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The Use of Bite Mark Evidence as an Investigative Aid

The purpose of this research paper is to review the literature dealing with the handling and subsequent examination of bite marks. The approach taken will be to explain the various uses of bite marks as an investigative aid to law enforcement personnel.

The examination of bite marks is a segment of forensic odontology, which has been defined as "the branch of odontology (dentistry) which deals with the proper handling and examination of dental evidence, and with the proper evaluation and presentation of dental findings in the interest of justice" [*1*]. The study of forensic odontology consists of three major areas: (1) the examination and evaluation of injuries to the teeth, jaws, and oral tissues; (2) the examination of dental remains from unknown bodies or persons for the purpose of possible identification of the individual; and (3) the examination of bite marks for the purpose of elimination or possible identification of a suspect as the originator [*2*].

The inclusion of bite marks as a component of forensic science has been developed and successfully used by the European countries since the beginning of this century. The Scandinavian countries, especially, have done considerable work in this field. Unfortunately, we in the United States have not kept up to the pace established by our European friends in this forensic field. The utilization of bite marks as evidence in criminal investigations has been greatly overlooked by the vast majority of law enforcement agencies in the United States. A review of several training programs conducted by Federal, military, and state investigative agencies reveals that the subject of bite marks is absent from their curricula. In addition, the leading texts dealing with criminal investigation also fail to mention the possible utilization of bite marks as an investigative aid.

At this point skeptics may wonder if bite marks are really important. They may feel that their occurrence is quite rare. The Biggar murder case, which occurred in Scotland in 1967, should disprove this skepticism [*3,4*]. Until this time the use of bite marks was rarely considered in Scotland, but through the cooperation of personnel in the forensic community the murderer was identified and ultimately convicted, primarily through the utilization of bite mark evidence. Immediately after this case there was a general feeling that although the bite mark evidence was instrumental in this case, it was unlikely that

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this type of evidence would be obtained in another case. In rapid succession, however, came a series of cases from various parts of Scotland in which investigation revealed that the victims had been bitten. It is unlikely that these crimes were a new trend of assault; rather, it should be assumed that the same proportion of bite mark cases existed in the past but were not investigated properly. Only through the awareness generated by the Biggar case did criminal investigators and the forensic community become aware of the "current crop" of bite marks.

In this country we must educate the forensic community, particularly law enforcement personnel, to the possible presence and utilization of bite marks in their investigations.

The Nature of Bite Marks

The human adult dentition consists of 32 teeth, each of which has its own characteristics, size, and shape. Because of extractions, malalignment, malposition, malformation, spacing, fractured teeth, dental restorations, and numerous other factors, the human dentition is quite individual [*5–7*]. Thus, when a person bites an object he usually, depending on the consistency of the object, will leave a dental pattern unique to that set of teeth [*5*].

Normally when a person bites an object, the upper teeth hold the object while the lower teeth do the actual cutting [*8*]. The mark that is left by the upper teeth, however, is still extremely valuable, for it provides information as to the alignment of the teeth and the size and form of the dental arch.

Objects that are bitten that may be useful in a criminal investigation are either inanimate, primarily foodstuffs, or human tissue. Bites involving foodstuffs will occasionally occur in criminal cases, as criminals sometimes eat at the scene of a crime, leaving their bite marks in the discarded or uneaten portions of food. These marks are caused primarily by the shearing action of the anterior teeth, and may be the only clue that the criminal investigator has to identify the perpetrator of the crime [*6*]. Marks left in foodstuffs are subject to a wide variation, depending upon the consistency of the material bitten and the manner in which the bite is applied. Bites in baked material seldom provide marks that are usable, while bites in hard cheese, fruit, candy, and hard sausage will often provide excellent marks. Drying and deterioration of the material will distort the appearance and shape of these bite marks, however.

Bite marks on human tissue may result from an assault by either a human being or an animal. Bites caused by human beings may be seen in any case resulting from assault or homicide [*9*]. Dr. L. J. Levine has stated, however, that in the experience of the New York Medical Examiner's Office the bites caused by human beings are normally the result of two types of crime [*5*]. The first is associated with sexual activity, which may be heterosexual or homosexual in nature, while the other type occurs in victims of "child abuse." This Medical Examiner's office reveals that child abuse victims are normally bitten in a rapid, random, enraged manner, resulting in tissue laceration and distribution over a diffused area but poor detail of the marks [*5*].

Bite marks that result from a sexual attack may be present on the victim or on the perpetrator. The marks found on the perpetrator are caused by the anterior teeth of the victim biting the assailant in self-defense [*6*]. They are often found on the hand of the assailant as he attempts to stifle the outcry of the victim. These bites may be quite severe, causing a wound and even ripping the skin, as the victim bites quickly and in a haphazard manner.

The bite marks on the victim may be caused by the assailant or by the victim biting himself [*10*]. In both instances the bite mark is primarily caused by the anterior teeth. Cases in which the victim bites himself are most uncommon, but may result from the

assailant forcing the victim's hand or arm into her mouth to prevent an outcry. The most common marks, however, are caused by the assailant's teeth. These marks may be produced before, during, or after a sexual attack or assault, and they normally will cause some type of wound on the victim. The areas generally bitten are the neck, cheek, arms, thighs, and the female breast [*10*]. Occasionally the nipples of the breast are entirely bitten off [*11*].

The marks are often well defined, being the work of a sadist who bites the victim slowly and intentionally. These bite marks in human tissue will vary from slight indentations of the skin to lacerations and penetration of the underlying tissues. Unfortunately, these wounds are often mistakenly considered bruises caused by other activity. These marks must be considered significant, however, as they may prove a relationship between the victim and the perpetrator.

As mentioned previously, bites caused by animals can also be found on deceased persons but it is easy to distinguish animal bites, particularly those caused by dogs, from those caused by humans. Dogs have a much narrower mouth than man, and the size and shape of their teeth are different. Cat bites are also easy to distinguish from human bites, as they are generally small and round. Rat and rodent bites are occasionally discovered in corpses found in the open. Their bites can also be distinguished from human bites, since the teeth of these animals show continuous growth and leave long grooves.

Investigating Personnel

Prior to a discussion of the actual processing and comparison of bite mark evidence, a brief discussion is needed concerning the personnel who are involved in this type of investigation.

Normally at the scene of a crime the first member of the "forensic team" to arrive is the criminal investigator. Ideally, he should have some awareness of the possible utilization of bite mark evidence. During this initial search of the crime scene he must be observant for the possible presence of this type of evidence. If bite marks are present on the victim or on foodstuff at the crime scene, he should immediately contact the medical examiner's or coroner's office for assistance.

Ideally, every medical examiner or coroner should have a forensic odontologist on his staff as a consultant. Unfortunately this is not usually the case, for there is a shortage of trained forensic odontologists in this country. In fact, only a few dental schools offer courses in forensic dentistry, and these courses tend to be elective in nature. The best exposure to the subject in this country is the annual Forensic Odontology Course presented at the Armed Forces Institute of Pathology. Dentists, pathologists, law enforcement personnel, and lawyers attend this course, which provides an introduction to forensic odontology.

If a law enforcement agency or a medical examiner's office does not have the services of a forensic odontologist, *now* is the time to recruit such a person, rather than waiting for a bite mark case to arise. If an agency fails in its attempt to recruit a forensic odontologist, an alternative would be to query the nearest dental school for possible consultation services.

For cases involving the military, the Armed Forces Institute of Pathology should be consulted for assistance in bite mark cases.

In cases in which the bite mark is in foodstuff, the services of a toolmark examiner should be sought in addition to those of a forensic odontologist. Toolmark examiners and firearms examiners are both experienced in the examination and comparison of striations in various materials.

It cannot be overemphasized, however, that the processing, examination, and interpretation of all bite marks should be overseen by a forensic odontologist. In addition, for quality control purposes, the forensic odontologist should have his examination and interpretations confirmed by a colleague.

Processing and Evaluation

In the processing and evaluation of bite marks, rapid action by those involved in the investigation is required, for changes rapidly occur in the appearance of bite marks, both in human tissue and in foodstuffs, because of the effects of time.

Changes in Human Tissue

In the event the bitten person is alive, the evaluation of the marks is made extremely difficult by changes in their appearance. Among these changes are possible infection, swelling, and discoloration of the area from bruising of the underlying tissues [*12*]. The bite marks may become indistinct and obscured because of these changes, or they may even disappear from view by the naked eye. In the event the marks disappear, the use of the ultraviolet lamp may make the marks visible again [*12*].

When the victim is deceased, the skin alterations are quite different, depending upon whether the bite marks were inflicted just prior to death or shortly thereafter. The turgor of the skin lasts for some hours after death, and during this period the marks are relatively sharp. When this turgor departs hours later, however, the bite marks are less easily seen and may have smoothed out [*11*]. In addition, the effects of putrefaction, which may occur 48 to 72 h after death, will also influence changes in the shape and appearance of the bite mark. Likewise, shrinkage of the corpse, which is due to the loss of water, will have an effect on the appearance of the bite mark.

Some European forensic odontologists recommend excising the area of the skin containing the bite mark for purposes of preservation and later evaluation, but studies have shown that shrinkage is increased by this method in spite of immediate fixing of the skin [*13,14*].

Studies have shown that the duration of a bite mark on human skin varies considerably, depending upon the force applied and the extent of damage to the underlying tissue. Bite marks that do not break the epithelial layer last from 3 min to 24 h. In cutting bites, which break the epithelial layers, the edges last from one to three days, depending on the thickness of the area bitten, with the thinner area retaining a sharp edge the longest [*11*]. Other studies have determined that bites on the face disappear more rapidly than those on the arms. It is interesting that the bites in women were found to be visible longer than those in men [*11*]. The studies mentioned all agree that the most insignificant bite marks are those that are made without breaking the continuity of the epithelial covering.

Changes in Foodstuff

Edible material that has been bitten should be processed for study as soon as possible. Just as human tissue will alter its shape, so will edible material as time progresses. The deterioration that can occur in foodstuff is due primarily to the drying of the material. The usefulness of edible material depends upon the consistency of the material bitten, the manner in which the bite is applied, and the amount of deterioration that transpires prior to its processing. As previously mentioned, bite marks in baked material seldom provide marks that are usable, while bites that occur in hard cheese, fruit (particularly apples), candy, and hard sausage will often provide excellent marks.

Since it is not always possible to have a forensic odontologist immediately available to evaluate bitten material, a brief discussion of the methods of preservation of edible material is here provided.

Studies have shown that fruit can be preserved without distortion if placed in a mixture of alcohol and formalin or in a solution of alcohol, formalin, and acetic acid (90 ml of 70 percent alcohol, 5 ml of 40 percent formaldehyde, and 5 ml of glacial acetic acid) [7]. Cheese, candy, baked material, and meat can be preserved by refrigeration until examination is possible. It should also be mentioned that extreme care must be taken in the handling of all edible material, as the bite mark itself is fragile and could easily be inadvertently damaged.

After this material has been examined, it should be placed in an isotonic solution to prevent drying and deterioration, for the material may be required as evidence in subsequent legal proceedings.

Numerous methods have been developed for the processing and evaluation of bite marks. The majority of the methods are similar in regard to the registering and recording of the bite marks, but some of them vary as to the evaluation of this bite mark evidence. Each method has its own advantages and disadvantages, but it must be realized that there is no one correct method for the processing and evaluation of bite marks. For this reason the forensic odontologist must be aware of the various methods available and must utilize the best method for the particular circumstances of the bite mark case at hand.

In this section one method will be discussed for the process and registering of bite marks.

Saliva Sampling

The majority of the population (approximately 85 percent), secrete in their body fluids blood group substances corresponding to their major blood group. The identification of saliva is particularly important, for the concentration of agglutinogen, the blood grouping substance, is four times as strong in saliva as it is in normal human blood cells. When a bite is executed it is always accompanied by the presence of saliva. Thus, if saliva can be identified or recovered, it can usually be easily tested for the specific major blood group substance.

For the aforementioned reasons, a saliva washing should be taken of bite marks, both those in human tissue and those in edible material. The saliva washing should be taken prior to any other processing, as some of the other steps that have to be conducted will hamper the collection of saliva.

The New York Medical Examiner's Office utilizes a cotton swab moistened in saline for the saliva washing of bite marks [5]. The washing is started at the outer portions of the bite and worked inward with a circular motion. After each cotton swab is used, it should be placed in a glass container and labeled, and a chain of custody must be initiated. The swabs are then sent to a forensic serologist for blood group processing.

Photography

Photographing the bite mark is normally the next step taken in the processing and registering of bite marks. Photographs can register the actual circumstances of the bite mark better than any other procedure [*11*]. Unfortunately, there is one major drawback to the use of photographs: The registration of a factual three-dimensional relationship of a bite is almost impossible unless carried out (with considerable difficulty) by the use of a stereoscopic camera.

Ideally, while the photographs and impressions of the bite mark are taken, the victim should be placed in the exact position in which the bite was inflicted [*14*]. The reason for

this is obvious, since the skin is elastic and any other position assumed by the victim may alter the shape of the bite mark.

If the victim is deceased, however, it is virtually impossible to determine the exact position he was in when the bite mark was inflicted. Regardless of whether the victim is deceased or alive or whether the bite marks are in foodstuff, photographs must be taken, for they are necessary for later comparison and evaluation. For this reason, care must be taken to ensure that every detail of the bite mark is properly recorded.

The bite mark should be photographed with both black-and-white and color film. A scale of size should be included in the photographs so that the actual dimensions of the bite mark can be determined. In addition, the scale should be placed on the same plane as the surface of the bite mark. For every photograph taken with a scale of size included, an additional photograph should be taken without the scale. This is to ensure that the scale of size is not hiding or obscuring anything.

In instances in which the bite mark is on a curved surface, it is extremely difficult to depict the exact distances between individual teeth marks by means of a single photograph. For this reason separate photographs should be taken of the different areas of the bite mark, for example, of the upper and lower jaws or different sides of the bite. When the bite mark indentations are shallow, results can best be attained if the light source falls obliquely upon the surface.

Photographs should be taken at intervals of 24 h, as on occasion dramatic changes in the appearance of the bite mark can occur during the first 24 h, and these changes may continue for a considerable period of time [*15*].

After each photograph is taken, the photographer must ensure that every detail of the bite mark is properly recorded and that the information normally required for crime scene photographs is also recorded. This information includes the type and make of the camera and film, focal length of the lens, lighting utilized, time and date the photograph was taken, distance from the camera to the subject, camera position, and the name of the photographer [*16*]. In addition, a complete chain of custody for the photographic film must be initiated.

Impressions of the Bite Mark

If the bite mark has depth, impressions should be taken as the next step in the processing of this evidence. A delay in taking the impressions may result in shrinking and other changes in the appearance and shape of the bite mark. This step of the processing should be undertaken by a forensic odontologist, for the taking of an impression may alter the bite mark by either drying it out or by the introduction of fluids present in the material being used to record the bite mark.

Various materials have been utilized for the taking of impressions. Luff and Hess recommended that materials intended for this purpose have the following characteristics: (1) a high viscosity that can be regulated to give a variation in setting time, (2) high cohesion and firmness, (3) elasticity, (4) ability to disclose fine details, (5) easy solubility, (6) a high constancy of volume, (7) no deteriorating influence on tissues or materials through chemical or thermal action, (8) easy availability, and (9) ease of handling [*11*]. Silicons, with which most dentists have experience, meet the above requirements and have been successfully utilized in taking bite mark impressions.

Care must be taken when making an impression of bite marks in foodstuffs, as some impression materials may alter the mark in the edible material. When impressions are being made in foodstuffs, the services of a toolmark examiner can assist the forensic odontologist. Only a forensic odontologist or a dentist should take bite mark impressions from human tissue, however.

Two or more impressions should be made of the bite mark. The first impression should not be utilized in the comparative examination, for it is meant to be the untouched evidence that can later be used in court. If the second impression cannot be relied upon for accuracy because of alterations of the bite mark caused by the taking of the first impression, the first impression can be used for procuring duplicate impressions [*13*].

Treating the Wound

In those cases in which the victim is alive, it is at this point that the wound should be treated to prevent possible infection [*10*]. The victim's mouth should be thoroughly examined to determine if tissue from the assailant has been trapped between the teeth of the victim [*10,17*]. To eliminate the possibility that the bite mark was self-inflicted or that the victim bit the assailant, impressions should be taken of the victim's teeth.

After the above steps have been taken in processing and recording the bite mark, an attempt should be made to preserve the bite mark itself. The method of preservation utilized will depend on the bitten material. Human tissue can be excised and placed in Keyserling's solution [*18*], and edible material can be refrigerated or placed in an isotonic solution.

Obtaining Impressions of the Suspect's Teeth

Various methods have been developed in order to register the actual number of "marks" from any particular set of teeth. The simplest and most widely used method is to have the suspect bite a sample of plasticine. Plasticine nearly always produces an accurate reproduction of all the teeth, as it offers no resistance. If the bite is sufficiently deep, every tooth imprint will be clearly visible [*10*].

A model of the suspect's teeth should be taken for use in making impressions and later comparisons with the bite mark. Only a licensed dentist should take models of the suspect's teeth. Also, a dentist other than the forensic odontologist should perform this task. This can prevent future allegations that the forensic odontologist was prejudiced in his evaluation after coming in contact with the suspect.

After the models have been taken and test bites have been made, a detailed description should be made of the suspect's teeth and bite. The following details should be recorded: (1) the relationship between the upper and lower jaws, (2) the form and size of the arches, (3) missing teeth, (4) spacing between teeth, (5) supernumerary (extra) teeth, (6) rotation of teeth, (7) width of the teeth, and (8) any special features such as fractures, ridges, caries, and the maximal opening of the mouth [*11*]. Additionally, the possibility of changes in the suspect's teeth since the date of the crime should be investigated. An examination of the suspect's current dental records could prove most rewarding.

Comparison

After all the bite mark evidence has been collected, it is sent to the forensic odontologist for comparison and evaluation. In evaluating the bite mark evidence there is no specific number of points of comparison required for making a bite mark identification. The quality of the mark, rather than quantity, is the key [*9*]. The relationship of the specific bite mark and the suspect's teeth, coupled with the professional experience and training of the forensic odontologist, is the basis of the conclusion [*9*].

Ideally, the best method of comparison would be to have the suspect bite the same material in which the original bite was found. This method has been effectively utilized in those cases in which the bitten material is foodstuff. Unfortunately, this method is impractical in cases that involve bite marks in human tissues, as human bites are among the

most dangerous from the standpoint of infectivity [*11*], and it is doubtful that willing "samples" could be procured.

The first recorded method of bite mark comparison was called the "odontoscopy" and was developed by Sorup [*13,19*]. This method involves taking plaster casts of the teeth of the suspect. The casts, once obtained, are dried and varnished, after which the incisal and occlusal surfaces are coated with printer's ink. A sheet of moistened paper is pressed upon the inked surfaces of the teeth, and the resulting "print" is transferred to another sheet of transparent paper. The transparent paper is then superimposed upon a life-size photograph of the bite mark for comparison. This method has been criticized for being unusually complicated, and it does not allow for changes in the size and shape of the bite mark [*11*].

On the basis of this method, however, numerous other methods have been developed. One of these involves the comparison of a life-size photograph of the actual bite mark with the diapositive of the suspect's bite mark, which is made in an impression material [*13*]. While this method is not as complicated as the "odontoscopy" method, it also fails to allow for possible changes in the bite mark.

As previously mentioned, the identification of bite marks in soft parts of the body (that is, the female breast) can be quite difficult because of the elasticity of the tissue. Buhtz and Ehrhadt [*13,19,20*] developed a method that considers the shape of the bitten body part. They constructed a phantom model of the bitten area. This phantom is constructed of an adequately shaped piece of wood covered with sponge rubber and a 3-mm layer of baked dough. Models of the suspect's teeth are placed in a dental articulator, and bite marks are made on the phantom and then photographed. The diapositives of the photographs are then compared with photographs of the actual bite mark.

A method utilizing stereometricgraphic plotting of plaster casts was developed by Frykholm, Wictorin, and Torlegard [*21*]. In this method a model of the suspect's dentition and a photograph of the bite mark are compared tooth by tooth so that common points of reference on each tooth in the bite mark as a whole can be established. These reference points are connected by straight lines, thereby forming a closed polygon. The length of the sides of the polygon and the angles between them are measured and compared. The originators of this method believe that this procedure allows the examiner to make a more conclusive evaluation and comparison.

A method widely used in the European countries was developed by John Furness [*19*]. This method consists of seven steps: (1) Photographs are taken of the bite marks. (2) Casts are made of the suspect's teeth. (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 occlusal views of the cast (front and top views). (5) The negatives are printed to correspond in size with the previously enlarged photographic print of the victim's bite mark and mounted on a single sheet of white cardboard. (6) The curvature of the teeth in the bite mark is compared with the curvature of the dental arch and measured from left to right. The spaces between the teeth and the width of the biting edges are then compared, and lines are drawn to show the similarities. (7) The casts and the photographs are then labeled and rephotographed and then are ready for production as court exhibits.

The forensic odontologist must be aware of the advantages and disadvantages of the various methods utilized in bite mark comparison. The methods or combination of methods utilized by the forensic odontologist will depend primarily upon the location and quality of the bite mark at hand. It must also be remembered that there is no one best method for all situations and materials.

Results of Comparison

In bite mark comparisons a positive identification can be established only in rare cases in which there are large numbers of comparable points or very characteristic details. Thus, the governing rule should be to test the bite mark comparison by first attempting to prove that the victim could not have administered the mark. Elimination based on the presence of characteristic traits in a suspect's teeth and their absence from the bite mark is relatively easy to make, whereas a positive identification is extremely difficult. Thus, bite mark comparison is of the greatest assistance as an exclusionary process rather than an inclusionary process. The elimination of innocent suspects by bite mark comparison relieves the police of making a time-consuming comprehensive investigation of the suspect.

In this country there is currently a controversy among forensic odontologists over the manner of reporting the findings of bite mark identifications. Some odontologists do not report findings as specific to a particular set of teeth, but use "consistent with/not consistent with" terminology [5]. Other members of this forensic community will give more positive and specific findings [9]. To be fully effective, forensic odontologists should establish for nationwide use a method for the classification and reporting of their results.

Perhaps a satisfactory system for the classification of bite mark results would be one similar to the conclusions reached in other forensic disciplines: positive identification, positive elimination, possible identification, possible elimination, and inability to reach a conclusion. As in other areas of forensic science, the examiner bases his opinion not only on the findings from his examination but also on his own professional training and experience. This classification system would allow for those rare cases in which a positive identification is made, and in addition it provides law enforcement agencies and the courts with more definitive results.

Legal Considerations

There are primarily two legal problems that can confront the investigating team in the collection of evidence in a bite mark case. When an attempt is made to obtain photographs and impressions of a bite mark or molds of the suspect's dentition, the suspect may attempt to raise two objections: the suspect's privilege not to incriminate himself (Fifth Amendment) and his right to be free of unreasonable searches and seizures (Fourth Amendment).

A search of reported cases in this country has failed to reveal a case in which the issue of the constitutionality of compelling a suspect to submit to the taking of dental impressions or molds has been litigated, nor has the admissibility of expert testimony concerning the identification of a suspect through bite mark evidence been "reported." By analogy, however, the subject of body intrusions and body searches has been discussed and litigated extensively.

The Supreme Court held in *Schmerber v. California* [22] 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 further noted that many identification procedures are not protected by the Fifth Amendment, stating: "both federal and state courts have usually held that it (the Fifth Amendment) offers no protection against compulsion to submit to fingerprinting, photographing, or measurements. . . ."

In *United States v. Culver* [23], a case involving the comparison of a tooth fragment with the accused's dentition, the Court of Military Review upheld the dentist's examina-

tion of the accused's dentition. The Court ruled that the "passive submission" of the accused's body to a physical examination does not constitute a "statement" within the meaning of Article 31 or the Fifth Amendment.

It is interesting that in a recent Connecticut case, *State v. Rice* [5], a motion to suppress as evidence dental casts of the defendant, that were allegedly taken without consent, was denied. In this case, aside from the question of consent, the judge stated, "the police may take impressions of a suspect's teeth incidental to arrest where needed for evidence and such action does not violate the privilege against self-incrimination."

Since the *Schmerber* decision, intrusions of the body have been considered to be searches and not testimonial in nature [24]. Thus, if the identification procedures are limited to observations and comparisons and no testimonial communication is required of the accused, there should be no Fifth Amendment problem.

The next problem concerns the question of whether the taking of dental molds and impressions constitutes an unreasonable search or seizure under the Fourth Amendment. Guidance for this problem can also be found in *Schmerber*. The Court in *Schmerber* [22] stated, "The over-riding function of the Fourth Amendment is to protect personal privacy and dignity against unwarranted intrusion by the state. . . . The values protected by the Fourth Amendment thus substantially overlap those which the Fifth Amendment helps to protect. The Fourth Amendment's proper function is to constrain, not against all intrusions as such, but against intrusions which are not justified in the circumstances or which are made in an improper manner."

This clearly points out that any intrusions of the person, which in bite mark cases could be the taking of a mold of the accused's dentition, must be justified and conducted in a proper manner. Thus, probable cause should be shown prior to seeking bite mark molds or impressions of a suspect.

A suspect could easily destroy or alter his dentition, however, upon learning of its intended use as evidence. In this case the question remains as to whether the authorities can take molds of a lawfully detained suspect without his consent or before waiting for judicial approval.

Another legal problem that can be raised is whether a person has a reasonable expectation of privacy for his dentition. Nearly everyone constantly exposes his teeth to the general public, in addition to leaving their impression in food material. In *Katz v. United States* [25] it was determined that an inspection of what is voluntarily exposed to the public is not a violation of the Fourth Amendment.

It is interesting that in a recent case, *United States v. Dionisio* [26], involving voice exemplars, the United States Supreme Court held that a Federal grand jury witness may not interpose Fifth Amendment privilege against self-incrimination against an order compelling him to produce voice samples that are to be examined for their physical characteristics. Also, in reference to the Fourth Amendment, the Court ruled that it does not require the "showing of reasonableness" before the grand jury witness is compelled to produce voice samples. By analogy, this could be interpreted to include the taking of dental molds.

Perhaps until specific legal guidelines are established in this area, the best procedure would be for the police and the forensic odontologist to seek guidance from their legal advisor prior to the taking of molds or impressions.

In those instances in which the victim is deceased the medical examiner or coroner, under the county or state law, has the authority to recover whatever evidence is needed to evaluate the death of the victim. In the military that authority can be granted by the commanding officer.

Recent Cases

In an attempt to illustrate how bite mark evidence can be used as an investigative aid, this author will briefly discuss some recent bite mark cases that can be found in the literature. Two of the following cases occurred in the United States, and it is to be hoped that they will set a precedent that will enable a greater use of bite mark evidence in criminal cases.

Case 1 [27]

The investigation of a burglary of a grocery store in Texas revealed that the perpetrator had been eating at the meat counter, as some of the cold meat and cheese were not in their accustomed places, and on the counter a large piece of cheese bearing pronounced teeth marks was found. Among the stolen items were two bottles of whiskey and 13 silver dollars. Early in the morning the local sheriff arrested a man for public intoxication, and in his possession were 13 silver dollars. Later that day this suspect was interrogated in reference to the burglary. During his interrogation he was asked to bite into a piece of cheese, which he did voluntarily.

The two pieces of cheese were sent to the State firearms examiner, who photographed and made plaster of paris impressions of each piece of cheese. The examiner's opinion, after using caliper measurements, was that both pieces of cheese had been bitten by the same person. A dentist later examined the plaster casts and photographs and reached the same conclusion. Subsequently the accused was convicted of the burglary.

Case 2 [21]

Within a three-day period two thefts occurred at the Harimay Shopping Center in Japan. At both crime scenes, portions of a partly eaten apple were found. Plastic models of the apples were made that revealed tooth marks indicating the presence of diastema (space between the teeth). A few days later a suspect was arrested, and plaster models of his dentition were made, which also exhibited diastema. It should be mentioned that diastemata are quite rare among the Japanese. Two forensic odontologists examined the plaster models and determined the suspect's model to be almost perfectly matched to the model of the apple. Later in court, when confronted with this evidence, the suspect admitted both thefts.

Case 3 [3,10]

In the city of Glasgow, Scotland, a young woman walking home from work was attacked from behind by a man who attempted to rape her. In defense she bit the assailant on the finger so violently that a piece of skin was torn away from his finger, and he subsequently ran away. The woman removed the piece of skin from her mouth and gave it to the police when she reported the incident. Examination of the piece of skin by the police revealed that it contained fraction ridges. The police photographed the skin and took steps to preserve it.

Two days later a man was arrested and charged with the crime. Examination of the suspect revealed that a portion of skin and flesh was missing from his right forefinger. This wound was photographed and compared to the photograph of the recovered piece of skin. This comparison revealed that the piece of skin was roughly the size and shape of the area of the suspect's wound, but, since the wound had started to heal, it was not an exact fit. Further examination disclosed that the trend of 21 ridges from the piece of skin were in agreement with the trend of the suspect's wound. This evidence was subsequently presented at the subject's trial, and he was found guilty.

Case 4 [3,4]

In Biggar, Scotland, a 15-year-old girl was found strangled in a local cemetery. Investigation by police revealed that there were bite marks on her right breast, which were subsequently photographed. Shortly thereafter 29 "possible" suspects had dental impressions and molds of their teeth taken. The 29 models were compared with photographs of the bite marks on the girl. By this comparison 24 "suspects" were eliminated. Further examination revealed unique ring marks in the bite marks. It was further determined that the ring marks were caused by severe hypoplasia (pitting of the teeth). Reexamination of the remaining five models revealed that only one of the models had such pits. A study was made to determine how common an occurrence is this type of hypoplasia. The study revealed that this type of hypoplasia is quite rare in the age bracket of the one suspect having the pits. This evidence was later presented in court, and the suspect was found guilty.

Case 5 [9]

At a military post in Maryland, a young woman was found murdered. At the autopsy an alert Army criminal investigator observed a bruise on the victim's arm that appeared to be a bite mark. A request was made and granted for a forensic odontologist from the Armed Forces Institute of Pathology to assist in the investigation. Photographs were initially made of the bite mark. After a suspect was arrested, models of his teeth were taken, which were subsequently photographed. The odontologist mounted the models in an articulator and made test bites on a wax material that was mounted on a phantom model of the victim's arm. By comparison of the test bites and the photographs of the bite mark, coupled with the superimposing of transparencies of the bite mark and the suspect's teeth, the forensic odontologist concluded that the suspect had inflicted the bite marks on the victim. At the court martial this information was presented, and the suspect was convicted of murder. This case is presently being appealed, and it is hoped that after the decision on the appeal is reached the case can serve as a precedent for future bite mark cases.

Conclusions

This paper has shown that the utilization of bite marks can be an extremely important aid in criminal investigations. To become fully effective, however, action is needed in three areas.

First, law enforcement personnel must understand the uses of bite mark evidence. This information must be incorporated into law enforcement curricula and texts.

Second, there is a need for further interest and research in forensic odontology, particularly in the field of bite mark comparisons, within the medical and dental professions of this country. A recruiting program is needed to locate dentists with an interest in this field. In addition, all dental schools should offer a course in forensic odontology to their students. Medical examiners and coroners must assiduously seek the assistance of the forensic odontologist and make him a member of the medicolegal investigative team.

Third, there are several unanswered legal questions pertaining to the collection of bite mark evidence that need clarification. To this date, there has not been a single bite mark case mentioned in a "Law Reporter." If the questions of the legality of collecting bite mark evidence are litigated in the future, this problem can be clarified.

Currently, the major contribution of bite mark evidence is the elimination of suspects, since the establishment of a positive identification is rare. Although work is required in

the three areas mentioned, bite mark identification deserves a valid place along with other forensic procedures. To become fully effective, the utilization of this evidence must be supported by the entire forensic community.

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