**Forensic Dentistry**

Forensic dentistry (odontology) is the field within the greater disciplines of dentistry and forensic science that

evaluates, manages, and presents dental evidence in legal proceedings in the interest of justice.1 Forensic dental

casework often involves identification of unidentified or missing individuals, human remains, or victims of mass

fatality incidents, including natural and accidental disasters.

This is accomplished by comparison of a victim’s dentition and supporting structures with dental records of

known individuals. The latter records may be obtained from private dental offices, prison or military dental databases,

or records retained by the Federal Bureau of Investigation through its National Crime Information Center’s

Missing, Unidentified, and Wanted Persons files in a Web environment.2

Since forensic odontology is one of several forensic specialties, the forensic dentist’s role often interfaces with those

of the anthropologist, criminologist, toxicologist, pathologist, and law enforcement official involved with a case. Only

a brief summary is given here with general references addedto cited references for further reading.

**JAWS AND TEETH**

Unlike the static, genetically determined friction ridgesfound on the human hand and foot (commonly referred to

as *fingerprints* and *footprints*) each individual’s dentition is fluid and changes throughout life as the deciduous teeth are

exfoliated and the permanent dentition erupts. In addition,the teeth are subject to dental and periodontal disease, theoral manifestations of systemic diseases that may affect the individual, and alterations of dental structures related to

techniques of restoration and replacement that are employed by the dental practitioner.

Historically, despite this potential for an ever-changingdentition, inspection of the teeth and jaws has been used as

a legally accepted method of human identification. Significantcases in which identification has been resolved by means

of examination of dental evidence include identification ofRevolutionary War hero Dr. Joseph Warren, the prominent

Boston murder victim Dr. George Parkman, and AdolphHitler.3

Paramount to the success of a forensic dental comparisonbetween antemortem and postmortem dental records is the

requirement that both sets of records provide the maximumamount of dental information for analysis. Thus, dentists are

encouraged to document all dental anomalies, existing restorations,and missing teeth in their written, photographic,

and radiographic records

**CHRONOLOGICAL AGE**

Chronological age determination is a central issue in population studies, and racial and sex differences in tooth

development and eruption patterns are acknowledged.6,7

Dental age assessment is also important in the forensic dental evaluation of human remains or living individuals.

Aging of the dentition has been employed in forensic dental casework involving estimation of age of unidentified

individuals.8,9

Separation of victims of multiple fatality incidents by age facilitates the narrowing of searches for eventual identification by comparison of medical and dental records. Dental evaluation of illegal immigrants, who may present authorities with misinformation concerning their age, is important in cases in which protection of unaccompanied minors is aconcern.2 A variety of dental age estimation procedures have been employed. Some are useful in the analysis of radiographic changes associated with development of the dentition of children.10 Others use dental radiographs to determine the dental chronological age in living or deceased adult individuals.11,12

Estimation of the age of an adult may also be based on six characteristics first identified by Gustafson in 195013 by

his observation of ground sections of extracted teeth. These six variables include attrition of the occlusal or incisal surfaces, degree of deposition of secondary dentin (evaluation of the size of the pulp chamber and canal), deposition of

apical cementum, attachment level of the periodontium, root resorption, and radicular translucency.

In addition, biochemical methods that assess the ratios of levorotatory and dextrorotatory isomers of the long-lived,

metabolically stable amino acid aspartate have been employed in both living and deceased subjects to age tissues in which this substance is found. Through a racemization process the L form of aspartic acid is slowly transformed into its stereoisomer, which is the D form of the amino acid. As enamel and dentin age, levels of the D form of aspartic acid increase in these calcified dental structures. These values can be measured and related to known levels for age estimation.

**DENTAL DNA**

Each individual’s unique genetic information is containedwithin the nuclear and mitochondrial deoxyribonucleic acid

(DNA) molecules of their cells. Only identical twins share the same DNA. Nuclear DNA is transmitted from either

parent, whereas mitochondrial DNA is derived only through a maternal route. As a unique biological molecule, DNA

offers the forensic scientist a means of positively identifying an individual when this material can be obtained from tissues or bodily fluids recovered at a crime scene or from human

remains or other forensic evidence.

The most widely used method for forensic analysis of DNA material is the restriction fragment length polymorphism

(RFLP) technique. This laboratory procedure requires that large amounts (100 ng) of DNA be used in

the analysis. The polymerase chain reaction (PCR) technique is employed when this cannot be accomplished because

of degradation of the DNA molecule submitted as evidence, when only small amounts (100 pg) of DNA are available

for analysis, or when the DNA sample is fragmented.15 The PCR method amplifies the amount of DNA available for

analysis by copying a specific locus of genetic material.16Since only small amounts of DNA evidence need be evaluated

using PCR technology, a positive identification may still be effected when human remains have been left unburied

for long periods or have been incinerated, or when DNA trace evidence is obtained from saliva, blood, or fluid

samples. The calcified and pulp tissues within a tooth often present the forensic scientist with the most uncontaminated

and protected DNA samples for analysis. Thus, even small amounts of DNA recovered from these tissues often may be analyzed using the PCR method when other means of identification have been lost or degraded as

evidence.17,18 In addition, the sex of a decedent can be determined through DNA analysis of the sex-linked amelogenin gene. A DNA sample from the victim can be compared directly with one obtained from the clothing or other personal

effects of a putative subject of interest or indirectly with a sample from the parents or siblings of the individual one is

attempting to identify.19

**BITE MARKS**

When the dentition of a human or animal impresses thesurface of an object during the act of biting, a pattern mark

is often imprinted on that surface (Figure 4-1, *A*). Like atool mark left as forensic evidence, the pattern left by the

teeth can be evaluated and compared to the dentition thatallegedly caused it (Figure 4-1, *B*). Whether the bite mark

pattern involves the skin of a victim or suspect or remains on the surface of an inanimate object, to be probative, it

must have class and individual characteristics consistent with a mark caused by teeth.

Class characteristics of a bite mark include the size and shape of the pattern. In most cases this should be consistent

with the dental arch size of the suspected biter (human or animal) and retain a circular shape consisting of two half

arches (maxilla and mandible) separated by a space (temporomandibularjoint). One arch should be larger in its greatest

dimension, representing the greater arch length of the

maxilla.

Individual characteristics associated with a bite markinvolve the patterns routinely made by specific teeth. In the

human dentition these include the following

Maxillary central incisor—large rectangle

Mandibular incisor and maxillary lateral incisor—small

rectangle

Cuspid—point or triangle (when there is incisal wear)

Maxillary cuspid—figure-eight pattern directed buccal to

lingual

Mandibular cuspid—point representing the buccal cusp

Molar—not routinely seen in the patterns left by human

biters

It is generally accepted that no two individuals have an identical dentition based on variations in the arrangement,

spacing, size, and shape of specific teeth and dental arches. Currently, however, neither quantitative values nor databaseshave been established for the dentition that are similar to those described for fingerprint and DNA analysis and

comparison. Thus, although bite mark evidence has been admissible in the federal and state courts of the United

States based on the Frye rule and decisions related to the Federal Rules of Evidence,20,21 this evidence is often used in

an exculpatory manner.

Guidelines have been established and are continuallyreviewed and revised to provide the forensic odontologist

with evidence gathering and analytical procedures to be followed to ensure that recovered bite mark evidence is admissiblein court and supports corroborative evidence in the case