F19 Inquiry Into the Scientific Basis for Bite Mark Profiling and Arbitrary Distortion Correction

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The goal of this presentation is to illustrate the potential problems that can arise with bite mark profiling and arbitrary distortion correction of bite mark images.

This presentation will impact the forensic science community by providing data that demonstrates bite mark profiling, and arbitrary distortion correction of bite mark images, may not be advisable.

It is well known that distortion can occur in a bite mark. What may not be recognized is the limitation that this distortion can place on two potential tenets of bite mark analysis. Prediction of dental characteristics from a bite mark (bite mark profiling), and arbitrary distortion compensation are two practices that have been proposed in bite mark analysis. The assumption that a bite mark photograph can be arbitrarily altered to account for the tissue distortion is one theory. In this situation bite mark photograph is enlarged/decreased in attempt to correlate it to an unadulterated dental overlay of a suspect. A second supposition is that a profile can be generated from a bite mark in an attempt to anticipate the dental configuration of a biter. Recent research on the effect of inherent skin tension properties in bite mark analysis, however, suggests that these practices may be questionable.

One of the properties of skin responsible for distortion is anisotropy, meaning that skin possesses different properties in different directions. Thus in a bite mark, the transferred dental pattern can be distorted unequally in one direction, or another, due to the inherent pre- tension that exists in skin. Anisotropy itself can dictate the overall resultant configuration of a bite mark.

Skin pre-tension does not have a uniform distribution in a human body. Tension not only varies from person to person but also varies at a single site on the same individual. Tension is always greater parallel to tension lines and more relaxed perpendicular to them, resulting in anisotropy in skin. Therefore, the degree of distortion will not be uniform throughout a bite mark. There may be intra-arch as well as inter-arch distortion. The magnitude of these distortional changes can also vary considerably both within and between each arch.

To assess these issues, evaluation of 122 bites created on 11 human cadavers was completed. Of the 122 bites, 66 were selected for this study. Bite marks created to investigate issues such as postural distortion and laceration were excluded from this study, as the distortion in these bites would have been more extreme. Human Subject Institutional Review Board (HSIRB) exemption was granted for all phases of this project.

The bites were inflicted with models mounted to a handheld vice grip. The maximum anterior bite force capable of the vice grip was tested with a bite force transducer and found to be within the range of maximum anterior human biting capacity. This range was established by a volunteer's *in-vivo* test biting on the bite force transducer giving an average of 190N. This range was also consistent with studies of mean maximum anterior bite force.

Photography was performed with a Canon Rebel XTi 10.1 Mp digital camera. An ABFO #2 scale was in place for each photograph. Each photograph was sized 1:1 and metric and angular measurements were made to calculate the distortion that resulted. The changes for each bite were tabulated. Hollow volume overlay comparison was also performed. The experimental intra-observer measurement error was +/- 0.2mm for the inter-canine and mesial to distal distances, and +/- 2 degrees for the rotational angle difference.

For bite mark profiling, the photographs were analyzed, and any bite pattern that had a deviation great enough from the dentition of the biter that could be misleading for an investigator was included in this study.

Though some bite patterns reflected the biter's dental arrangement, in many instances the bite pattern, if profiled, would misdirect an investigator to a person that had features not present in the perpetrator's dentition. Of the 66 bites, 25 (38%) showed a change that could be misleading if profiled.

For arbitrary distortion compensation, three sets of three bite marks (each set produced on the same body part) were created with the same dentition and metric and angular measurements were made to calculate the distortion that resulted. The deviations for angle between teeth, mesial to distal length and inter-canine diameter for the six anterior maxillary and mandibular teeth tooth for each bite were tabulated. Hollow volume overlay comparison was also performed.

Arbitrarily and uniformly altering the bite mark photographs produced an inconsistent increase/decrease of dental features to the biter's dental overlay. This study indicated that arbitrary distortion of a bite mark photograph to "match" a dental overlay in an attempt to compensate for tissue distortion is not an appropriate technique. The anisotropic nature of human skin cannot at this time be precisely anticipated to arrive at a percentage enlargement or reduction of an image in any given direction. Results showed distortional ranges were non-uniform both between bites, as well as within each bite. Thus

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enlarging/decreasing the photograph uniformly would not correct the distortion that resulted.

There may be compelling evidence associated with a bite mark, including the presence of DNA, crime scene context, corroboration of victim accounts, timing of injury/death, exclusion, perpetrator identification, and other factors, which will continue to make bite mark evidence important in court. However, caution should be exercised in bite mark profiling as well as the enlargement/decrease of photographic bite mark evidence to correct for any skin distortion.

Forensic Odontology, Bite Mark Profiling, Bite Mark Distortion

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