

〈教育セミナー〉

しわのサイエンス～成因から改善アプローチまで～

シワ形成のバイオメカニクス

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Biomechanics of Wrinkle Formation

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Abstract

Biomechanics is mechanics applied to biological systems to study their structure and function. Mechanical aspects of wrinkle formation were studied in the back skin of hairless mice. Wrinkles were induced by ultraviolet (UV) B irradiation for 10 weeks, while observing deformation of the skin during wrinkle formation. Changes in skin dimensions were also observed during the specimen excision process: wrinkle depth and interval were measured before and after removal of the cutaneous muscle layer. Deformation of wrinkled skin during uniaxial stretch was measured paying attention to local difference. Changes in curvature of skin specimens upon muscle layer removal were observed to determine the force balance in skin layers. The skin showed spontaneous contraction in response to UV irradiation. Wrinkled skin showed a marked decrease in the wrinkle depth and a slight increase in wrinkle interval following muscle layer removal, a unique deformation that cannot be explained if homogeneity is assumed to skin deformation. This response was due to compressive deformations of dermal tissue caused by the muscle layer and concentrated at valleys of the wrinkles. Measurements of the skin curvature indicated that the muscle layer compressed the dermal tissue predominantly in the craniocaudal direction. Morphological observations showed that the wrinkles coincided with rows of pores and sulci cutis, *i.e.*, the areas where the structural stiffness of the horny layer was relatively low. Taken together, a hypothetical mechanisms of wrinkle formation during UV irradiation was proposed: spontaneous contraction of the dermis while maintaining or increasing the epidermal area induces buckling of the epidermis into the dermis at mechanically weak lines, namely, the rows of pores and sulci cutis, and buckling may be amplified by the axial compression of the dermis by the muscle layer. Biomechanical consideration is important in studying the mechanism of wrinkle formation.

Key words: force balance, residual stress, skin, tensile test.