

Chapter 70

Forensic Odontology

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In its most literal sense, forensic odontology is the application of the art and science of dental medicine to the resolution of matters pertaining to the law. Some of the diverse facets of this unique discipline can range from the identification of human remains to mass disaster management; from the assessment of bitemark and patterned skin injuries to the use of dental materials in the examination of evidence. This brief introduction only begins to describe the scope that exists within the field of forensic odontology.

Although the practice of forensic odontology is not a recent arrival on the legal scene, it is only within the past 30 years or so that the forensic odontologist has become a distinct specialist, achieving a more visible and productive position within the forensic sciences. At one time, the dental expert was viewed in court primarily as an expository witness in cases involving dental injuries. Today it is not unusual to observe a forensic odontologist working alongside identification teams at an air crash, gathering bitemark evidence at a crime scene, or examining a victim of child abuse.

A practicing dentist can be an important witness in civil cases involving dental injuries. Legal liabilities often arise in these cases as the result of trauma that causes injuries to the teeth, their supporting structures, and other portions of the dentofacial anatomy. Knowledge of oral anatomy and the functional relationships of these parts uniquely qualifies the dentist to give testimony. However, testimony in many criminal cases, involving such matters as critical interpretations in human identification and bitemarks, deserves the attention of a qualified forensic odontologist. This is so because the expertise in these matters is a result of the additional training and experience required to achieve competency as a forensic odontologist.

To be formally perceived as a forensic odontologist, a dentist should have additional training, especially in relevant areas of the forensic sciences, e.g., oral pathology, as well as anthropology, the basic sciences, and the law. Furthermore, he or she should be actively working in the field, preferably connected with a law enforcement agency or a coroner/medical examiner's office. Additional evidence of qualification is indicated in achieving certification by the American Board of Forensic Odontology (www.abfo.org), membership or fellowship in the Odontology section of the American Academy of Forensic Sciences (www.aafs.org),

and membership in the American Society of Forensic Odontology (www.asfo.org). The dentist who makes the effort to meet these requirements and become a part of these active organizations is greatly enhanced in qualifying as an expert witness in the courts.

BASIS OF FORENSIC ODONTOLOGY

The most basic concept in forensic odontology is centered on a form of pattern recognition and comparison. This conclusion ultimately arrives at a comparison of the unknown pattern with a known pattern in order to determine the extent of similarity. For example, the dentition described in a set of dental records can exhibit a unique pattern against which to evaluate the dentition of an unknown body. In mass disaster incidents, this problem-solving experience is repeated on a much larger scale.

The same is true in bitemark evaluations. An accurate representation of the bitemark injury, as a pattern, is compared with an accurate representation of the suspect's dentition, both being similarly scaled in measurement.

Of course, the pattern recognition analogy is a simplistic accounting of the core of forensic odontology. Investigator experience, knowledge of testing methodologies, and decision analysis abilities, among other issues, all contribute to successful evidence evaluation and assessment.

DENTAL IDENTIFICATION

The dentition is significant in the human identification process primarily because teeth and the jaw structures can resist even the most severe environmental conditions and trauma. This is so, particularly for the teeth, because of the inherent durability of tooth enamel (the outermost covering of the crowns of teeth) and of cementum (the outer covering of the roots of teeth). As a result, aside from fingerprint analysis, one of the most legally reliable forms of identification of human remains is by comparison of dental structures with dental records.

A consideration should be made of the surprising resistance of teeth and jaws to environmental exposure, such as

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even the most severe fires. The oral cavity seems to be so well insulated against the high temperature of fires that often even the supporting tissues surrounding the teeth are also well preserved. In addition, the dental restorations are frequently completely intact.

Identification case example 1. *A husband suspected his wife of infidelity. He confronted her in a bar with another man and shot them both. The shooter took off with the police in pursuit and returned to his trailer home. The police surrounded the trailer and his car, and the car erupted into flames. When the fire was extinguished, severely burned human remains were discovered. In particular, there was a mandible with only a part of the cranium attached to the maxilla. The question to be answered: was this the shooter they were after or was someone else planted in the vehicle? This author examined the skull and, finding most of the dentition was intact, compared the antemortem dental records with the postmortem remains. There was complete concordance, including a distinctive gold crown and several other dental restorations, thus confirming the identity of the shooter.*

The inherent possibilities for uniqueness in the human dentition enable the forensic dentist to determine the degree of concordance between antemortem dental records and the oral structures of specific human remains under examination. The human adult dentition typically consists of 32 teeth, each with 5 surfaces, thus providing 160 possibilities for individual variations of surface anatomy and dental restorations in configuration, size, shape, material, and wear patterns. This does not even take into account, and is not limited to, such factors as decay, missing and extra teeth, alignment of the dental arches, individual tooth positioning, and prosthetic appliances. In fact, in the United States there are many more dental records on file than fingerprint records. The experienced dental clinician can detect many subtleties in observable detail of the teeth and jaws which are most useful in confirming a human identification. Among other distinctive characteristics for antemortem and postmortem comparisons are maxillary sinus patterns, bone trabeculation patterns, and orbital outlines.

A question often arises as to the number of points of concordance necessary to render a valid decision on a dental identification. However, this is not as significant as the singular quality, or exclusivity, of the points of comparison involved. In addition, when all of the points of concordance in a particular case are considered as a set of aggregate data, the investigator should be able to state, if possible, whether the identification is "positive within reasonable scientific certainty."

The following categories and terminology for body identification are suggested for use in communicating the results of a forensic odontology identification investigation:

Positive identification: *The antemortem and postmortem data match in sufficient detail to establish that they are from the same individual. In addition, there are no irreconcilable discrepancies.*

Possible identification: *The antemortem and postmortem data have consistent features, but, due to the*

quality of either the postmortem remains or the antemortem evidence, it is not possible to positively establish dental identification.

Insufficient evidence: *The available information is insufficient to form the basis for a conclusion.*

Exclusion: *The antemortem and postmortem data are clearly inconsistent. However, it should be understood that identification by exclusion is a valid technique in certain circumstances.¹*

However, this caveat from the American Board of Forensic Odontology should be noted: "The forensic dentist is not ordinarily in a position to verify that the antemortem records are correct as to name, date, etc.; therefore, the report should state that the conclusions are based on records which are purported to represent a particular individual."²

In summary, the forensic odontologist can best be relied upon to render expert opinions concerning identifications based on postmortem evaluation of dental structures, while testing for concordance with antemortem dental records that are as complete as can be obtained.

Identification case example 2. *Two white males speeding on a highway ended their trip in a fiery crash. Tracing from the registration of the vehicle, the owner/driver was tentatively identified and witnesses indicated who the male passenger was alleged to be. Dental records were requested from the dentists of the victims for use by this author in the postmortem examinations and comparisons. The driver was readily identified by this process; however, the passenger did not match the dental chart furnished, although the family insisted that the passenger victim had to be their relative. Further investigation revealed that this victim had loaned his Medical Card to a friend so that the friend could receive unauthorized dental treatment at no charge. Ultimately, another set of dental records was located which did indeed match the passenger victim. Here is an example showing that, while people may lie, the dental evidence does not.*

MASS CASUALTY INCIDENTS

Perhaps mass casualty incident identifications are best appreciated as being a greatly extended application of dental identifications as described above. In fact, the most descriptive definition for a mass disaster or mass casualty incident would be: "Any situation, man-made or natural, which overtaxes the normal emergency resources available within a community."³

When the typical casualty incident is simultaneously multiplied many times over, and the local consulting forensic odontologist and/or the local dental ID team is incapable of handling the incident because of the number of victims and lack of resources, outside help should be requested. For this reason, the federal government has instituted a program under the NDMS (National Disaster Medical System) and FEMA (Federal Emergency Management Agency) called D-MORT (Disaster Mortuary Operations Recovery Team).

Currently, these programs will be coordinated under the Department of Homeland Security.

These teams are set up regionally across the country and are composed of specialists trained in disaster operations, such as pathologists, anthropologists, dentists, and funeral directors. The D-MORT units are prepared for rapid response, complete with supplies, in times of mass casualty incidents to bolster any community's resources when needed. Examples of D-MORT mobilization were seen in the events of September 11, 2001.

BITEMARK EVIDENCE

Another area that utilizes identifying characteristics of the teeth, although on a more functional level, is bitemark analysis. Bites on human tissue may be observed in violent incidents where the attacker may bite the victim or the victim may bite the attacker during defensive responses. In more passive incidents, a person may bite him or herself or an inanimate object left at a scene, e.g., an apple core.

Paramount is the ability to differentiate a patterned injury as a bitemark from a mark made by another source. Here, the forensic odontologist, through training and experience, is the individual most qualified to assess the injury pattern.

Teeth may be considered as tools leaving marks on skin, food, or various other materials. However, there are often more characteristics involved in the analysis of bitemarks than would occur from perceiving of the teeth as merely simple tools. There are class characteristics to be considered, such as which type of tooth inflicted the bite, e.g., incisor, cuspid, etc. The biting surfaces of the individual groups of teeth are related to their function, such as teeth that incise, or tear, or grind. In addition, also seen are individual characteristics, such as rotations, fractures, or missing or extra teeth. The size relationships of the bitemark, as described by the width of the dental arches, could relate to a child or adult bite. Ability to open the mouth maximally may vary from individual to individual. It should be noted that bitemarks can also *exclude* a suspect by revealing a tooth pattern, or opening range, inconsistent with that of a particular person.

The methodologies for preserving and comparing bitemark evidence are crucial to the proper and uniform objective analysis of patterned markings for legal substantiation. Further details may be accessed by reading the ABFO Bitemark Methodology Guidelines.⁴

Bitemark case example 1. *An elderly woman was found unconscious beneath a pile of concrete blocks, the victim of a brutal beating and rape. Investigators noticed what appeared to be a bitemark on the victim's right breast. A suspect was apprehended in the area and circumstantially linked to the crime. Permission was granted by the suspect for dental impressions and photographs to be taken. Comparison of a scaled photograph of the bitemark on the victim and plaster models poured from the suspect's dental impressions placed the accused at the scene of violence. Additional comparisons were performed using computer*

enhancements and overlays. The concordance of the suspect's dentition to the victim's bitemark was able to play a major role in the conviction of the perpetrator.

Bitemark case example 2. *A nurse, checking on a middle-aged female patient in a critical care unit, discovered a patterned skin mark on the inner surface of the patient's left thigh. She questioned the patient, who was under sedation, about the marks. The nurse, getting "positive" responses to her questions, suggested that it was a bitemark. A report was filed and the police were notified. The police photographed the patient's injury and made further inquiries, which resulted in charges being filed against her physician on suspicion of molestation. A forensic odontologist was consulted by the police and took impressions on anyone who had contact with the patient during the estimated window of opportunity. All dental models obtained were compared by the prosecution forensic odontologist to the patterned skin mark photos. As a result of the comparisons, the suspect physician was arrested and held for trial on criminal charges. This author was consulted by the defense to evaluate the same materials and found that, although there were characteristics resembling a human bitemark, there were areas on the patterned markings to which the physician's dentition could not be matched positively. In addition, upon reviewing the patient's medical record, the defense odontologist found that an indwelling urinary catheter had been taped to the inner left thigh within the time range of the incident. An overlay of the catheter was then compared to the so-called "bitemark" and a near-perfect outline accounted for all of the patterned marks. When the case came to trial, the judge's verdict (a bench trial) was in favor of the defendant, since the only conclusive evidence was that the urinary catheter was the culprit! ("The only truth that counts in court is that which can be proven.")⁵*

MISCELLANEOUS PATTERNED MARKINGS

Often there are patterned markings observed in the course of assaults, rapes, homicides, and child abuse. Marks, such as fingernail scratches, imprints of hands, jewelry, or household objects, can be observed in many cases. This author participated in the first case of fingernail scratch identification admitted to and upheld by the United States courts.⁶ In this case, deep fingernail scratches on the neck of a victim of homicide by manual strangulation were recorded by impressions and photography. The suspect was apprehended soon after the murder and his fingernails were able to be matched to unusual curvatures and fractures captured in the marks on the victim's neck. The court admitted the evidence based on the same standards accorded tool marks. The guilty verdict survived appellate review.

Other cases have occurred in which markings on skin were recorded and matched to objects used to strike a victim. Therefore, the expertise of the forensic odontologist in interpreting bitemarks can be transferred to the evaluation of many other patterned injuries to the skin surface and inanimate objects at crime scenes.

HUMAN ABUSE EVIDENCE

Another area in which the forensic odontologist is being consulted more frequently is in cases of alleged human abuse, especially in the case of children. Usually in cases of child abuse with apparent bitemarks, there are only a limited number of persons who could have been able to have intimate enough access to the child to have the opportunity to inflict a bite. This, then, greatly limits the suspect range for comparisons of dentition to the bitemark. Family members, friends of the family, siblings, paramours, and caregivers are most often high on the suspect list in child abuse bitemarks and patterned injuries.

To help determine the physical abuse status, the patterned injuries are usually categorized as recent, healing, and/or healed injuries. This helps to assess whether the abuse status is related to a solitary event or has been continuing over a period of time.

Other types of patterned injuries can be evaluated by the forensic odontologist to assist in determining the instrument of abuse. For example, victims beaten with coiled electric extension cords, belts (with or without buckles), household appliances (electric irons, hair curlers), or ropes can exhibit class characteristics that can be revealing. Cases involving elder and spousal abuse could be examined in like fashion for telling evidence of the instrument of abuse.

Abuse case example. *This author was called to a hospital emergency department to examine a 2-year-old child with apparent multiple bitemarks on the body. The mother had gone to work, leaving her daughter in the care of a 14-year-old baby-sitter. After examination, measurement, and photography of the bitemarks, a determination was made that the source of the bitemarks was the young baby-sitter. She was questioned by the police and confessed to the biting activity, evidently a "normal" activity of interplay in the sitter's family. If prosecution instead of counseling had been preferred in this case, the correlation between biter and bitemarks could readily have been demonstrated with admissible legal certainty.*

ANALYSIS OF DENTAL EVIDENCE

The profession of dental medicine has become significantly more complex and varied within the past 50 years. Most recently, this is especially true because of the advent of the newer dental materials and technologies that have evolved. The presence of dental prosthetic tooth replacements (including dentures, bridges, partials, etc.) at a crime scene can be analyzed by the forensic odontologist. These materials can potentially yield information such as geography of origin, approximate dating of construction, and even linkage to a particular dentist or dental laboratory. Many unique characteristics and variations exist "labeling" the type, quality, and socioeconomic levels of the dental restorations performed both currently and in the past. These factors and analyses can be helpful in a forensic investigation, both in opening avenues of exploration and for court

expert testimony. In a number of cases, the finding of a single tooth or fragment of a tooth has been a pivotal point in assisting in an investigation.

Tooth fragment case example. *A portion of an upper right first molar was found adjacent to a badly beaten homicide victim on the north shore of the river. The tooth fragment did not belong to this homicide victim. The appearance of the fractured crown was such that this author felt that the tooth fragment had sheared off as the outcome of a traumatic blow to the right side of the mandible, which probably fractured as a result. A bulletin was broadcast to check all treatment facilities for anyone requesting treatment for a mandibular fracture and broken molar. No leads developed until, several days later, another battered homicide victim was found in another area of the city. Upon examination, this victim had a fractured mandible and the tooth fragment matched the broken upper right first molar. Because of the evidence of a single tooth fragment, the two homicides were able to be linked to the same homicide case.*

DEVELOPMENTAL APPLICATIONS

The field of forensic odontology continues to advance as a science. The computer is being used more and more in many aspects, from assistance in identification matching (especially mass disaster incidents), to enhancement of x-ray films and bitemark evidence photographs. The scanning electron microscope is being used to amplify details of individual components of bitemark evidence.

Reconstruction of the soft tissue layers of skulls can enable investigators to estimate the actual appearance of a person in life. The caveat here is that certain features, such as eyebrows, eyelids, external nares, and external ears, are subject to extensive conjecture. In many cases, there may be little resemblance to those features in life.

Saliva washings from bitemarks can be serotypic indicators of blood group antigens and can also be a source of DNA for analysis and comparison with a suspect. The downside of saliva washings is that they can be easily contaminated (e.g., by medical treatment at a scene or in the hospital) before being adequately preserved.

Alternative light sources, such as UV range, infrared, etc., can be helpful in the visualization of suspected healed skin injuries. These light sources, in various wavelengths, can penetrate the skin surface, or filter out overlying debris, in order to better document bite or patterned skin mark evidence photographically.

UV light case example. *An unknown intruder invaded a woman's apartment and kept her hostage for 8 hours, brutalizing and sexually molesting her. After the incident, she called the police and was taken to the hospital emergency department where she was interviewed, photographed, and treated. One of the photographs showed an apparent bitemark on her left scapular area, which was confirmed by the victim. Five months later a suspect developed, but by now the bitemark had healed. In addition, the original hospital bitemark photograph did not have a reference scale and appeared to have little evidentiary value. Under court*

order, the suspect submitted to dental impressions and photographs of his dentition. The victim gave permission for new photographs of the healed bitemark site. This author and a colleague felt that reflective UV photography might be able to revisualize the original healed bitemark imprint. This was successfully accomplished with special equipment and a reference scale was included in the photographs. During trial, the court allowed the original hospital photograph to be introduced into evidence as there was demonstrated that there was a 7 mm piping border on the hospital gown the victim was wearing. Comparison of the original hospital photograph, the reflective UV photograph, and the dental models of the suspect indicated significant matching characteristics. A guilty verdict resulted which was upheld on all appeals.⁷

CONCLUSION

Forensic odontology, like most areas of the forensic sciences, is constantly changing and developing in usefulness to the court systems and the world community. The identification and application of a growing subset of forensic matters by

qualified forensic odontologists and their team interactions with law enforcement agencies, other forensic scientific specialists, and the legal community can be perceived as a rapidly growing relationship of significant benefit to both the civil and criminal justice systems.

Endnotes

1. American Board of Forensic Odontology, *ABFO Body Identification Guidelines*, www.abfo.org.
2. *Id.*
3. A.M. Butman, *Responding to the Mass Casualty Incident: A Guide for EMS Personnel* (Akron, Ohio: Emergency Training, 1982).
4. American Board of Forensic Odontology, *ABFO Bitemark Methodology Guidelines*, www.abfo.org.
5. Paraphrased from the 1997 Dutch film, *Character*.
6. J.A. Perper & M.N. Sobel, *Identification of Fingernail Markings in Manual Strangulation*, 2(1) *Am. J. Forensic Med. Pathol.* 45-48 (1981).
7. T.J. David & M.N. Sobel, *Recapturing a Five-Month-Old Bite Mark by Means of Reflective Ultraviolet Photography*, 39(6) *J. Forensic Sci.* 1560-67 (1994).

