F8 The Role of the Skin in Bite Marks, Part III: Microscopic Analysis

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In this presentation, microscopic methods of investigation into bite marks are assessed. This study represents a fundamental approach to obtaining the maximum information that could potentially link a dentition to a bite mark through the techniques of Optical, Scanning Electron (SEM), and Confocal Laser microscopy. As inspection of exemplars by microscopy requires the highest quality of model fabrication, an improved method of exemplar fabrication will also be discussed.

This presentation will impact the forensic science community by providing knowledge of microscopy methods, as well as, demonstration of the type of information that can be achieved with regard to bite mark analysis. These techniques will be discussed with application to both the teeth and the skin separately as well as transfer of the tooth surface to the skin.

If an object is viewed with increasing magnification, a point is reached at which detail is observed which renders that object unique. In the oft- quoted example, if a hundred identical objects (such as a ruler) were examined with sufficient resolution, they could all be considered different. This is true for both the skin and teeth.

Under magnification as little 20x-30x, individual characteristics and patterns on teeth can be recognized which undeniably render the surfaces unique. Under this level of enlargement, it is the small chips, angulations, restorations and wear patterns that give each tooth its own identity. Few would argue the uniqueness of the dentition on this level. If unique features of individual teeth transferred to the skin, and could be recognized by standard methodology, then investigators would have an additional means of exclusion or inclusion of a suspect.

However, skin is a poor recording medium that possesses a number of qualities that hinder registration of detail during and after infliction of a bite mark. Distortion due to the anisotropic mechanical properties, visco-elastic behavior and the hyteresis effect during rebound after the bite all compound to alter the possible detail transfer. The skin also possesses dynamic properties that result in the eventual healing and disappearance of bite mark evidence. Also the angulation of the tooth-skin contact may result in transfer of detail from unexpected features on a tooth, for example, the detail on a lingual surface may be evident, but not the detail from the incisal edge. The skin also possesses its own individual patterns which are unique to site on the body and between individuals. These are the primary, secondary and tertiary lines that comprise the topography of the epidermis.

Thus, a bite mark may be described as the superimposition of one pattern over another. Now that we can visualize the two patterns separately, is it possible to discern the combination of the patterns? The detail observable in teeth consists of irregular and geometrically complex shapes, whereas the skin has a repetitive, although still unique, surface topography. Attendees will appreciate the difficulties encountered in interpretation of a bite mark by microscopy.

The stereomicroscope is of particular utility in inspection of bite marks and teeth. The twin optical paths of the microscope result in a true three-dimensional view of a surface. Photographs taken with this instrument, however, use only one of the optical paths so the resulting image is two-dimensional. Oblique illumination can aid in visualizing shallow topography. The SEM uses a scanned electron beam to produce images of the sample surface. The SEM has superior depth of field and excellent resolution, allowing fine surface detail to be seen. The Confocal Laser microscope is an optical system with which a sequence of images with very shallow depth of field may be taken. The images may be stacked together to produce a true three-dimensional data set.

However, in order to use these microscopy techniques and visualize these minute details, exemplars of high quality, detail and resolution must be fabricated.

The standard method of impression collection using an extra light body polyvinylsiloxane (PVS) compound is used. A heavy body PVS backing may be applied if necessary, but no further stabilization is required. After cleaning in alcohol, the impression is poured with the resin. A low viscosity epoxy resin is then mixed and placed under vacuum to remove any admixed air. Because the resin has a water-like consistency it is possible to completely encase the impression without risk of distortion. The poured impression is then placed back in a vacuum. It is this step that helps to achieve the replication of detail with few bubbles in the model. If the model is being prepared for Confocal Microscopy, it would be necessary to add a fluorescent agent to the epoxy during the initial mixing stage. For this project, Eosin was used as the fluorescent agent.

Following curing the resin, the model is trimmed on a band saw and coated with gold. Gold coating is a standard preparation step for SEM, but it also renders the surface reflective and suitable for inspection by stereomicroscopy.

This method is applicable to any surface that needs to be replicated and is used in other branches of forensics such as tool mark analysis. This paper explores the application of microscopy in bite mark analysis and describes exemplar fabrication techniques. **Bite Marks, Bite Mark Research, Microscopy**

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