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Thermal aging: A new concept of skin aging

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Summary

Background: Sunlight damages human skin, resulting in a wrinkled appearance. Human skin temperature, measured inside the dermis by a needle-type thermometer, can be increased up to about 40 °C in direct summer midday sunlight within 15—20 min, and this heat may contribute significantly to sun-induced skin damage. Recent studies suggest that heat as well as UV may play an important role in premature skin aging. However, our knowledge about the effects of heat or infrared light, which certainly increase the temperature of the skin and may possibly interfere with or enhance the damaging effects of UV, on the development of skin aging is limited.
Objectives: This review provides an outline of the thermal effects on skin aging process in human skin.

1. Introduction

Skin aging can be divided into two basic processes, intrinsic aging and photoaging [1]. Photoaging describes premature skin aging in chronically photodamaged skin. If habitually sun-exposed skin in the elderly is compared with sun-protected skin covered by clothing, the exposed skin appears more aged. Intrinsic aging is characterized by smooth, dry, pale and finely wrinkled skin. On the other hand, photoaging is characterized by coarse, deep, severe wrinkling and pigmentary changes, on exposed areas such as the face, neck and forearm (Fig. 1). The histologic findings of intrinsic aging show a general decrease in the extracellular matrix with reduced elastin and the disintegration of elastic fibers [2]. In contrast, the histologic findings of photoaged skin characteristically show the accumulation of dystrophic elastotic material in the reticular dermis, a process referred to as solar elastosis [3—5].

Heat is a form of energy that may be transmitted in different ways, by direct contact-conduction, by circulating currents-convection, or by infrared radiation from a heated body [6]. Despite these different means of transmission, the final product (heat energy) is the same, manifesting as an increased skin temperature. Human skin is exposed daily to UV and infrared radiation. We found that the temperature of human skin, measured inside the

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Fig. 1 Clinical manifestation of photoaging and intrinsic skin aging.

dermis by a needle-type thermometer, was increased to 40—43 °C in direct summer midday sunlight within 15—20 min (personal observation). Radiant heat, as a by-product of stoves, furnaces, and similar devices, can also cause cutaneous changes similar to those found in chronically sun-exposed skin [7]. On more prolonged heat exposure, severe elastic fiber hyperplasia develops, which extends deeply into the dermis, in combination with the degeneration of dermal collagen [8,9]. Infrared radiation is converted to heat in the skin, and therefore, may have a more significant biological effect than previously realized. Chronic IR exposure can cause pronounced elastosis in mouse skin that mimics the damage caused by UV [10]. However, our knowledge of environmental factors such as radiant heat or infrared light, which certainly increase the temperature of the skin and may possibly interfere with or enhance the damaging effects of UV, is limited. This review provides an outline of the thermal effects on skin aging process in human skin.

2. Causes and mechanisms of wrinkle formation in human skin

Aging is an inevitable phenomenon. As we get older, our skin becomes wrinkled more and more (Fig. 2). Various factors such as age, sun-exposure, smoking, and endocrinological changes are considered to be important risk factors for wrinkles in the human skin.

Alterations and deficiencies of collagen, the major structural component of skin, have been suggested to be a cause of the skin wrinkling observed in photoaged and naturally aged skin [11,12]. The dermis contains predominantly type I and type III collagen, elastin, proteoglycans, and fibronectin. Since collagen fibrils and elastin are responsible for the

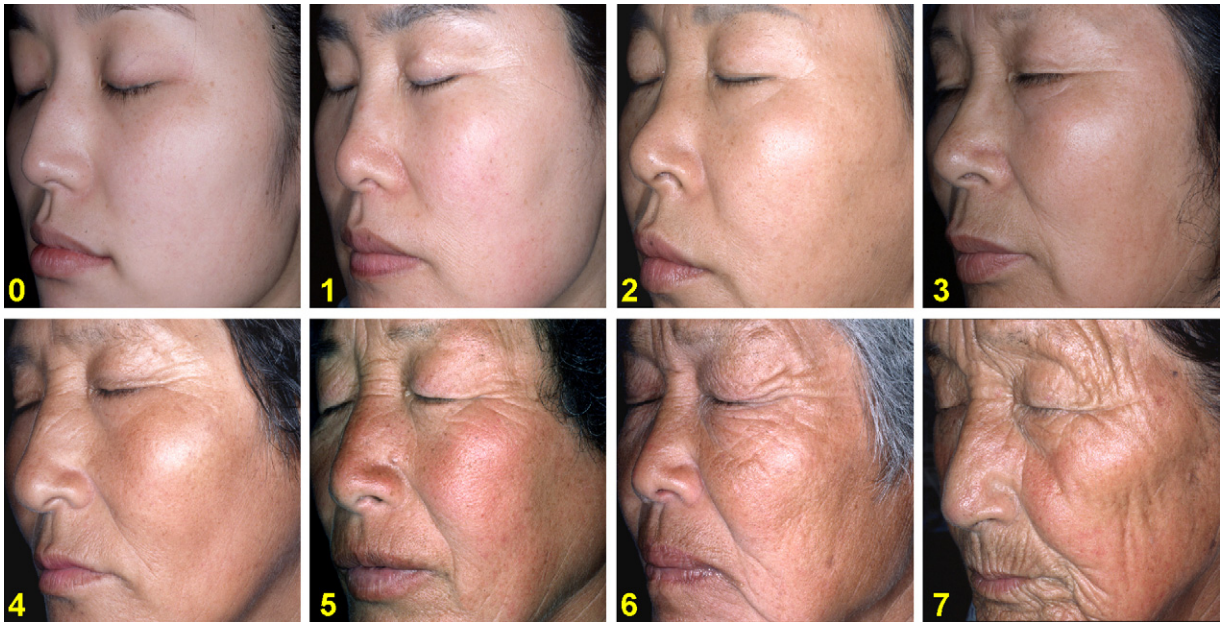

Fig. 2 Photographic wrinkle grades in Koreans. Grade 0 indicates no wrinkles, while grade 7 represents severe wrinkles.