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

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IX. Bite Mark Evidence

Bite mark analysis has been used for more than 50 years to establish a connection between a defendant and a crime. The specialty developed within the field of forensic dentistry as an adjunct of dental identification, rather than originating in

295. E.g., State v. Dillon, 161 N.W.2d 738, 741 (Iowa 1968) (screwdriver and nail bar fit marks on door frame); State v. Wesling, 150 N.W.2d 301 (Iowa 1967) (screwdriver); State v. Hazelwood, 498 P.2d 607, 612 (Kan. 1972) (screwdriver and imprint on window molding); State v. Wade, 465 S.W.2d 498, 499-500 (Mo. 1971) (screwdriver and pry marks on door jamb); State v. Brown, 291 S.W.2d 615, 618-19 (Mo. 1956) (crowbar and screwdriver marks on window sash and door); State v. Ekmeier, 191 N.W.2d 815, 816 (Neb. 1971) (screwdriver and marks on door).


300. For example, in United States v. Murphy, 996 F.2d 94 (5th Cir. 1993), an FBI expert gave limited testimony "that the tools such as the screwdriver associated with Murphy 'could have made the marks on the ignitions but that he could not positively attribute the marks to the tools identified with Murphy.' Id. at 99; see also State v. Gancirich, 928 P.2d 799, 802 (Colo. App. 1996) (upholding expert testimony that three different sets of pliers recovered from the accused's house were used to cut wire and fasten a cap found in the debris from pipe bombs: "The expert's premise, that no two tools make exactly the same mark, is not challenged by any evidence in this record. Hence, the lack of a database and points of comparison does not render the opinion inadmissible.").

Although most courts have been receptive to toolmark evidence, a notable exception was Ramirez v. State, 810 So. 2d 836, 849-51 (Fla. 2001). In Ramirez, the Florida Supreme Court rejected the testimony of five experts who claimed general acceptance for a process of matching a knife with a cartridge wound in a murder victim—a type of "toolmark" comparison. Although the court applied Frye, it emphasized the lack of testing, the paucity of "meaningful peer review," the absence of a quantified error rate, and the lack of developed objective standards. In Sexton v. State, 93 S.W.3d 96 (Tex. Crim. App. 2002), an expert testified that cartridge cases from unofficial bullets found in the appellant's apartment had distinct marks that matched fired cartridge cases found at the scene of the offense. The court ruled the testimony inadmissible: "This record qualifies Crumley as a firearm identification expert, but does not support his capacity to identify cartridge cases on the basis of magazine marks only." Id. at 101.

crime laboratories. Courts have admitted bite mark comparison evidence in homicide, rape, and child abuse cases. In virtually all the cases, the evidence was first offered by the prosecution. The typical bite mark case has involved the identification of the defendant by matching his dentition with a mark left on the victim. In several cases, however, the victim’s teeth have been compared with marks on the defendant’s body. One bite mark case involved dentures\(^{302}\) and another braces.\(^{303}\) A few cases have entailed bite impressions on foodstuffs found at a crime scene: apple,\(^{304}\) piece of cheese,\(^{305}\) and sandwich.\(^{306}\) Still other cases involved dog bites.\(^{307}\)

Bite marks occur primarily in sex-related crimes, child abuse cases, and offenses involving physical alterations, such as homicide. A survey of 101 cases reported these findings: “More than one bitemark was present in 48% of all the bite cases studied. Bitemarks were found on adults in 81.3% of the cases and on children under 18 years-of-age in 16.7% of cases. Bitemarks were associated with the following types of crimes: murder, including attempted murder (53.9%), rape (20.8%), sexual assault (9.7%), child abuse (9.7%), burglary (3.3%), and kidnapping (12.6%).”\(^{308}\)

### A. The Technique

Bite mark identification is an offshoot of the dental identification of decedent persons, which is often used in mass disasters. Dental identification is based on the assumption that every person’s dentition is unique. The human adult dentition consists of 32 teeth, each with 5 anatomic surfaces. Thus, there are 160 dental surfaces that can contain identifying characteristics. Restorations, with varying shapes, sizes, and restorative materials, may offer numerous additional points of individuality. Moreover, the number of teeth, prostheses, decay, malposition,

\(^{302}\) See Rogers v. State, 344 S.E.2d 644, 647 (Ga. 1986) ("Bite marks on one of Rogers’ arms were consistent with the dentures worn by the elderly victim.").

\(^{303}\) See People v. Shaw, 664 N.E.2d 97, 101, 103 (Ill. App. Ct. 1996) (In a murder and aggravated sexual assault prosecution, the forensic odontologist opined that the mark on the defendant was caused by the orthodontic braces on the victim’s teeth; “Dr. Kenney admitted that he was not a certified odontomark examiner: no abuse of discretion to admit evidence”).

\(^{304}\) See State v. Ortiz, 502 A.2d 400, 401 (Conn. 1985).

\(^{305}\) See Doyle v. State, 263 S.W.2d 777, 779 (Tex. Crim. App. 1954); Seivewright v. State, 7 P.3d 24, 26 (Wyo. 2000) ("On the basis of his comparison of the impressions from the cheese with Seivewright’s dentition, Dr. Huber concluded that Seivewright was the person who bit the cheese.").

\(^{306}\) See Banks v. State, 725 S.W.2d 711, 714–16 (Miss. 1987) (finding a due process violation when prosecution expert threw away sandwich after finding the accused’s teeth consistent with the sandwich bite).

\(^{307}\) See Davasher v. State, 323 S.W.2d 863, 870 (Ark. 1992) (expert testified that victim’s dog could be eliminated as the source of mark found on defendant); State v. Powell, 446 S.E.2d 26, 27–28 (N.C. 1994) ("A forensic odontologist testified that dental impressions taken from Bruno and Woody [accused’s dog] were compatible with some of the lacerations in the wounds pictured in scale photographs of Prevette’s body.").


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malrotation, peculiar shapes, root canal therapy, bone patterns, bite relationship, and oral pathology may also provide identifying characteristics.\(^{309}\) The courts have accepted dental identification as a means of establishing the identity of a homicide victim,\(^{310}\) with some cases dating back to the nineteenth century.\(^{311}\) According to one court, "it cannot be seriously disputed that a dental structure may constitute a means of identifying a deceased person . . . where there is some dental record of that person with which the structure may be compared."\(^{312}\)

1. Theory of uniqueness

Identification of a suspect by matching his or her dentition with a bite mark found on the victim of a crime rests on the theory that each person’s dentition is unique. However, there are significant differences between the use of forensic dental techniques to identify a decedent and the use of bite mark analysis to identify a perpetrator.\(^{313}\) In 1969, when bite mark comparisons were first studied, one authority raised the following problems:

[Bite]marks can never be taken to reproduce accurately the dental features of the originator. This is due partially to the fact that bite marks generally include only a limited number of teeth. Furthermore, the material (whether food stuff or human skin) in which the mark has been left is usually found to be a very unsatisfactory impression material with shrinkage and distortion characteristics that are unknown. Finally, these marks represent only the remaining and fixed picture of an action, the mechanism of which may vary from case to case. For instance, there is as yet no precise knowledge of the possible differences between biting off a morsel of food and using one’s teeth for purposes of attack or defense.\(^{314}\)

309. The identification is made by comparing the deceased’s teeth with antemortem dental records, such as charts and, more importantly, radiographs.

310. E.g., Wooley v. People, 367 P.2d 903, 905 (Colo. 1961) (dentist compared his patient’s record with dentition of a corpse); Martin v. State, 636 N.E.2d 1268, 1272 (Ind. Ct. App. 1994) (dentist qualified to compare X rays of one of his patients with skeletal remains of murder victim and make a positive identification); Fields v. State, 322 P.2d 431, 446 (Okla. Crim. App. 1958) (murder case in which victim was burned beyond recognition).

311. See Commonwealth v. Webster, 59 Mass. (5 Cush.) 295, 299–300 (1859) (remains of the incinerated victim, including charred teeth and parts of a denture, were identified by the victim’s dentist); Lindsay v. People, 63 N.Y. 143, 145–46 (1875).


314. S. Reiser-Nikison, Forensic Odontology, 1 U. Tol. L. Rev. 633, 636 (1969); see also NRDC. Forensic Science Report, supra note 3, at 174 ("[B]ite 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.").
Dental identifications of decedents do not pose any of these problems; the expert can often compare all 32 teeth with X rays depicting all those teeth. However, in the typical bite mark case, all 32 teeth cannot be compared; often only 4 to 8 are biting teeth that can be compared. Similarly, all five anatomic surfaces are not engaged in biting; only the edges of the front teeth come into play. In sum, bite mark identification depends not only on the uniqueness of each person’s dentition but also on “whether there is a [sufficient] representation of that uniqueness in the mark found on the skin or other inanimate object.”

2. Methods of comparison

Several methods of bite mark analysis have been reported. All involve three steps: (1) registration of both the bite mark and the suspect’s dentition, (2) comparison of the dentition and bite mark, and (3) evaluation of the points of similarity or dissimilarity. The reproductions of the bite mark and the suspect’s dentition are analyzed through a variety of methods. The comparison may be either direct or indirect. A model of the suspect’s teeth is used in direct comparisons; the model is compared to life-size photographs of the bite mark. Transparencies made from the model are used in indirect comparisons.

Although the expert’s conclusions are based on objective data, the ultimate opinion regarding individuation is essentially a subjective one. There is no accepted minimum number of points of identity required for a positive identification. The experts who have appeared in published bite mark cases have testified to a wide range of points of similarity, from a low of eight points to a


316. See David J. Sweet, *Human Bite Marks: Examination, Recovery, and Analysis*, in Manual of Forensic Odontology 162 (American Society of Forensic Odontology, 3d ed. 1997) [hereinafter ASFO Manual] ("The analytical protocol for bite mark comparison is made up of two broad categories. Firstly, the measurement of specific traits and features called a metric analysis, and secondly, the physical matching or comparison of the configuration and pattern of the injury called a pattern association."); see also David J. Sweet & C. Michael Bowers, *Accuracy of Bite Mark Overlays: A Comparison of Five Common Methods to Produce Exemplars from a Suspect’s Dentition*, 43 J. Forensic Sci. 362, 362 (1998) ("A review of the forensic odontology literature reveals multiple techniques for overlay production. There is an absence of reliability testing or comparison of these methods to known or reference standards.").

317. See Roland F. Koubbe & Geoffrey T. Craig, *A Comparison Between Direct and Indirect Methods Available for Human Bite Mark Analysis*, 49 J. Forensic Sci. 111, 111 (2004) ("It is important to remember that computer-generated overlays still retain an element of subjectivity, as the selection of the biting edge profiles is reliant on the operator placing the ‘magic wand’ onto the areas to be highlighted within the digitized image.").

318. See Reiter-Nelson, supra note 314, at 637–38; see also Stohs v. State, 845 So. 2d 656, 669 (Miss. 2003) ("There is little consensus in the scientific community on the number of points which must match before any positive identification can be announced.").
high of 52 points. Moreover, disagreements among experts in court appear commonplace: "Although bite mark evidence has demonstrated a high degree of acceptance, it continues to be hotly contested in 'battles of the experts.' Review of trial transcripts reveals that distortion and the interpretation of distortion is a factor in most cases." Because of the subjectivity, some odontologists have argued that "bitemark evidence should only be used to exclude a suspect. This argument is supported by research which shows that the exclusion of non-biter within a population of suspects is extremely accurate; far more so than the positive identification of biter."  

3. ABFO Guidelines

In an attempt to develop an objective method, in 1984 the American Board of Forensic Odontology (ABFO) promulgated guidelines for bite mark analysis, including a uniform scoring system. According to the drafting committee, "[t]he scoring system has demonstrated a method of evaluation that produced a high degree of reliability among observers." Moreover, the committee characterized "[t]he scoring guide as the beginning of a truly scientific approach to bite mark analysis." In a subsequent letter, however, the drafting committee wrote:

While the Board's published guidelines suggest use of the scoring system, the authors' present recommendation is that all odontologists await the results of further research before relying on precise point counts in evidentiary proceedings. . . . [T]he authors believe that further research is needed regarding the quantification of bite mark evidence before precise point counts can be relied upon in court proceedings.  


320. Raymond D. Rawson et al., Analysis of Photographic Distortion in Bite Marks: A Report of the Bite Mark Guidelines Committee, 31 J. Forensic Sci. 1261, 1261–62 (1986). The committee noted: "[P]hotograph distortion can be very difficult to understand and interpret when viewing prints of bite marks that have been photographed from unknown angles." Id. at 1267.


324. Id.

B. The Empirical Record

The 2009 NRC report concluded:

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.326

Moreover, “[t]here is no science on the reproducibility of the different methods of analysis that lead to conclusions about the probability of a match.”327 Another passage provides: “Despite the inherent weaknesses involved in bite mark comparison, it is reasonable to assume that the process can sometimes reliably exclude suspects.”328

Although bite mark identifications are accepted by forensic dentists, only a few empirical studies have been conducted329 and only a small number of forensic dentists have addressed the empirical issue. In the words of one expert,

The research suggests that bite mark evidence, at least that which is used to identify biters, is a potentially valid and reliable methodology. It is generally accepted within the scientific [dental] community, although the basis of this acceptance within the peer-reviewed literature is thin. Only three studies have examined the ability of odontologists to utilise bites marks for the identification of biters, and only two studies have been performed in what could be considered a contemporary framework of attitudes and techniques.330

326. NRC Forensic Science Report, supra note 3, at 175. See also id. at 176. (“Although the majority of forensic odontologists are satisfied that bite marks can demonstrate sufficient detail for positive identification, no scientific studies support this assessment, and no large population studies have been conducted.”)
327. Id. at 174.
328. Id. at 176.
329. See C. Michael Bowers, Forensic Dental Evidence: An Investigator's Handbook 189 (2004) (“As a number of legal commentators have observed, bite mark analysis has never passed through the rigorous scientific examination that is common to most sciences. The literature does not go far in disputing that claim.”); Iain A. Pretty, Unresolved Issues in BiteMark Analysis, in BiteMark Evidence 547, 547 (Robert B.J. Dorion ed., 2005) (“As a general rule, case reports add little to the scientific knowledge base, and therefore, if these, along with nonscientific reviews, are discarded, very little new empirical evidence has been developed in the past five years.”); id. at 561 (“[T]he final question in the recent survey asked, 'Should an appropriately trained individual positively identify a suspect from a bite mark on skin'—70% of the respondents stated yes. However, it is the judicial system that must assess validity, reliability, and a sound scientific basis for expert forensic testimony. A great deal of further research is required if odontology hopes to continue to be a generally accepted science.”).
Commentators have highlighted the following areas of controversy: "a) accuracy of the bitmark itself, b) uniqueness of the human dentition, and c) analytical techniques."

One part of a 1975 study involved identification of bites made on pigskin: "Incorrect identification of the bites made on pigskin ranged from 24% incorrect identifications under ideal laboratory conditions to as high as 91% incorrect identifications when the bites were photographed 24 hours after the bites made." A 1999 ABFO Workshop, "where ABFO diplomats attempted to match four bitemarks to seven dental models, resulted in 63.5% false positives." A 2001 study of bites on pigskin "found false positive identifications of 11.9–22.0% for various groups of forensic odontologists (15.9% false positives for ABFO diplomats), with some ABFO diplomats scoring far worse." Other commentators take a more favorable view of these studies.

1. DNA exoneration

In several cases, subsequent DNA testing has demonstrated the error in a prior bite mark identification. In State v. Krone, two experienced experts concluded that the defendant had made the bite mark found on a murder victim. The defendant, however, was later exonerated through DNA testing. In Otero v. Warlick, a forensic dentist testified that the "plaintiff was the only person in the world who...

331. Pretty & Sweet, supra note 313, at 87. Commentators had questioned the lack of research in the field as long ago as 1985. Two commentators wrote:

There is effectively no valid documented scientific data to support the hypothesis that bite marks are demonstrably unique. Additionally, there is no documented scientific data to support the hypothesis that a latent bite mark, like a latent fingerprint, is a true and accurate reflection of this uniqueness. To the contrary, what little scientific evidence that does exist clearly supports the conclusion that crime-related bite marks are grossly distorted, inaccurate, and therefore unreliable as a method of identification.


334. Bowers, Problem-Based Analysis, supra note 332, at S106 (citing Iain A. Pretty & David J. Sweet, Digital Bitemark Overlays—An Analysis of Effectiveness, 46 J. Forensic Sci. 1265, 1290 (2001) (“While the overall effectiveness of overlays has been established, the variation in individual performance of odontologists is of concern.”)).

335. See Pretty, Reliability of Bitemark Evidence, supra note 330, at 538–42.

336. 957 P.2d 621, 622, 623 (Ariz. 1995) ("The bite marks were crucial to the State's case because there was very little other evidence to suggest Krone's guilt."); "Another State dental expert, Dr. John Pakos, also said that Krone made the bite marks. . . . Dr. Raymond himself said that Krone made the bite marks. . . ."


C. Case Law Development

People v. Marx (1975) emerged as the leading bite mark case. After Marx, bite mark evidence became widely accepted. By 1992, it had been introduced or noted in 193 reported cases and accepted as admissible in 35 states. Some courts described bite mark comparison as a "science," and several cases took judicial notice of its validity.

339. Id. at 178.
340. 405 F.3d 66, 73 (1st Cir. 2005).
341. See also Bowers, Prothonotary Analysis, supra note 332, at 5104 (citing several cases involving bite marks and DNA exonerations; Gates, Bannier, Morris, Knorr, Otene, Young, and Dever); Mark Hansen, Out of the Blue, A.B.A. 50, 51 (1996) (DNA analysis of skin taken from fingernail punctures of the victim conclusively excluded Bourne). 
342. See Pretty, Wib-Bed Jone, supra note 321, at 1119 ("The use of DNA in the assessment of bite marks has been established for some time, although previous studies have suggested that the uptake of this technique has been slow. It is encouraging to note that nearly half of the respondents in this case have employed biological evidence in a bite mark case.").
343. 126 Cal. Rptr. 350 (Cal. Ct. App. 1973). The court in Marx avoided applying the Frye test, which requires acceptance of a novel technique by the scientific community as a prerequisite to admissibility. According to the court, the Frye test "finds its rational basis in the degree to which the trier of fact must accept, on faith, scientific hypotheses not capable of proof or disproof in court and not even generally accepted outside the courtroom." Id. at 355-56.
344. Two Australian cases, however, excluded bite mark evidence. See Lewis v. The Queen (1987) 29 A. Crim. R. 267 (odontological evidence was improperly relied on, in that this method had not been scientifically accepted); R v. Carroll (1985) 19 A. Crim. R. 410 ("The evidence given by the three odontologists is such that it would be unsafe or dangerous to allow a verdict based upon it to stand.").
346. See People v. Marsh, 441 N.W.2d 33, 35 (Mich. Ct. App. 1989) ("the science of bite mark analysis has been extensively reviewed in other jurisdictions"); State v. Sager, 600 S.W.2d 541, 569 (Mo. Ct. App. 1980) ("an exact science").
1. Specificity of opinion

In some cases, experts testified only that a bite mark was "consistent with" the defendant's teeth. In other cases, they went further and opined that it is "highly probable" or "very highly probable" that the defendant made the mark. In still other cases, experts made positive identifications (to the exclusion of all other persons). It is not unusual to find experts disagreeing in individual cases—often over the threshold question of whether a wound was even a bite mark.
2. Post-Daubert cases

Although some commentators questioned the underlying basis for the technique after Daubert, courts have continued to admit the evidence.

X. Microscopic Hair Evidence

The first reported use of forensic hair analysis occurred more than 150 years ago in 1861 in Germany. The first published American opinion was an 1882 Wisconsin decision, Knoll v. State. Based on a microscopic comparison, the expert testified that the hair samples shared a common source. Hair and the closely related fiber analysis played a prominent role in two of the most famous twentieth-century American prosecutions: Ted Bundy in Florida and Wayne Williams, the alleged Atlanta child killer. Although hair comparison evidence has been judicially accepted for decades, it is another forensic identification discipline that is being reappraised today.

A. The Technique

Generally, after assessing whether a sample is a hair and not a fiber, an analyst may be able to determine: (1) whether the hair is of human or animal origin, (2) the part of the body that the hair came from, (3) whether the hair has been dyed, (4) whether the hair was pulled or fell out as a result of natural causes or disease, and (5) whether the hair was cut or crushed.

352. See Pretty & Sweet, supra note 313, at 86 ("Despite the continued acceptance of bitemark evidence in European, Oceanic and North American Courts the fundamental scientific basis for bite-mark analysis has never been established.").

353. See State v. Timmendequas, 737 A.2d 55, 114 (N.J. 1999) ("Judicial opinion from other jurisdictions establish that bite-mark analysis has gained general acceptance and therefore is reliable. Over thirty states considering such evidence have found it admissible and no state has rejected bite-mark evidence as unreliable." (citations omitted)); Shubh v. State, 853 So. 2d 670; Howard v. State, 853 So. 2d 781, 795-96 (Miss. 2003); Seiwert v. State, 7 P.3d 24, 30 (Wyo. 2000) ("Given the wide acceptance of bite mark identification testimony and Seiwert's failure to present evidence challenging the methodology, we find no abuse of discretion in the district court's refusal to hold an evidentiary hearing to analyze Dr. Huber's testimony.").

354. E. James Crocker, True Evidence, in Forensic Evidence in Canada 259, 265 (1991) (the analyst was Rudolf Virchow, a Berliner).

355. 12 N.W. 369 (Wis. 1882).


357. See Delaware v. Fennewald, 474 U.S. 15, 16-17 (1985) (FBI analyst testified hair found at murder scene had been forcibly removed).

358. See 2 Giannelli & Imwinkelried, supra note 177, § 24-2.