Mechanisms of Laser-Induced Hair Regrowth

Michael R. Hamblin, PhD, Associate Professor, Harvard Medical School
hamblin@helix.mgh.harvard.edu

1. Alopecia

Male androgenetic alopecia (AGA) is the most frequent type of thinning or loss of hair in males. The condition, also known as male pattern baldness, causes hair loss as early as late adolescence. Polygenic heredity is assumed to be the primary cause, although the male hormone testosterone plays an important role, seemingly independent of genetic predisposition. In the hair follicle cells, testosterone converts into the biologically more active metabolite, 5α-dihydrotestosterone (DHT) catalyzed by the enzyme 5-alpha reductase. This hormone binds to androgenic receptors in the hair follicle and the specific bond triggers cellular processes, which reduce the anagen phase of the hair cycle. For this reason the hair passes earlier into the telogen phase and falls out. Gradually, over succeeding cycles terminal hair converts into thinner and shorter vellus hair (i.e. the retrograde phase of the cycle) and the hair follicle becomes minute. The density of the androgenic receptors in the hair follicles varies according to location and this is genetically determined. Age factors too play an important role in AGA, the first manifestation is usually appearing in the third decade. Further factors are probably involved. In males usually symmetric fronto-parietal retraction of the hair-line occurs. The hair in the central part of the vertex is rarefied and thin, and the skin becomes transparent. The alopecia progresses and sooner or later results in a bald spot on the vertex. The remaining hair is distributed in crown-like pattern above the ears and at the scruff of the neck. However, it also becomes gradually thinner and silky, and growing more slowly. Histological findings of the initial phase are characterized by focal perivascular basophil degeneration of connective tissue around the lower third of the anagen follicle. A perifollicular lymphocyte infiltrate then occurs. In the late stage, involution of all the structures in corium becomes apparent; the terminal hairs turn into subtle, vellus hairs, which are located higher in the dermis.

2. Low-Level Laser (Light) Therapy

In 1967 a few years after the first working laser was invented, Endre Mester in Semmelweis University, Budapest, Hungary decided to test if laser radiation might cause cancer in mice [1]. He shaved the hair off their backs, divided them into two groups and gave a laser treatment with a low powered ruby laser (694-nm) to one group. They did not get cancer and to his surprise the hair on the treated group grew back more quickly than the untreated group. This was the first demonstration of "laser biostimulation". Since then, medical treatment with coherent-light sources (lasers) or noncoherent light (light-emitting diodes, LEDs) has passed through its childhood and adolescence. Currently, low-level laser (or light) therapy (LLLT), also known as "cold laser", "soft laser", "biostimulation" or "photobiomodulation" — is considered part of light therapy as well as part of physical therapy. In fact, light therapy is one of the oldest therapeutic methods used by humans (historically as solar therapy by Egyptians, later as UV therapy for which Nils Finsen won the Nobel prize in 1904 [2]). The use of lasers and LEDs as light sources was the next step in the technological development of light therapy, which is now applied to many thousands of people worldwide each day. In LLLT the question is no longer whether light has biological effects but rather how energy from therapeutic lasers and LEDs works at the cellular and organism levels and what the optimal light parameters are for different uses of these light sources.

One important point that has been demonstrated by multiple studies in cell culture, animal models [3] and in clinical studies is the concept of a biphasic dose response with the total delivered light energy density (fluence). The reason why the technique is termed LOW-level is that there exists an optimal dose of light for any particular application, and dose lower than this optimum value, or more significantly, larger than the optimum value will have a diminished therapeutic outcome, or for high doses of light a negative outcome may result.