

## Can a topical scalp treatment reduce hair bulb extraction?

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### Synopsis

Generally speaking, when people talk about “hair breakage” they are typically referring to the idea that as they comb or brush their hair, the fibers are elongating and snapping at some weak point in the fiber length. It is well established that as people chemically treat their hair, the keratin proteins are degraded further and the hair become more brittle and susceptible to breakage. For the consumer, hair breakage is registered as hair fibers noted in their comb or brush, and in the drain that they see after a cosmetic treatment. However, a fundamental question that needs to be asked is whether or not the hairs that are seen in the drain are really the result of hair breakage (i.e., a fiber snapping) or are they the result of hairs that are actually being extracted from the scalp by their root bulbs. If the bulk of the hair fibers are actually extracted by the bulb, than it seems somewhat superfluous to try and improve hair strength by improving the exterior of the fiber. The fiber is dead and topical treatments can only smooth, and possibly moisten already established fiber structure and integrity. This paper will attempt to address hair strength by looking at the scalp and follicle as the target for treatment, showing that topical application of a product containing a blend of well-known skin active ingredients can demonstrate potential reductions in hair extractions. An *in vivo* testing protocol in which 15 voluntary participants with at least 12" hair length were professionally shampooed, and then treated, half-head, with a commercial conditioner, or the same conditioner that contained 5% of a mixture of yeast peptides, fruit acids and green tea polyphenols every day for five days will be discussed. At the beginning and end of the treatment period, the number of hairs that either broke along the fiber, or extracted by the bulb were gathered, separated and counted for both the treated and untreated side of the head. The results of this one-week study demonstrate that the number of hairs that actually break pales in comparison to the number of hairs that are extracted complete with intact root bulb from the follicle.

### INTRODUCTION

Aside from treatments of the skin, the human hair remains one of the most heavily treated sites on the human body. It is generally established that once a human hair fiber has emerged from the scalp follicle, the cellular components have lost their nuclear material and the keratin proteins of the hair have become highly crosslinked offering, to the external environment, a non-living, fibrous entity (1,2). On the other hand, below the stratum corneum, in the follicle, the hair is very much alive (3). At the base of the follicle resides the hair bulb, the source for dermal papillae cells which are the living cells from which hair fibers emerge.

The growth of the hair passes through various stages depending on a number of biochemically-induced signals. Principally, hair growth is highly dependent on steroidal signals such as testosterone and estrogen levels (3). The principal steroid responsible for changes in the hair growth cycles is testosterone. Testosterone binds to the androgen receptor (AR) within the dermal papillae cells and transfers hair from a resting state

called catagen to an active growing state called anagen (4). When hair emerges into the anagen phase, it begins to change its physical appearance from small colorless fibers called vellus hairs to thick hair that contains color called terminal hairs (1). Testosterone breaks down in the human body principally via action of an enzyme called 5- $\alpha$ -reductase which converts testosterone into 5- $\alpha$ -dihydrotestosterone (DHT) (5-7).

Dihydrotestosterone is also a powerful androgen which binds to the androgen receptor. Typically, for most people, this binding of dihydrotestosterone is reversible and does not interfere with the anagen growth of the hair. However, for some individuals (men and women), the binding of dihydrotestosterone begins to dominate the steroidal cycle and the hair follicles are driven out of anagen phase and into telogen and catagen phase. Subsequently, the terminal hair fibers shrink and lose their color. This leads to a condition known as alopecia or baldness (8). The exact biochemical and genetic reasons for this situation are not presently known, although considerable research is being conducted to better understand the reasons why some people lose their hair and others do not.

However, it stands to reason that in order to influence the strength of a hair fiber, it would be necessary to try and do this at the point in which the hair is still living. In this regard, a shift in treatment perspective is required and instead of looking at how to improve the structure of the dead hair fiber, might it be possible to influence the fiber integrity at earlier stages of growth while it is still within the confines of the follicle? In addition, the definition of hair strength must also be renewed as improving hair fiber strength means something entirely different if one is talking about keeping the hair fiber from being extracted, intact, from the follicle. In a normal human being with non-alopecia hair, the head will typically lose nearly 100 hairs a day through normal exfoliation processes (2). This level is grossly increased due to a number of situations such as alopecia, damage of the hair fibers, or attempts to comb the hair when it is wet and tangled. While some have argued that hair fibers do not simply break by elongation, but rather through interaction with other fibers that become entangled and crossed on the tangs of the brush or comb, it must be fundamentally understood what force is greater for apparent hair loss, hair breakage or hair extraction (9,10). This paper will attempt to address these inconsistencies by looking at hair fiber health via well established skin care treatment practices.

## METHODS

### TREATMENT INGREDIENTS

For this study, a hair treatment composition which comprises the following ingredients at the ratios shown was developed (Table I).

### CONDITIONER COMPOSITION

A commercially available, silicone-free conditioner was used throughout the study. To the commercial conditioner was added 5% of the composition shown above to create the "Active" formulation. The conditioner with additional water equal to the amount of water added to the active formulation was used as the "Placebo."

Table I  
Treatment Ingredients

Ingredient (INCI name)	Percentage in composition
Water	46–50
Hexapeptide-11	1–2
Fruit acids	25–30
Betaine	8–12
Green tea polyphenols	2–3
Hexylene glycol	8–12

#### IN VIVO TESTING PROTOCOL

The entire study was conducted at a clinically-sponsored salon which the participants visited every day for five days. Prior to commencing the study, the participants signed informed consent agreements. Participants were all Caucasian women with a mixed population of damaged and non-damaged hair, between the ages of 30 and 60, of general good health and non-pregnant. Each participant was required to have hair of at least 12 inches in length. None of the participants reported signs of female alopecia or other known scalp conditions which might skew the test results.

Prior to commencing the study, the participants went through a five day wash out period on their hair using a simple ionic shampoo and the placebo conditioner. In addition, after the wash-out period, but prior to the treatment period, each participant had a fabric collar transfixed around their neck so that during drying, any hairs which fell from the head were captured in the collar. The participant's hair on one half of their head (to remain consistent with the test results from the half-head study described below) was then dried for three minutes with a brush and a 1200 W hair dryer. At the end of the drying period, the clinician then gathered all of the hair fibers that were trapped in the brush and those that had fallen into the collar and these hair fibers were culled into plastic bags and labeled as "Day 0." Only fibers that could be visibly seen were gathered (typically greater than ½-inch in length or greater).

The participants came into the salon every day at the same time for their hair treatments. During the treatment, each participant was shampooed with the same simple shampoo and then the hair was combed to afford half-head treatment sites. To one side of the head, the salon clinician applied the placebo conditioner and allowed the conditioner to reside on the head for five minutes prior to rinsing. To the other side of the head, the participants were treated with the conditioner containing the active ingredients which were also allowed to reside on the scalp and hair for five minutes prior to rinsing. Each side of the hair was rinsed in such a way as to prevent treatment from one side of the head to wash over to the other side of the head. Such treatments were continued once a day for five complete days.

At completion of the study period, after the final conditioning rinse, the participants were affixed with the same collar mentioned above and each side of the head was dried for three minutes. After completion of one side of the head, all the hair fibers were gathered before the other side of the head was similarly dried. The hair fibers were culled as before and placed into plastic Ziploc bags and labeled as "Day 5" with identification of whether they were from the active- or placebo-treated side of the head.

## SEPARATION OF HAIR FIBERS

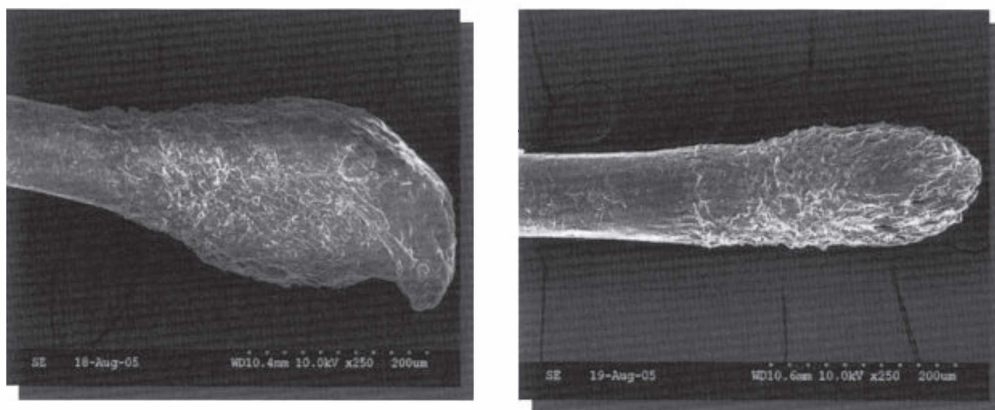
The hair fibers that were gathered at Day 0 and Day 5 were transferred to a laboratory housing a stereomicroscope. The contents of each plastic bag were carefully examined in order to determine whether or not the hair contained an intact hair bulb. Care had to be taken here as some telogen hair fibers can look very much like broken hair fibers (i.e., the hair bulb is tiny). However, clinicians were able to meticulously separate hairs that had broken from hairs that were removed with intact hair bulbs.

## RESULTS AND DISCUSSION

Shown below are two SEM images of typical hair fibers in which the hair was removed from the scalp with an intact follicle bulb (Figure 1). As can be seen, the appearance of the hair fiber in telogen phase shows a very tiny hair bulb which can be mistaken for a broken hair. Broken hair fibers are generally quite easy to distinguish as are hair fibers that retain an anagen hair bulb. None-the-less, separation of the hair fibers is a tedious process which must be done carefully to assure accurate identification of the hair fibers as either intact or broken.

After the hairs were separated the numbers of hairs in each group, Day 0 Intact, Day 0 Broken, Day 5 Treated-Intact, Day 5 Treated-Broken, Day 5 Placebo-Intact and Day 5 Placebo-Broken, were counted. The results of this study are shown in Figure 2.

What becomes immediately apparent in looking at the data in Figure 2 is that in every instance, the number of hairs that were extracted intact from the scalp far exceeded the number of hairs that broke (by nearly a factor of six in every case). This result implies that the concept of hair loss must seriously take into account the difference between hairs that break (which we prefer to call brittleness) and those that are removed (extracted) fully intact from the scalp. This data also suggests that hair fiber strength studies which employ tresses and hair elongation techniques are overlooking a major route of hair removal which cannot, by definition, be accounted for in such *ex vivo* type studies. In addition, as these results are taken from a realistic treatment protocol, the mode of hair breakage, i.e., elongation versus hair entanglement on the brush tangs, is minimized.



**Figure 1.** Scanning electron photomicrographs of two intact hair fibers, one that is in apparent anagen phase growth (left) and the other that appears to be in telogen phase growth (right).

### Hair Strength Study (n=15)

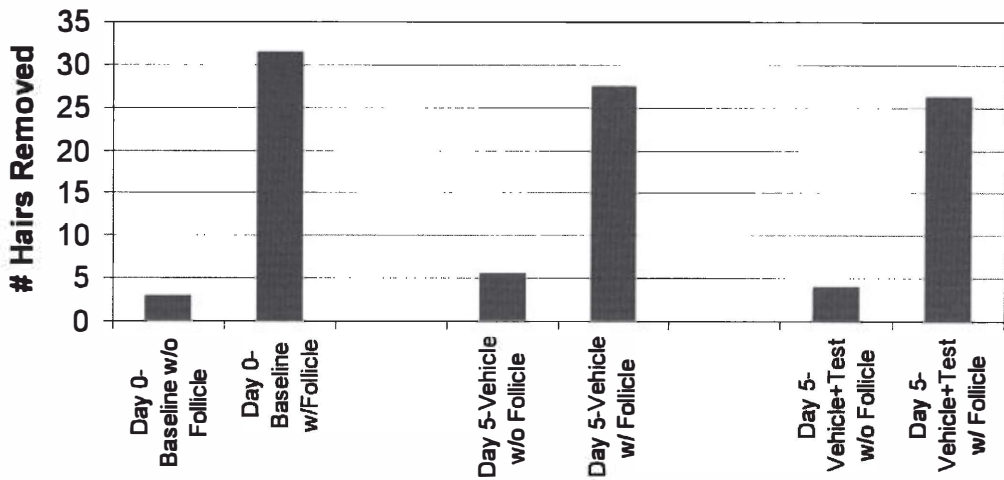


Figure 2. Data from *in vivo* hair combing study showing numbers of hair fibers found broken (light bars) versus number of hairs found with intact hair bulbs (dark).

Either the hair fiber breaks or it is extracted. The results suggest that extraction is the principal mode of hair removal from the scalp.

No doubt, however, these results can be influenced by a number of factors including hair length, combing force, type of combing instrument (comb or brush), and hair damage and type (i.e., Asian, Caucasian, etc). As we did not select between participants with damaged versus undamaged hair or make stipulations on hair type, this does suggest that additional studies are required to fully understand the influence of hair damage and type on these results.

Examining the data from the “placebo-treated” verse the “active-treated” side of the head for hairs that were removed intact, we note that while not statistically significant, there appears to be a slight reduction in the number of hair fibers that were extracted from the treated side compared to the placebo side suggesting the possibility that topical treatment with the active ingredients described via application from a conditioner does offer some improvements in reduction in hair extraction. Two critical factors would influence this test result including 1) length of treatment period and 2) number of participants in the study. It appears that five days and fifteen participants are not a large enough participant pool to make statistically significant judgments about treatment effects.

### CONCLUSIONS

The study described above presents data suggesting that under normal conditions the hair that a person finds in their comb or in the drain after washing and drying is principally hair fibers that have been physically extracted, intact, from the scalp, not broken along the fiber length. For this reason, hair strength studies conducted on tresses may not be addressing the dominant mode of hair removal. However, testing scalp

treatment products to look for improvements in hair “strength” are difficult to do to gain statistically-significant data. This does not preclude however, the possibility that improving hair strength can occur at the follicle level where hair fiber structure and integrity is laid down for the first time. In this regard, viewing hair fiber health as a skin related issue is certainly a viable approach to enhancing the strength and beauty of the scalp hair as a whole.

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