

Forensic Odontology: The Roles and Responsibilities of the Dentist

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A b s t r a c t

Dentistry has much to offer law enforcement in the detection and solution of crime or in civil proceedings. Forensic dental fieldwork requires an interdisciplinary knowledge of dental science. Most often the role of the forensic odontologist is to establish a person's identity. Teeth, with their physiologic variations, pathoses and effects of therapy, record information that remains throughout life and beyond. The teeth may also be used as weapons and, under certain circumstances, may leave information about the identity of the biter. Forensic odontology has an important role in the recognition of abuse among persons of all ages. Dental professionals have a major role to play in keeping accurate dental records and providing all necessary information so that legal authorities may recognize malpractice, negligence, fraud or abuse, and identify unknown humans.

MeSH Key Words: dentists; forensic dentistry; dental records

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Interest in forensic dentistry was relatively dormant until the 1960s when renewed interest was sparked by the first formal instructional program in forensic dentistry given in the United States at the Armed Forces Institute of Pathology. Since then the number of cases reported has expanded to such an extent that the term "forensic odontology" is familiar, not only to the dental profession, but also to law enforcement agencies and other forensic groups.¹

Forensic odontology involves the management, examination, evaluation and presentation of dental evidence in criminal or civil proceedings, all in the interest of justice. The forensic odontologist assists legal authorities by examining dental evidence in different situations. The subject can be divided roughly into 3 major fields of activity: civil or noncriminal, criminal and research.^{2,3}

Identification

Dental identification assumes a primary role in the identification of remains when postmortem changes, traumatic tissue injury or lack of a fingerprint record invalidate the use of visual or fingerprint methods. The identification of dental remains is of primary importance when the deceased person is skeletonized, decomposed, burned or dismembered. The principal advantage of dental evidence is that, like other hard tissues, it is often preserved after death. Even

the status of a person's teeth changes throughout life and the combination of decayed, missing and filled teeth is measurable and comparable at any fixed point in time.^{3,4}

The fundamental principles of dental identification are those of comparison and of exclusion. For example, dental identification is used when antemortem records for the putative deceased person are available and circumstantial evidence suggests the identity of the decedent, and when antemortem records of other suspicious, unidentified persons are available and must be ruled out. Identification requires a list of the possible persons involved so that appropriate antemortem records can be located. The availability and accuracy of these records determine the success of identification. Unfortunately, dentists often maintain poor records, resulting in confusion that makes dental identification impossible.⁴

Regardless of the method used to identify a person, the results of the comparison of antemortem and postmortem data lead to 1 of these 4 situations⁵:

1. Positive identification: Comparable items are sufficiently distinct in the antemortem and postmortem databases; no major differences are observed.
2. Possible identification: Commonalities exist among the comparable items in the antemortem and postmortem databases, but enough information is missing from



Figure 1a: Antemortem radiograph.

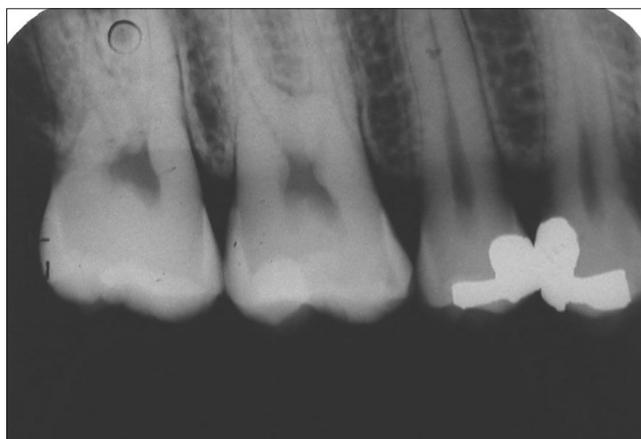


Figure 1b: Postmortem radiograph of the same person as in **Fig. 1a**.

either source to prevent the establishment of a positive identification.

3. Insufficient identification evidence: Insufficient supportive evidence is available for comparison and definitive identification, but the suspected identity of the decedent cannot be ruled out. The identification is then deemed inconclusive.
4. Exclusion: Unexplainable discrepancies exist among comparable items in the antemortem and postmortem databases.

Sometimes explainable discrepancies are present, such as changes in restorations related to the passage of time, avulsion of a tooth or teeth secondary to the trauma at the time of death, or additional treatments by a second party that were not registered in the antemortem record. In all these cases, the discrepancies can be explained and identification can still be made.

Dental Record as a Legal Document

The dental record is a legal document owned by the dentist, and contains subjective and objective information about the patient. Results of the physical examination of the dentition and supporting oral and surrounding structures must be recorded. In addition, the results of clinical laboratory tests, study casts, photographs and radiographs become components of the record, and should be kept for 7 to 10 years. All entries should be signed or initialled by recording personnel. Changes in the record should not be erased, but corrected with a single line drawn through the incorrect material. This method permits the original entry to remain readable and removes any questions about fraudulent intent to alter recorded information.

Computer-generated dental records are becoming more common for dental records. The obvious advantage of the electronic record is that it can be easily networked and transferred for routine professional consultation or forensic cases requiring dental records for identification. However, the use of electronically managed dental records creates an

ethical issue about the maintenance of patients' privacy. Additionally, potential for insurance fraud is associated with the computer enhancement of dental lesions or restorations on electronically generated dental radiographs.⁶ Whether dental records are preserved in written form or on a computer database, following the principles of record management ensures that all dental information that may be required to resolve a forensic problem is properly maintained and retrievable.³

Radiographic Examination

Comparison of antemortem and postmortem radiographs is the most accurate and reliable method of identifying remains (**Figs. 1a** and **1b**). Observations such as distinctive shapes of restoration, root canal treatment, buried root tips, bases under restorations, tooth and root morphology, and sinus and jawbone patterns can be identified only by examination of radiographs. In some instances a single tooth may be all that remains, and upon comparison of radiographs, a positive identification can be made. Original antemortem dental radiographs are of immense value for comparison; therefore it is essential that all routine radiographs exposed during the course of a dental practice be adequately fixed and washed so that they remain viewable years later. The best results are obtained when the angulation of the film to the x-ray tube is the same as that of the original films.¹

Identification becomes a problem when few restorations are available for antemortem–postmortem comparison. Today, fewer people have dental restorations because of the success of preventative intervention. However, at some stages of the development of human dentition, digital dental radiographic superimposition (**Figs. 2a** and **2b**) can be used for identification, allowing comparison of the spatial relationships of the root and support structures of the teeth in antemortem and postmortem records.⁷ When an antemortem record is unavailable, the postmortem chart of the

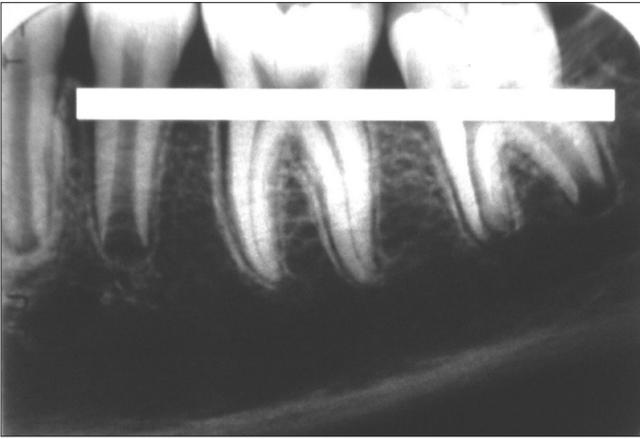


Figure 2a: Digitized images showing a horizontal section of the roots randomly selected from the antemortem radiograph.

deceased may be used to exclude his or her identity upon comparison with the available antemortem records of others.

Age Determination Based on Dental Data

Age estimation is a subdiscipline of the forensic sciences and should be an important part of the identification process, especially when information relating to the deceased is unavailable.⁸ Small variations in tooth formation and eruption among persons has made dental estimation of chronological age the primary method of age determination for younger persons. Human dentition follows a reliable and predictable developmental sequence, beginning about 4 months after conception and continuing to the beginning of the third decade of life when development of all the permanent teeth is completed.⁹ The use of radiographs is characteristic of techniques that involve observation of the morphologically distinct stages of mineralization. Such determinations are also based on the degree of formation of root and crown structures, the stage of eruption, and the intermixture of primary and adult dentitions.

Mass Disaster Identification

Transport accidents form the majority of cases in which dental identifications are needed, particularly aircraft accidents in which both fire and trauma are often severe. Fires in and collapse of heavily occupied buildings are another source of multiple problems of identification. The forensic odontologist is usually a member of the investigating team, the composition of which varies, depending on the nature of the disaster. Generally, the team includes a coordinator or head of the team, a pathologist and various specialists with experience related to the particular type of disaster, in addition to the forensic odontologist.²

In a situation involving fire or severe trauma, physical features are often destroyed. Because teeth are heavily calcified, they can resist fire as well as a great majority of traumas. Dental examination is significantly confounded when heat and flames have fragmented tooth enamel, and soot

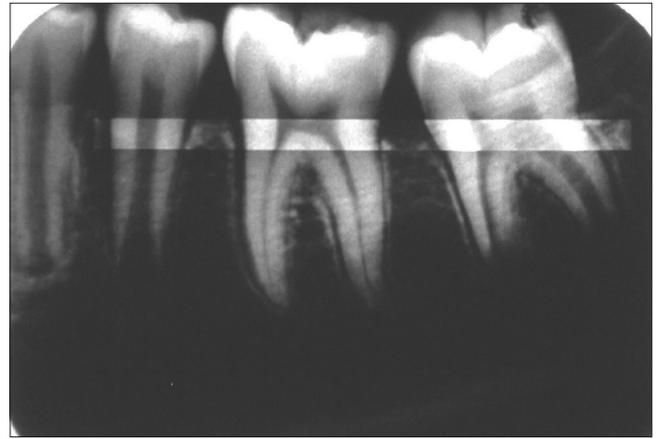


Figure 2b: The horizontal section of the roots is superimposed on the postmortem radiograph with cut and paste commands. The horizontal cut consisted of a viewable section across the roots of a group of teeth from the posterior area and shows a high degree of concordance between dentitions.

and smoke have been deposited on the teeth. Generally, teeth and restorations are resistant to heat, unless they are exposed directly to flame. Preservation is possible in most cases.⁴

Anthropologic Examination

In addition to analysis of teeth, the most common methods of identification include visual identification, fingerprinting, serologic and DNA comparison, and anthropologic examination of bone. Each method has its advantages and disadvantages. They all rely on the principle that identification is derived from a positive correlation between known information about a person and findings from a physical examination of the decedent.³

Forensic anthropologists and forensic odontologists may work together to resolve problems associated with identification. Both disciplines are concerned with the analysis of calcified structures of the body, namely the bones and the teeth. The bones and teeth of the craniofacial complex, key identification tools for the forensic odontologist, effectively distinguish one person from others and one population from another and are used to determine the race, age and sex of a person.¹

This anatomic material can be used for identification when the skull and facial bones are used as a foundation for the reconstruction of facial soft tissues. With the use of standard anthropologic thickness measurements at specific points on the face, soft-tissue thickness points can be connected with sculpting clay and the reconstructed features can sometimes be digitized on a computer screen. Because computers permit the addition of components directly to cranial features, computers have been useful for techniques involving facial superimposition. The underlying skeletal structures can thus be viewed below the soft tissue, providing a means to check its accuracy. The

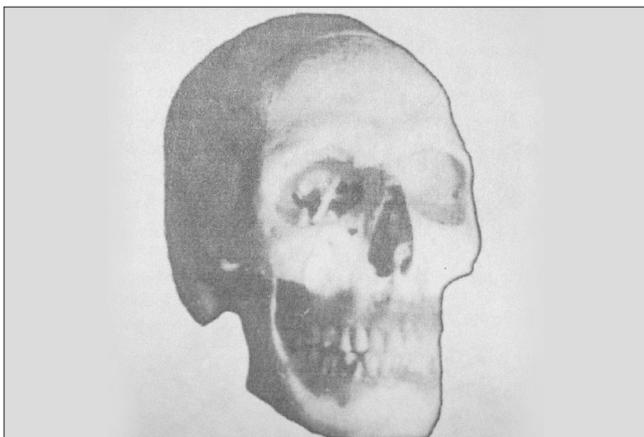


Figure 3a: Prosthetic teeth were custom fitted into the sockets. Figures 3a to 3c reprinted with permission from Wood and others.¹⁰



Figure 3b: A sketch of the decedent was completed before the computer-aided reconstruction.

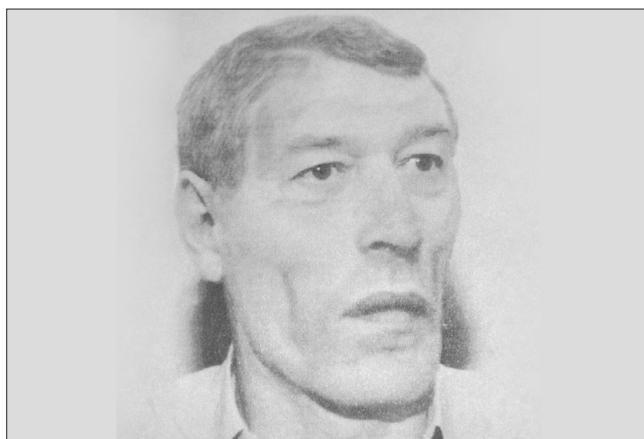


Figure 3c: The sketch formed the template for the final drawing.

result of these techniques is a recreation of the contour of the soft-tissue features that permits visual identification (Figs. 3a to 3c). Various versions can then be stored and reproduced for comparison.¹⁰

Bite-Mark Evidence

Comparison of bite marks represents dentistry's vital contribution to forensic science. The bite-mark pattern is compared with the dental characteristics of the dentition of a suspect. Depending upon the circumstances, a bite-mark pattern may be deposited within foodstuffs, other objects,^{11,12} or upon the victim of an assault or homicide.¹³ Bite-mark evidence inflicted by a deceased victim may also be seen on a living assailant.¹⁴ For children, in cases other than those of domestic violence, or physical or sexual abuse, biting can represent a form of expression that occurs when verbal communication fails. Biting injuries can result from playground altercations or sports competition. They are also common in daycare centres.¹⁵

On occasion, nonhuman bite injuries are found on victims. Animal bites are usually distinguished from human bite injuries by differences in arch alignments and specific tooth morphology. Animal bites often cause shear rather

than impact injuries, producing lacerations of the skin and open wounds.¹⁶ Dog bites, perhaps the most common nonhuman bite, are characterized by a narrow anterior dental arch and consist of deep tooth wounds over a small area. A dog (or other carnivorous mammal) is more likely than a human to cause avulsion of human tissue during violent biting. Cat bites are small and round with pointed cuspid-tooth impressions caused by the conical shape of these teeth.⁴

From the evidence, the forensic odontologist has to first determine whether the pattern is truly the result of biting. Once he or she has established that the pattern is related to the teeth and was not made by a tool, instrument or piece of clothing, and does not represent any kind of cutaneous lesion, infection or injury, the pattern can be compared with the suspect's dentition for inclusionary or exclusionary purposes. For evaluation of a pattern mark, its characteristics must be recognizable and distinguishable. The shape of the dentition, the teeth and specific anatomical characteristics can create a representative pattern (Fig. 4). To accomplish these goals, the forensic odontologist can use numerous methods. Because there is no single method for the analysis of bite-mark evidence, the particular method used would depend on the circumstances of each case and on the preference and ability of the analyst.

Family Violence

The dentist should be aware of child, elderly or spousal abuse when confronted with unusual oral injuries, especially in cases of persons with accompanying head or body injuries. Suspicion is further aroused if, in the dentist's opinion, the nature of the injuries is inconsistent with the historical and chronological explanation of their origin.¹ Abusive trauma to the face and mouth includes fractured teeth, laceration of the labial or lingual frenum, missing or displaced teeth, fractures of the maxilla and mandible, and bruised or scarred lips. Other characteristics of human-

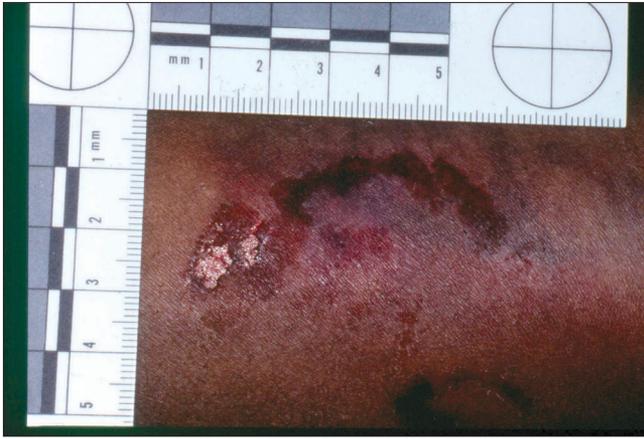


Figure 4: Bite mark inflicted on the right arm.

abuse injuries are related to their multiplicity and repetitive nature. They often appear in various stages of resolution.^{5,17}

Reporting an instance of human abuse to the proper authorities is mandatory in most jurisdictions. The dentist must also understand that his or her testimony may be needed for future legal proceedings. If oral injury is involved, the dentist should maintain complete and precise records of the findings for scrutiny by legal authorities. Necessary radiographic studies should be retained as a part of the record. Photographs of the injury or injuries are often helpful to document injuries. Although child abuse or abuse inflicted on people of any other age is not a frequent area of concern to the dentist, as a provider of primary health care he or she is required by law to report such instances to the proper authorities.¹ Unfortunately, the incidence of dentists' reports is low. Major reasons preventing dental professionals from getting involved in cases of abuse include ignorance about maltreatment, lack of awareness of legal mandates to report it, fear of dealing with an angry parent, reluctance to believe parents (or others) could be abusive or neglectful, and fear of losing patients and therefore income.¹⁶ The primary role of a dentist intervening in any form of violence is to interrupt the violence, not to attempt to resolve individual conflicts or provide counselling to abuse victims. Simply recognizing the signs of abuse, privately discussing these concerns with the patient and knowing where to refer abuse victims are appropriate goals for a dentist confronted with violence. Attempting to provide advice or therapeutic counselling for victims of violence is beyond the scope of dentistry and could, in some situations, result in more harm than benefit.¹⁸

Education

Most Canadian dental schools devote several hours to forensic odontology during the students' last 2 years of school by integrating the subject into their oral pathology courses. The Bureau of Legal Dentistry at the University of British Columbia offers master's and postdoctoral programs

in the field of forensic odontology. The Bureau is a forensic odontology laboratory and is the first and only laboratory in North America that is dedicated to full-time forensic dentistry research, casework and graduate teaching. Another excellent source of postgraduate forensic dental training is the Armed Forces Institute of Pathology of Washington, DC, which offers an annual week-long program. The American Academy of Forensic Sciences established the American Board of Forensic Odontology in 1976 and began certifying qualified dentists in the field of forensic odontology.

Conclusion

Each practitioner has a responsibility to understand the forensic implications associated with the practice of his or her profession. Appreciation of the forensic field should give the dental clinician another reason to maintain legible and legally acceptable records, and assist legal authorities in the identification of victims and suspects. ♦

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References

1. Luntz L. History of forensic dentistry. *Dent Clin North Am* 1977; 21(1):7-17.
2. Cameron JM, Sims BG. Forensic dentistry. Edinburgh: Churchill Livingstone; 1974.
3. Neville B, Douglas D, Allen CM, Bouquot J. Forensic dentistry. In: Oral and maxillofacial pathology. 2nd ed. Philadelphia (PA): W.B. Saunders Co.; 2002. p. 763-83.
4. Spitz WU. Spitz and Fischer's medicolegal investigation of death: guidelines for the application of pathology of crime investigation. Springfield, Ill: Charles C. Thomas; 1993.
5. Guidelines for bite mark analysis. American Board of Forensic Odontology, Inc. *J Am Dent Assoc* 1986; 112(3):383-6.
6. Tsang A, Sweet D, Wood R. Potential for fraudulent use of digital radiography. *J Am Dent Assoc* 1999; 130(9):1325-9.
7. Wood RE, Kirk NJ, Sweet DJ. Digital dental radiographic identification in the pediatric, mixed and permanent dentitions. *J Forensic Sci* 1999; 44(5):910-6.
8. Willems G. A review of the most commonly used dental age estimation techniques. *J Forensic Odontostomatol* 2001; 19(1):9-17.
9. Whittaker DK. An introduction to forensic dentistry. *Quintessence Int* 1994; 25(10):723-30.
10. Wood RE, Clark B, Brooks SE, Blenkinsop B. Combined physical and computer-aided facial reconstruction in human skeletal remains. *Can Soc Forensic Sci J* 1996; 29(4):195-203.
11. MacDonald DG. Bite marks: recognition and interpretation. *J Forensic Sci* 1974; 14(3):229-33.

12. Aksu MM, Gobetti JP. The past and present legal weight of bite marks as evidence. *Am J Forensic Med Pathol* 1996; 17(2):136–40.
13. Pretty IA, Sweet D. Anatomical location of bitemarks and associated findings in 101 cases from the United States. *J Forensic Sci* 2000; 45(4):812–4.
14. Brown KA, Elliot TR, Rogers AH, Thonard JC. The survival of oral streptococci on human skin and its implication in bite-mark investigation. *Forensic Sci Int* 1984; 26:193–7.
15. Harvey W. Bites and bite-marks. In: Dental identification and forensic odontology. London: Henry Kimpton Publishers; 1976. p. 88–123.
16. Epstein J, Scully C. Mammalian bites: risk and management. *Am J Dent* 1992; 5(3):167–71.
17. da Fonseca MA, Feigal RJ, ten Bensele RW. Dental aspects of 1248 cases of child maltreatment on file at a major county hospital. *Pediatr Dent* 1992; 14(3):152–7.
18. Chiodo GT, Tolle SW, Tilden VP. The dentist and family violence. *Gen Dent* 1998; 46(1):20–5.