Healthy Hair: What Is it?

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Shiny hair with a smooth texture and clean-cut ends or tapered tips is generally perceived to be healthy. Hair texture and shine relate to hair surface properties, whereas the integrity of hair ends relates to the hair cortex. Hair can be straight, wavy or curly, blonde, black, brown, red, gray white, and its natural variations are important to our identity. Manipulation of the normal structure of the hair shaft is epidemic and dictated by culture, fashion, and above all, celebrity. Although cosmetic procedures are intrinsically safe, there is potential for damage to the hair. Loss of lustre, frizz, split ends, and other hair problems are particularly prevalent among people who repeatedly alter the natural style of their hair or among people with hair that is intrinsically weak. This may be due to individual or racial variation or less commonly an inherited structural abnormality in hair fiber formation. Hair health is also affected by common afflictions of the scalp as well as age-related phenomena such as graying and androgenetic alopecia. Hair products that improve the structural integrity of hair fibers and increase tensile strength are available, as are products that increase hair volume, reduce frizz, improve hair manageability, and stimulate new hair growth.

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INTRODUCTION

This review aims to help the clinician to understand the complex interplay between the various medical and biological factors, scalp care habits, hair care procedures and environmental factors to hair health.

Hair is an important component of body image. It is one of few physical characteristics we can change and manipulate to the dictates of culture and fashion. Hair cosmetics are widely used to alter the physical and mechanical properties of hair, which are dependent on internal structural organization and protein constituents.

HAIR STRUCTURE

Hair consists of an outer hydrophobic lipid epicuticle, a layer of flattened overlapping cuticle cells surrounding the elongated polyhedral cortical cells. The normal cuticle has a smooth appearance, allowing light reflection and limiting friction between the hair shafts It is responsible for the lustre and texture of the hair. (Draelos, 1991) The cuticle may be damaged by frictional forces like brushing. The cortical cells surround an optional and often discontinuous central medulla. The cortical layer determines many of the mechanical properties of the hair. The surface of the hair is covered in a covalently bound, monomolecular layer of a unique, branched, fatty acid – 18-methyl eicosanoic acid (Figure 1).

The cortex consists of closely packed spindle-shaped cortical cells filled with keratin filaments that are orientated parallel to the longitudinal axis of the hair shaft (Dawber and Messenger, 1997), and an amorphous matrix of high sulfur proteins (Dawber, 1996). The intermediate filament hair keratins (40–60 kDa), comprising 400–500 amino-acid residues in heptad sequence repeats, form hard keratin polypeptide chains which pair together to form protofilaments (Dawber and Messenger, 1997). The keratin chains have a large number of sulfur-containing cysteine residues. Cysteine residues in adjacent keratin filaments form covalent disulfide bonds forming a strong crosslink between adjacent keratin chains. (Feughelman, 1977) The disulfide bonds contribute much to the shape, stability, and texture of the hair. These disulfide bonds remain intact when the hair is wet allowing the hair to resume its original shape. Other weaker bonds link the keratin polypeptide chains together such as Van der Waal interactions, hydrogen bonds, and Coulombic interactions known as salt links. (Feughelman, 1977) These weaker bonds can be overcome with water.

Combinining the outer, intensely hydrophobic layer and the cortex confer the physical properties of lustre (shine) and volume (body) so essential for the appearance of ''health'' (Figure 2).

HAIR PHYSICAL PROPERTIES

When wet, hair can be stretched by 30% of their original length without damage; however, irreversible changes occur when hair is stretched between 30 and 70%. Stretching to 80% causes fracture (Dawber and Messenger, 1997).

Hair is porous: damaged hair is intensely so. Water absorption causes hair shaft swelling. And when soaked in water hair weight increases by 12–18%. Wetting and subsequent drying in a predetermined position are basic to hair styling. Wet hair has higher combing friction than dry

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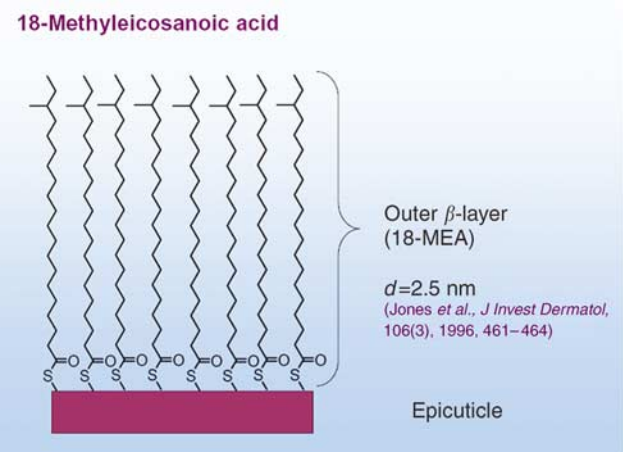

Figure 1. **The f-layer – 18-methyl eicosanoic acid is intimately bound to the exo-cuticle and intensely hydrophobic.**

Figure 2. **Healthy hair as evinced by shine and body.**

hair. Combing wet hair is more likely to stretch brittle hair to its breaking point (Draelos, 2005).

Hair shafts, when dry produce static electricity. Static can cause hair shafts to repel, creating flyaway hair. Moisture reduces static and frizz (Draelos, 2005).

Hair shape, especially in cross-section influences wave and curl, light reflection and therefore hair shine, sebum retention, and ease of grooming (Draelos, 2005).

COSMETIC ALTERATION

Successful cosmetic alteration requires chemical processes that alter the normal structure of the hair shaft (Harrison and Sinclair, 2004). For a permanent change in the hair, the chemical reaction of coloring, perming, or straightening must occur in the cortex. Bleaching, perming, and straightening alter the physical properties of hair. The f-layer is removed with any chemical procedure and the internal disulfide bonds of the cortex are

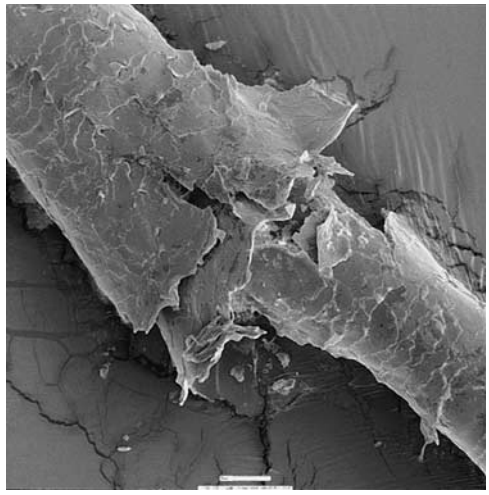

Figure 3. **A significant degree of weathering to the hair shaft.** Most weathering is self-inflicted.

broken in hair styling with permanent waves. Excessive or repeated chemical treatment, poor grooming habits, and environmental exposure produce changes in hair texture and if extreme can result in hair breakage. These changes can be seen microscopically as ''weathering'' of the hair shaft and contribute to rendering the hair structurally weaker, more prone to tangling, and rougher in appearance (Figure 3).

Different types of hair have varying affinity for the different coloring and waving methods. Damaged hair also has a different affinity for hair products (Brown, 1977).

In addition hair strength and resistance to damage by exogenous factors show racial as well as individual variation. Inherited structural abnormality in hair fiber formation are rare and beyond the scope of this article.

In people of African descent, permanent hair loss in the form of hot comb alopecia and possibly also central centrifugal alopecia are recognized, rare consequences of hair straightening procedures (Sinclair *et al.,* 1999). Traction alopecia is potentially reversible hair loss that occurs as a consequence of certain hair styles (Sinclair *et al.*, 1999).

WEATHERING

Weathering is the progressive degeneration from the root to the tip of the hair of the cuticle and then later the cortex due to routine everyday wear and tear.

Although all hair exhibits some degree of weathering, longer hair, subjected to repeated insults, inevitably shows more severe changes of weathering (Figure 2) (Gummer, 1999). Features of weathering include damaged cuticles, longitudinal fissures known as spilt ends and transverse fissures resembling the nodes seen in trichorrhexis nodosa (Dawber, 1996).

The hair shaft documents the history of the cosmetic practices of an individual (Gummer, 1999). Hair grows at $\approx$ 1 cm per month, and so the tip of a hair 24 cm in length, is in fact 2 years old (Gummer, 1999). Therefore, newly growing roots have different properties to the hair tips. The older part of the hair shaft, particularly the tip has undergone over 700

washes, the application of hot styling implements and other cosmetic procedures such as bleaching, permanent coloring and perming, and may show features of weathering, whereas the root may be less porous and have different chemical properties (Gummer, 1999).

SPECIFIC CAUSES OF WEATHERING

Bleaching

Bleaching oxidizes the existing melanin in the cortex. Darker hair requires longer bleaching times. Red hair is more difficult to bleach than brown hair. The oxidization reaction destroys some of the disulfide bonds within the keratin and can damage the cuticle making it more porous (Bolduc and Shapiro, 2001).

Permanent styling

Permanent styling is achieved through the use of permanent waving or straighteners. Both processes involve denaturation of the structural disulfide bonds and as such have the potential to cause significant damage to the hair (Zviak, 1986). They also remove covalently bound surface lipids, changing) the surface of the hair from hydrophobic to hydrophilic to allow the interaction of water and styling products (Gummer, 1999).

Permanent waving or perming changes the shape of the hair so that the new shape persists through several shampoos. Structural disulfide bonds need to be broken (Borish, 1977; Gray, 1997). The neutralization process may be more damaging than the thiol reduction and free radicals may cause some of this damage (Borish, 1977). Newly growing hair will not be affected and so the perm eventually grows out.

Chemical hair relaxing or lanthionization is similar to permanent waving, but the hair is permanently straightened instead of curled.

Hair straightening needs to be repeated every 4–6 weeks and only new regrowth needs to be straightened, otherwise damage to the hair can occur (Ahn and Lee, 2002).

Individual and racial variation. Mongoloid hair is straight and is more commonly dark brown in color than black. It has a circular cross-section. Caucasoid hair has an elliptical cross-section and may be straight, wavy, or curly. The color may vary from red, blond, brown to true black. Negroid hair is identical to Caucasoid and Mongoloid hair in amino-acid composition and distribution (Khumalo and Dawber, 2005), but has a larger diameter, lower water content, flattened elliptical cross-section. It is usually black or dark brown, tightly curled, low in shine when compared to Mongoloid hair and high in sebum. It has increased grooming friction, which combined with low tensile strength makes it more difficult to manage.

HAIR GROOMING

Shampoos are detergents designed to remove sebum, sweat, fungal elements, desquamated corneocytes, styling products, and dirt. Conditioners are used to moisturize hair after removal of sebum to leave the hair soft, smooth, hydrated, and low in static. Many different shampoo detergents and conditioning agents exist and are reviewed in detail elsewhere (Draelos, 2005).

Figure 4. **Cosmetic products restore the optical and physical properties of hair after weathering.** 960 × 1458 mm (72 × 72 DPI).

HAIR CARE

Modern cosmetic products are formulated to cleanse hair of detritus, restore and improve cuticular and cortical function and reduce detangling and grooming force. Intensive conditioners containing poly-quaternium polymers, dimethicones, and gum extracts are designed to obviate the self-inflicted excesses of chemical and physical damage. Intensive conditioning can temporarily ''replace'' the f-layer, improve moisture retention in the cortex restoring some of the diminished physical properties of hair. Improvement in hair shine is a key benefit of modern products (Figure 4).

CONFLICT OF INTEREST

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