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How to Put Your Patients on a "Hair Diet"

Faraz Yousefian, DO | *Aventura, Florida, USA;* Jennifer Krejci, MD, FISHRS | *San Antonio, Texas, USA* | jkrejci@limmerhtc.com

ABSTRACT

The integrity of hair is determined by the intricate building blocks of the many layers of the hair follicle, but it also relies on proper nutrition. Weak hair can result from external factors such as physical trauma, heat manipulation, and chemicals, as well as internal factors such as inadequate nutrition. A "hair diet" addresses both internal and external factors that lead to fragile or damaged hair and provides the basis for a conversation with patients to improve the health of their hair.

Keywords: chemical processing, ethnic hair styling, hair anatomy, hair dye and bleach, hair structure, heat damage to hair, nutrition for hair

INTRODUCTION

As hair restoration experts, we see patients with hair loss primarily due to genetics, yet some of our patients also suffer from thinning due to external causes—the damage they inflict upon themselves. Although genetics determines an individual's hair color, texture, and density, grooming techniques allow a person to express their personal style. Unfortunately, many of these grooming techniques can be damaging or lead to scarring.

This article reviews the anatomical structure and chemical composition of hair and how it relates to damage caused by certain grooming practices. This is especially important when it comes to understanding cultural or ethnic variations where traumatic grooming practices are common. With a better scientific understanding of hair follicle structure and growth, the physician can more effectively counsel patients on hair care regimens and implement treatment strategies that minimize damage and promote hair health and growth.

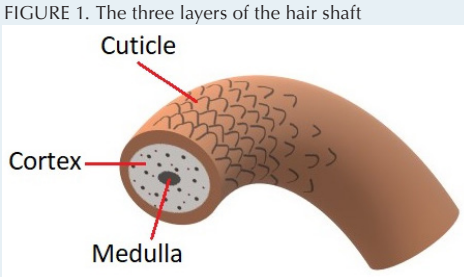
For this purpose, we introduce the concept of a "hair diet." Much like a weight control diet, which emphasizes limiting consumption of "bad" foods and increasing intake of "healthy" ones, the hair diet guides patients to limit the use of styling practices that can damage or weaken the chemical and physical properties of hair, and it teaches them how to fortify the hair with the building blocks—both products and nutrition—that are required for hair synthesis and growth.

PHYSICAL AND CHEMICAL ANATOMY OF THE HAIR

Hair exists in three stages: anagen, catagen, and telogen. The anagen phase refers to the stage at which hair actively grows, and it accounts for 90% of the life cycle of a scalp hair follicle. During this phase, hair grows approximately one centimeter per month, although this rate may be slower in people of African descent. Subsequently, a hair follicle enters the catagen or involution phase, which is a short transitional phase. About 8% of our hairs are in the telogen phase, the final stage, and it is used to denote a resting period where the hair follicle is no longer actively growing. After the conclusion of this phase, a hair strand is shed, and the cycle begins once again.

The hair follicle consists of several concentric compartments. Each individual hair consists of an external segment that is visible to the naked eye and a deeper portion embedded within the dermal and adipose layers of the skin. The former is referred to as the hair shaft, while the latter is called the hair follicle or hair root. As shown in Figure 1, each hair shaft has three layers: inner (medulla),

FIGURE 1. The three layers of the hair shaft



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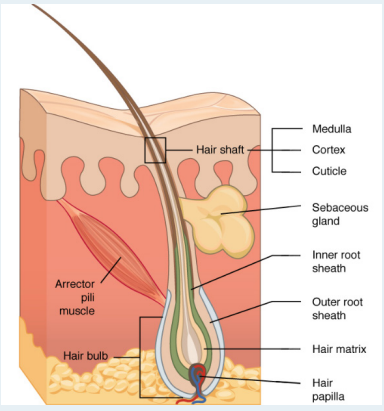
middle (cortex), and outermost (cuticle). The internal portion of the hair follicle is divided into three segments: infundibulum (from the surface to the sebaceous gland duct), isthmus (from the duct to arrector pili muscle), and the inferior segment/bulb, which is only present in the growing phase (from the arrector muscle to the base of the matrix).

The medulla, the innermost portion, consists of a porous center of air spaces and sparse structural proteins. This characteristic allows water absorption from the environment leading to increased fiber volume during humid weather. In humans, the purpose has yet to be fully understood, but in other mammals, this air-filled layer helps regular body temperature. The cortex is the major player in mass and tensile strength of the hair shaft. The cortex consists of keratin proteins and lipids, which provide elasticity characteristics of the hair shaft.[1] In addition, the cortex contains melanin granules, which add color to the hair shaft. The cuticle, the outermost layer, is a mixture of ceramides, cholesterol, fatty acids, and an overlapping scale-like formation of protein keratins to provide maximum protection against water and chemical substances. The overlapping cuticular cell thickness, which gradually decreases from root to tip as the hair is exposed to environmental damage to the cuticle over time, is greatest towards the ends of the hair, which results in hair shaft splitting (trichoptilosis) and low hydrophobic properties.

The inner root sheath (IRS) engulfs and safeguards the growing hair. It lies between the cortex and the outer root sheath (ORS) peripherally (Figure 2). These three structures are derived from the matrix cells of the follicular bulb. The inner root sheath has three layers: Henle's layer, Huxley's layer, and the cuticle of the IRS. The ORS serves as a stem cell reservoir, allows glycogen storage, provides IRS structural support, and supplies a route for nutrient and oxygen delivery for the inner portion of the hair follicle. Dermal papillae have a regulatory role in hair growth as they contain mesenchymal cells of the hair follicles. In addition, the hair follicle size and shaft circumference are correlated by the fibroblast volume in the dermal papilla. The vascular plexus consists of arterioles, capillaries, and venules, which supply hair follicles with nutrients and oxygen.

FIGURE 2. The many parts of a hair follicle



Cell membrane complex (CMC) acts as adhesive material that connects hair cells together.[1] Depending on location, various types of CMC exist such as cuticle–cuticle, cuticle–cortex, and cortex–cortex.

Genetic mutation of the structures discussed above leads to permanent hair malformation. The hair follicle is derived from ectodermal stem cells and the alteration of differentiation factors (HOXC13), transcription factors (FOXQ1 and FOXN1), and keratin gene clusters (acidic and basic) can inherit hair abnormalities, like monilethrix, ectodermal dysplasia, or alopecia areata.[2-4] Yet, chemical and physical hair manipulation can disrupt the characteristics of healthy hair as well. Self-induced or voluntary manipulations can alter the high lipid content and smoothness in the cuticle or disrupt the cell membrane complex (CMC) and disulfide bonds in the cortex.[5] The cuticle and cortex are the vulnerable hair components affected by cosmetic hair practices such as bleaching, dyeing, perming, or heat manipulations.

COSMETIC PRACTICES THAT DAMAGE HAIR

Permanent Styling Practices

By far, one of the most invasive procedures that can disrupt the integrity of the hair is permanent styling. Some examples include permanent waving and straightening, also known as "perms" or "relaxing." While the cross-sectional shape of a hair follicle dictates how curly or straight a natural strand is, it is disulfide and hydrogen bonds that maintain the shape of the hair.[6,7] Permanent styling leads to potential hair damage and loss due to denaturing of disulfide bonds and changing the integrity of covalent bonds on the hair surface, altering the hydrophobic property to hydrophilic.[8] Permanent styling formulations rely on high alkaline chemicals, such as sodium hydroxide ("lye") or guanidine, lithium, or potassium hydroxide ("no-lye"), to disrupt the natural disulfide bonds of the hair. It is the release of free sulfur from the amino acids that lends itself to the foul odor during this process. Chemical analysis of treated hair showed significantly lower levels of cysteine, sulfur-containing amino acids, and the levels of cysteine decline even more at the distal end of the hair where hair is the weakest.[8,9] So whether straight or curly hair is the endpoint, perm solutions weaken the hair strands, and the damage is compounded over time if repeated.

The "Brazilian blowout" or "keratin straightening treatments" rely on formaldehyde-based straightening solutions. This straightening procedure has three steps: hair wash, application of formaldehyde/"formaldehyde-free" products, and drying at a temperature of 400-450°F.[10] This is considered a temporary straightening method due to the temporary alteration of the disulfide bond. Caution should be exercised with this treatment due to heat-induced formaldehyde gas exposure, which has been linked to eye irritation, breathing difficulty, and cancer.[10] After much bad publicity, manufacturers developed a so-called "formaldehyde-free" product that is currently available; however, the ingredients contained in this product—glyoxylic acid glyoxyloyl carbocysteine (oxoacetamide carbocysteine) or phenyl trimethicone—ultimately transform into formaldehyde gas when exposed to high heat during the procedure, resulting in the same harmful exposure. This procedure is most popular for Caucasian hair with mild to moderate curl to reduce frizz from environmental humidity.

Bleaching and Hair Dyeing

Similar to permanent styling, hair dyeing and highlighting also disrupt the hair's natural disulfide bonds. In both cases, the oxidation reaction disrupts the disulfide bonds of keratin molecules. Degradation of amino acids, such as tyrosine, threonine, and methionine, and loss of cysteine in the disulfide bonds of the hair shaft create irreversible color changes. Due to this disturbance, the new bonds are much weaker than the preexisting bonds resulting in a more brittle and porous hair cuticle.

When it comes to hair dye, the degree of damage may depend on whether the dye is temporary, semi-permanent,

or demi-permanent and the frequency of and extent of hair that is dyed. Most men and women will need to apply dye to the roots every 4-8 weeks to cover gray. There is always some amount of overlap, so there can be more damage with every application. For bleach, the amount of damage depends on the length of time the bleach is applied and the degree of change from dark to light that is attempted in what is known as "lift," or removal, of pigment from the hair.[12] Lightening hair from very dark brown or black to blond or white is the most extreme example and the most damaging. In today's trends of rainbow shades of hair color like blue, green or magenta, dark hair must first be lightened to nearly white before the vibrant color is applied, which compounds the damage from the dyeing process.

These cosmetic hair alterations not only damage the hair cuticle, but they can also lead to negative side effects such as scalp irritation, chemical burns, and trichoptilosis (i.e., split ends). Therefore, it is essential to exercise caution when performing these hair manipulations.

Heat Manipulations

Although less severe, heat manipulation of hair including the use of curlers, curling rods, or straightening irons will also alter the physical properties of hair and lead to damage and breakage. High heat devices, especially flat irons, are adjustable up to 300-500˚F, and this high heat disrupts the hair's hydrogen bonds. These hydrogen bonds are easily broken as the mere addition of water disrupts their structure. For this reason, heat manipulations of hair are temporary. Once the hair is washed, the style is reversed. If only used occasionally, damage from heat elements is less severe, but when used day after day, the damage adds up and can wreak havoc. It is significant to note that healthy hair burns at around 450˚F, while damaged hair sustains a similar injury at a *lower* temperature.

Ethnic Hairstyling Practices

Ethnic hairstyling practices that have been adopted over the years to enhance hair manageability have also significantly influenced fashion trends. However, these customs can have adverse consequences, including inflammation, infections, hair breakage, and even scarring hair loss. Such practices encompass a range of techniques such as hair locking, plats, braiding, weaving, wig usage, or relaxing or perming with lye or non-lye solution.

While the hair-locking process (e.g., dreadlocks and sisterlocks) is considered a cosmetic procedure by some individuals, for others, it may have a spiritual or political connotation.[13] Similarly, wigs and weaves are typically used to add volume and length but can also serve as an expression of personal and cultural style. It is important to be aware of these practices so that you can discuss them with patients in a thoughtful manner. Wigs should be washed and conditioned regularly and worn with a soft or silk band or cap to protect the underlying hair. Patients should be advised about the damaging effect of long-term repeated tightening and pulling that comes from extensions, braids, plats, and locks. Any repeated or chronic tension can cause hair breakage or traction alopecia, eventually leading to scarring and permanent hair loss.

PREVENTION AND RECOMMENDATIONS

Fortunately, there are steps that can be taken to prevent hair damage and promote growth. These steps are centered around generating a healthy-hair regimen, or "hair diet." Proper cleansing with shampoo and using conditioners to coat and seal the cuticle after washing are essential. These products should be lathered in with the fingertips, focusing on the scalp to remove sebum and debris. Fortunately, shampoos are formulated and marketed according to different hair types and textures. If you have fine, limp hair, a shampoo labeled for your hair type should work well. If you have coarse, curly, or greasy hair, you should look for one to match your hair texture and level of oils. Of note, despite current trends, sulfate-free shampoo is NOT necessary for all hair types nor is it toxic (see below for color-treated hair).[14] Silicone derivatives, such as dimethicone and cyclomethicone, are common and effective ingredients in conditioners and hair serums as they help seal the hair cuticle that has sustained damage from perms, heat, or dyes. This doesn't reverse the damage, but it can help protect from future damage.

Individuals who suffer from seborrheic dermatitis or dandruff will benefit from using a medicated shampoo at least three times a week and letting the shampoo sit longer on the scalp for better efficacy. In contrast, individuals with dry or curly hair should only wash their hair one to two times a week to prevent excessive dryness. Pre-shampoo treatments, such as coconut oil application to the hair, have been proven to lessen cuticle swelling, prevent moisture loss, and diminish wet-grooming hair damage.[15] Chemically processed hair *can* benefit from using sulfate-free shampoo to minimize stripping of color and provide longer-lasting color. Finally, depending on the extent of hair damage and breakage, fractured ends should be trimmed every 2-4 months.

As previously noted, many individuals tend to dye their hair every 4-8 weeks to cover new growth; however, the damage caused by hair dyes can be minimized by decreasing this frequency. Ideally, a patient would dye their hair no more than two to three times per year; however, for many, this is not feasible because of the growth rate and visibility of gray roots. Still, it is worth discussing the consequences of frequent hair coloring with patients so that they can make an informed decision when it comes to their grooming practices. Avoiding synthetic dyes that contain paraphenylenediamine (PPD) will also minimize chemical damage. PPD is well known to cause allergic reactions and inflammation; however, it is the most commonly used ingredient and the most colorfast. Changing to a natural dye like henna is healthier but may be a hard buy-in for patients. It's also worth noting that some "natural" dyes may add PPD or other ingredients to improve their permanence.

When it comes to preventing hair damage from thermal manipulations of the hair via blow-drying, straightening, curling, etc., an effort should be made to minimize the frequency of hot tool usage (i.e., no more than once per week). This can be a hard sell for patients who are used to blow-drying and straightening on a daily basis, especially in locations with high humidity or high frizz environments. Still, this should be a talking point in patient education. Reducing usage from daily to 2-3 times weekly is less damaging and worth discussing. Likewise, when an option, temperature settings should be maintained at a low or medium temperature, below 350˚F. Remember, healthy hair normally burns at temperatures greater than 450˚F while already damaged hair burns at *lower* temperatures.

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For the purpose of this review, the "hair diet" primarily applies to things patients *do* to their hair, but it is also important to understand the basic nutritional aspects required for hair synthesis. A complete and healthy diet is important to promote hair growth and structure. Therefore, hair experts should assess possible nutritional deficiencies or insufficiencies in patients seeking treatment for hair loss. Micronutrients are essential for proper hair growth such as vitamin D, iron, vitamin B12, folate, biotin, zinc, and selenium. The integrity of the hair shaft and cell wall requires cholesterol and fatty acids. In addition, adequate daily calorie and protein intake ensures proper keratin production of hair follicles. If patients are following fad diets, restrictive diets, vegetarian/vegan, or simply consuming poor nutritional foods (fast food), counseling them on the nutritional requirements for hair is prudent. It is important to consider gastrointestinal disorders and surgeries, high-fiber diets, psychological history (e.g., bulimia and anorexia nervosa), mental capacity, and certain medication that may lead to malabsorption of micronutrients and vitamins.

Zinc has a pivotal role in more than 200 zinc-dependent metalloenzymes. It has a regulatory function for the synthesis and degradation of lipids, proteins, and nucleic acid. Acquired zinc deficiency is correlated with insufficient zinc intake, decreased absorption due to high fiber intake, malabsorption symptoms (e.g., cystic fibrosis), renal failure, human immunodeficiency virus, pregnancy, and medication (e.g., penicillamine). In order to protect hair from oxidative damage, selenium is a vital component of glutathione peroxidase enzyme. Vitamin A controls the expression of many proteins and regulates the normalization of epidermal function. Vitamin D plays a role in the function of keratinocytes. Vitamin C aids in collagen synthesis, regulation of leukocyte function, absorption of iron, and metabolism of folic acid. In addition, vitamin C intake is important for hair loss patients due to iron deficiency since it has a vital role in the absorption, chelation and reduction, and mobility of iron in the intestinal tract.[16] Biotin is an essential cofactor for several carboxylases which play an important role in gluconeogenesis, fatty acid synthesis, and amino acid catabolism. In hair, biotin's function is primarily protein synthesis for keratin production, which explains its contribution to healthy nail and hair growth.[17]

Normal hair growth is also affected by various growth-modulatory neurotransmitters and hormones such as androgens, estrogen, retinoids, calcitriol, and thyroxine. For instance, the systemic surge of androgen in puberty is a crucial regulatory step for vellus-to-terminal hair transformation in androgen-dependent hair follicles. Certain food consumption and environmental exposures can affect the balance of neurotransmitters and hormones that ultimately can affect normal hair growth.

CONCLUSION

For every hair specialist who sees patients in consultation for hair loss, before we jump to surgical or other modes of restoration, we must first examine the patient's hair and determine to what extent they are sustaining damage from outside trauma that is potentially reversible. We also need to inquire about poor eating habits or behaviors at play that may be accentuating male/female pattern hair loss. This article hopefully allows you to have a better dialogue with patients regarding grooming practices that could not only harm their existing hair but also potentially diminish the outcomes of a hair transplant or other procedures. The "hair diet," like a weight loss diet, is about both what we do and *don't do* to achieve results. For weight loss, we advise our patients to omit or limit fast foods, processed foods, sugars, trans fats, and starchy foods. Similarly, hair patients should omit or limit dyes, perms, traction, and heat appliances in order for their hair to maintain structural integrity. For healthy eating, we tell patients to consume green leafy vegetables, lean protein, and complex carbohydrates, and we can counsel our patients that foods that are good for our heart are also good for our hair. Additionally, we should encourage good hair habits like the regular use of medicated or gentle shampoo, conditioner, and silicone or coconut-based serums to protect the hair from outside factors. Lastly, we can explain the importance of removing the most damaged hair by trimming the ends regularly. It's like exercise for your hair! In short: more good and less bad leads to healthier hair. If you want your patient to have their best hair through all means possible, start with a discussion on the potential benefits of the "hair diet."

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