



B100 The Effects of Environmental Exposure on Human Scalp Hair Root Morphology

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After attending this presentation, attendees will gain a greater understanding of the manifestation of hair root degradation from isolated anagen and telogen hairs as a result of environmental exposure.

This presentation will impact the forensic community and/or humanity by shedding light on the fact that hairs from different growth phases are indeed susceptible to changes from environmental exposure. This will add an element of understanding about the interpretation of hair root degradation to microscopic hair examination. It also underscores the importance of hair as evidence in criminal investigations when it comes to classification of certain degradation patterns as being postmortem root bands or patterns resulting from environmental exposure.

The relevance of hair roots as evidence has long been established by forensic scientists, especially in areas of trace evidence examination and molecular biology. It has been shown that microscopic examination of a hair root can reveal information about the hair's growth phase, determine if it may have been unnaturally shed, or show evidence of decompositional changes. Other types of analyses with hair roots include sex-typing and nuclear DNA extraction to yield short tandem repeat profiles, which aid in identifying the subject possessing the hair. In order to glean this information from hair roots, it is important that the root be intact and not extensively altered by the external environment. Unfortunately, there is a dearth of work on hair root degradation. Some of the work that has been done includes examination of postmortem hair samples to assess the frequency of root banding patterns, as well as experimentation with conditions that give rise to decompositional changes in the root. This project explores the results of exposure to different experimental environments on hair root morphology.

In this study, a set of experiments examined the effects of environmental exposure on the morphology of human scalp hair roots taken from follicles in the anagen and telogen growth phases. Anagen phase represents active hair growth and is characterized by amorphous morphology and incomplete keratinization of the root end. Telogen phase represents the quiescent phase of hair growth, distinguished by complete keratinization of the root end. Human scalp hairs, submitted by volunteers, were examined and classified as being from follicles in the anagen or telogen growth phase. They were subsequently exposed to experimental environments of air exposure (negative control), soil burial, and pond water immersion. Examination of these hairs was performed with brightfield light microscopy. Because of the incomplete keratinization of anagen roots, it was postulated that they would be more susceptible to changes from environmental exposure. The results showed more advanced morphological alteration in anagen versus telogen roots in the soil and water environments. The initial experiment revealed certain patterns of change that arose after environmental exposure in four different subjects. The patterns consisted of banding, darkening, shriveling, and fraying. There was also evidence of adhering debris, including the presence of microorganisms, to the roots. Further experiments examined the progressive changes in hair root morphology over time in soil and water exposure. Changes in anagen roots often initially began as apparent shriveling and advanced to erosion of root structure, banding, or complete obliteration of the root structure. This progression began as early as 24 hours of exposure and was advanced at 4 days of exposure. Telogen roots were minimally affected by exposure, yielding only slight fraying and darkening of the root bulb even with the longest exposure times. In later experiments, sterilization of hairs and environments was introduced to determine whether nonsterile conditions produced earlier and more advanced degradation in hairs as compared to sterile conditions. The results showed that they did, suggesting that hair root morphology changes are at least partly attributable to microbial activity from the environment.

This study demonstrates the vulnerability of anagen roots to degradation after soil and water exposure. Certain patterns of change arose in these roots that suggested a breakdown in the structural integrity of the hair at the proximal end. While the causes for these degradation patterns are unknown, preliminary work here has demonstrated that microbial action is a contributor. Banding patterns that have arisen in isolated anagen hair roots exposed to certain environments bear a resemblance to published images of postmortem root banding. Since this issue has arisen in legal cases, there is a need for further research to determine the detailed causes of this banding pattern arising from microbial activity on isolated anagen hairs and on anagen hairs remaining *in situ* in scalp tissue from deceased individuals.

Hair Root Morphology, Environmental Exposure, Degradation