

CASE REPORT

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Bite Mark Evidence: A Case Report Using Accepted and New Techniques

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ABSTRACT: A case report of murder involving bite marks on the victim is presented. The bite mark examination procedures are outlined. Microbiologic and histologic/histochemical techniques are used to further delineate the nature of the bite marks and to aid in the identification of the murderer. Preparation and presentation of evidence are discussed.

KEY WORDS: pathology and biology, bite marks, human identification

A bite mark is a mark made by the teeth either alone or in combination with other mouth parts [1]. The bite mark may be considered a mirror image of the arrangement and characteristics of the dentition. Epidermal bite mark evidence has led to the indictment, trial, and conviction of suspects in crimes associated with child abuse, sexual assaults, and homicides [2].

The establishment of a bite mark as an acceptable record of identification requires analysis of specific dental characteristics. The dental findings must include:

- (1) presence or absence of each tooth,
- (2) shape of each tooth,
- (3) relationship between the upper and lower jaw,
- (4) arch form,
- (5) mesiodistal dimensions, and
- (6) any unusual features (supernumerary teeth, rotation, fractured teeth, diastemas, and so forth) [1-6].

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Further, other factors must be considered that are germane to the acceptability and reliability of the human bite mark record:

1. Differentiation between human and animal bite marks must be made. In animals, the arch size is narrower; teeth are sharper; and the skin indentations are smaller and deeper. A broad U-shaped arch and broad, shallow, blunt indentations are more characteristic of human bites [7].

2. Bite mark evidence depends on the type of material in which the record is made (for example, human tissue or food stuffs). Human tissue has been described as one of the least dependable substances for the recording of the bite marks.

3. The status of the tissue (antemortem or postmortem), the time elapsed between the actual biting and when the impression is made, the condition of the skin injured by the bite pressure, the size of the wound, the clearness of the marks, and the reaction of the surrounding tissue must all be considered in determining the reliability of the evidence [8].

4. While the amount of hypodermic fat has little influence on the form of the tooth marks and the degree of their vividness, the tooth marks showing the shape of the incisal edges remain two to three times longer in victims with little hypodermic fat as compared with those having a great deal of hypodermic fat. The size of the dental arch differs from the original by an increase in width and a decrease in length in subjects with a great deal of hypodermic fat; the reverse is apparent in subjects with little hypodermic fat [8].

5. In general, the stronger the bite pressure, the deeper the depression; the slighter the sucking, the clearer the forms of the cutting edges of the incisors impress in the skin [8].

Acceptance of bite mark evidence in a court of law is often a precedent-establishing procedure. It is important that all procedures be well documented, that new procedures be carefully outlined, and that the court be able to draw conclusions on the basis of its own interpretation of the evidence. The purpose of this paper is to delineate the manner of accomplishing these ends in a case of murder involving bite marks in a state criminal court where such evidence had not been accepted before.

Materials and Methods

The investigation of this bite mark case followed a specific sequence of events [3]. First, both breasts were swabbed to obtain residual saliva to determine the blood type of the person causing the bite [4]. Care was taken not to include any traces of blood found near the wounds. The entire body and the breast wounds were photographed with a millimetre rule for orientation and size determination of the bite marks. The photography included infrared lighting, ultraviolet lighting, and black and white and color exposures in natural light. Impressions were made by using irreversible hydrocolloid (alginate) backed with a thin veneer of plaster of paris for support. Models of the impressions were poured in dental stone within 15 min to maintain accuracy and were marked appropriately for orientation. The impression technique was photographed.

Because both nipples had been traumatically avulsed, it was decided to obtain the tissue for microscopic examination from the right breast during the initial postmortem examination (within 24 h of death) and to obtain the tissue for microscopic examination from the left breast five days later, following the suggestion of Harvey [5]. Both specimens were semilunar and included the macerated tissue of the wound and a margin of uninvolved areolar tissue. Each specimen was placed on cardboard for stability and orientation and fixed in 10% neutral buffered formalin. After 24 h of fixation, the tissue was trimmed to include both involved and uninvolved breast tissue and was paraffin-processed. The sec-

tions were cut at 3 μm and stained with hematoxylin and eosin (H&E), periodic acid-Schiff (PAS), Brown and Brenn (B&B), and Grocott's methenamine silver (GMS), using appropriate controls [9].

One month later a suspect was apprehended and willingly signed a release to allow search of his body. At time of presentation, the suspect and his dentition were photographed by using color photography and natural light. It was noted that the suspect had gross gingivitis, mild periodontal disease, and very poor oral hygiene. Irreversible hydrocolloid impressions of the suspect's dentition were made and impressions were poured in dental stone immediately. The impressions were articulated with a wax wafer record of the suspect's occlusion. Comparison of the dental stone models of the suspect's dentition and the dental stone models of the victim's breasts matched in the areas of the incisors, and the suspect was charged with murder.

Because ultimately all evidence had to be presented to the court (jury), the photographic comparisons were made in the following manner:

1. A photograph was made of the models of the defendant's teeth and enlarged 3:1 with a millimetre rule in the photograph as a guide for magnification.
2. A photograph (with millimetre rule) was made of the models of the defendant's teeth, reversed and enlarged 3:1.
3. A photograph (with millimetre rule) was made of the models of the defendant's teeth with the incisal edges of the six anterior teeth outlined in black ink. This photograph was made so that only the outlined incisal edges and the millimetre rule showed on the otherwise transparent photographic film. This photograph was enlarged 3:1 and became an overlay that allowed the jury to compare one set of photographs (enlarged 3:1) of the wounds to the outlines of the incisal edges of the suspect's teeth.
4. Photographs (with millimetre rule) of the bite marks were enlarged 3:1.

Results

Saliva Analysis

Analysis of the saliva taken from the wounds was nonproductive for blood typing evidence.

Histologic and Histochemical Analyses

The histologic results from both the right and left breast were similar except for autolytic and shrinkage changes seen in the left breast resulting from the five-day delay between death and fixation. The slides stained with H&E revealed an abrupt break in the epidermis at the site of the wound along with compression and tearing of the dermis. There was actually a depressed cavity in the tissue corresponding to the tooth imprint (Fig. 1). Recent hemorrhage was not a prominent feature, and there was no inflammatory response; these features are consistent with the time of trauma being at or just after death. Polarized light revealed multiple birefringent crystals at the base of the cavity and within the dermis of the connective tissue. The crystalline structure and polarization pattern was consistent with dental calculus (Fig. 2).

The PAS stain revealed positive material within the cavity and within the compressed dermis. Because the positive staining was not well defined and because the anatomic site might be expected to have such material intrinsically, the stain was not particularly useful. The B&B stain revealed only gram-positive cocci on the surface of the epidermis. Numerous microorganisms were found within the cavity and the macerated connective tissue of the wound. The microorganisms were both gram-negative and gram-positive

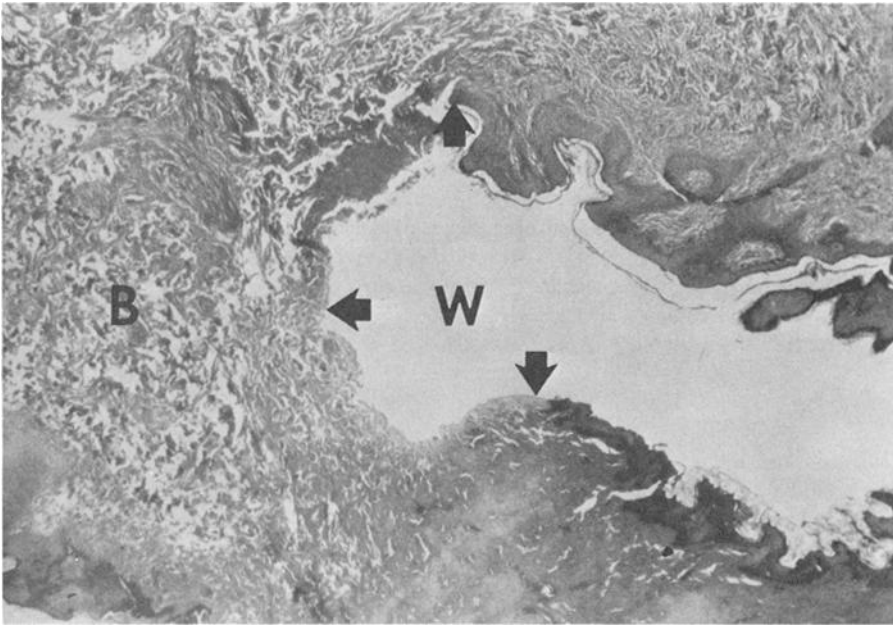


FIG. 1—The breast wound (W). Note the break in the epidermis (arrows) and the compression of the breast tissue at this point compared with the more normal areolar dermis (B). Original magnification, $\times 4$.

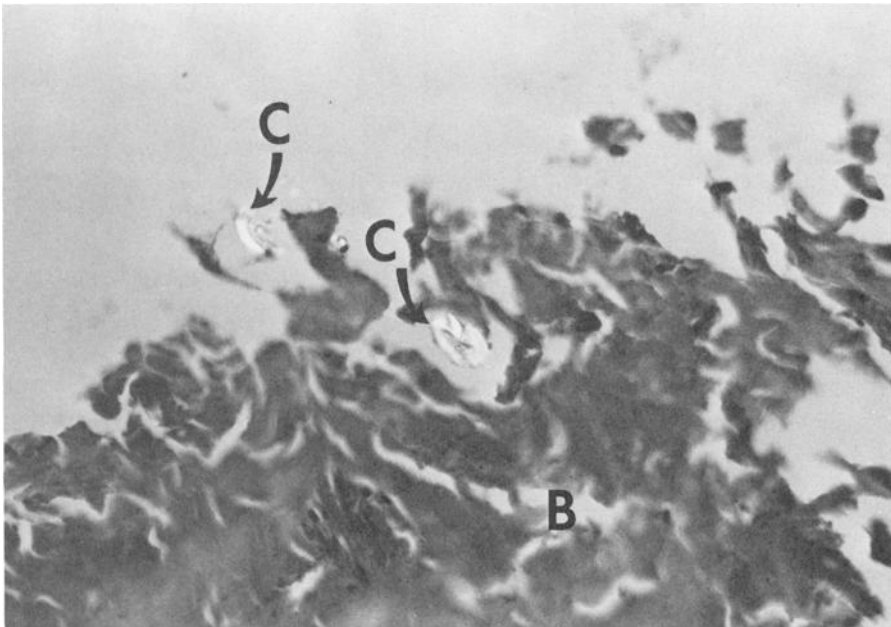


FIG. 2—Birefringent crystalline material (C-arrows), consistent with dental calculus, from deep within the breast tissue (B). (Original magnification, $\times 40$.)

and included cocci and bacilli along with pleomorphic rods consistent with *Actinomyces*. Colonies of microorganisms were also associated with dental calculus (Fig. 3). Microorganisms seen deep within the tissue were in significant numbers and were interpreted as being consistent with normal oral flora, thereby substantiating the fact that the wounds were caused by biting. The GMS stain revealed bacteria with absence of yeast or fungi. The special stains on the left breast were less consistent in quality and thus considered less reliable.

Photomicrographs were made of all tissue sections and were presented initially to the presiding judge *in camera*. After his review of and deliberation on the material he ruled that it could be entered as evidence because the jury was able to consider the evidence on the basis of substance rather than just the word of an expert witness. The evidence was presented by using a slide projector and screen in the courtroom.

Photographic Analysis

Infrared and ultraviolet illumination of the wounds revealed refringent material that was concluded to be unreliable as to its source and, therefore, was of no value as evidence. Comparisons of the photographs taken from the wound of the victim with overlays as previously described revealed that the right breast showed 17 points of comparison and the left breast showed 23 points of comparison (Fig. 4). The total number of exhibits introduced into evidence associated with photographic analysis was 27, including the actual models of the suspect and the victim.

Discussion

While both microbiologic techniques and histologic/histochemical techniques have been employed in investigating bite mark evidence, the two had not previously been combined



FIG. 3—Mixed aggregate of microorganisms associated with calculus (C) from deep within the breast tissue. (Original magnification, $\times 100$.)

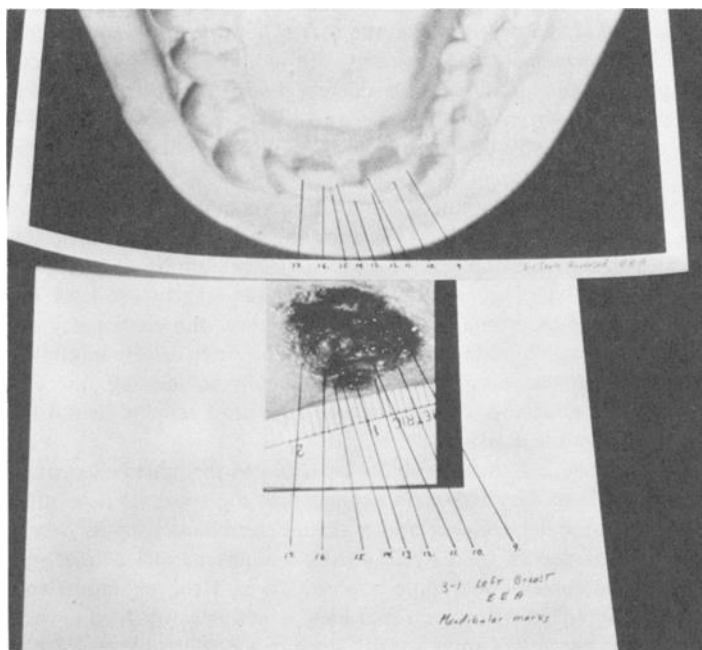


FIG. 4—An example of enlargements and points of agreement used in the courtroom presentation.

as they were in this particular case. Microbiological analysis of human bite marks using culture techniques has revealed as many as 224 strains of aerobic or facultative bacteria. Some investigators have found α -hemolytic streptococci to be the predominant organism while others have found *Staphylococcus aureus* to predominate. The most common anaerobic strain isolated was *Bacteroides* species [10-13]. The organisms that predominate would be those considered normal oral flora. As exemplified in the case presented, the number and type of organisms are dependent on the oral health of the individual inflicting the bite. The suspect in this case at the time of presentation had marked gingivitis with food and microbial plaques on all anterior teeth. Because of his difficulty incising he also would have applied more pumping action to the tissue, driving the organisms deep into the subcutaneous areas. While cultures were not performed in this particular case, the histologic sections revealed that it would have been wise to submit the tissue for culture rather than attempting to swab or aspirate the area.

Most of the histologic/histochemical studies of tissue have been related to time of death assessment and compression artifacts. Evidence of vascular leakage in both the form of red blood cells and edema has been used to determine the time of the bite infliction relative to the time of death. If there is a great deal of edema and hemorrhage, the bite was inflicted before the death of the victim. The presence of hemosiderin would signal a bite of some duration, and the absence of any vascular change would suggest a postmortem bite. When collagen has been stressed before the fixation of the tissue, the collagen fibers retain the red of a Masson dye, therefore showing the characteristic color change [14]. The load applied by the teeth to the tissue during experimental bites was sufficient to initiate a marked increase in the red staining of the collagen with the maximum color change occurring in the lower dermal region. Evidence of stress was also seen in the central region of a bite mark owing to the suction and tongue thrusting, but this was

found to be less than that brought about by the teeth [5]. In the case presented, there was evidence of collagen compression consistent with the above findings. There was also PAS-positive material at the depth of the bite mark; however, of greater significance was the finding of birefringent material consistent with dental calculus and of large numbers of both gram-positive and gram-negative microorganisms, consistent with normal oral flora, deep in the tissue. From this evidence, the expert witness was able to suggest that the injury was probably due to bite marks made by an individual with substantial dental disease.

Positive identification of bite marks by photographic superimposition cannot be used unless the exact position of the body at the time the bite mark was made is known and duplicated because of the distortion caused by a change of position and irregular shrinkage of the excised human tissue [15]. In this case, care was taken to at least reposition the body as it was found at the scene of the crime. Further, the consistency of the photographic enlargements was maintained by the use of millimetre rulers. In addition, because the suspect had pronounced prognathism and difficulty in incising, there was a great deal of maceration of the tissue. For this reason, the most reliable dental findings were found at the edge of the bite marks.

Of greatest importance is that all evidence germane to this particular case was able to be presented in a court of law. It was so explicit that the court (that is, either judge or jury) was able to examine the evidence and make a determination by its own comparison. For this reason, the models of the suspect's teeth and the models of the injured breast, the photographic enlargements and superimpositions, and the photomicrographs of the breast wound were submitted. The expert testimony was heavily weighted toward explaining the technique and the manner of comparison. The jury was then able to make a conclusion predicated on the evidence rather than the word of an expert witness.

Summary

Although bite mark evidence is still controversial and had not been accepted in this state, care in the preparation of the evidence and the use of reported techniques aided in the acceptance of such evidence. In this paper a case has been presented in which reported methods of comparisons of impressions, models, and photographs were used. Histologic and histochemical analyses of the wound, unused prior to this case, revealed the presence of calculus and microorganisms that supported the contention that this was a bite mark made by an individual with substantial dental disease.

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