in striae distensae is the close relationships between differentials in L* and b* between the reticulated networks and their enclosed honeycomb alveolae both inside and outside the striae distensae. This study was performed using a unique device^{19,20} allowing colour determinations on very small areas. We also used colour photographs magnified 8.5 times to allow analytical quantification of the patterned network of skin colours. As striae distensae and their surrounding skin were present on the same photographs, comparisons of colour differentials were made possible and relevant. The correlations obtained between all combinations of ΔL^* and Δb^* suggest that a unique cause is responsible for the colour changes. This finding further supports the mechanobiological hypothesis involving melanocytes. By contrast, Δa^* appeared not correlated with ΔL^* and Δb^* , meaning that the microvasculature did not respond to the same signals as the epidermal melanocyte unit.

In conclusion, many coloured aspects of striae distensae are probably dependent on direct or indirect mechanobiological influences on melanocytes. Angiectasias, when present, are not correlated with the melanization process.

Acknowledgements

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