



B157 Microscopical and Ultrastructural Investigation Into Possible Chemical and/or Mechanical Degradation Mechanisms of Hair Roots Containing Induced Postmortem Root Band (PMRB) -Like Features

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After attending this presentation, attendees will understand the ability of various ionic and pH-specific buffers to elicit PMRB-like ultrastructural features in antemortem hairs as observed by light and scanning electron microscopy.

This presentation will impact the forensic science community by presenting possible mechanisms of hair root degradation for the formation of PMRBs with the goal of ultimately better understanding the complex processes that result in true PMRB formation *in situ*.

A PMRB is a microscopic feature that results from degradation of the pre-keratinized region of the roots of anagen and early catagen hairs obtained from cadavers.^{1,2} A PMRB is located *in situ* approximately 0.5mm from the root tip and is surrounded by root sheath issue. A PMRB forms due to degradation to the Intermacrofibrillar Matrix (IMM) (or cell membrane structures) in the cortex, resulting in elongated, gas-filled void spaces. Scanning Electron Microscope (SEM) analysis has shown that the degradation is confined to the cortex and does not extend to the hair cuticle.³ The morphology of the IMM degradation is highly complex; in some instances, the elongated void spaces are lined with jagged “saw-teeth” that are interpreted to be remnant IMM.³ These structures may be due to chemical degradation or perhaps represent “pull apart” structures resulting from the build-up of decomposition gas. Resolution of this premise may provide valuable insight into the mechanism of PMRB formation.

Prior work has shown that exposing human scalp hairs to slightly alkaline (pH 7-8) aqueous ammonium salt solutions results in degradation that is microscopically similar to that observed in known PMRBs.⁴ In addition, similar PMRB-like decomposition could also be achieved by immersing antemortem anagen head hair in various pH-specific (pH 6-8) aqueous buffers. The mechanism and manner for this decomposition is not known.

One hypothesized mechanism for *in vitro* band formation is the presence of the ammonium ions or ammonia gas that may chemically attack the IMM. Another hypothesis is that the change in hair pH, due to immersion in various buffers, may lead to IMM degradation/ collapse. Alternatively, decomposition gases may build up and subsequently become trapped inside the cortex, thus mechanically disrupting the integrity of the pre-keratinized region of the root. This process is hypothesized to be possible due to the presence of the root sheath or cuticle trapping the gas, preventing it from escaping from the hair into the surrounding tissue.

This work investigates whether the damage to the IMM is of chemical or mechanical origin and if the presence of the root sheath plays a role in the formation of PMRBs. To address this question, antemortem anagen hairs were obtained from living human donors. Hairs with root sheaths were included to better mimic *in situ* hair follicle conditions; hairs without root sheaths were included to investigate whether the root sheath is necessary for the development of PMRB-type degradation. Hairs were either left intact (controls) or embedded and sectioned by ultramicrotome. Hairs were then incubated in the following test solutions: 100mM ammonium acetate (pH 7.8); a



proportional mixture of sodium phosphate solutions (pH 7.8); or ultra-pure water. After three to ten days, the hairs were examined via light and electron microscopy.

Preliminary data suggest intact hairs with and without root sheaths exposed to the ammonium acetate and pH 7.8 solutions developed dark PMRB-like degradation similar in appearance to true PMRBs; these results agree with prior work.⁴ The hair samples immersed in ultra-pure water did not produce PMRB-like degradation. Next, in an attempt to investigate the potential effects of containment on the occurrence of IMM degradation, thin-sections of hair were immersed in the same solutions. If gas were produced while immersed in the various buffers it would not be able to build up in the hair shaft. These sections were compared to similarly prepared healthy anagen head hairs. Preliminary data suggest that the untreated and water-exposed head hairs exhibit little degradation to the cortex of the pre-keratinized region; however, hair sections immersed in ammonium acetate solutions, both with and without root sheath, do exhibit significant ellipsoidal voids similar to features seen in known PMRBs in the pre-keratinized region. Sectioned hairs exposed to the pH-matched buffer exhibit some voids, but these are less prominent than those observed in hairs exposed to ammonium acetate solutions. Taken together, these results suggest that ammonium may play a role in the chemical attack of the IMM and that mechanical damage due to gas buildup is a less likely mechanism for PMRB formation.

Reference(s):

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Postmortem Hair Root Banding, Hair Microscopy, Trace Evidence