K37 Analysis of Cocaine Analytes in Human Hair: Ultrastructural Evaluation of Human Hair by Microscopy for the Determination of Morphological Differences Following Surface Contamination and Laboratory Decontamination

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After attending this presentation, attendees will understand the morphological structure of different human hairs, the permeability of hairs and potential variations in drug absorbance, and how processes and procedures used by hair drug testing laboratories may affect hair morphology and consequently drug analyte concentrations in hair.

This presentation will impact the forensic science community by providing a better understanding of the relationship between hair morphology and the permeability of hair to drugs.

Introduction: The factors affecting the permeability of hair to drugs are not fully understood. In order to improve the analytical tools used in hair drug testing and better interpret the meaning of test results from that testing, research that examines the deposition of drugs onto hair, the factors that can contribute to drug deposition onto hair, and the role of environmental drug contamination is needed. If it is shown that hair color and or structure influences drug permeability, the current drug testing methods and interpretations may need to be modified in order to take these variations into account and remove any potential for bias and or unjustified accusation. The goal of this research is to examine the permeability of different hair types (color and ethnicities) to cocaine analytes by utilizing microscopy to help understand the relationship between hair structure and the extent of drug absorption.

Methods: Hairs (Caucasian light and dark hair types, African American; n=12 each) were contaminated with cocaine HCl powder. The structural differences between the hairs of the different types and ethnicities were visually examined before and after contamination and washing. Hairs from each sample were examined employing a variety of microscopy techniques including scanning electron microscopy (SEM), freeze fracturing combined with SEM, fluorescence microscopy, and brightfield microscopy. During fluorescence and brightfield microscopy, hairs were stained with methylene blue and rhodamine B and the extent of stain penetration examined.

Results: Multiple images were taken of each sample during examination with each microscopy technique and compiled into individual portfolios for comparison. Rhodamine B and methylene blue produced similar staining patterns when observed with bright field and fluorescent microscopy. Due to variations in excitation wavelengths, Rhodamine B fluoresced significantly better than methylene blue when examined with fluorescence microscopy. Significant differences were observed not only between hairs of different ethnicities, but between hairs within a single ethnicity as well. Deposition of dye was largely associated with the cuticular scale edges. In hair with damage or missing cuticle, the cortex was strongly stained. The thickness and number of cuticular scale layers were also examined between individuals and between ethnic groups. The SEM examination revealed ultrastructural details of the relationship between the cuticle and cortex, and demonstrated a wide variability in cuticle forms and delamination from the main hair body.

Conclusion: These preliminary data suggest that the collection of structural information from microscopic examination of hair may allow for the observed differences in hair morphology to be applied to differences in the permeability of hair to drugs. The information from this study may be useful to improve laboratory procedures employed by hair drug testing laboratories.

Hair Morphology, Drug and Dye Incorporation, Microscopy

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