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# THE JUDICIAL VIEW OF BITEMARKS WITHIN THE UNITED STATES CRIMINAL JUSTICE SYSTEM

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## ABSTRACT

When examining most traditional sciences a thorough review of the relevant primary literature is usually sufficient to provide the investigator with a sound insight into the discipline. Forensic science differs in this regard, as it is presented in two main arenas: the peer-reviewed forensic journals and the Courts of Law where testimony is proffered. Because of this duality of scientific assessment the following legal review is presented. The review analysed Appellate Court rulings from the United States and identified trends of objections to bitemark testimony.

Nine major trends were identified within the cases assessed: bitemark evidence not sufficiently reliable or accepted, arguments regarding the uniqueness of the human dentition, constitutional arguments, inflammatory photographs, inaccuracy of techniques and errors in protocol, use of historical bitemarks and previous biting behavior, funds for defence witnesses and objections pertaining to witness credibility.

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## INTRODUCTION

A recent study showed that 42% of bitemark cases handled by forensic dentists resulted in a Court appearance.[1] The acceptance of bitemark evidence into the Court system and the qualification of forensic dentists as experts are essential to the continued development of the discipline. It is also essential that forensic dentists ensure that their testimony in Court strengthens the discipline rather than sets negative precedents.

In 1978 Hale wrote a paper entitled "The Admissibility of Bite Mark Evidence", which was published in the Southern Californian Law Review.[2] This extensively cited article concluded that the admissibility of bitemark evidence should be barred until forensic odontologists produced policies for the analysis of bitemarks. This work was partly responsible for the creation of the American Board of Forensic Odontology (ABFO) working committees on bitemark standards, initiated to satisfy the recommendations of Hale and others.[3] This review analyses the U.S. Appellate literature to see if such a conclusion should still be reached today. Areas of investigation centre on the admissibility of bitemark evidence and the acceptance of forensic odontologists as expert witnesses.

## METHOD

Using the Lexis® database* American Appellate law was used to review the legal position. Appellate cases chosen as lower Court proceedings are rarely published unless new law is being established. The Freestyle™ search engine on the Lexis/Nexis database* using the "Mega" library of US Appeals identified cases. The search terms used were "Bite", "Mark", and "Odontologist". Following examination of the cases, it was found that the admission of bitemark evidence within the U.S. legal system is commonplace. Cases were identified where bitemark evidence was proven unreliable or unfairly prejudicial to the defendant.

## THE ADMISSION OF BITEMARK EVIDENCE IN THE U.S. COURTS

Bitemark identification, as it is most commonly referred to in legal terms, has been virtually unanimously admitted by the Courts. Indeed, most U.S. jurisdictions have allowed such testimony. Table 1 provides a state-by-state summary of the number of bitemark cases used in this review.

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***Table 1:*** *Distribution of the Appellate bitemark cases examined by U.S. State*

| STATE | NUMBER OF CASES | STATE | NUMBER OF CASES |
|---|---|---|---|
| Alabama | 2 | Nevada | 3 |
| Arizona | 2 | New Jersey | 1 |
| Arkansas | 3 | New York | 5 |
| California | 5 | North Carolina | 4 |
| Connecticut | 2 | Ohio | 3 |
| Florida | 5 | Oklahoma | 4 |
| Georgia | 2 | Oregon | 3 |
| Illinois | 13 | Pennsylvania | 2 |
| Indiana | 2 | Rhode Island | 1 |
| Kansas | 2 | South Carolina | 1 |
| Louisiana | 2 | Tennessee | 1 |
| Massachusetts | 1 | Texas | 7 |
| Michigan | 1 | Vermont | 1 |
| Military Cases | 2 | Virginia | 2 |
| Minnesota | 1 | Washington | 4 |
| Mississippi | 7 | West Virginia | 1 |
| Missouri | 5 | Wisconsin | 1 |

**The Historical Basis for the Admissibility of Bitemark Evidence**

While *Doyle* v. *State*[4] represented the first bitemark case in modern U.S. legal history, it did not examine the scientific basis for the admissibility of the evidence. A critical review of the bitemark literature found that the scientific issues surrounding bitemark evidence can be summarised as the uniqueness of the human dentition, its rendition on the bitten substrate, the use of statistical evidence and the lack of a consistent method of analysis.[5] *People* v. *Marx*[6] is generally regarded as the landmark case for bitemark evidence. However, it is interesting to note that more contemporary cases have cited *Doyle* as the basis for rejecting arguments for unproven reliability and acceptance.[7]

The *Marx* case involved the murder of an elderly woman who sustained a bitemark on her nose that, following exhumation of the body, was examined by four forensic odontologists, three of which presented for the prosecution. The case is well described in the Journal of Forensic Sciences.[8] All three witnesses for the prosecution testified that the defendant caused the bite and an attempt was made to demonstrate the significance of Marx's highly unusual dentition. At appeal, the defence stated that the techniques and skills utilised were not generally accepted and therefore should have failed the *Frye*[9] test. The appeals Court stated that they considered the use of bitemarks as novel, although the techniques employed were not i.e., photographs, models, and radiographs. The Court went further by stating that unlike some other forensic disciplines, "… the Court did not have to sacrifice its independence and common sense in evaluating it".[6]

This implied that the jury could perform their own analyses by examining the methods that the forensic dentists had used, and they did not require the expert to explain the nuances of the techniques to them. The evidence was, in essence, self-explanatory. The Court did not state that experience in bitemark analysis, nor the knowledge of the gross, class and unique characteristics of teeth were required by the jury in order to properly assess the *value* of the evidence. They justified this statement by comparing bitemark analysis, which employs (for the main part physical exemplars) with that of polygraph evidence stating that the trier-of-fact (usually the jury) had to rely entirely on the testimony of the polygrapher with only "marks on paper" to verify the claims being made.[8] The result of this reliance on the expert would lead to the jury sacrificing its independence in deference to the expert. One can argue that the provision of scaled photographs and overlays to a jury is problematic and the temptation for members to conduct their own analysis is high; yet this would be undertaken without the scientific understanding to permit the results to be properly interpreted.

It is interesting to note that an expert is called precisely for their knowledge and to aid the jury.[10] Indeed many forensic dentists may be unsettled with the thought that once the physical exemplars are collected, no further expertise is required.[6] This case initiated the premise that bitemarks should be admitted although the weight of such evidence should be carefully examined by the trier-of-fact. The *Marx* Court also commented on the experts' enthusiasm to develop or extend forensic dentistry into the area of bitemark identification. It is useful to note that the *Marx* holding stated that ".. the theory of bitemark indentification is…based on an assessment of the probability that two or more people could leave the same bitemark" The term *probability* is one steeped in statistical nuance and there are no published scientific studies that have presented evidence for the calculation of probabilities in relation to bitemark suspects.[6] Before *Marx* forensic odontological work had largely been limited to the identification of found remains by dental records.

An Indiana Court also compared bitemark identification with polygraph techniques finding that bitemark comparison was simply the examination of items of physical evidence to see if they were reciprocal.[11] The methods of achieving this comparison, while complex, were determined to be accurate. As a concise statement of the current status of bitemark admissibility the following, written in 1981, serves well:

> "The reliability of bite mark evidence as a means of identification is sufficiently established in the scientific community to make such evidence admissible in a criminal case, without separately establishing scientific reliability in each case, but subject to the establishment by foundation evidence of the authenticity of the materials used and propriety of the procedure followed in the particular case and to cross-examination intended to test the reliability of the conclusion reached in that case".[12]

It should be noted that this case employed the *Frye*[9] rule which has now been superceded by *Daubert;* [13] however, the general acceptance of bitemark evidence persists and there is still a continuing acceptance of the scientific credibility of bitemark evidence. A number of high profile US cases featuring bitemarks are currently under review due to the post-trial testing of DNA samples that have demonstrated that the convicted individual may not have been responsible for the crime. The outcomes of these appeals may well challenge this general acceptance.

## APPELATE CASE ASSESSMENT OF BITEMARK EVIDENCE ADMISSIBILITY

Following an examination of the admission issues for bitemarks it is possible to isolate several important trends pertaining to bitemark admissibility from the 103 cases examined. These are: bitemark evidence not sufficiently reliable or accepted, arguments regarding the uniqueness of the human dentition, constitutional arguments, inflammatory photographs, inaccuracy of techniques and errors in protocol, use of historical bitemarks and previous biting behaviour, funds for defence witnesses and objections pertaining to witness credibility. Each of the areas is discussed, with accompanying examples, below. Further case law examples illustrating each of the trends are provided in Table 2, with a full citation list provided in Table 3.

### Bitemark evidence not sufficiently reliable or accepted

This argument is frequently used by defence teams attempting to bar the admission of incriminating bitemark evidence and, despite many years of uninterrupted bitemark admission, was used as recently as 1997.[14] One of the pervasive reasons for refusing appeals on this basis is that once a scientific method has been accepted as reliable under one *Frye*[9] hearing then general acceptance has been established. Judge Cox[15] stated that bitemarks have been so overwhelmingly accepted by the Courts that a proponent need not establish the principle of general acceptance on each occasion.

The case of *State* v. *Hodgson*[16] is significant as it was the first appeal case to examine bitemark evidence in the light of the *Daubert* ruling. Convicted of two counts of first-degree murder, Hodgson appealed the admissibility of the odontological evidence linking a bitemark on his arm to one of the decedents. Arguing that bitemark evidence was not generally accepted he claimed that the science did not meet the requirements of *Frye*. The Court disagreed with Hodgson stating that *Daubert* and FRE 702 [17] had superseded *Frye*[9] and that they were satisfied that bitemark evidence by an accepted expert was neither novel nor an emerging science and thus was admitted correctly. Following *Marx* and *Hodgson* no bitemark evidence has been refused admission due to arguments regarding *Frye,* FRE, or *Daubert.* It should be noted that the Kumho Tire case[18] further influenced the application of *Daubert* by stating that the gatekeeper role of the judge was not limited to *novel* scientific testimony; leaving the possibility that the scientific credibility of bitemark analyses could be revisited. In essence *Kumho* provides trial judges a broad discretion to apply any and all useful factors in determining the reliability of proffered evidence. Table 2 provides a reference list for bitemark cases that feature this objection.

***Table 2:*** *Index to illustrative cases, grouped by issue of admissibility*

| ISSUE OF ADMISSIBILITY | ILLUSTRATIVE CASES FROM TABLE 3 |
|---|---|
| Bitemark evidence not sufficiently reliable or established. Abuse of Court discretion in admitting testimony and evidence | 4, 5, 6, 8, 10, 11, 14, 15, 17, 18, 23, 25, 26, 29, 31, 32, 40, 44, 45, 46, 50, 53, 57, 58, 61, 64, 67, 68, 70, 75, 80, 82, 87, 88, 95, 98 |
| Arguments regarding the uniqueness of the human dentition | 3, 9, 15, 20 |
| Constitutional argument (5th Amendment) improper seizure of exemplars | 1, 4, 17, 27, 48, 51, 56, 60, 94, 98 |
| Photographs of bitemark eviodence inflammatory | 7, 10, 18, 33, 52, 86, 88 |
| Ubaccyract if tecgbuqyes Errors in bitemark protocol | 2, 9, 13, 19, 80, 97 |
| Use of previous bitemarks or evidence of previous biting behaviour | 22, 30, 54, 86, 88, 89, 103 |
| Defence requesting prosecution's testimony or funds for own witness | 28, 34, 41, 43, 73, 74, 85, 92 |
| Witness prejudiced or other witness related objections | 32, 33, 34, 58, 61, 62, 91, 97, 102 |

**Arguments regarding the uniqueness of the human dentition**

Several appellants have raised the issue of the uniqueness of the human dentition (or lack thereof) as an argument against the admission of bitemark evidence. In *State* v. *Garrison*[19], the appellant argued that the testimony of the forensic dentist, who stated that the probability of the bitemarks not being made by Garrison was 8 in 1,000,000, was unreliable and flawed. When questioned regarding the validity of the stated probability the witness testified that the figure had been arrived at following consultation of several leading textbooks and journal articles. It is likely that the figure was obtained from the work of McFarlane *et al* who, in an example, stated that the probability of another individual having the same dentition as their volunteer was 1 in 800,000.[20, 21]

The majority opinion in this case stated that experts quoting from books or articles fell under the hearsay exception for learned treatises, and thus the point of appeal was overturned. It is interesting, however, to examine the dissenting opinion in this appeal. Justices Gordon and Cameron noted that the witness had neither performed any of his own mathematical calculations nor was he aware of any of the formulae used to derive the quoted figures. The expert's ignorance of the statistical weighting that should be given to each variable used in the equation and his inability to replicate the findings in Court were serious shortcomings of his testimony.

The Justices carried out a literature search and were unable to locate the articles or formulae to which the witness alluded. The dissenting opinion continued by describing the inherent difficulties of determining the uniqueness of the human dentition and in particular the hazards of applying the product rule. Gordon and Cameron concluded that witnesses who offered statements representing direct quotes from books or similar materials should only be permitted to do so if the referenced sources were available to the Court and opposing council. Within the published literature there is considerable evidence that the human dentition is unique.[22] However, little of this research has assessed or described the unique features of the anterior teeth, i.e. those involved in the biting process. Even if one concedes that the anterior dentition is unique the greater question is the degree to which these unique features are recorded on the bitten substrate; for example human skin.[22] Table 2 provides a reference list for bitemark cases that feature this objection.

**Constitutional arguments. Improper seizure of exemplars**

The Fifth Amendment, that forms the basis of most constitutional appeals against bitemark evidence, states that no person shall be compelled to be a witness against himself. A case example of the Fifth Amendment in a bitemark appeal can be found in *State* v. *Sapsford*[23], an appeal against a conviction of three counts of rape and one count each of attempted aggravated murder and felonious sexual penetration. Sapsford claimed that he was compelled to submit to dental impressions that resulted in the production of exemplars making him the source of incriminating evidence. Using this argument, he claimed that such compulsion was in violation of his Fifth Amendment privilege against self-incrimination. Examining this point the Court overturned his claim by stating that the Fifth Amendment privilege extended only to communicative or testimonial acts and not to the taking of dental exemplars. In this manner, dental impressions did not differ from the taking of fingerprints, photographs, or blood.[23]

In an attempt to use the protective shield of self-incrimination to overturn the admission of bitemark evidence, Asherman[24] stated that the Connecticut State Constitution offered further protection than the Fifth Amendment . Claiming that the use of the word "evidence" rather than "witness" in the State Constitution extended the protection to non-testimonial evidence, Asherman appealed his conviction. The Judges disagreed and found the nature, spirit, and principle of the two statements were the same. They noted that some jurisdictions had widened the meaning of such clauses by finding that evidence that required the defendant to perform an affirmative act should be excluded.[24] This wider interpretation would allow dental impressions and fingerprint samples but would not allow handwriting or speech samples. Table 2 provides a reference list for bitemark cases that feature this objection.

**Photographs of bitemark evidence inflammatory**

Photographs play a crucial role in both the analysis and subsequent Court presentation of bitemark injuries. It is usually essential to the expert witnesses' testimony that such photographs are available for demonstration to the jury. Defendants frequently object to the display of such images in Court. *State* v. *Kendrick*[25] offers a typical example of such an appeal.

During the original trial against Kendrick, the dental expert presented testimony regarding a bitemark that

***Table 3:*** *U.S. Appeal Cases examined with citation*

| CASE No, NAME and CITATION | CASE No, NAME and CITATION |
|---|---|
| [L1] Doyle v. State, 159 Texas, C.R.310, 263 S.W.2d 779 (Jan. 20, 1954)<br>[L2] People v. Johnson, 8 Ill. App.3d 457, 289 N.E.2d 772 (Nov. 16, 1972)<br>[L3] People v. Marx, 54 Cal. App.3d 100, 126 Cal. Rptr. 350 (Dec. 29, 1975)<br>[L4] People v. Milone, 43 Ill. App.3d 385, 356 N.E.2d 531 (Apr.7 1976)<br>[L5] State v. Routh, 30 Or. App.3d 901, 568 P.2d 704 (Sep. 12, 1977)<br>[L6] Niehaus v. State, 265 Ind. 655, 359 N.E.2d 513 (Jan 25, 1977)<br>[L7] People v. Watson, 75 Cal. App.3d 384, 142 Cal. Rptr. 134 (Nov. 28, 1977)<br>[L8] People v. Slone, 76 Cal. App.3d 611, 143 Cal. Rptr 61 (Jan. 6 1978)<br>[L9] State v. Garrison, 120 Ariz. 255, 585 P.2d 563 (Sept. 20 1978)<br>[L10] State v. Howe, 136 Vt. 53, 386 A.2d 1125 (Mar 15, 1978)<br>[L11] State v. Jones, 273 S.C. 723, 259 S.E. 2d 120 (Oct. 11 1979)<br>[L12] Deutscher v. State, 95 Nov. 669, 601 P.2d 407 (Oct. 18 1979)<br>[L13] State v. Peoples, 227 Kan. 127, 60S P.2d 135 (Jan. 19, 1980)<br>[L14] State v. Kleypas, 602 S.W.2d 863 (Mo. App.) (July. 10, 1980)<br>[L15] State v. Sager, 600 S.W.2d 541 (Mo. App.) (May 5, 1980)<br>[L16] People v. Geer, 624, S.W.2d 143; (Mo. App.) (Sep. 22, 1981)<br>[L17] People v. Middleton, 54 N.Y.2d 42, 429 N.E.2d 100 (Oct. 27, 1981)<br>[L18] State v. Temple, 302 NC.I., 273 S.E.2d 273 (Jan. 6, 1981)<br>[L19] State v. Green, 305 N.C. 463, 290 S.E.2d 625 (May 4, 1982)<br>[L20] Bludsworth v. State, 98 Nev. 289, 646 P.2d 558 (June 18, 1982)<br>[L21] State v. Turner, 633 S.W.2d 421 (Mo. App) (Mar. 2 1982)<br>[L22] United States v. Martin, 13 M.J. 66 (CMA 1982) (Apr. 19, 1982)<br>[L23] Kennedy v. State, 640 P.2d 971 (Oklahoma) (Feb. 3, 1982)<br>[L24] People v. Queen, 108 Ill. App.3d 1088, 440 N.E.2d 126 (July 13, 1982)<br>[L25] Aguilar v. State, 98 Nev. 18, 639 P.2d 533 (Jan. 28, 1982) | [L50] Jackson v. State, 511 So.2d 1047 (Fla. App.) (Aug. 7, 1987)<br>[L51] People v. Dace, 153 Ill. App. 3d 891, 506 N.E.2d 280 (Apr. 3 1987)<br>[L52] State v. Kendrick, 47 Wash. App. 620, 736 P.2d 1079 (May 11, 1987)<br>[L53] Handley v. State, 515 So.2d 121, Court of Appeal of Alabama (June 30, 1987)<br>[L54] People v. Wachal, 156 Ill. App. 3d 331, 509 N.E.2d 648 (May 29, 1987)<br>[L55] State v. Vital, 505 So.2d 1006 (La. App.) (Apr. 9, 1987)<br>[L56] Marquez v. State, 725 S.W.2d 217 (Tex. Cr. App.) (Jan. 14, 1987)<br>[L57] Harward v. Commonwealth, 5 Va. App. 468, 364 S.E.2d 5Il (Jan. 19, 1988)<br>[L58] Mitchell v. State, 527, So.2d 179 (Fla. Sup. Ct) (May 19, 1988)<br>[L59] State v. Pierce, Slip opinion not designated for publication, Supreme Court<br>[L60] DuBoise v. State, 520 So.2d 260 (Fla. Sup. Ct) (Feb 4, 1988)<br>[L61] State v. Armstrong, 369 S.E.2d 870 (W.Va.)<br>[L62] Bromley v. State, 380 S.E.2d 694 (Ga. 1989) (June 30, 1989)<br>[L63] United States v. Sergeant Rickey J. Covington. ACM 27337<br>[L64] People v. Marsh, 441 N.W.2d 33 (Mich. App. 1989) (May 15, 1989)<br>[L65] Chaney v. State, 775 S.W.2d 722 (Texas App. Dallas) (July 5, 1989)<br>[L66] State v. Richards, 166 Ariz. 576, 804 P.2d 109 (Aug. 7, 1990)<br>[L67] People v. Calabro, 555 N.Y.S2d 321, 161 A.D.2d 375 (May 15, 1990)<br>[L68] Spence v. State, 795 S.W.2d 743 (Tex. Crim. App.) (June 13, 1990)<br>[L69] Litaker v. State, 784 S.W.2d 739 (Tex. App.) (Feb. 21, 1990)<br>[L70] Commonwealth v. Henry, 524 Pa, 135, 569 A.2d9 929 (Feb. 8, 1990)<br>[L71] State v. Moen, 110 Ore. App. 372; 822 P.2d 762 (Dec. 18, 1991)<br>[L72] Salazar v. State, Slip opinion (Tex. App. Houston) (Jan, 16, 1991)<br>[L73] Wilhoit v. State, 809 P.2d 1322 (Ct. of Crim. App. Of Okla) (April 16, 1991)<br>[L74] Washington v. State, 863 P.2d 673; 1992 Okla. Crim. App.<br>[L75] State v. Burgos, 53 Ill. 2d 218; 606 N.E.2d 1201 (Nov 19, 1992)<br>[L76] Harris v. State, Slip opinion (Arkansas App.) (Nov 18, 1992) |

[L26]Commonwealth v. Graves, 310 Pa. Super 184; 456 A.2d 561 (Feb. 4, 1983)
[L27]State v. Sapsford, 22 Ohio App.3d 1 (Nov. 9, 1983)
[L28]State v. Stokes, 433 So.2d, 29 (La. 1983) (May 23, 1983)
[L29]People v. Bethune, 484 N.Y.S. 2d 577. 105 A.D.2d 262 (Dec. 31, 1984)
[L30]People v. Smith, 63 N.Y.2d 41, 468 N.E.2d 879 (July 2, 1984)
[L31]Bradford v. State, 460 So.2d 926 (Fla. App. 2d Dist. 1984) (Nov. 30, 1984)
[L32]Bundy v. State, 455 So.2d 330 (Florida Sup. Ct.) (June 21, 1984)
[L33]State v. Asherman, 193 Conn. 695, 478 A.2d 227 (July 17, 1984)
[L34]State v. Adams, A.2d 218 (R.I. 1981) (Aug. 21, 1984)
[L35]People v. Williams, 128 Ill. App.3d 384, 470 N.E.2d 1140 (Oct. 22, 1984)
[L36]Smith v. State, 253 Ga. 536, 322 S.E.2d 492 (Nov. 16, 1984)
[L37]State v. Carter, 74 N.C.App 437, 328 S.E.2d 607 (May 7, 1985)
[L38]State v. Dickson, 691 S.W.2d 334 (Mo. App. 1985) (April 2, 1985)
[L39]Tuggle v. Commonwealth, 230 Va. 99, 334 S.E.2d 838 (Sept. 6, 1985)
[L40]State v. Ortiz, 198 Conn. 220, 502 A.2d 40Q (Dec. 31, 1985)
[L41]Standridge v. State, 701 P.2d 761 (Okl. Cr. 1985) (June 6. 1985)
[L42]State v. Johnson, 317 N.C. 343, 346 S.E.2d 596 (Aug. 12, 1986)
[L43]McCrory v. State, 505 So.2d 1272 (Ala. Cr. App) (Dec. 9, 1986)
[L44]State v. Stinson, 134 Wis. 2d 224, 397 N.W.2d 136 (Oct. 28, 1986)
[L45]People v. Pante, 147 Ill. App.3d 1039, 498 N.E.2d 889 (Oct. 3. 1986)
[L46]Commonwealth v. Cifizzari, 397 Mass. 560, 492 N.E.2d 357 (May 14, 1986)
[L47]State v. Bingham, 105 Wash. 2d 820, 719 P.2d 109 (Wash.1986) (May 15 1986)
[L48]Wade v. State, 490 N.E.2d 1097 (Ind. 1986) (April 3, 1986)
[L49]People v. Walkey, 177 Cal. App. 3d 268, 223 Cal. Rptr. 132 (Cal. App., 4th Dist) (Jan. 23, 1986)
[L77]State v. Lyons,124 Ore. App. 598; 863 P.2d 1303; 1993 Ore. App.
[L78]Davis v. State, 611 So. 2d 906 (Miss. Sup. Ct.) (Dec. 17, 1992)
[L79]Williams v. State, 829 S.W.2d 216, (Tex. Crim. App. En Blanc) (April 1992)
[L80]People v. Holmes. 234 Ill. App. 3d 931, 601 N.E. 2d 985 (Sept. 8, 1992)
[L81]State v. Hill, 64 Ohio St. 3d 313 (Dec, 11, 1992)
[L82]Verdict v. State, 315 Ark. 436, 868 S.W.2d 443 (Dec. 20, 1992)
[L83]State v. Welburn, Slip opinion (Ohio App.) (Nov. 17, 1993)
[L84]People v. Gallo, 260 Ill. App. 3d 1032, 632 N.E.2d 99 (Mar. 18, 1994)
[L85]Harrison v. State, 635 So.2d 894 (Miss. Sup. Ct.) (Apr. 14, 1994)
[L86]Kinney v. State, 315 Ark.481, 868 S.W.2d 463 (Jan. 10, 1994)
[L87]State v. Hodgson, 512 N.W.2d 95 (Minn. Sup. Ct.) (Feb. 11, 1994)
[L88]State v. Cazes, 875 S.W.2d 253;Tenn (Feb. 14, 1994)
[L89]State v. Noguera, 512 U.S. 1253; 114 S.Ct. 2780; (Feb. 20, 1994)
[L90]People v. Brown, 162 Misc. 2d 555, 618 N.Y.S.2d 188 (N.Y. Co. Ct.) (1994)
[L91]State v. Warness, 77 Wash. App. 636, 893 P.2d 665 (May 1, 1995)
[L92]State v. Krone, 182 Ariz. 319, 897 P.2d 621 (Ariz. Sup. Ct) (June 22, 1995)
[L93]Naples v. State, 666 So. 2d 763 (1995)
[L94]State v. Payne, 282 Ill. App. 3d 307; 667 N.E.2d 643; 199 Ill. App.
[L95]State v. Shaw, 278 Ill. App. 3d 939; 664 N.E.2d 97; 199 Ill. App.
[L96]Rios v. State, Unpublished opinion. 04-96-00375-CR
[L97]Banks v. State, 725 So. 2d 711; (1997)
[L98]Howard v. State, 697 So. 2d 415; (1997)
[L99]State v. Kiser, 87 Wash. App. 126; 940 P.2d 308; (1997)
[L100]Walters v. State, 720 So.2d 856; (1998)
[L101]State v. Steward, 179 Ill. 2d 611; 705 N.E.2d 447; (1998)
[L102]Brewer v. State, 725 So.2d 106; (19978)
[L103]State v. Fortin, 318 N.J. Super. 577; 724 A.2d 818; (1999)

involved over 180 exhibits, including numerous photographs. Kendrick argued that several of the photographs, including those of his mouth, should not have been admitted, as they were unnecessarily gruesome. The Court examined the photographs of the victims (including shots depicting the bitemarks) and found that they were indeed gruesome, but not overly so. They accurately depicted the horrific nature of the two victims' last moments and so were determined to be probative. The Court stated that violent crimes could not be explained to the jury in a "lily-white" manner.[26] Kendrick particularly objected to the photographs of his mouth that were taken using cheek retractors on the grounds that it made him look "vampirish". The Court stated that the photographs were essential aids to the often complex testimony of the forensic odontologists. The reasons for the use of the cheek retractors were carefully explained and thus the Judges concluded that the photographs were correctly admitted in the original trial. Table 2 provides a reference list for bitemark cases that feature this objection.

**Inaccuracy of techniques and errors in bitemark protocol**

Defendants in Court can question the accuracy of the techniques involved in the analysis of bitemark injuries. A representative case is that of *State* v. *Peoples*[27] in which Peoples, on appeal, challenged the accuracy of the exhibits and models used by the forensic dentist in arriving at his conclusions. Peoples' concerns were centred on the enlargement of a series of photographs and the production of plaster models of his teeth. The Court carefully assessed the exhibits and the techniques used to produce them and found no error in the original trial to admit them into evidence. The Court stated that any doubts regarding the accuracy of the exhibits should be applied to the weight of the evidence and not dictate its admissibility. It should be noted that forensic dentists must be prepared to defend the accuracy of their exhibits and be able to describe how they check and validate such materials.

A case example of a technique being questioned by a defendant can be found in *People* v. *Holmes.*[28] The expert used a plaster cast of Holmes' teeth to make an imprint in a sheet of Styrofoam from which hand-traced overlays were produced. The accuracy of this technique was questioned in light of the availability of more precise methods. The odontologist was asked to repeat the analysis using a radiographic technique and the original verdict was affirmed. There are many techniques and methods employed by those who examine bitemarks and such experts should expect to have their protocols questioned by opposing counsel. The use of controversial or novel systems is likely to make such inquiries more probable.

*Banks* v. *State*[29] where the single item of physical evidence linking Banks to the crime scene was a bitemark in a sandwich, highlights a more serious example of protocol error. Following his analysis of the bitemark, the prosecution's dental expert threw the sandwich away believing that it would become susceptible to mould and hence be useless. The destruction of this evidence denied Banks the opportunity to obtain his own expert who could examine the bitemark and rebut the prosecution's expert. The Court agreed that this error had caused an unfair disadvantage to the defence and that the bitemark evidence should not have been admitted. Due to the pivotal nature of the evidence, the verdict was reversed. Table 2 provides a reference list for bitemark cases that feature this objection.

**The use of previous bitemarks or evidence of previous biting behaviour**

Examples exist of historical bitemarks being used to compare to contemporary injuries allegedly caused by the same defendant. An example of this can be found in *State* v. *Smith.*[30] The prosecution in this case used two techniques to identify the biter. The first used a plaster cast of the suspect's teeth to compare to a scaled photograph of the injury. The second, contested method, used a photograph-to-photograph comparison. The prosecution presented a black-and-white photograph of a bite injury allegedly made by Smith in 1977 on the nose of a murder victim. Smith had confessed to this crime and thus the prosecution argued that it was reasonable to assume that Smith was responsible for the bitemark. The expert then compared the historical bite with the bitemark from the contemporary crime and found them similar. The defence strongly objected to this technique stating that the method was not well accepted. The Court, however, disagreed and the original verdict was affirmed.

The premise that if an individual has bitten before then they will be likely to bite again has been offered into evidence by State prosecutors and tenaciously objected to by defence teams. *United States* v. *Martin*[31] represents an example of such a prosecutorial technique. The prosecution offered testimony that at times of stress the defendant bit or chewed items, such as toothbrushes or pencils. A bitemark was found on the neck of Martin's murdered

wife and the prosecution stated that because of the aforementioned biting behaviour the injury was likely to have been caused by Martin. Upon appeal, Martin claimed that this evidence was wrongly admitted; the linking of biting objects to biting his wife was nonsense. The Court found that the evidence had been admitted in error. Had the expert established a link between the biting of objects and a propensity to bite humans it may have been marginally admissible. However, despite agreeing with Martin's point of appeal the Court determined that the evidence did not have a substantial prejudicial effect on the outcome of the trial and the original verdict was upheld.

**Defence requesting prosecution's testimony or funds for own witness**

Courts take the issue of the State withholding evidence from the defence seriously and timely, accurate disclosure is well grounded in the doctrine of the U.S. legal system. The disclosure rules insist that a defendant be entitled to all results or reports of physical or mental examinations and of scientific tests or experiments conducted concerning a particular case. The rules also state that, subject to an appropriate protection order, all tangible objects that were used in the execution of such tests should also be released to the accused.[32]

*State* v. *Adams*[26] demonstrates an example of disclosure issues within the context of a bitemark case. Adams claimed that the Court had erred in failing to dismiss the case when it became apparent that the State had not disclosed the existence of a scientific report concerning an alleged bitemark of the victim or the existence of a cast impression of the injury. The prosecution was instructed to disclose fully the materials, but when this was done the cast of the impression was not included. The Appellate Court stated that there had been a deliberate misinterpretation of the disclosure rules and this had resulted in gross error in favour of the State. This non-compliance was compounded by the ultimate failure of complete disclosure despite specific instructions from the Court to do so. The implications of the lack of disclosure were significant, as Adams was unable to secure an independent forensic dentist who could have offered an alternative opinion to that of the state. Following several other points of appeal the original verdict was overturned, which was a very serious consequence of the State's actions.[26]

The issue of Courts providing funding for accused individuals to secure expert witnesses is heavily debated. *Washington* v. *State*[33] provides an example of this issue in relation to a forensic dental expert. Washington's appeal against the death sentence was based upon many grounds but in particular he claimed that the Court erred when it denied him funds to obtain a forensic dentist to refute the prosecution's witness. In examining the original trial, the Appeals Court found that the bitemark evidence had a "high impact" upon the trial and the Court's refusal to grant funds for a defence expert was an irreversible error. The verdict was overturned and the case was remanded for a new trial. This example is often contradicted by other jurisdictions that believe that it is not the State's responsibility to provide the defendant with numerous experts to testify on their behalf.

**WITNESS RELATED OBJECTIONS**

This section examines the objection to bitemark testimony based on expert witness issues. The cases represent instances where the witness has been accepted as an expert and offered an opinion during the trial. It is a recognised defence strategy to suggest to the jury that the witness is less credible, and thus reduce the weight afforded to their testimony. Before examining some of the case-related issues, it is worthwhile to examine some aspects of what it is to be an expert witness.

A legal definition of an expert witness is "one who possesses extraordinary knowledge concerning a subject which was obtained from experience or by careful study".[34] A more general view is that experts are persons with special knowledge, skill, experience, training, and/or education that goes beyond the normal experience of ordinary members of the public. Some Courts have stated that experts can be qualified if they are, without other qualification, merely "helpful" to the jury.

It is argued that nearly anyone could provide expert testimony in some form or another. If the brakes fail on your new vehicle, a brake specialist from a local automotive shop would be able to inform the Court of the processes behind the failure. In this field, they would be providing expert testimony. If you receive dental treatment that is of poor quality, a general practitioner with many years experience would be an excellent witness to choose. When examining bitemark evidence, however, the selection of a *forensic* dentist can be problematic.

Dentists in all jurisdictions have an obligation to pursue continuing education throughout their

professional careers. This can result in a plethora of diplomas, additional degrees, and memberships in organisations. Lawyers, and others, who employ dental expert witnesses, need to be able to interpret what may appear to be an extensive *curriculum vitae* and extract the salient features. With regard to bitemark evidence an expert will either have to have a) been board certified by the ABFO, b) completed a research degree followed by extensive casework experience, or c) extensive documented experience in the discipline. The selection of Court specialists should be limited to those individuals represented by these groups. The use of non-dental personnel to testify concerning bitemarks is fraught with danger. This was shown by the Appeal case *State* v. *Adams,*[35] where the use of a physician's testimony concerning a bite injury was ruled inadmissible.

**What is a Bitemark Expert Witness?**

Dental experts testifying regarding bitemarks use their knowledge of: a) dental materials, b) associated instruments, c) the morphology of the human dentition in terms of gross, class and unique characteristics, d) the effects of use, misuse and abuse of the dentition leading to the production of unqiue characteristics, e) a knowledge of the masticatory system and f) the dynamic interaction between teeth and objects to assist the Court.[36] An effective odontologist's testimony is the culmination of extensive research and preparation. This will frequently involve the use of pattern analysis, often using some form of transparent overlay and a careful metric assessment of both the injury and the suspect's(s') dentition. The results of such preparation, combined with direct observations or examinations represents the foundation of all expert testimony and is estolled within the guidelines of the major forensic dental organisations such as the American Board of Forensic Odontology.[37,38]

One of the most serious allegations that can be brought against a witness is that of perjury. In *Bromley* v. *State*[39] the defence alleged at appeal that the State's witness had lied during cross-examination. At Bromley's original trial, the dentist was asked if he had consulted with any other expert during his analysis of the evidence and the formulation of his conclusions. He responded that he had not. It was later proved that he had infact consulted with the defence witness in the case. The Court found that the testimony given by the expert, although false, was harmless to the appellant, and did not warrant an assignment of error.

Another example where the integrity of the witness was questioned is *Brewer* v. *State,*[40] a capital case in which the appellant had been convicted of the rape and murder of a three-year-old child. In this case, the appellant claimed that the forensic dentist's testimony should not have been permitted, as previous testimony by the witness in another trial had been deemed inadmissible. *Brewer* also stated that the witness had been less than forthright concerning his qualifications in previous testimony.[41] The Court examined the issues and found that one of the previous trials did not involve dental testimony and the second was about membership of a professional organisation that the witness had properly explained. The Court stated:

> "...the record evidence shows that Dr ..... possessed the knowledge, skill, experience, training, and education necessary to qualify as an expert in forensic odontology. The problems in *Maxwell* and *Keko* went to the weight and credibility to be assigned to his testimony by the jury - not his qualifications."

The appeal Court found no assignments of error and affirmed the trial Court ruling. Other cases[24-42] examined the issues of prejudice of experts and prosecution witnesses working in teams, none of which was found to have any merit. See Table 2 for further citations. However, the cases do illustrate that the behaviours and actions of forensic odontologists are open to negative interpretation. Therefore, care should be taken to demonstrate no impropriety, lest it be brought in front of a public Court. Forensic odontologists must subscribe to rigorous and comprehensive standards of practice to ensure fair and equitable treatment for all parties concerned.[43] It should be noted that the *Brewer* case has been re-examined in light of DNA evidence that has demonstrated that two individuals' DNA were responsible for the rape of the child and neither were Kennedy Brewer. The odontology testimony and its application may therefore well be questioned again, but it should be clear that the original appeal was based on the expert's qualifications not the methods of analysis employed.

**SUMMARY AND CONCLUSION**

It can be stated in summary that historically bitemark evidence has been generally accepted within the forensic field, and the admission of such evidence on this principle is correct within the definitions provided by *Frye* [9] and the Federal Rules of Evidence (FRE, Rule 702).[17] Indeed within the U.S. evidence

of positive identification of bitemark suspects has been admitted in all States with the single exception of Oklahoma;[44] where the odontologists conclusion level was limited to "probable bitemark". Unfortunately the case literature does not described how this conclusion was reached in light of the state's newly adopted *Daubert* standard. The impact of *Daubert*[13] and its clarification under *Kumho* have not yet been fully assessed. *Daubert* requires published evidence of reliability of forensic procedures and these are limited with regard to bitemark evidence.[45,46] *Daubert* states that purported scientific testimony should be based on scientific procedure or method and comprise of more than subjective belief or unsupported speculation.[13] Further requirements include that evidence is supported by appropriate validation, again the bitemark literature is sparse in this regard.[22] It is important to note that the degree of acceptance of bitemark evidence does vary widely in the field with many odontologists sceptical about the conclusions that can be drawn from such analyses.[47] The trends analysed previously describe some of the attempts by defence lawyers to highlight the weaknesses inherent in bitemark analysis. It is important for testifying odontologists to be aware of such issues and strategies, and be prepared to address them if required. The surest means by which odontologists can avoid complications in Court is by following guidelines issued by their regulatory or advisory bodies, restricting bitemark analysis to those injuries demonstrating the highest level of forensic significance and ensuring that the conclusions drawn can be supported not only by the evidence at hand, but by the scientific base for the procedure employed in reaching that conclusion. There is a clear need for further bitemark research to ensure that a robust and effective answer can be provided under a *Daubert* challenge and in particular studies that assess the validity and reliability of both metric and pattern analysis are required.[13]

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# GOOD BITE MARK EVIDENCE: A CASE REPORT

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## ABSTRACT

Bite mark analysis is unquestionably the most difficult, and contentious, work undertaken by forensic odontologists. Each injury must be assessed to determine if it was made by human or animal teeth, if the quality of the evidence allows presentation to a Court of Law, and if the pattern can be reasonably compared to a suspect dentition. Many injuries examined by forensic odontologists do not meet these criteria. A case is presented in which a Victim Statement could be corroborated, with evidence of good probative value.

**J Forensic Odontstomatol 2006:24:12-3)**

**KEY WORDS:** bite mark, forensic odontology, evidence, digital overlay

## CASE HISTORY

In November 2004, a 25 year old female was examined following an alleged sexual assault. Injuries included severe bruising to the face, arms and back. In the mid-scapular position there was a semi-circular bruising pattern measuring approximately 30 x 45 mm, exhibiting the class characteristics of a human bite[1] (Fig.1). Biological swabs and photographs of the injury were taken.

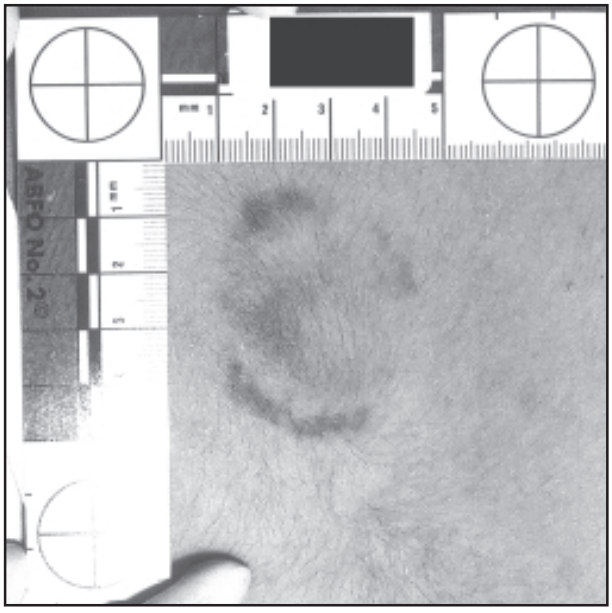


***Fig.1:*** *Bite mark*

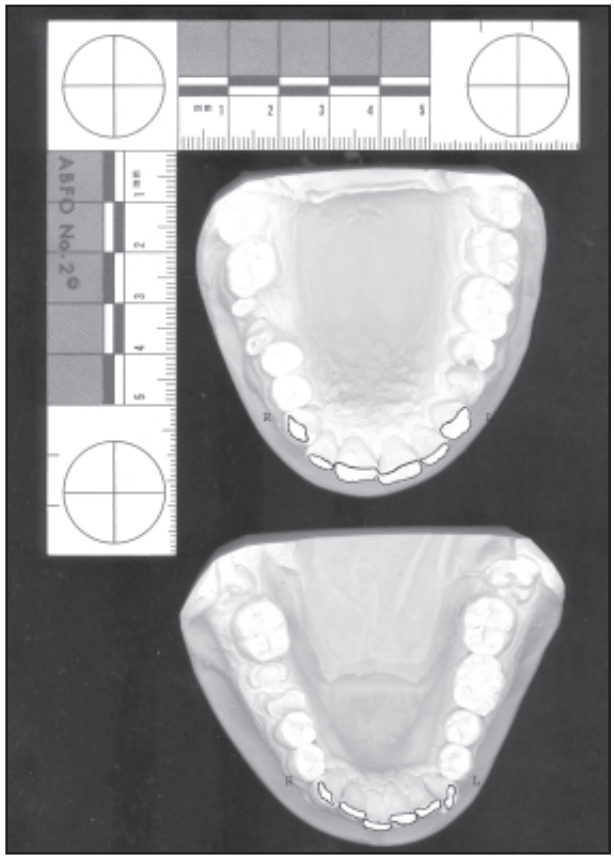


***Fig.2:*** *Suspect casts with overlays*

Impressions of a suspect were obtained by voluntary consent under Category 3 of the South Australian Criminal Law (Forensic Procedures) Act 1998 and cast in white diestone.* Digital overlays were produced using the techniques described by Johansen and Bowers[2] (Fig.2) and compared to the injury (Fig.3).

Arch width, for both upper and lower casts, was consistent with the injury. The spatial arrangement of the maxillary teeth was not distinctive, but crowding was evident in the lower arch. Tooth 41 was displaced labially and tooth 33 rotated disto-lingually. These features could be clearly seen in the pattern injury. However, moderate crowding of the lower anterior

* Ainsworth Dental Co. Pty. Ltd, Marrickville, Australia

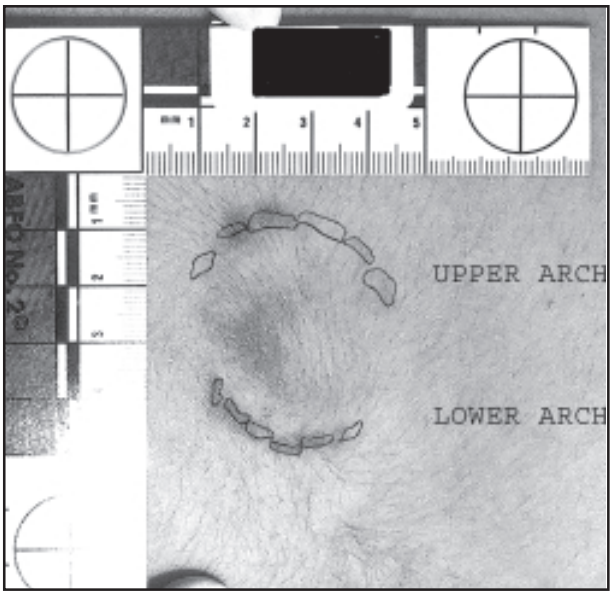


***Fig.3:*** *Comparison*

teeth is not uncommonly seen in Australian dentitions and the frequency of occurrence of these tooth positions in the population is unknown. The suspect could clearly not be excluded as the perpetrator. It is for a jury to decide if he did indeed inflict the bite.

## CONCLUSIONS

1. The injury is consistent with an adult, human bite. It is not in a position to be self-inflicted.
2. It is not possible to say with certainty who has inflicted the injury.
3. It is not possible to exclude the suspect.
4. There are significant concordant features between the pattern injury and the spatial alignment of the teeth of the suspect.

## OUTCOME

This bite mark case demonstrated quality evidence of good probative value which could confidently be presented in a Court of Law. However, charges against the suspect were withdrawn five days later by the victim, citing “he really loves me”.

## ACKNOWLEDGEMENTS

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# BITE MARK ANALYSIS AND COMPARISON USING IMAGE PERCEPTION TECHNOLOGY

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## ABSTRACT

To analyse and compare a bite mark left on human skin with a suspect's dentition is a difficult procedure. The assumption that the human dentition is unique plays an important role in this process. However it is near impossible to prove that a particular bite mark was produced by a specific dentition. Key elements to analyse a bite mark are the amount of detail available in the information about the bite mark and the suspected biter's dentition. Both are of vital importance to the investigating forensic odontologist. In this article a new method of analysing bite marks using image perception technology is described. With this technology it is possible to artificially colour areas with equal intensity values and depict a 2-D image as a pseudo-3-D surface object. The use of image perception technology may allow visualization of a degree of detail unavailable with any other method.

**(J Forensic Odontostomatol 2006;24:14-7)**

**Key words:** Bite marks, comparison overlays,forensic science, forensic odontology, image perception technology

## INTRODUCTION

Bite mark analysis and comparison is a complicated matter. The standard techniques for examining bite marks are based upon interpreting photographic evidence in which a bite is compared with the models of the teeth of suspects.[1] The quality and angle of the bite mark photographs and the precision of the impression of the suspect's dentition is of extreme importance to the forensic odontologist. Rawson investigated the uniqueness of the human dentition mathematically using a precise method of measurement.[2] The uniqueness of a bite mark, however, is not such a clear-cut issue. Human skin is a very poor bite registration material.[3] Bite marks may disclose individual tooth imprints. They may appear as a double arched pattern, or even a homogeneous bruise.[4] Bite marks can be distorted by the elastic properties of the skin tissue or by the anatomic location. Also the pressure of the bite and the angle of the maxilla and mandible can change the appearance of a bite mark. The position of the body at the time the bite was inflicted may also play a part.[5]

The process of comparing bite marks with a suspect's dentition includes analysis and measurement of size, shape and position of the individual teeth.[6] Most comparison methods involve the fabrication of overlays.[7] There are a number of different ways to produce overlays from a suspect's dentition: hand-tracing from dental study casts,[8] hand-tracing from wax impressions,[8] hand-tracing from xerographic images,[9] the radiopaque wax impression method[10] and the computer-based method.[11] Sweet and Bowers studied the accuracy of these bite mark overlay production methods and concluded that the computer-generated overlays provided the most accurate and reproducible exemplars.

This article describes a new method of comparing and analysing photographs of bite marks with overlays of a suspected biter's dentition using image perception software.

## MATERIALS AND METHODS

The computer hardware used with this research includes an Intel® Pentium CPU PC running at 3.06 GHz, with 1.00 Gb RAM,* Microsoft® Windows® XP home edition operating system,** a 15 inch colour monitor,† an HP PSC 1350 Printer‡ and an Epson Expression 1680 Pro flatbed scanner.§

Photographs of bite marks were resized to 1:1 scale using Photoshop® of Adobe Systems.®§§ Dental study casts were scanned using the flatbed scanner. Hollow and compound overlays were produced from

* Fujitsu, Siemens Computers, Munich, Germany
** Microsoft Corp., Redmond, USA
† Fujitsu, Siemens Computers, Munich, Germany
‡ Hewlett-Packard Company, Palo, Alto, USA
§ Seiko Epson Corporation, Tokyo, Japan
§§ Adobe Systems Inc, San Jose, USA

these casts. The methods used for both procedures are described by Bowers and Johansen.[12] The life-size photographs were imported into the image perception program¶ and processed. With image perception software, it is possible to make 256 different greyscale values visible by rendering intensity information as surface height by mapping individual pixel intensities to the z-axis. Areas of equal luminance can also be artificially coloured to enhance the image information that facilitates the recognition of the individual tooth impressions in the bite mark area and thus improving diagnostic procedures.

**Image perception software procedure**

A photograph of a bite mark is opened with the image perception software, and a region of interest is then selected (Fig.1). After such selection, one can add colour to different greyscale areas of the image. The assigning of selected colours to levels of grey values enables the forensic odontologist to select regions with similar grey values or to enhance subtle differences of grey values in the picture. The human eye can only distinguish about 40 shades of grey in a monochrome image, but can distinguish hundreds of different colours.[13] This will make it easier to establish which regions of pixel intensity are part of the bite mark and which are not. By omitting certain areas of pixel intensity, it is possible to isolate the region of the image which shows the bite mark.

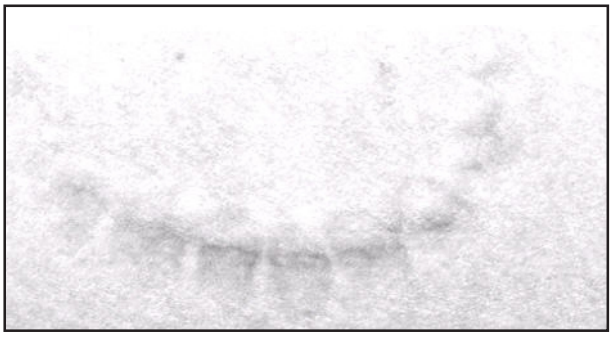

***Fig.1:*** *Selected region of interest from original photograph*

A detailed image of the bite mark is produced (Fig.2) and the resolution of the image is then altered to be compatible with the resolution of the original photograph. Most bite mark images are scanned at 300dpi. Part of the ABFO No.2¶¶ scale has to be visible to accommodate the placement of the image over the original photograph with 100% exactitude.[14] The coloured image of the bite mark is now layered over the original bite mark photograph using Photoshop® of Adobe Systems®§§ (Fig.3).

The opacity of individual layers can be increased or decreased according to the requirements of the forensic odontologist. The enhanced image can now be used to accommodate an overlay of the suspected biter's dentition. Both hollow and compound overlays can be used, depending on the amount of incisal detail. With this improved degree of information it is not uncommon to distinguish aspects previously invisible (Figs.4A and 4B).

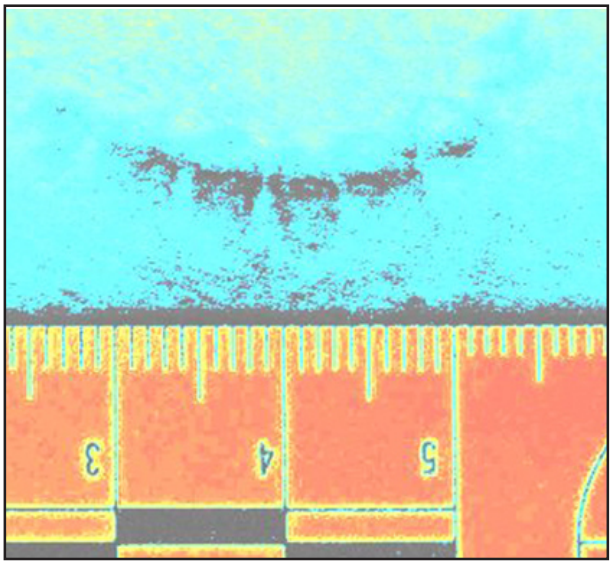


***Fig.2:*** *Image artificially coloured with image perception technology software*

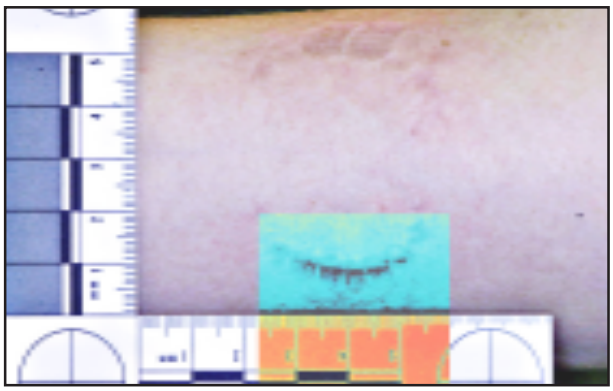

***Fig.3:*** *Coloured image with visible incisal detail layered over original photograph*

¶ ForensicIQ, LumenIQ Inc., Bellingham, USA
¶¶ Lightning Powder Co. Inc. Jacksonville, USA

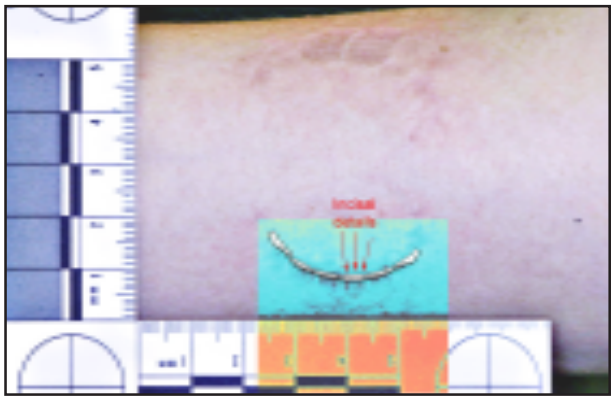

***Fig.4A:*** *Overlay comparison*

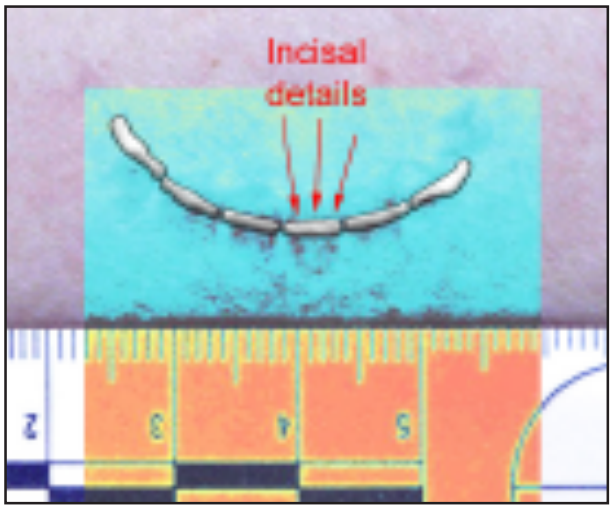


***Fig.4B:*** *Corresponding incisal detail in bite mark photograph and compound overlay*

With image perception software it is also possible to depict a 2-D picture as a 3-D surface object. Different pixel intensities are converted to different surface heights, yielding additional information contained in 256 intensity values ranging from black (intensity=0) to white (intensity=256). The scale of the z-axis can be adjusted to create the best possible pseudo 3-D view. These 3-D images can be freely moved, rotated, or zoomed to any specific region of interest.

The forensic odontologist is now able to combine the information from conventional analysis and pseudo 3-D images to investigate the bite mark and attempt to establish its origin with a higher degree of certainty than would be possible using other methods (Fig.5).

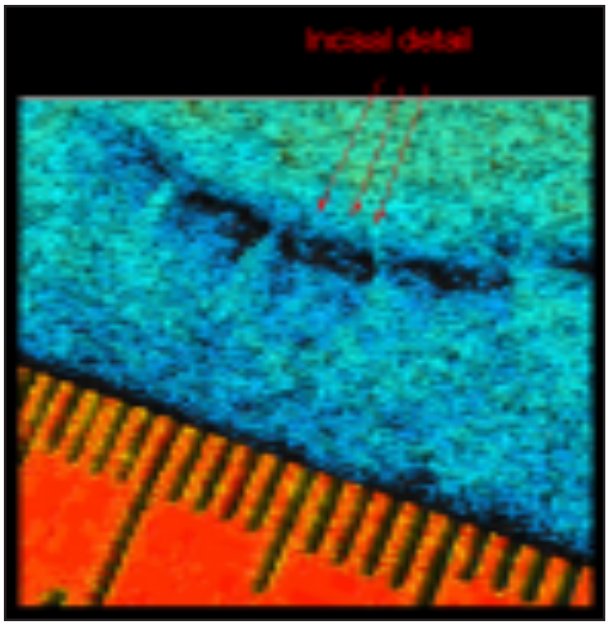


***Fig.5:*** *Pseudo 3-D image with visible bite mark detail*

## DISCUSSION

Human bite mark analysis is by far the most demanding and complicated part of forensic dentistry. There is no dependable way of stating that one or more tooth marks seen in a wound are irrefutably unique to just one person in the population.[15] Bite mark distortion through skin elasticity, anatomical location and body positioning is a recurring problem. With the recent developments regarding expert testimony, the need for accurate, reliable, reproducible and above all objective methods for bite mark analysis and comparison has never been greater. Although more research is needed to explore the possibilities of image perception technology, its possibilities to visualise more details in a bite mark photograph are promising. The availability of additional colouring of selected areas with similar intensity values as well as rendering 2-D photographs as pseudo 3-D images may enable the researcher to analyse the image more extensively and come to a more accurate conclusion regarding the source of the bite. However, bite mark analysis alone should not be allowed to lead to a guilty verdict, but it will offer the opportunity to exclude a suspect from a crime when the data do not correspond.

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# UNUSUAL FOREIGN METALLIC OBJECT (NAIL) IN THE DENTITION OF A SKULL FROM THE ANTHROPOLOGICAL COLLECTION OF RUDOLF VIRCHOW (BERLIN)

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## ABSTRACT

Foreign bodies in the dentition of present day patients are frequently diagnosed. They are more rare in mediaeval and anthropological specimens. Rudolf Virchow, the doyen of pathology in Germany formed a huge collection of anthropological specimens in the 19th century. Among these specimens one skull from Tiflis (Tbilisi, Georgia) found its way into the collection of Virchow in 1881. The skull is that of a prisoner of war who died in 1877 due to dysentery. The skull is remarkable in that a metallic nail was adapted around the second right maxillary molar. Both radiological and clinical findings indicate that the nail was adapted to the tooth while the individual was still alive. In particular, erosion of the cortical bone plate in the affected area and osseous healing between the first and second maxillary molar may be taken as proof of adaptation of the nail *in vivo*. The reasons why the nail was applied, however, are difficult to explain. The authors assume that the nail was applied not by the individual himself. Probably, the nail was adapted as an amulet to protect the individual from injury or death.
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**Keywords:** anthropology, foreign object, forensic odontology

## INTRODUCTION

Numerous reports on foreign objects found in the dentition of present day dental patients have been published including objects such as needles, pins, staples, screws, beads, hair, remnants of tooth picks and many others.[1-6] Reports on foreign objects in paleo-odontology are much less frequent. Tooth mutilations and foreign objects as inlays made of precious stones have been recorded in teeth of pre-Columbian skulls.[7] An unusual bead made of jade, which was considered to represent a bridge was observed in the dentition of a Maya skull found in Guatemala.[7] Møller-Christensen[8] described a rosary bead used as tooth filling material in a human mandibular canine tooth of a skull from the Danish middle ages.

Zias and Numeroff described a 2.5mm bronze wire implanted in a maxillary lateral incisor of a skull from ancient Israel dated to 200 BCE.[9]

During recent studies of the anthropological collection of Rudolf Virchow (Berlin, Germany, 1821-1902) the authors had the opportunity to study a skull, which found its way into the collection in the year 1881. This particular skull is one specimen among skulls and osteological specimens of 3,365 individuals, which were registered in 1990 (Creutz, personal communication). The purpose of this report is to shortly describe this skull, in the dentition of which a most unusual foreign object was found, namely a metallic nail.

## CASE REPORT

The well-preserved skull bears several lines of inscriptions in German script allowing for a detailed history of the skull. The inscriptions read as follows (Fig.1):

Line 1: *Tatar, Tiflis* - The skull was brought from the land of the Tatars with the capital of Tiflis (present day: Tbilisi, Georgia).
Line 2: *R.V. 662.* - The abbreviation R.V. stands for Rudolf Virchow, 662 indicating the number of registration at the time when the skull was acquired.
Line 3: *Koroman Suli Ogly, Mohamedaner (Sunnit)* - The name of the individual was Koroman Suli Ogly who was a follower of the Mohammedans (Sunnite).
Line 4: *28 Jahre alt, aufgenomen ins I. Kriegs-*

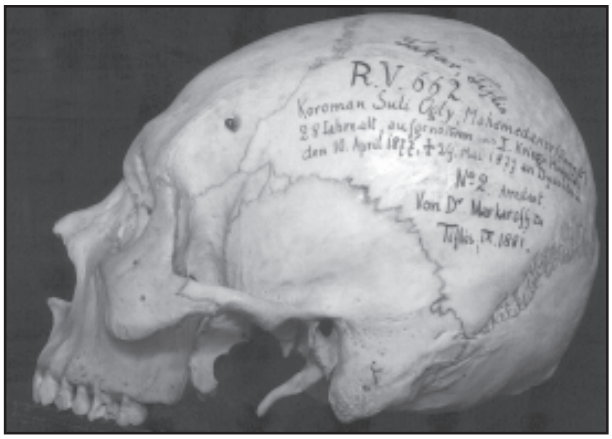


***Fig.1:*** *Lateral view (left side) of the skull from Tiflis*

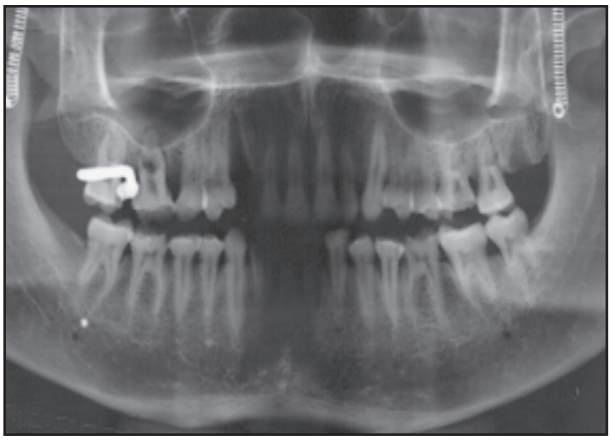

*Fig.2: Panoramic radiography of the maxilla and mandible. The maxillary right canine, the left maxillary third molar as well as both mandibular central incisors and the left lateral incisor are missing. The foreign object is seen between the right first and second maxillary molar with the nail extending over the neck area of the second molar. The periodontal space of the first maxillary molar is slightly widened. There is a translucency between the mesial and distal buccal root of the maxillary first molar*

*Hospital* - 28 years old, admitted to I. (first) war hospital.
Line 5: *den 10. April 1877, † 29. Mai 1877 an Dysenterie.* - 10th of April 1877, died 29th of May 1877 due to dysentery.
Line 6: *N°. 2. Arrestant.* - No. 2, prisoner.
Lines 7 and 8: *Von Dr. Markaroff zu Tiflis; IX. 1881.* - From Dr. Markaroff at Tiflis; September 1881.

Both maxilla and mandible are entirely intact. The dentition of the maxilla (Fig.2) is complete except post mortem loss of the right maxillary canine and the left maxillary third molar. In the mandible the right and left central incisors and the left lateral incisor are missing with the losses most probably having occurred post mortem. Also, the mandibular right third molar is missing. Whether it has been lost ante mortem, or was congenitally missing cannot be determined.

The panoramic radiograph shows a radiodense metallic object between the right maxillary first molar extending over the neck of the second maxillary right molar. The clinical occlusal view shows a nail the head of which is adapted to the buccal interproximal space. The corroded, rusty nail is firmly bent around the neck of the second maxillary right molar. The tip of the nail somewhat extends away from the buccal plate (Fig.3). A lateral view of the involved two teeth shows that the second maxillary molar is slightly dislocated distally (Fig.4), forming a diastema between the first and second maxillary molar. The missing maxillary third molar might have influenced the size of this diastema. Beneath the head of the nail bone is present in the interproximal space. The buccal cortical plate is missing in this area as well as in between the mesial and distal root of the first maxillary molar. Also, mesially to the first molar the bony plate is eroded. On panoramic radiography a slight interradicular translucency is seen corresponding to the clinical finding of bone erosion in that area (Fig.2). The palatal bone is intact. All maxillary molars and premolars are covered by a white material representing calculus.

## DISCUSSION

Foreign objects in the dentition and soft tissues of the oral cavity mostly occur in children, adolescents and psychiatric patients.[1-6,10,11] In most of cases foreign bodies are detected accidentally. Foreign objects may have found their way into oral structures unintentionally or as part of a fashion including “body art”.[12] Mutilations, particularly of dental hard structures have been practised from prehistoric times until recently.[7,13,14] Generally, mutilations imply permanent or lasting sectioning or lesions of a part of the body comprising skeletal deformations, dental mutilations, circumcisions, ablation of the clitoris, scarification, tattoos and perforations.[12] Usually, mutilations are performed intentionally. Automutilation is a phenomenon performed with a neuropsychiatric or psychotic background.[15]

***Fig.3:*** *Occlusal view of the right maxillary first and second molar with the nail around the second molar*

***Fig.4:*** *Lateral view of the same teeth as in Fig. 3. The cortical bone plate is eroded mesially and distally to the first maxillary molar. Both buccal roots of the first molar are exposed*

The present case of a nail in the dentition of a prisoner is unique and is difficult to explain. In order to explain the presence of the nail the following questions must be asked:

1. When was the nail applied?
2. Who performed the adaptation of the nail to the tooth?
3. What was the reason for the application of the nail?

Both clinical and radiological findings indicate that the nail was applied to the tooth during the life time of the individual. The nail was forcibly adapted creating a space between the two molars, dislocating the second molar to the distal side. The interproximal space between both teeth was filled by septal bone, showing that after application of the nail osseous healing had occurred. The erosion of the buccal cortical plate is a further proof that the nail was adapted *in vivo*. The presence of the nail as a foreign body had caused inflammatory changes, which resulted in loss of the buccal cortical bone in the area of the first and second maxillary molar. In addition, horizontal bone loss at the first maxillary molar resulted in exposure of the interradicular space. In general, horizontal bone loss was rather limited. Both bone formation between the first and the second maxillary molar as well as the inflammatory changes of the buccal cortical plate may be taken as proof of application of the nail during life time.

The exact adaptation of the nail around the second maxillary molar most probably was not performed by the individual himself but by someone else. The procedure of adaptation must have been difficult and needed considerable force. Bending a nail of the size as represented in this case in the oral cavity comes close to torture. In this context it is of interest whether the nail has been applied as a voluntary act or whether the procedure was forced on the prisoner, perhaps as an act of torture. Closely related to these questions is the question why the nail has been applied to the tooth at all. It is well-known that in former times prisoners of war often tried to attract the authorities by acts of automutilation. The general intention usually was to be admitted to the hospital. Application of a nail to a tooth, however, seems to be an unlikely procedure to attract the attention of medical doctors or dentists of war hospitals. The other reason why the nail could have been applied was to wear it as an amulet. In many societies amulets are worn to ward off mishaps and death during fighting and war. Probably, the strength of a nail might have represented such secret power characteristic for amulets. Møller-Christensen[8] in his article on a rosary bead used as a tooth filling material in a human mandibular canine tooth explained that "…popular medicine made extensive use of numerous purely magic remedies such as 'dead man's tooth', coffin nails, amulettes, written or spoken magic formulae, conjurations, invocations of saints, in particular St. Appolonia, and much more". While a definite explanation for the presence of this nail in the dentition of a 19th century skull from Tiflis cannot be given, it is an unusual example of a foreign object applied to a tooth, and would certainly qualify as a unique identifying object.

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# DENTAL RECORDS: A BELGIUM STUDY

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## ABSTRACT

The aim of this study was to deduce the quality of the average dental record kept by Belgian dentists and to evaluate its potential use for forensic dental casework. The evaluated material originated from 598 Dutch speaking and 124 French speaking Belgian dentists who completed a questionnaire and returned it by mail or through the internet. The age of the participating dentists ranged from 22 to 72 years of age. The results of the inquiry were statistically analysed taking parameters such as language, gender, age, university and ZIP code into account. In general there was a tendency for the young dentists from the age category 22 to 34 years of age, especially those living in larger cities, to perform better on several of the questions asked such as completion of the dental record, storage of x-rays, working with digital x-rays and a digital dental record.

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**Keywords:** Dental record, dental chart, forensic odontology, dental identification

## INTRODUCTION

Updated, high-quality dental records are keystones in the dental identification process. The recent seaquake in South-East Asia on December 26th 2004 with more than three hundred thousand killed and wounded persons has highlighted this fact.[1] The successful identification of a victim depends on the availability of accurate and comparable antemortem and postmortem data.[2] Teeth are frequently the last and only remains to identify a victim; for instance in cases of advanced decomposition, mutilation or incineration. However, from a forensic point of view, dentists often do not keep adequate files. Incomplete dental files may obstruct forensic work, delaying identification and prolonging grief and mourning of relatives.

Besides this forensic motivation for keeping adequate and updated files, general practitioners and patients benefit from well-kept dental records. Good files provide the best defence in law suits against dentists.[3,4] Incomplete files may be harmful to the dentist and to the patient.[4] Patients are now more aware and litigation is on the increase. The dental file is an official document: based on that file the dentist may be prosecuted or cleared of alleged dental malpractice. A good file also enables the dentist to follow the patient's dental health and makes it easier for another dentist, to whom the patient was referred, to continue treatment.[5]

The dental file may also contain information on evidence of suspected child abuse. Since most reported symptoms of child abuse are located in the head and face region it is not surprising that dentists are often among the first health care workers to spot evidence of child abuse. The dental practitioner should note these findings in the dental file and should discuss the topic with the parents or guardian, or inform the legal authorities.[6]

With the publication in "Het Belgisch Staatsblad" on August 26th, 2004 the text on patients' rights became law in Belgium.[7] Prior to this there was no strict legislation relating to dental files. General practitioners were more or less free to keep whatever record they preferred or even no record. Only deontological and ethical codes could stimulate dentists to keep records of their patients. Now, due to Article 9 of the specified law, every practitioner is legally obliged to keep records of his patients. Each patient has the right to a meticulously kept and safely stored personal file and, on request, the dentist has to provide the patient with a copy of his dental record.

The aim of the present inquiry was to obtain an overall idea of the quality of the average dental record kept by Belgian dentists and to evaluate its potential use for forensic casework.

## MATERIALS AND METHODS

A specific questionnaire was designed in order to evaluate the quality of Belgian dental files. This questionnaire was published in the monthly journal of both the Dutch and French speaking national dental

societies. This journal is distributed to about 5,000 Dutch and 4,000 French speaking dentists. Both groups of dentists were simultaneously given the opportunity to complete a digital version of the questionnaire which was made available on a national website. In total approximately 9,000 dentists were invited to complete the questionnaire either in digital or in analogue form.

Both the Dutch and the French version of the questionnaire contained the same questions. A total of 133 questions was asked (Appendix 1). The opportunity was provided to complete the questionnaire anonymously, but most responding dentists provided their details on the questionnaires. The answer to each question could be yes or no. Answers that were left open were not taken into account for statistical analysis. Not all respondents answered all questions, therefore the reported numbers may show some fluctuation. Each question was analysed separately. The 'yes' answer scored 1, the 'no' answer scored 0. At the next level of analysis, questions were grouped according to seven themes. All the positive answers for each question separately were summed per theme and an analogue scale was drawn up. The influence of language, gender, age, university training and geographical location of the practice (ZIP code) was evaluated. The seven themes were set up as follows:

1. Type of data
The first group consisted of 30 questions from the questionnaire relating to the patient's identification, such as name, maiden name, date of birth, address, complete medical history, radiological examinations performed, updated dental chart, and detailed personal treatment. The intention was to evaluate whether there was any significant effect noticeable on the type of data that was entered into the dental record based on language, gender, age, university training and ZIP code of the dentist.

The next group consisted of 36 questions from the questionnaire concerning data in the dental record relevant for identification such as alterations in tooth position, oral anatomical characteristics, information on dental materials used in restorations, serial numbers of implants etc. Another group consisted of nine questions relating to extraordinary information useful in insurance or civil litigation cases such as referral letters, prescribed medication, whether x-rays had ever been taken of patients, etc.

Questions relating to medical history were bracketed (18 questions). Statistical analysis was performed to find out whether a significant difference exists among Belgian dentists in the way they keep information concerning these topics.

2. Methodology
Questions relating to whether or not an odontogram or chart was used were grouped. It was asked whether this was completely filled in, whether it was renewed each year for the same patient and whether in the case of a new patient also the existing dental status was recorded. It was also questioned how complete and accurate this recording was.

3. Radiology
The first group contained questions relating to the exposure or production of dental x-rays, both intra-oral and extra-oral. Does the dentist consistently take apical radiographs or a full radiographic examination, or has he access to panoramic radiography? Next it was evaluated whether the dentist consistently takes dental radiographs during the first contact with the patient. Finally the mode of storage of dental x-rays was evaluated: are these stored in analogue or digital format?

4. Child abuse
It was questioned whether dentists would notice signs of trauma relating to child abuse such as multiple oral trauma, bruises or trauma in the head and neck region, neglected teeth, and others. Five questions were grouped for this analysis.

5. Record Management
Questions were asked relating to the use of digital dental records, access to the internet and the use of a password for accessing the dental file of a patient. It was the intention to evaluate the number of dentists who have computerised their office and work with digital dental files.

On the other hand it was also checked how detailed and current the record keeping of the dentist is: are serial numbers of implants noted in the file and are prosthetic devices marked with a serial number?

6. Informed Consent
This group of questions examined whether dentists use any kind of informed consent and how well they are aware of the medico-legal value of this principle. Informed consent can be procured orally or in

written form. Also the registering of what is said to the patient is of great importance.

7. Dental Law and Record Keeping
A number of questions was grouped relating to the property rights and the medico-legal value of the dental record. It was also questioned for what duration a dental record should be kept by the practicing dentist in relation to litigation cases, how long radiographs should be stored and whether this was done in an analogue or a digital format.

Statistical analysis
Mantel-Haenzel Chi-square test was used to evaluate the presence of associations between two variables and the strength of these associations. Furthermore the non-parametric Kruskall-Wallis test was used to examine whether at least one of the associations is significantly different from the others. When applicable a Bonferroni correction was applied. Finally, in case of continuous variables that were normally distributed, an analysis of variance with Tuckey comparison was used to point out statistical differences.

**RESULTS**
Seven hundred and twenty two Dutch or French speaking dentists responded to the questionnaire, either by completing it and returning it by mail or electronically through the use of the website. This is about 8% of the total dentist population in Belgium, 12% of the Dutch speaking and 3% of the French speaking dentists. Table 1 shows the gender and training of the 722 respondants. The number in each age group is shown in Table 2.

Type of data
Statistical analysis showed that the dental records kept by the youngest age group between 22 and 34 years of age (98 dentists out of 698 that answered this question), were reported to be more complete ($p=0.01$) compared to all other age groups investigated. Also the location of the dental office seemed to have a significant influence: dentists having their offices in larger towns are more complete when registering dental information into the dental records of their patients compared to colleagues practicing in villages and small towns. The difference between the former and the latter was defined based on the ZIP code. Language, gender and university training did not have a significant influence on the amount of data registered into the dental record.

From the comparison of the completeness of the information in dental records relating to forensic identification and litigation, it appears that Belgian dentists keep better track of information relating to litigation cases compared with identification cases ($p<0.001$).

Relating to information on medical history it was noted that French speaking Belgian dentists tend to be more complete in the information they gather. Differences between age groups were also found and the youngest age group scored somewhat better ($p<0.001$). Dentists graduated from the Université de Liège (26 dentists out of a total of 694 responding dentists) scored significantly better compared to all other universities ($p=0.03$). No effect of gender or ZIP code was found.

Methodology
Only one question was examined when trying to find statistical data on the use of dental charts or odontograms. From the 665 dentists that answered this question, 308 responded not to use any chart at all. For the 357 that responded positively, neither dentist's age,

***Table 1:*** *Number of dentists that participated in this study by returning a completed questionnaire. (M: male; F: Female; NA: not available; KUL: Katholieke Universiteit Leuven; RUG: Rijksuniversiteit Gent; VUB: Vrije Universiteit Brussel; UCL: Université Catholique de Louvain; ULB: Université Libre de Bruxelles; ULG: Université de Liège)*

| **Dutch-speaking Dentists** | | | | **French-speaking Dentists** | | | |
|---|---|---|---|---|---|---|---|
| University | Gender | Number | Total | University | Gender | Number | Total |
| KUL | M | 147 | | UCL | M | 35 | |
| | F | 152 | | | F | 27 | |
| | NA | 1 | 300 | | | | 62 |
| RUG | M | 117 | | ULB | M | 24 | |
| | F | 71 | | | F | 12 | |
| | NA | 1 | 189 | | | | 36 |
| VUB | M | 51 | | ULG | M | 16 | |
| | F | 27 | | | F | 10 | |
| | NA | 1 | 79 | | | | 26 |
| Unspecified | | | 30 | | | | |
| Sub total | | | 598 | | | | 124 |
| **Total** | | | | | | | **722** |

***Table 2:*** *Age range of participating dentists*

| **Age** | **Number** |
|---|---|
| 22-34 years | 98 |
| 35-44 years | 171 |
| 45-54 years | 328 |
| >55 years | 99 |
| Unknown | 26 |
| **Total** | **722** |

ZIP code, nor gender had any significant influence on the answer to the question. On the other hand it was found that significantly more Dutch speaking dentists systematically make use of odontograms or charts to record dental information in the dental file ($p<0.001$), and in particular those trained at the Katholieke Universiteit Leuven (51%) complete the dental chart. It is shown that Dutch speaking dentists ($p=0.01$) and especially those practicing in the cities ($p=0.04$), work more methodologically, i.e. by using odontograms, compared to their French speaking colleagues.

Radiology
Statistical analysis revealed that French speaking dentists ($p<0.001$), especially living in larger cities ($p=0.01$), belonging to the youngest age category between 22 and 34 years of age ($p<0.001$), and graduated from both the Université Catholique de Louvain and the Université de Liège ($p<0.001$) take more dental radiographs compared to their Dutch speaking colleagues. The gender of the dentists has no statistical influence on the results.

Most of the French speaking dentists take dental radiographs at the first visit of the patient (90% versus 80% for the Dutch speaking colleagues). Gender, age, and ZIP code have no statistical impact on the results. Dutch speaking dentists store their radiographs significantly more often in digital format compared to their French speaking colleagues ($p<0.001$). This effect is especially seen with dentists who graduated from the Katholieke Universiteit Leuven and the Rijksuniversiteit Gent. There is no influence noted from age, gender or ZIP code.

Child abuse
No significant effects were observed based on gender, ZIP code, university training or language. The only significant effect that was noted was an age effect: Dutch speaking dentists of the age category between 22 and 34 years of age pay more attention to possible child abuse related findings compared to all other age categories and also compared to their French speaking colleagues of the same age group.

Record Management
The results of the statistical analysis showed the trend that Dutch speaking dentists have kept up with digital evolution more than their French speaking colleagues ($p=0.01$). Especially the youngest ($p=0.004$), male ($p=0.002$) dentists working in the big cities ($p=0.005$) have changed to or started a digital dental system. The same number of dentists in both Dutch and French speaking groups note detailed information such as serial numbers of implants and prosthetic devices in their dental files.

Informed consent
Overall, male dentists score a little better compared to female colleagues on the question whether informed consent is practised and what its medico-legal value is. In general, no influence of language, ZIP code, university training or age was noticed. Dutch dentists use informed consent more ($p=0.04$), but mostly in the form of an oral informed consent, compared to their French speaking colleagues. Written informed consent is mostly used by the youngest dentists ($p=0.01$).

Dental Law and Record Keeping
Regarding the property rights of the dental records it seems that the oldest group ($p=0.01$) of the Dutch speaking ($p=0.003$) dentists are more aware that the dental file is their legal property. Gender, university training or ZIP code has no influence on the results.

Male dentists seem more aware of the medico-legal value of the dental files ($p=0.01$). While younger ($p<0.0001$), female ($p=0.001$) dentists are more aware they have to store the dental file for a certain amount of time. Dental graduates from the Rijksuniversiteit Gent score better on this topic. Related to this it seemed that French speaking dentists are less confidential with patient-related data when speaking to other patients compared to Dutch speaking dentists.

Dutch speaking dentists keep their files longer than French speaking colleagues ($p=0.001$). Seventy three percent of the Dutch speaking dentists and 58% of the French speaking dentists keep their files permanently, while 10% and 18% respectively store them for less than 10 years. Female dentists in general seem to keep their files for a shorter period than male dentists ($p<0.001$).

A general trend was also noted for the format in which the dental file is kept. It seems that digital files in general are kept significantly longer compared to analogue files ($p<0.001$). Digital files are in general also more complete compared to analogue files ($p<0.001$): i.e. more x-rays are stored with the dental file ($p=0.001$). Seventy three percent of the dentists keep their files stored in an alphabetical order.

## DISCUSSION

The response rate to this questionnaire was relatively low, especially considering that availability of the questionnaire on the national website enabled dentists to participate in this study without cost except for some 10 minutes of their time. Only 12% of the Dutch speaking and 3% of the French speaking colleagues responded to the questionnaires that were set up in their native language. It may reflect the lack of interest Belgian dentists have in this particular topic. Although the results of the questionnaire were rather positive, the reality may well be very different considering the problems forensic odontologists often face in identification cases. Ante mortem records are often incomplete, outdated and sometimes unreadable.

Forensic odontologists use dental files as ante mortem records in order to identify an unknown person. From that perspective, every detail of the dental file matters because it gives additional ante mortem information that might be crucial in the final identification process. However, and this confirms the trend already discussed, apart from the dental files recorded by the youngest dentists, completeness of the dental record seems an unattainable goal in Belgium. On the other hand, information such as reports from colleagues, referral letters, patient's non-attendance rates and personal notes are very well kept. Dentists who have faced a litigation or insurance case are probably more aware of the possibility that something similar might occur again in the practice. Therefore he would be more interested in keeping and safeguarding related documents, rather than being as meticulous as possible when completing the dental chart of a patient thinking that one day he could be asked to produce ante mortem records of one of his patients for identification purposes.

The tendency noted in this study, that the dental records of younger dentists are more complete compared to all other age groups, could be related to the use of digital dental records in which a lot of the information is stored simply or even automatically. It might also be related to the teaching of forensic odontology at universities which in recent years has become part of the dental curriculum in some universities in Belgium or with the publication in Belgium in 2002 of a law on patients' rights, in which among other rights, the right to a meticulously kept and safeguarded dental/medical record is included. Another reason might be that forensic odontology has attracted a lot of media attention in the last decade through a number of mass disasters and famous murder cases.

Although we realise that only a small sample of the Belgian dentists responded and that we must be careful extrapolating the results to the general dental population, it seems that the digital format of the dental record has some additional impact on the completeness of the record itself. This is important for both litigation and forensic cases. A radiograph may contain unique data not written in the file, so in this way it completes the file. For forensic purposes radiographs add important information such as skeletal and dental anatomy of structures like sinuses or tooth roots, supernumerary teeth, endodontic treatment, etc.

The finding that dental radiographs are taken in up to 90% of the first visits of a patient to a dentist is important as well. It means that, in almost every forensic case, if there is a dental file, there should be some type of dental radiograph available.

## CONCLUSION

Response rates for completing the questionnaire were rather low. Nevertheless a total of 722 completed questionnaires were received, either by regular mail or through the website. In view of the absolute number of questionnaires returned, it is reasonable to assume that the actual situation might indeed be worse than the one measured. It is at least possible that there is a self-selection bias in this study. Those who made the effort to complete the questionnaire might arguably be the type that would also be more likely to fully complete their dental charts.

In general, especially young male dentists, practicing in larger cities, keep their dental records updated and store most of their radiographs and dental files indefinitely, especially when working with a digital recording system. They frequently use electronic odontograms or dental charts by means of an overview of dental treatment and update it yearly. A trend for less complete dental records was found with increasing age of the dental practitioner.

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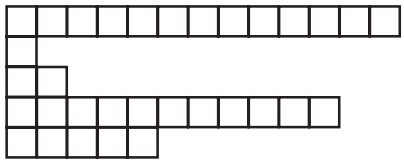
***Appendix 1:*** *Questionnaire concerning the dental file*

Nowadays more and more dentists get confronted with third party claims . To defend oneself against them it's indispensable to keep an updated and well-documented dental record . More often it occurs that files are retrieved from forensic medicine in order to identify unknown bodies .Using this questionnaire we try to gauge the lay-out , the content and the accuracy of the files kept by dentists .Meanwhile it should be a stimulation to each colleague in order to pay more attention to this problem in the near future .

To make it easy , we just ask you to cross a 'yes' or 'no' square . The filled up forms may be returned anonymously .

Please mention:
-country and city
-male(M) or female(F)
-age
-university
-date of certificate



| DENTAL FILE | YES | NO |
|---|---|---|
| *1* Do you start a dental file of all new patients ? | ☐ | ☐ |
| - immediately when the patient enters ? | ☐ | ☐ |
| - or at the end of the consultation ? | ☐ | ☐ |
| *2* Do you work - manually with • pre-printed forms ? | ☐ | ☐ |
| • non pre-printed forms ? | ☐ | ☐ |
| - with a computer programme ? | ☐ | ☐ |
| *3* For each new patient,do you note-the full name ? | ☐ | ☐ |
| - for ladies: • girls name ? | ☐ | ☐ |
| • husbands name ? | ☐ | ☐ |
| - date of birth | ☐ | ☐ |
| - address ? | ☐ | ☐ |
| - telephone number ? | ☐ | ☐ |
| - mobile number ? | ☐ | ☐ |
| - email address ? | ☐ | ☐ |
| - previous dentists name and address ? | ☐ | ☐ |
| - name and address of the treating orthodontist ? | ☐ | ☐ |
| - name and address of the treating periodontologist ? | ☐ | ☐ |
| - name and address of the dental surgeon ? | ☐ | ☐ |
| - name and address of the physician ? | ☐ | ☐ |
| - national health service number ? | ☐ | ☐ |
| - emergency phone number of relatives or acquaintances? | ☐ | ☐ |
| - in a group practice : • the treating dentist ? | ☐ | ☐ |
| • per treatment ? | ☐ | ☐ |
| - patients profession ? | ☐ | ☐ |

## *Anamnesis*

**- Medical anamnesis**

| | | |
|---|---|---|
| Do you make notes of the general medical data in the file ? | ☐ | ☐ |
| If you do, do you ask for - the medical past history ? | ☐ | ☐ |
| - the medical complaints ? | ☐ | ☐ |
| • heart complaints? | ☐ | ☐ |

| | YES | NO |
|---|---|---|
| • blood pressure ? | ☐ | ☐ |
| • blood-curdle-problems ? | ☐ | ☐ |
| • diabetes ? | ☐ | ☐ |
| • epilepsy ? | ☐ | ☐ |
| • asthma ? | ☐ | ☐ |
| • allergy? | ☐ | ☐ |
| • allergy to: antibiotics ? | ☐ | ☐ |
| anaesthetics ? | ☐ | ☐ |
| latex ? | ☐ | ☐ |
| others ? | ☐ | ☐ |
| • liver complaints ? | ☐ | ☐ |
| • radiotherapy ? | ☐ | ☐ |
| • female: pregnant ? | ☐ | ☐ |
| Do you make an update of the anamnesis after each consultation ? | ☐ | ☐ |
| Do you note these new data in the file ? | ☐ | ☐ |
| **- Dental anamnesis** | | |
| At the first visit : - do you note the reason of the consultation ? | ☐ | ☐ |
| - do you do a complete mouth examination ? | ☐ | ☐ |
| - do you make x-ray's : • apical ? | ☐ | ☐ |
| • full status ? | ☐ | ☐ |
| • panoramical ? | ☐ | ☐ |
| **Examination of the mouth** | | |
| Do you use a pre-printed dental chart ? | ☐ | ☐ |
| If you do - do you fill up completely ? | ☐ | ☐ |
| - do you note the pre-existing situation at the first visit ? | ☐ | ☐ |
| - do you note your own treatments ? | ☐ | ☐ |
| - do you note with detail of treatment ? | ☐ | ☐ |
| - do you note which materials you used? | ☐ | ☐ |
| - do you note the treated surfaces of the tooth ? | ☐ | ☐ |
| - do you note the health service number code ? | ☐ | ☐ |
| Do you update the dental examination file yearly ? | ☐ | ☐ |
| Do you use abbreviations ? | ☐ | ☐ |
| If you do - being taught by university ? | ☐ | ☐ |
| - abbreviations of your own ? | ☐ | ☐ |
| Do you keep a list to explain these abbreviations ? | ☐ | ☐ |
| Do you note eventual abnormalities ? | ☐ | ☐ |
| - supernumerary teeth | ☐ | ☐ |
| - congenital absent teeth/missing teeth | ☐ | ☐ |
| - microdontia | ☐ | ☐ |
| - abnormal shape | ☐ | ☐ |
| - rotations | ☐ | ☐ |
| - diastema | ☐ | ☐ |
| - torus maxillaris/mandibularis | ☐ | ☐ |
| - dysgnathic anomaly/ malocclusions | ☐ | ☐ |
| For children : - do you fill in the right phase of the mixed dentition ? | ☐ | ☐ |
| - do you adjust it during the next patients visit? | ☐ | ☐ |
| - do you note multiple trauma? | ☐ | ☐ |
| - do you note facial bruises? | ☐ | ☐ |
| - do you note neglected dentition? | ☐ | ☐ |
| - do you note broken teeth? | ☐ | ☐ |
| - do you note intra-oral lesions? | ☐ | ☐ |

| | YES | NO |
|---|---|---|
| **Radiological examination** | | |
| Do you take for each patient • a panoramic x-ray ? | ☐ | ☐ |
| • a full RX-status ? | ☐ | ☐ |
| • an apical RX or bitewing ? | ☐ | ☐ |
| Do you work digitally ? | ☐ | ☐ |
| If you do | ☐ | ☐ |
| - Is there an internet connection on the same PC ? | ☐ | ☐ |
| - Do you provide for any safety system to the dental file ? | ☐ | ☐ |
| Do you work analogously ? | ☐ | ☐ |
| If so | ☐ | ☐ |
| - Do you mention this x-ray in the file ? | ☐ | ☐ |
| - Is every x-ray added to your file ? | ☐ | ☐ |
| - Is every x-ray classified separately ? | ☐ | ☐ |
| - Is every x-ray identified with ? | ☐ | ☐ |
| • name | ☐ | ☐ |
| • date | ☐ | ☐ |
| • tooth | ☐ | ☐ |
| Do you write the x-ray protocols in the file ? | ☐ | ☐ |
| **Treatment plan** | | |
| Do you mark the treatment plan on a dental chart ? | ☐ | ☐ |
| Planning extended dental works, do you make the patient sign up for a cost quotation ? | ☐ | ☐ |
| For extended dental works , do you apply an informed consent principle? | ☐ | ☐ |
| • verbally ? | ☐ | ☐ |
| • in writing ? | ☐ | ☐ |
| **Treatment** | | |
| Do you write down every treatment in the file ? | ☐ | ☐ |
| • in code ? | ☐ | ☐ |
| • fully written ? | ☐ | ☐ |
| Do you mention- what kind of filling used ? | ☐ | ☐ |
| • material ? | ☐ | ☐ |
| • brand? | ☐ | ☐ |
| Do you mention which denture the patient has ? | ☐ | ☐ |
| • kind of denture? | ☐ | ☐ |
| • material? | ☐ | ☐ |
| • number of teeth ? | ☐ | ☐ |
| • number of clamps and on which teeth? | ☐ | ☐ |
| • colour? | ☐ | ☐ |
| • origin of the denture? | ☐ | ☐ |
| • conformity certificate? | ☐ | ☐ |
| • do you make a denture marking? | ☐ | ☐ |
| Do you mention the serial number of an implant? | | |
| **Miscellany** | | |
| Do you mention in the file if the patient | | |
| • doesn't show up on the appointment ? | ☐ | ☐ |
| • asks for advice by phone ? | ☐ | ☐ |
| Do you mention treatments that are not refundable ? | ☐ | ☐ |
| Do you add answers /reports/referral letters to/ from specialists to the file ? | ☐ | ☐ |
| Do you mention prescribed medication in the file ? | ☐ | ☐ |
| Do you mention if the patient takes away x-rays or mouldings ? | ☐ | ☐ |
| Do you make the patient sign up for it ? | ☐ | ☐ |

| | YES | NO |
|---|---|---|
| Do you mention personal impressions about the patient (such as mental condition)? | ☐ | ☐ |
| Do these personal notes legally go with the file? | ☐ | ☐ |
| Do you add referrals to/from colleagues to the file? | ☐ | ☐ |
| Do you keep the file • in alphabetical order? | ☐ | ☐ |
| • in order of date of birth? | ☐ | ☐ |
| • otherwise ? | ☐ | ☐ |
| How long do you keep a patients file of someone who hasn't consulted you | | |
| • for many years | ☐ | ☐ |
| • < 5 years? | ☐ | ☐ |
| • 5-10 years? | ☐ | ☐ |
| • 10-15 years? | ☐ | ☐ |
| • 15-20 years? | ☐ | ☐ |
| • always kept? | ☐ | ☐ |
| Is a dentist in your country legally obliged to keep files? | ☐ | ☐ |
| Where you already asked in the past to give a certain file for identification? | ☐ | ☐ |
| Where you already asked in the past to make a dental age estimation? | ☐ | ☐ |
| Do you talk about one patients data with other patients? | ☐ | ☐ |
| Are the dental files of patients legally your property? | ☐ | ☐ |
| Do you know the medico-legal value of a file? (third party risks, insurance, identification ) | | |

That' s it! Thanks for your cooperation .

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