



**NIST Interagency Report
NIST IR 8352sup3**

**Summary of Published Criticisms of
Bitemark Foundations and
Responses by Forensic
Odontologists**

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Abstract

This report provides supplemental information to NISTIR 8352 **Bitemark Analysis: A *NIST Scientific Foundation Review***. This report summarizes the concerns raised about bitemark analysis by various groups including the National Academy of Sciences, the President's Council of Advisors on Science and Technology, and the Texas Forensic Science Commission. Responses given by members of the bitemark analysis community are also provided.

Keywords

bitemark; forensic science; forensic odontology; pattern evidence; dentition; scientific foundation review.

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1. Introduction

There have been several published criticisms of bitemark analysis over the years by various groups including the National Academy of Sciences, the President's Council of Advisors on Science and Technology, and the Texas Forensic Science Commission. Below are summarized some specific concerns raised and responses provided by members of the bitemark analysis community.

2. Published Criticisms

2.1. NRC 2009 Report

In 2009, the National Research Council (NRC), part of the National Academy of Sciences (NAS) published a report entitled *Strengthening Forensic Science in the United States: A Path Forward* (NRC 2009) that proposed 13 recommendations to improve the practice of forensic science, especially those areas involved in pattern analysis and feature comparison. The NRC report discusses forensic odontology and bitemark analysis on pages 173 through 176. Five articles were cited (Kieser 2005, Rothwell 1995, Pretty 2003, Bowers 2006, Pretty & Sweet 2001) along with a presentation given to the NAS Committee in April 2007 (Senn 2007).

Regarding bitemark analysis, the 2009 NRC Report found that current procedures are unable to reliably exclude or include suspects as potential matches. The report labeled bitemark comparison as “the most controversial area” of forensic odontology as there is a continuing dispute over the value and scientific validity of comparing and identifying bitemarks. The NRC Report pointed to several key limitations of bitemark analyses:

- Lack of research using large populations to determine the uniqueness of human dentition and degree of similarity; no error rates provided.
- Lack of blind comparisons.
- Uncommon use of a second expert.
- No establishment of the ability of dentition to transfer a unique pattern to skin or of the skin to maintain a unique impression.
- No established effect of distortions in bitemark patterns and the ability to analyze them.
- No thresholds for evidentiary value of type, quality, or number of individual characteristics needed.
- Large potential for examiner bias.
- No agreement among examiners about standards of comparison.

The report concludes that bitemark analysis has shown no evidence of a scientific basis for identifying an individual to the exclusion of all others. The scientific basis of these methods was “insufficient to conclude that bitemark comparisons can result in a conclusive match” (NRC 2009, p. 175).

In the intervening years, considerable limitations on establishing a scientific foundation for the methods remain.

2.2. PCAST 2016 Report

In 2016, the President’s Council of Advisors on Science and Technology (PCAST) published a report entitled *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature Comparison Methods*. This report evaluated the scientific validity of seven of the most often utilized feature comparison methods in the legal systems including DNA (single source, simple mixed, and complex mixed samples), fingerprint, bitemark, firearms, footwear, and hair analyses.

The report found that current scientific evidence suggests that examiners cannot accurately identify sources of bitemarks or whether marks were made by human teeth, and that there are no well-defined standards regarding the identification of features or degree of similarity needed to support reliable conclusions of a match or non-match. As a result, the conclusions are left to the judgment of the examiner and are open to potential bias. Therefore, the PCAST report concludes that the discipline of bitemark analysis is far from meeting the scientific standards for foundational validity.

While the PCAST report acknowledges that there is concern that the exclusion of bitemarks in court could hamper the ability to convict defendants, the report recommends that the solution to this is to not admit expert testimony based on invalid and unreliable methods, but instead attempts should be made to develop scientifically valid ones. However, the PCAST report expresses doubt at the discipline’s ability to do this and advises against devoting significant resources to such efforts.

2.3. Texas Forensic Science Commission

The Texas Forensic Science Commission (Austin, TX) published two reports related to bitemark analysis ([TXFSC 2016](#), [TXFSC 2017](#)). The first is a lengthy investigative report issued in response to a complaint filed by the Innocence Project on behalf of Steven Mark Chaney. This 1,303-page report contains a wealth of information and input from the American Board of Forensic Odontologists (ABFO) and other interested forensic odontologists, as well as from criminal justice stakeholders ([TXFSC 2016](#)). In November 2017, the Commission published a second report describing the results of a collaborative review of bitemark comparison cases in Texas ([TXFSC 2017](#)).

As a result of its review of published literature and related input from stakeholders, the Texas Forensic Science Commission recommends in its April 2016 report “that bitemark comparison not be admitted in criminal cases in Texas unless and until the following are established: (1) Criteria for identifying when a patterned injury constitutes a human bitemark... (2) Criteria for identifying whether a human bitemark was made by an adult versus a child... (3) Rigorous and appropriately validated proficiency testing using the above criteria. (4) A collaborative plan for case review including a multidisciplinary team of forensic odontologists and attorneys” ([TXFSC 2016](#), pp. 15-16).

This Commission report continues: “If subsequent published data supports the ability of forensic odontologists to identify human bitemarks reliably and accurately based on defined criteria and to distinguish between the bitemarks of adults and children reliably and accurately, the

Commission will revise its recommendations to reflect these developments...we must be vigilant to ensure the science used in criminal cases stands on a solid foundation of research and data, both for the benefit of victims and the accused” (TXFSC 2016, p. 17).

As of mid-2021, there have been no revisions to the above recommendations, and the ban on the use of bitemark evidence in Texas criminal cases remains in place. In fact, according to Lynn Garcia of the Texas Forensic Science Commission, there have been a series of subsequent court decisions, starting with *Ex parte Chaney* by the Texas Court of Criminal Appeals, where courts have overturned convictions resting on bitemark evidence due to the discrediting of the methods by the broader scientific community (see e.g., *People v. Prante*, 2021 WL 1381347 (Ill. App. Ct., 5th Dist. Apr. 12, 2021); *Howard v. Mississippi*, 300 So.3d 1011 (Miss. S.Ct. 2020); *Commonwealth v. Kunco*, 173 A.3d 817 (Pa.Super. 2017), *Ex parte Chaney*, 563 S.W.3d 239 (Tex. Crim. App. 2018), and *State v. Denton*, 2020 WL 7232303 (Ga., Super. Ct. Feb. 7, 2020).

2.4. Saks et al. 2016

An academic perspective on the status of bitemark analysis was provided in a 2016 article published in the *Journal of Law and the Biosciences* with 39 authors led by Professor Michael Saks from Arizona State University (Saks et al. 2016). Professor Saks and his colleagues highlighted the weak scientific foundations of bitemark analysis, specifically citing the field’s lack of research and lack of support provided by existing research. The authors conclude that no sound evidence exists to support the claim that forensic odontologists can accurately associate a bitemark to a single unique individual dentition and as the “notion of dental uniqueness, central to bitemark analysis [comes] into considerable doubt,...so does the claim that bitemark comparison can dependably link a bite mark to its source” (Saks et al. 2016).

Several of the issues they identified were also raised in earlier reports (NRC 2009, PCAST 2016):

- Lack of population frequency data and probability estimates for comparison of a bitemark with a suspect’s dentition.
- The substrate on which the bitemark pattern is transferred can distort the appearance of a bitemark pattern. Human skin for example, can distort the image due to its elasticity, unevenness, and healing response.
- Lack of reliable and valid methods utilized in the comparison process as well as lack of widespread standardization and specific inclusion/exclusion criteria.
- Potential for bias among practitioners and lack of implementation of bias-reducing methods (e.g., blind comparisons, use of a second examiner).
- Lack of support for the assumption that dental characteristics are unique and identifiable to the individual level.

As discussed below, follow-up to this article in the published literature includes an ABFO response (Barsley et al. 2018) and a law review article (Zalman & Windell 2019/2020).

3. Responses to Criticism

3.1. ABFO 2011 Responses to the Subcommittee on Forensic Science

In response to the problems identified in the 2009 NRC report, the White House Office of Science and Technology Policy (OSTP) coordinated the establishment of the Subcommittee on Forensic Science (SoFS) under the National Science and Technology Council (NSTC). The goal was to identify challenges and ways to address the NRC report recommendations (see [Butler 2015](#)).

SoFS established five interagency working groups. One of which, the Research, Development, Testing, and Evaluation Interagency Working Group (RDT&E IWG), asked forensic practitioners to provide examples of foundational literature that supported the methods used within their disciplines. Representatives of 10 forensic disciplines responded with annotated bibliographies (see [Butler 2015](#)).

These annotated bibliographies have been archived on the NIST website¹. They provide practitioner perspective for a given discipline at the time provided and were given in response to specific questions raised by the RDT&E IWG. The bibliographies did not undergo further review or analysis when they were received by the RDT&E IWG and are not endorsed by the federal government. On October 2, 2011, the American Board of Forensic Odontology (ABFO) supplied a 62-page response to 18 questions on bitemark analysis ([ABFO 2011](#)).

The 18 questions were as follows:

- 1) What is the literature on bitemark production and the factors that affect it, including but not limited to body location, elasticity and contour, age, health factors, coagulation status, intermediate material (i.e., clothing), time, and force?
- 2) What is the literature on the experimental and computational models of bitemark analysis and what validation studies have been conducted to support these?
- 3) What is the literature on validation studies of bitemark analysis such as blind trials, concordance rate between and among examiners, correlation with DNA studies, witnesses, and/or video recordings of incidents?
- 4) What is the literature on potential changes in bitemark analysis from orthodontic treatment, other dental treatments, and time delays in analysis?
- 5) What empiric studies of bitemark analysis error rates exist in the literature?
- 6) What is the literature on quantitative measures, measurement imprecision, and uncertainty of bitemark analysis including but not limited to individual tooth measurements and total pattern measurements? What is the literature on reproducibility between examiners, between institutions, and by the same examiner over time in blinded and double-blinded trials?

¹ See <https://www.nist.gov/topics/forensic-science/working-groups/legacy-scientific-working-groups>

- 7) What is the literature on frequency statistics of class and subclass dental characteristics in various populations? What is the literature on thresholds or limitations on bitemark analysis (e.g., population pools, size, bitemark quality, etc.)?
- 8) What interpretation guidelines exist for bitemark analysis? What is the literature to support these guidelines? Areas include but are not limited to standardized protocols, standard measurements, imaging procedures, performance, interpretation, reporting, and quality assurance, variations between individual examiners, institutions, and by a single examiner over time. Is there literature that describes a numeric threshold for identification? Is there literature that describes what is (or should be) the scientific validation of this threshold?
- 9) What is the literature on the perceptual and cognitive human factors of bitemark examiners and the potential and actual (or empiric) bias involved in bitemark interpretation?
- 10) Is there literature that describes performance differences between certified examiners and examiners who are not certified?
- 11) What is the literature on the evolution of bitemarks in living persons (in both persistence and healing changes over time) and in deceased persons (in both persistence and decompositional changes over time)? What is the literature on the variables (i.e., age, health, body location, nutrition, etc.) regarding evolution of bitemarks? What is the literature on the variables (i.e., lividity, tattoos, race, patterns, age, health, body location, nutrition, onset of decomposition, etc.) regarding bitemarks in deceased individuals?
- 12) What is the literature comparing bitemark analysis on the bodies of deceased individuals, analysis of excised tissue with the bitemark, and any supplemental testing (i.e., histology, DNA, analysis of dermal components, etc.) available in deceased individuals?
- 13) What is the literature on the factors which contribute to distortion of bitemarks (hydration, temperature, location and body contour, dermatoses, bite force and duration, postmortem positioning, etc.)?
- 14) What is the literature on supplemental and trace evidence (such as DNA, foreign material, etc.) that may be a component of bitemark analysis and interpretation?
- 15) What is the literature to support digital image processing of bitemarks for bitemark analysis? What traceable standards exist for digital image processing of bitemarks and the literature to support this?
- 16) What is the literature to support spectral imaging of bitemarks for bitemark analysis?
- 17) What are the research needs in bitemark analysis and what areas of research should receive the highest priority?
- 18) What are the technical needs to advance the science of bitemark analysis?

In 2011, the ABFO responded to these 18 questions raised by the SoFS RDT&E IWG with an annotated bibliography reflecting the state of the field at the time ([ABFO 2011](#)). The majority of

the cited references are peer-reviewed empirical journal articles from *Journal of Forensic Sciences*, *Forensic Science International*, *Science & Justice*, *Journal of Clinical Pathology*, and *International Journal of Forensic Dentistry* or edited volumes such as *Bitemark Evidence* (Dorion 2011) and *Manual of Forensic Odontology* (Bowers & Bell 1995).

However, the sources listed for question two, concerning existing experimental models and validation studies, were overwhelmingly taken from presentations given at the American Academy of Forensic Sciences annual meetings. A particular downside to this type of source material is that aside from the abstracts, the information in those presentations is unavailable unless subsequently published. Additionally, while seemingly comprehensive at the time, this annotated bibliography was completed in 2011 and therefore, literature published after that date is not included.

3.2. ABFO 2018 Response to Saks et al. 2016

In a 2018 editorial titled “Epidermis and Enamel: Insights into Gnawing Criticisms of Human Bitemark Evidence” published in the *American Journal of Forensic Medicine and Pathology*, members of the forensic odontology community shared that critics of bitemark evidence have ignored progress made in standards, terminology, and taking steps to reduce bias (Barsley et al. 2018). These bitemark advocates claimed that a more “conservative” approach has been adopted in recent years. This editorial provides a path forward from their perspective that discusses (1) standards and guidelines, (2) knowledge transfer and education, (3) research, (4) certification, (5) proficiency tests, and (6) casework assessment of the quality, quantity, and significance of the materials involved (Barsley et al. 2018).

The following year a law review article titled “The Bite Mark Dentists and the Counterattack on Forensic Science Reform” (Zalman & Windell 2019) discussed the ABFO response (Barsley et al. 2018) to Saks et al. 2016. This law review notes that the ABFO response is “riddled with logical flaws; [fails] to critically address scientific analyses showing the unreliability of bitemark analysis; erroneously [deflects] criticism of bite-mark (in)accuracy by noting that wrongful convictions often have multiple causes; [mischaracterizes] social scientific research; falsely [claims] that a number of exonerations were not wrongful convictions; [is] highly defensive; [cites] the testimonials of supporters; and [defames] its critics” (Zalman & Windell 2019).

4. References Cited

- [ABFO 2011] RDT&E IWG Human Bitemark Analysis Question List. Available at <https://www.nist.gov/system/files/documents/forensics/Annotated-Bibliography-Odontology.pdf> (accessed July 5, 2022).
- Barsley RE, Bernstein ML, Brumit PC, Dorion RBJ, Golden GS, Lewis JM, McDowell JD, Metcalf RD, Senn DR, Sweet D, Weems RA (2018) Epidermis and enamel: insights into gnawing criticisms of human bitemark evidence. *American Journal of Forensic Medicine and Pathology* 39(2):87-97.
- Bowers CM and Bell G (1995) *Manual of Forensic Odontology, Third Edition*. Colorado Springs: American Society of Forensic Odontology.
- Bowers CM (2006) Problem-based analysis of bitemark misidentifications: the role of DNA. *Forensic Science International* 159:S104-S109.
- Butler JM (2015) U.S. initiatives to strengthen forensic science & international standards in forensic DNA. *Forensic Science International: Genetics* 18:4-20. <https://doi.org/10.1016/j.fsigen.2015.06.008>.
- Dorion RBJ (editor) (2011) *Bitemark Evidence: A Color Atlas and Text, Second Edition*. CRC Press: Boca Raton.
- Kieser JA (2005) Weighing bitemark evidence: A postmodern perspective. *Forensic Science, Medicine, and Pathology* 1(2):75-80.
- [NRC 2009] National Research Council (2009) *Strengthening Forensic Science in the United States: A Path Forward*. National Academies Press, Washington, D.C.
- [PCAST 2016] President's Council of Advisors on Science and Technology (PCAST) (September 20, 2016) *Report to the President: Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods*. Available at https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf (accessed July 5, 2022).
- Pretty IA, Sweet D (2001) The scientific basis for human bitemark analyses—a critical review. *Science & Justice* 41(2):85-92.
- Pretty IA (2003) A web-based survey of odontologist's opinions concerning bitemark analyses. *Journal of Forensic Sciences* 48(5):1117-1120.
- Rothwell BR (1995) Bite marks in forensic dentistry: a review of legal, scientific issues. *Journal of the American Dental Association* 126(2): 223-232.
- Saks MJ, Albright T, Bohan TL, Bierer BE, Bowers CM, Bush MA, Bush PJ, Casadevall A, Cole SA, Denton MB, Diamond SS, Dioso-Villa R, Epstein J, Faigman D, Faigman L, Fienberg SE, Garrett BL, Giannelli PC, Greely HT, Imwinkelried E, Jamieson A, Kafadar K, Kassirer JP, Koehler J, Korn D, Mnookin J, Morrison AB, Murphy E, Peerwani N, Peterson JL, Risinger DM, Sensabaugh GF, Spiegelman C, Stern H, Thompson WC, Wayman JL, Zabell S, Zumwalt RE (2016) Forensic bitemark identification: weak foundations, exaggerated claims. *Journal of Law and the Biosciences* 3(3):538-575. doi:10.1093/jlb/lsw045.

Senn DR (2007) Presentation on Forensic Odontology: Bite Marks. National Academies: Committee on Identifying the Needs of the Forensic Science Community, Meeting 2. Washington, D.C., April 23, 2007.

[TXFSC 2016] Texas Forensic Science Commission (2016) Forensic Bitemark Comparison Complaint Filed by National Innocence Project on Behalf of Steven Mark Chaney – Final Report. Available at <https://www.txcourts.gov/media/1454500/finalbitemarkreport.pdf> (1303 pages, 100 MB file; accessed on July 5, 2022).

[TXFSC 2017] Texas Forensic Science Commission (2017) Bite Mark Case Review Report. Available at <https://www.txcourts.gov/media/1445768/bite-mark-review-report.pdf> (15 pages, 667 kb file; accessed July 5, 2022).

Zalman M, Windell J (2019/2020) The bite mark dentists and the counterattack on forensic science reform. Albany Law Review 83:749-829.