

# All Hair Is Not the Same

Zoe Diana Draelos, MD



Ever wondered why there are so many different shampoos, conditioners, and hairstyling products? The answer is simple. All hair is not the same. It is not the same color. It is not the same shape. It is not the same age. As a matter of fact, there are more types of hair than Fitzpatrick skin types. Confused? Probably. Do not worry, even the consumer is confused about which bottle to buy for great-looking hair. Fortunately, if the current purchase does not provide the desired result, it can be washed out tomorrow and another attempt made with another purchase to produce another result. This type of trial-and-error drives much of the hair care market, yet as dermatologists we must put some type of science to the field.

In reality, some of the most accomplished scientists work in the hair care industry. Hair care product design is a fine art with many advances derived from textile manufacture. Why is there so much excellent research on hair care? Because this area of cosmetics is unregulated and because hair is nonliving, there are few health issues, which provides for increased creativity and diverse technologies. If this were the case with skin care, there would be many more skin care products with enhanced efficacy. Changes that occur in the hair shaft with chemical exposure and age are much better understood than similar skin changes. This makes the study of hair care an interesting endeavor.

The goal of this article is to highlight the differences between various types of hair. These differences result from underlying unique hair physiology and translate into hair appearance and behavior when exposed to various chemicals. Understanding these differences is key to developing a rational approach to selecting appropriate hair care products.

---

*Dr. Draelos is Consulting Professor, Department of Dermatology, Duke University School of Medicine, Durham, North Carolina.*

*The author reports no conflict of interest in relation to this article.*

*Correspondence: Zoe Diana Draelos, MD, 2444 N Main St, High Point, NC 27262 (zdraelos@northstate.net).*

## Hair Fiber Shape

There are 3 basic hair fiber shapes corresponding to the major ethnicities in the world. The fiber shape is determined in cross section by slicing the hair perpendicularly to the fiber. Hair that is perfectly straight has a round cross section. It is the symmetry of the round cross section in any plane that allows the hair to hang straight. Round cross sectional hair is characteristic of Asian hair. When the round cross section becomes oval, it loses its symmetry in all planes. This asymmetry leads to wavy hair with the degree of curl influenced by the shape of the ellipse. As the major axis of the ellipse becomes longer and longer, the hair becomes more and more tightly curled. This type of hair is characteristic of Caucasian hair. When the ellipse becomes dramatically flattened and highly asymmetrical, the hair is tightly kinked, representative of African American hair. Variation in the cross section of the hair shaft accounts for the appearance of the hair curls found around the globe.

## Hair Fiber Behavior

Hair fiber shape determines its behavior and other interesting attributes.<sup>1</sup> Analysis of these attributes allows a better understanding of the differences in grooming needs between the various hair types and facilitates development of hair care products and procedures that enhance the beauty and performance of the hair. While it can be argued that hair is not essential for life, it can be proven that patients spend more money on their hair than on sunscreen!

For the sake of this discussion, we will generalize the appearance of hair into 3 ethnic types, even though there is much diversity in hair appearance. The 3 hair types that we will discuss are Asian, Caucasian, and African American hair, which can be described as straight, wavy, and kinky, respectively. Asian hair grows the longest of any hair type and is used in the manufacture of human hair wigs for this reason. The round hair fiber does not easily tangle and possesses less combing friction resulting in less hair shaft-breakage. Caucasian hair is intermediate with African American kinky hair

growing the shortest. The hair shafts grow at the same rate, but African American hair demonstrates the highest combing friction and is most susceptible to breakage. It is this common breakage with grooming that accounts for the popularity of hair-straightening in African American individuals.

The diameter of the hair fiber also varies among ethnicities. African American hair has the largest diameter followed by Caucasian hair and Asian hair is the finest. This may explain the coarseness of African American hair. The large hair shaft and its kinky tendency increase problems with ingrown hairs leading to pseudofolliculitis barbae and acne nuchae keloidalis.

### Hair Breakage

The most common cosmetic hair problem is hair breakage. Whether the patient is young or old, male or female, curly- or straight-haired, hair breakage is still the most common cause of hair loss. Hair breakage also can contribute to hair loss in patients with hair disease, such as alopecia areata, lichen planopilaris, and androgenetic alopecia. Asian hair is the strongest hair with a breaking force of 63 g, again explaining why it is used in the wig industry. Caucasian hair is intermediate with a breaking force of 43 g, and African American hair is the weakest with a breaking force of 33 g. The breaking force is the amount of weight that can be applied to a single hair shaft before fracture.

Machines that measure hair's breaking force are commonly used in the hair care industry. All chemical hair procedures, including dyeing, permanent waving, and straightening, weaken the hair shafts. This weakening can be measured by hair shaft fracture at a lower breaking force. This force is measured by hooking both ends of the hair up to a machine that puts a known amount of pull on the hair shaft with increasing pull exerted until the hair breaks. Superior hair chemical procedures would produce the desired cosmetic end result without weakening the hair shaft. This is impossible. Thus, a compromise must be achieved.

Dermatologists may have encountered patients who claim that their hair is falling out following a permanent wave or hair straightening procedure. The patient may perceive more hair on the comb or brush, but the hair is actually breaking off from chemical weakening rather than actual loss with the hair bulb intact. Hair that has been chemically weakened cannot be restored to its original strength. Hair care products are developed and tested to determine if they increase the breaking force of the hair. These are the products that are labeled for chemically damaged hair.

### Wet Versus Dry Hair Behavior

The behavior of hair strength also is altered by wetting and drying the hair shaft. Wet hair is easier to fracture than dry hair, as noted in Table 1, which is why hair should not be vigorously groomed when wet. Wet hair is highly elastic and can be easily stretched beyond its breaking point. Also, notice in Table 1 that again the breaking strength of Caucasian hair is greater than African American hair. Hair with a more regular cross section has a higher breaking strength. Further, Caucasian hair is more elastic than African American hair both wet and dry, based on the elongation at breaking point data. This easily explains why Caucasian hair grows to a longer length than African American hair, and highlights the need for hair care products specifically designed for each hair configuration.

### Amino Acid Hair Characteristics

The comparative amino acid characteristics of Caucasian and African American hair have subtle differences. There also is uniqueness to each type of hair as well. This observation has led hair care companies to design chemical procedures, shampoos, conditioners, and styling products for different hair types.

### Other Hair Attributes

There are other differences between African American hair and Caucasian hair worth mentioning. For example,

TABLE 1

### Rationale for Permanent Hair Straightening

- Hair manageability is improved.
- The hair can be more easily combed and styled.
- Hair breakage may be decreased due to less combing friction.
- Hair shine is improved with a straighter hair shaft.
- Fashion may dictate the need for straight hair.
- Versatility in straightening techniques allows multiple styling options: completely straightened, minimally straightened, texturized, or straightened and recurled.

# COSMETIC CONSULTATION

African American hair has fewer cuticle layers than Caucasian hair; 7 compared to 12. Since the cuticle is the outer protective layer of the hair shaft, fewer cuticle layers means the hair is more subject to damage and more easily weakened by cuticle loss. This also may explain the fragility of African American hair. African American hair also has lower water content, making the hair less elastic and more prone to fracture.<sup>2</sup>

## Hair Straightening

Hair straightening is a common practice among African American individuals with kinky hair.<sup>3</sup> The hair can be straightened with heat or chemical techniques.<sup>4</sup> Chemical techniques are more popular because the hair is permanently straightened, as opposed to heat straightening that temporarily rearranges the water-deformable bonds in the hair shaft.

The first permanent hair straighteners, also known as hair relaxers or perms, were developed around 1940 and consisted of sodium hydroxide or potassium hydroxide mixed into potato starch. Once the disulfide bonds were broken, the hair was pulled straight and the disulfide bonds reformed in their new configuration. The proper chemical name for hair straightening is lanthionization. Hair straightening is popular among individuals with wavy to kinky hair for many reasons, which are summarized in Table 1.<sup>5</sup>

## Hair Straightening Chemistry

Lanthionization is a chemical process whereby curly hair is straightened through the use of metal hydroxides, such as sodium, lithium, potassium, or guanidine hydroxide, to change about 35% of the cysteine contents of the hair to lanthionine along with minor hydrolysis of the peptide bonds.<sup>6</sup> Hair straightening can be achieved with lye-based, lye-free, ammonium thioglycolate, or bisulfite creams.<sup>7</sup> The lye-based and lye-free procedures are most popular and will be briefly discussed in this article.

Lye-based, or sodium hydroxide-based, straighteners are alkaline creams with a pH of 13. Sodium hydroxide is a caustic substance that can damage hair, produce scalp burns, and cause blindness if exposed to the eye. These products are generally restricted to professional or salon use and may contain up to 3.5% sodium hydroxide.<sup>8</sup>

Lye relaxers are available in base and no-base forms (Table 2). The base is usually petrolatum that is applied to the scalp and hairline prior to application of the sodium hydroxide. This prevents scalp irritation and burns. The base relaxers contain between 1.5% and 3.5% sodium

TABLE 2

## Ingredients in a Lye No-Base Relaxer

- Petrolatum
- Mineral oil
- Fatty alcohol
- Emulsifying wax
- Simethicone
- Water
- Propylene glycol
- Sodium lauryl sulfate
- Sodium hydroxide (lye)

hydroxide and therefore require that the scalp and hairline be coated with a petrolatum base prior to application. These higher concentration lye products are necessary for hard to straighten hair. No-base relaxers, on the other hand, contain 1.5% to 2.5% sodium hydroxide and only require base application to the hairline.<sup>9</sup> They are more popular since it is time consuming for the beautician to apply the base to the scalp and most individuals are restraightening hair that has already been chemically weakened.

Other strong alkali chemicals sometimes used in place of sodium hydroxide are guanidine hydroxide and lithium hydroxide, which are no-lye chemical hair straighteners (Table 3). These relaxing kits contain a calcium hydroxide cream 4% to 7% and liquid guanidine carbonate. The guanidine carbonate activator is then mixed into the calcium hydroxide cream to produce calcium carbonate and guanidine hydroxide, the active agent. These products do not require basing of either the scalp or the hairline.

## Summary

This article has reviewed the unique attributes of straight, wavy, and kinky hair. There are important differences in the chemistry and physics of hair behavior among different ethnic groups that mandate unique hair products and procedures designed to optimize hair

TABLE 3

## Ingredients in a No-Lye Cream Relaxer

Cream Relaxer Components	Liquid Activator Components
• Petrolatum	• Water
• Mineral oil	• Propylene glycol
• Fatty alcohol	• Xanthan gum
• Emulsifying wax	• Guanidine carbonate
• Dimethicone	
• Water	
• Propylene glycol	
• Calcium hydroxide	

performance and beauty. It is important that the dermatologist understand these subtleties when evaluating patients with hair loss issues that may be medical, cosmetic, or a combination of both. After this discussion, it should be apparent that not all hair is the same.

### References

1. Franbourg A, Hallegot P, Baltenneck F, et al. Current research on ethnic hair. *J Am Acad Dermatol.* 2003;48(suppl 6):S115-S119.
2. McMichael A. Ethnic hair update: past and present. *J Am Acad Dermatol.* 2003;48(suppl 6):S127-S133.
3. Bernard B. Hair shape of curly hair. *J Am Acad Dermatol.* 2003;48(suppl 6):S120-S126.
4. McDonald CJ. Special requirements in cosmetics for people with black skin. In: Frost P, Horwitz SN, eds. *Principles of Cosmetics for the Dermatologist.* St. Louis, IL: Mosby; 1982:302-304.
5. Syed A, Kuhajda A, Ayoub H, et al. African-American hair: its physical properties and differences relative to Caucasian hair. *Cosmet Toil.* 1995;110:39-48.
6. Hsiung DY. Hair straightening. In: deNavarre MG, ed. *The Chemistry and Manufacture of Cosmetics.* 2nd ed. Princeton, NJ: Continental Press; 1975:1155-1166.
7. Cannell DW. Permanent waving and hair straightening. *Clin Dermatol.* 1988;6:71-82.
8. Syed A. Ethnic hair care history, trends, and formulation. *Cosmet Toil.* 1993;108:99-108.
9. Khalil EN. Cosmetic and hair treatments for the black consumer. *Cosmet Toil.* 1986;101:51-58. ■