

## Bitemark identification in child abuse cases\*

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### Abstract

*Bitemarks in children represent child abuse until proven differently. They are rarely accidental and are good indicators of genuine child abuse.*

*There is a spectrum in the appearance of bitemarks throughout childhood. In infancy the bites tend to be punitive in nature and generally are located anatomically differently from bitemarks inflicted later in life. Older children reflect bitemarks which represent either assault or sexual abuse. These "tool marks" often can be separated on the basis of appearance as well as location.*

*Human bitemarks are identified by their shape and size. They have an elliptical or oval pattern containing tooth and arch marks. These impressions can be matched against the dentition and dental impressions of the victim and suspects.*

*Using tool-mark technology, comparisons are possible even in limited material. Computer enhancement of bitemark photographs increases a favorable comparison by further delineating unique characteristics of the arch and individual teeth.*

\* The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Department of the Navy or the Department of State.

The majority of child abuse patients are brought to hospital emergency rooms, pediatric clinics, or emergenciers with a history of accidental trauma supplied by the parents or adult guardian. Bitemark injuries are rarely accidental and are good indicators of genuine child abuse.<sup>1</sup> Where bitemark evidence exists it usually is possible to exclude all but one person as the assailant. In most cases, the person inflicting the bitemark is the person responsible for abusing the child.<sup>2</sup>

A wide spectrum of bitemark evidence exists within the confines of child abuse. Bitemarks found on infants tend to be in different locations than on older children or adolescents and reflect punitive measures.<sup>2-4</sup> Older children tend to exhibit bitemarks falling into 2 categories: assault, in which bites are inflicted in a rapid, random, enraged manner; and sexual abuse in which a well-defined bitemark is evident and frequently associated with a "suck" mark.<sup>1,5,6</sup> The sexual category also includes defense bitemarks, on either the victim or the assailant.

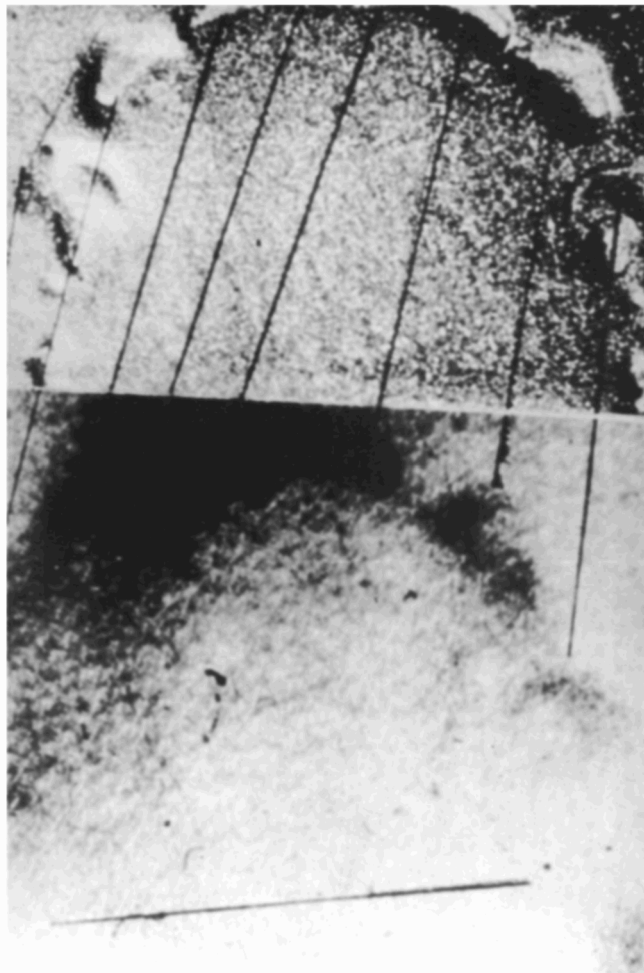
Human bitemarks are identified by their shape and size.<sup>3,7-9</sup> When necessary, serological techniques are available and may assist in identification. Frequently, there are sufficient dental similarities between the bitemark and the accused to exclude other suspects. With rare exception, identification is by exclusion rather than inclusion.<sup>5,9-11</sup> Although bitemarks rarely contain more features than those exhibited by the ante-

rior teeth, the unique character of an individual's mouth as modified by race, age, nutrition, occupation, and dental treatment is reflected in the "tool marks" left behind (Fig 1).<sup>8,12,13</sup>

Extractions, malalignment, malformation, injury, and dental restorations all contribute to the uniqueness of a bitemark. Serological evidence obtained during the investigation may aid in identifying or excluding a suspect and is a valuable adjunct to the efforts of the forensic odontologist.<sup>5,7,10</sup>

Photography is crucial to bitemark investigation and should be repetitive since bitemarks can change significantly over a 24-hr period. Ideally, all bitemark photographs should be in black and white as well as in color, with and without a scale.<sup>4,7,11,14</sup>

All evidence in a bitemark investigation should be



**FIG 1.** This photograph shows the comparison of two bitemarks for court presentation. The upper bitemark is from a dental impression of the accused assailant. The tool marks of the individual teeth are well defined. The lower bitemark is as it appeared on the victim. The bitemarks are compared on a 1:1 scale to show not only the matching tool marks, but also the arch size and shape.

obtained properly with authorization from appropriate authorities and processed with strict attention to the chain of evidence. Deviations from accepted procedures will cause loss of time and money.

## Identification of Bitemarks

Bitemarks are found in a significant number of child abuse victims. Most reported cases are the result of attack bites and are recognized and documented only when the victim is examined by a medical examiner-coroner in a death investigation. In this environment, the bitemark is recognized early, a forensic odontologist is called as a consultant, and the evidence is preserved for future prosecution.

Emergency room personnel, family practitioners, and law enforcement personnel can identify and preserve bitemarks in living victims. Bitemark identification entails several cognitive steps — recognition of the wound, documentation, and interpretation. Early recognition is critical if valuable evidence is to be preserved. Artefacts can be introduced quickly, complicating or negating existing evidence. Documentation begins with recognition and then proceeds to a step-wise work up of the case.

The nature and location of the bite is likely to change with increasing age of the child. Bitemarks in infants occur in body locations and under circumstances different from these of the preschooler, school age child, or adolescent.<sup>6,8,9,11,13</sup>

In infants, bitemarks tend to be punitive and are often a response to crying or soiling. As a result, bitemarks may appear anywhere, but tend to be concentrated on the cheek, arm, shoulder, buttocks, or genitalia. Punishment for soiling is usually centered about the buttocks or external genitalia. Usually there is other evidence of punishment as well, such as bruising, pinch marks, burns, etc.<sup>5</sup> A time spectrum of bites may reflect repetitive abuse, with bitemarks which are healed, healing, and fresh.<sup>2,5</sup> Separation and timing of injuries becomes important in assessing intent and state of mind.

In childhood (versus infancy) bitemarks tend to be less punitive and more a function of assault or defense. Sexually oriented bitemarks occur more frequently in adolescents and adults (Fig 2).<sup>4,12</sup>

Bitemarks resulting from sexual attack may be present on the victim or assailant. The marks on the assailant usually are caused by the anterior teeth of the victim biting in self-defense. These bites are found frequently on the hand of the assailant and may be severe, resulting in laceration or avulsion of tissue. Such tissue often has been matched with a wound on the assailant. Bitemarks on a victim may be caused by the assailant or the victim biting himself. The latter is uncommon but may be seen when there is an at-



**FIG 2.** This photograph shows the clearly defined irregular tool marks of individual teeth on the cheek of this adolescent. There are substantial abrasions about each tooth mark suggesting motion during the biting episode. Such information is valuable in reconstructing the attack and corroborating the statements of the victim, assailant, and witnesses.

tempt to stifle an outcry. The most common bite-marks, however, are those caused by the assailant. The areas generally bitten are the neck, cheek, arms, thighs, and breasts.<sup>5</sup> On occasion, nipples may be bitten off. Such marks tend to be well defined and frequently show an area of contusion between the tooth marks identifiable as a dental arch. The contusion is the result of sucking, which brings the tissue in apposition to the palate.<sup>5,14</sup>

Nonhuman bites are not uncommon in death investigations. They frequently are the result of the body being present in a confined space accessible to pets such as the household dog or cat, or the body may be in an open location. Examples often seen include artefacts caused by ants, roaches, mice, rats, skunks, raccoons, opossums, foxes, coyotes, bears, etc. The bites easily are recognizable as nonhuman. For example, dogs have a narrower mouth with prominent canines. Their teeth are shaped differently and cause deeper wounds. Cat bites tend to be small and round. Rodent bites usually have a scalloped edge and are associated with a moderate amount of adjacent soft tissue injury.

Human bitemark characteristics include an elliptical or ovoid pattern containing tooth and arch marks.<sup>4,5,12,14</sup> In its simplest form a bitemark consists of tooth marks produced by antagonistic teeth. An arch mark is identified when 4 or 5 marks of adjacent

teeth are present.<sup>5</sup> When marks of the maxillary canines are identifiable, the distance between the 2 canine marks should measure between 2.5 and 4.5 cm.<sup>2</sup> If the bite is human, and the canine-to-canine distance is less than 3.0 cm, the bitemark in question likely belongs to the deciduous dentition of a child. Class characteristics of tooth marks reflect the shape of their incisal or occlusal areas. Incisor marks are rectangles or portions of rectangles, whereas canine marks are triangles or portions of triangles.<sup>5,11</sup> Premolars or bicuspid marks are triangles, circles, or diamonds.<sup>5,11</sup>

The bitemark caused by the maxillary arch is usually diffuse reflecting the integrity of the maxilla in the skull. In contrast, the mandible is mobile and acts as a cutting instrument forming more distinct tooth marks. The location of the bite is important in the appearance of the pattern; skin thickness and slippage may give the bitemark an oblong shape.<sup>11,14</sup> The uniqueness of the bitemark depends on the displacement, rotation, incision, laceration, abrasion, or fracture of each tooth mark.<sup>4,8,11,14</sup>

In living victims, the bitemark evaluation can be made difficult by tissue changes. Infection, edema, and discoloration all contribute to distortion. Viewing the suspected area under an ultraviolet light may help discern the tooth marks.<sup>7,8,15</sup> The appearance of the bitemark will change during the postmortem interval with the most distinctive marks being present when the bite is inflicted just prior to death or shortly afterward.

The duration of a bitemark is dependent on the force applied and the extent of tissue damage. Tooth marks that do not break the skin last from several minutes to 24 hr.<sup>7,8</sup> In those cases where the skin is broken, the borders or edges will last several days depending on the thickness of the tissue. Thinner areas retain the marks longer.<sup>7,8</sup>

Timing of the injuries is difficult and complicated by individual variation. In living victims, the history is correlated to sequential color photographs depicting any changes. In these cases, reabsorption of tissue hemorrhage and re-epithelization can be documented.<sup>16</sup>

Photography is crucial to the documentation of bitemarks and all suspected bitemarks should be photographed early and sequentially. The photographs should be in color and in black and white, with and without a scale. In addition to photographs, tissue sections stained for iron, elastic, and collagen fibers as well as the standard hematoxylin and eosin will prove useful in deceased victims.<sup>16</sup>

Histochemical techniques are proving helpful in determining pre- and postmortem wounds.<sup>17</sup> Based on the premise that living tissue responds differently to injury than dying or dead tissue, investigators have

evaluated many tissue enzymes and substances. Some of the more useful seem to be the radioimmune assays for serotonin (5 hydroxytryptamine) and histamine. Based on comparison of tissue specimens from the suspected wound and a control specimen on the same body, a serotonin difference of 2x and a histamine difference of at least 1.5x between the wound and the control is indicative of premortem injury.<sup>17</sup>

Preservation of bite mark evidence has received much attention. Several guidelines are available. A method reported in 1968 by Furness is used widely and involves 7 steps:<sup>15</sup>

1. Photographs are taken of the bite marks. The photographs, in color, are selected for orientation and close-up documentation and show in each role at least 1 frame with a color scale for color balance. The photographs should be taken with and without a scale on the same plane as the injury.
2. Casts are made of the suspect's teeth. A variety of materials are available which will not distort the impression material on drying.
3. The biting edges of the teeth are marked with printer's ink.
4. Photographs are taken of the biting edges of the labial and occluded views of the cast (front and top views).
5. Negatives are printed to correspond in size with photograph prints of the victim's bite mark and mounted on white cardboard.
6. The curvature of the teeth in the bite mark is compared with the curvature of the dental arch and measured left to right. The spaces between the teeth and the width of the biting edge are measured and compared showing all similarities.
7. The casts and photographs then are labeled and rephotographed for court presentation.

An important procedure, frequently overlooked, is saliva sampling. By its nature, a bite mark will be accompanied by the presence of saliva. Identification of saliva is important because the concentration of agglutinin in saliva is 4 times greater than that found in human blood cells and the majority of the population (80%) secrete blood group substances corresponding to their blood type in their body fluids.<sup>5</sup>

Using absorption elution techniques and electrophoresis, a serological "fingerprint" can be developed to help individualize the assailant. The suspect bite mark, after being photographed, is swabbed with cotton moistened in saline, bottled, labeled, and refrigerated for processing by a forensic serologist. The washing should be started at the periphery of the bite and directed centrally in a circular motion. Alternatively the bite mark can be swabbed with distilled water and air dried. More information is available for comparison when these saliva washings are accompanied

by saliva and blood specimens from the victim and all suspects. If there is a question regarding the human origin of the bite mark, a simple precipitin test usually will suffice. This test is one of many in the armamentarium of the forensic serologist.

Obtaining bite mark impressions or molds from the skin is relatively simple and inexpensive. The materials required are widely available and include a light-bodied rubber base and catalyst, dental dye stone, a paper mixing pad, rubber base syringe, spatula and gauze. All the materials are available at any dental supply house. The base and catalyst are mixed on the mixing pad and squeezed into the syringe. The syringe then is used to apply the homogeneous mixture to the bite mark avoiding any air bubbles. The mixture, continuously applied, should cover the skin between and around each indentation and should be thick enough to permit later smoothing out of the surface. At least a ¼ to ½-in margin of normal skin should be included in the mold. A single layer of gauze is placed over the mixture, completely covering it and trimmed to the appropriate size. The mold is allowed to harden for at least 5 min. The dental dye stone is mixed with water, applied to the mold, and allowed to dry for approximately 15 min. The mold then can be removed gently, yielding a negative image of the bite mark with each tooth mark appearing as a raised structure. A positive mold can be made from the mold and compared with wax bite impressions of the suspect(s).

The collection of evidence in bite mark cases falls into several categories:

1. Description of bite mark(s)
2. Collection of evidence from the victim
3. Collection of evidence from the suspect(s)
4. Analysis of all evidence.

Description of the bite mark should include the demographics of the victim and examiner, followed by: a description of the anatomic location including surface, contour, and tissue characteristics; the shape, size, color, and injury type.

Injury types include hemorrhage (petechiae, ecchymosis, contusion or hematoma), abrasions, lacerations, incisions, avulsions, and artefacts.

Evidence obtained from victims and suspects must be with proper authorization from appropriate authorities.<sup>18</sup> The suspect may object to photographs, dental impressions, and examinations on the basis of self-incrimination and his right to be free of unreasonable searches and seizures. The Supreme Court held in *Schmerber v. California*<sup>19</sup> that the Fifth Amendment privilege "protects an accused only from being compelled to testify against himself or otherwise provide the state with evidence of a testimonial or communicative nature." The court noted that many

identification procedures are not protected by the Fifth Amendment. Since the *Schmerber* decision, intrusions of the body are considered to be searches and are not testimonial in nature.<sup>7</sup> Identification procedures under these circumstances are limited to observations and comparisons. In the same case,<sup>19</sup> the Supreme Court, in addressing the Fourth Amendment, noted that values protected by the Fifth Amendment overlap with those of the Fourth, and emphasized the fact that the Fourth Amendment's purpose was to constrain against unjustified intrusions or those made improperly, not against all intrusions. In *Katz v. United States*<sup>20</sup> it was held that a search of what is voluntarily exposed (i.e., dentition) to the public is not a violation of the Fourth Amendment.

Successful bitemark identification is dependent on a high index of suspicion. Unlike most other crimes against persons, there may be no scene evidence whatsoever, aside from the victim. The case may be prosecuted solely on evidence on the victim. If the evidence is unrecognized, contaminated, or lost, then there will be no successful prosecution.

An aspect not fully utilized at this point, but certainly worth considering, is computer enhancement. If adequate photographs have been obtained, then the bitemarks can be digitalized and viewed 3-dimensionally. The same is true with any impressions that might be relative to the case. These tool marks can be compared in detail. The addition of computer manipulation to tool mark identification has added greatly to the possibilities of bitemark identification. Tooth fragments and avulsed tissue examined under a scanning electron microscope and chemically analyzed can complete an investigation or provide the basis for a confession.

The capabilities of laboratory technology can be tapped only when the primary health officer takes appropriate action when confronted with evidence of physical abuse. Early recognition of bitemark evi-

dence, and its significance in suspected child abuse, is possible — and successful prosecution probable — when the primary health officer is alert and responsible.

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