

STRENGTHENING
**FORENSIC
SCIENCE**
IN THE UNITED STATES

A PATH FORWARD

Committee on Identifying the Needs of the Forensic Science Community

Committee on Science, Technology, and Law
Policy and Global Affairs

Committee on Applied and Theoretical Statistics
Division on Engineering and Physical Sciences

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By contrast, much more research is needed on the natural variability of burn patterns and damage characteristics and how they are affected by the presence of various accelerants. Despite the paucity of research, some arson investigators continue to make determinations about whether or not a particular fire was set. However, according to testimony presented to the committee,¹¹⁸ many of the rules of thumb that are typically assumed to indicate that an accelerant was used (e.g., “alligatoring” of wood, specific char patterns) have been shown not to be true.¹¹⁹ Experiments should be designed to put arson investigations on a more solid scientific footing.

FORENSIC ODONTOLOGY

Forensic odontology, the application of the science of dentistry to the field of law, includes several distinct areas of focus: the identification of unknown remains, bite mark comparison, the interpretation of oral injury, and dental malpractice. Bite mark comparison is often used in criminal prosecutions and is the most controversial of the four areas just mentioned. Although the identification of human remains by their dental characteristics is well established in the forensic science disciplines, there is continuing dispute over the value and scientific validity of comparing and identifying bite marks.¹²⁰

Many forensic odontologists providing criminal testimony concerning bite marks belong to the American Board of Forensic Odontology (ABFO), which was organized in 1976 and is recognized by the American Academy of Forensic Sciences as a forensic specialty. The ABFO offers board certification to its members.¹²¹

Sample Data and Collection

Bite marks are seen most often in cases of homicide, sexual assault, and child abuse. The ABFO has approved guidelines for the collection of evidence from bite mark victims and suspected biters.¹²² The techniques for obtaining bite mark evidence from human skin—for example, various forms of photography, dental casts, clear overlays, computer enhancement, electron microscopy, and swabbing for serology or DNA—generally are

¹¹⁸ J. Lentini. Scientific Fire Analysis, LLC. Presentation to the committee, April 23, 2007. Available at www7.nationalacademies.org/stl/April%20Forensic%20Lentini.pdf.

¹¹⁹ NFPA 921 Guide for Explosion and Fire Investigations, 2008 Edition. Quincy, MA: National Fire Protection Association.

¹²⁰ E.g., J.A. Kieser. 2005. Weighing bitemark evidence: A postmodern perspective. *Journal of Forensic Science, Medicine, and Pathology* 1(2):75-80.

¹²¹ American Board of Forensic Odontology at www.abfo.org.

¹²² Ibid.

well established and relatively noncontroversial. Unfortunately, bite marks on the skin will change over time and can be distorted by the elasticity of the skin, the unevenness of the surface bite, and swelling and healing. These features may severely limit the validity of forensic odontology. Also, some practical difficulties, such as distortions in photographs and changes over time in the dentition of suspects, may limit the accuracy of the results.¹²³

Analyses

The guidelines of the ABFO for the analysis of bite marks list a large number of methods for analysis, including transillumination of tissue, computer enhancement and/or digitalization of the bite mark or teeth, stereomicroscopy, scanning electron microscopy, video superimposition, and histology.¹²⁴ The guidelines, however, do not indicate the criteria necessary for using each method to determine whether the bite mark can be related to a person's dentition and with what degree of probability. There is no science on the reproducibility of the different methods of analysis that lead to conclusions about the probability of a match. This includes reproducibility between experts and with the same expert over time. Even when using the guidelines, different experts provide widely differing results and a high percentage of false positive matches of bite marks using controlled comparison studies.¹²⁵

No thorough study has been conducted of large populations to establish the uniqueness of bite marks; theoretical studies promoting the uniqueness theory include more teeth than are seen in most bite marks submitted for comparison. There is no central repository of bite marks and patterns. Most comparisons are made between the bite mark and dental casts of an individual or individuals of interest. Rarely are comparisons made between the bite mark and a number of models from other individuals in addition to those of the individual in question. If a bite mark is compared to a dental cast using the guidelines of the ABFO, and the suspect providing the dental cast cannot be eliminated as a person who could have made the bite, there is no established science indicating what percentage of the population or subgroup of the population could also have produced the bite. This follows from the basic problems inherent in bite mark analysis and interpretation.

As with other "experience-based" forensic methods, forensic odontology suffers from the potential for large bias among bite mark experts in evaluating a specific bite mark in cases in which police agencies provide the suspects for comparison and a limited number of models from which

¹²³ Rothwell, *op. cit.*

¹²⁴ American Board of Forensic Odontology, *op. cit.*

¹²⁵ Bowers, *op. cit.*

to choose from in comparing the evidence. Bite marks often are associated with highly sensationalized and prejudicial cases, and there can be a great deal of pressure on the examining expert to match a bite mark to a suspect. Blind comparisons and the use of a second expert are not widely used.

Scientific Interpretation and Reporting of Results

The ABFO has issued guidelines for reporting bite mark comparisons, including the use of terminology for conclusion levels, but there is no incentive or requirement that these guidelines be used in the criminal justice system. Testimony of experts generally is based on their experience and their particular method of analysis of the bite mark. Some convictions based mainly on testimony by experts indicating the identification of an individual based on a bite mark have been overturned as a result of the provision of compelling evidence to the contrary (usually DNA evidence).¹²⁶

More research is needed to confirm the fundamental basis for the science of bite mark comparison. Although forensic odontologists understand the anatomy of teeth and the mechanics of biting and can retrieve sufficient information from bite marks on skin to assist in criminal investigations and provide testimony at criminal trials, the scientific basis is insufficient to conclude that bite mark comparisons can result in a conclusive match. In fact, one of the standards of the ABFO for bite mark terminology is that, “Terms assuring unconditional identification of a perpetrator, or without doubt, are not sanctioned as a final conclusion.”¹²⁷

Some of the basic problems inherent in bite mark analysis and interpretation are as follows:

- (1) The uniqueness of the human dentition has not been scientifically established.¹²⁸
- (2) The ability of the dentition, if unique, to transfer a unique pattern to human skin and the ability of the skin to maintain that uniqueness has not been scientifically established.¹²⁹
 - i. The ability to analyze and interpret the scope or extent of distortion of bite mark patterns on human skin has not been demonstrated.
 - ii. The effect of distortion on different comparison techniques is not fully understood and therefore has not been quantified.

¹²⁶ Bowers, *op. cit.*

¹²⁷ American Board of Forensic Odontology, *op. cit.*

¹²⁸ Senn, *op. cit.*

¹²⁹ *Ibid.*

- (3) A standard for the type, quality, and number of individual characteristics required to indicate that a bite mark has reached a threshold of evidentiary value has not been established.

Summary Assessment

Despite the inherent weaknesses involved in bite mark comparison, it is reasonable to assume that the process can sometimes reliably exclude suspects. Although the methods of collection of bite mark evidence are relatively noncontroversial, there is considerable dispute about the value and reliability of the collected data for interpretation. Some of the key areas of dispute include the accuracy of human skin as a reliable registration material for bite marks, the uniqueness of human dentition, the techniques used for analysis, and the role of examiner bias.¹³⁰ The ABFO has developed guidelines for the analysis of bite marks in an effort to standardize analysis,¹³¹ but there is still no general agreement among practicing forensic odontologists about national or international standards for comparison.

Although the majority of forensic odontologists are satisfied that bite marks can demonstrate sufficient detail for positive identification,¹³² no scientific studies support this assessment, and no large population studies have been conducted. In numerous instances, experts diverge widely in their evaluations of the same bite mark evidence,¹³³ which has led to questioning of the value and scientific objectivity of such evidence.

Bite mark testimony has been criticized basically on the same grounds as testimony by questioned document examiners and microscopic hair examiners. The committee received no evidence of an existing scientific basis for identifying an individual to the exclusion of all others. That same finding was reported in a 2001 review, which “revealed a lack of valid evidence to support many of the assumptions made by forensic dentists during bite mark comparisons.”¹³⁴ Some research is warranted in order to identify the circumstances within which the methods of forensic odontology can provide probative value.

¹³⁰ Ibid.

¹³¹ American Board of Forensic Odontology, op. cit.

¹³² I.A. Pretty. 2003. A Web-based survey of odontologists' opinions concerning bite mark analyses. *Journal of Forensic Sciences* 48(5):1-4.

¹³³ C.M. Bowers. 2006. Problem-based analysis of bite mark misidentifications: The role of DNA. *Forensic Science International* 159 Supplement 1:s104-s109.

¹³⁴ I.A. Pretty and D. Sweet. 2001. The scientific basis for human bitemark analyses—A critical review. *Science and Justice* 41(2):85-92. Quotation taken from the abstract.