How Forensic Dentistry Works

In January 1978, a manhunt was underway for one of the most notorious serial killers in the history of the United States. Ted Bundy was being held in a small jail in Glenwood Springs, Colo., while awaiting trial for the murder of Caryn Campbell. He escaped by sawing through a metal plate in the ceiling, going through the crawlspace above and walking out through the apartment of the jailer, who happened to be out for the night.

After traveling through Illinois, Michigan and Georgia, Bundy ended up in Tallahassee, Fla. On Jan. 15, 1978, he went into the Chi Omega sorority house at Florida State University. He bludgeoned four students with a club and strangled them. Lisa Levy and Margaret Bowman were killed. Bundy also sexually assaulted Levy and bit her, leaving clear bite marks.

Bundy was recaptured in February 1978 and eventually went on trial for the murders he committed in the Chi Omega house. The bite mark was the only piece of physical evidence that he left at the scene. Investigators took plaster casts of Bundy's teeth, w-hich showed that his teeth were unevenly aligned and that several of them were chipped. A forensic dentist was able to show that these casts matched with photographs of the bite mark from the body of Lisa Levy. This evidence was instrumental in his conviction; if Bundy hadn't bitten Lisa Levy while assaulting her, he may not have been found guilty.

The Bundy case is just one example of how our teeth can uniquely identify us. **Forensic dentists** (also known as **forensic odontologists**) have two different tasks: to identify the dead by their teeth and to determine who (or what) did the biting when bite marks are found. Let's start by looking at the system that all dentists use to distinguish one tooth from another.

Types of Teeth

Teeth aren't fingerprints; they aren't inherently unique from birth. When teeth grow in, or **erupt**, they do so differently in each person. Teeth grow an average of 4 micrometers per day, so it's possible to give a rough age estimate based on teeth. It can also be possible to distinguish ethnicity from the teeth. Some Asians and Native Americans have incisors with scooped-out backs.

The patterns of tooth wear also vary and can change over time. Not only can people be identified by their teeth, you can also learn a lot about their lifestyles and habits by the state of their teeth.

Although each type of tooth has a different name, we have multiples of some types of teeth. For example, a full set of adult teeth includes two upper central incisors and two upper lateral incisors. Therefore, each individual tooth needs its own designation. There are dozens of methods for labeling teeth in use, but the three most popular methods are

the **Universal System**, the **Palmer Method** and the **FDI (Fédération Dentaire Internationale) World Dental Federation** notation.

In the United States, most dentists use the Universal System. In this system, each of the 32 adult teeth is assigned a number. Number one is the upper right third molar, while number 32 is the lower right third molar. The 20 deciduous, or baby teeth, are designated by the letters A through K or the number-letter combination of 1d through 20d.

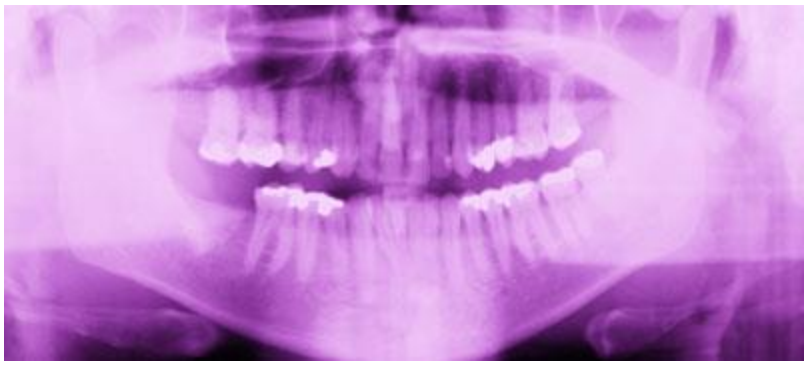
Some teeth, like molars, have multiple surfaces too. Each of these surfaces has a name. The center of the tooth is the biting surface, known as the **occlusal**. This surface has two elements: the **cusps**, or raised parts, and the **grooves**, or indentions. The **mesial** surface of the tooth is toward the front of the mouth, while the **distal** is toward the back. The side toward the inside of the mouth is the **palatal** surface on the upper jaw (**lingual** on the lower jaw). The tooth surface facing the cheek is the **buccal**. So if you get a filling on the distal of number 15, you'll know that means it's on the surface facing the back of the mouth on your upper second molar (or 12-year molar).

When you visit the dentist for a checkup, he or she uses a Universal System chart and makes a notation on each tooth to show variations such as chips and dental work such as fillings, crowns and bridges. The dentist also includes observations about the health of your teeth, like receding gums or signs of periodontal disease. Most dental visits involve taking sets of X-rays, which can also show work not easily seen, like root canals.

Tooth Identification

There is no database of teeth that corresponds with databases of fingerprints or DNA, so dental records are how forensic dentists identify the dead. Tooth enamel (the outer layer of teeth) is harder than any other substance in the human body, which is why teeth remain long after all other parts have decayed. Victims of fires are often identified by their teeth, which can withstand temperatures of more than 2,000 degrees Fahrenheit (1,093 degrees Celsius). Teeth that have been through especially intense heat are very fragile and may shrink, but they can be preserved with lacquer and used for identification as long as they are handled very carefully. Dental work, such as a partial or gold crown, will be distorted by fire but can still aid in identification.

To identify a person from his or her teeth, a forensic dentist must have a dental record or records from the deceased person's dentist. In the case of an incident involving multiple deaths, forensic dentists receive a list of possible individuals and compare available records with the teeth and find a match. Examining the teeth of an intact corpse often requires working in a morgue to expose the jaws surgically. Even if only a few teeth are available, a forensic dentist can still make a positive identification. The best comparisons come from X-rays, but even if those aren't available, notations on the tooth chart can tell the dentist if the teeth are the same.



X-rays are the best way to make a match as far as forensic dentistry is concerned.

Identifying an individual by his or her teeth without dental records is much more difficult. However, things like broken teeth, missing teeth and gold crowns might be recognized by the friends and family members of the deceased. Things about the biter's lifestyle can be determined by the teeth; a constant pipe smoker or a bagpipe player has a distinctive wear pattern. Dressmakers and tailors, who often put pins and needles in their mouths, may have chipped teeth.

In addition to the dental records, forensic investigators can retrieve DNA samples by extracting the pulp from the center of the tooth. Unlike the enamel, pulp can be damaged by fire and other conditions, but it can also last for hundreds of years. Dental identification is often the last resort, and it isn't always possible -- some people simply can't be identified.

Bite-mark Analysis

Although the Chi Omega murder trial had bite-mark evidence as its centerpiece, it's usually used in conjunction with other types of physical evidence. Bite-mark analysis is extremely complex, with many factors involved in a forensic dentist's ability to determine the identity of the perpetrator.

The movement of a person's jaw and tongue when he or she bites contributes to the type of mark that is left. Depending on the location of the bite, it's not typical to find bite marks where both the upper and lower teeth left clear impressions -- usually one or the other is more visible. If the victim is moving while being bitten, the bite would look different from that inflicted on a still victim.

If an investigator sees something on a victim that even resembles a bite, the forensic dentist must be called in immediately, because bite marks change significantly over time. For example, if the victim is deceased, the skin may slip as the body decays, causing the bite to move.

The first step in analyzing the bite is to identify it as human. Animal teeth are very different from humans' teeth, so they leave very different bite-mark patterns. Next, the

bite is swabbed for DNA, which may have been left in the saliva of the biter. The dentist must also determine whether the bite was self-inflicted.

Forensic dentists then take measurements of each individual bite mark and record it. They also require many photographs because of the changing nature of the bites. Bruising can appear four hours after a bite and disappear after 36 hours. If the victim is deceased, the dentist may have to wait until the **lividity** stage, or pooling of the blood, clears and details are visible. The bite photography must be conducted precisely, using rulers and other scales to accurately depict the orientation, depth and size of the bite. The photos are then magnified, enhanced and corrected for distortions.

Finally, bite marks on deceased victims are cut out from the skin in the morgue and preserved in a compound called **formalin**, which contains formaldehyde. Forensic dentists then make a silicone cast of the bite mark.

Forensic dentists use several different terms to describe the type of bite mark:

- **Abrasion** - a scrape on the skin
- **Artifact** - when a piece of the body, such as an ear lobe, is removed through biting
- **Avulsion** - a bite resulting in the removal of skin
- **Contusion** - a bruise
- **Hemorrhage** - a profusely bleeding bite
- **Incision** - a clean, neat wound
- **Laceration** - a puncture wound

In addition, there are several different types of impressions that can be left by teeth, depending on the pressure applied by the biter. A **clear** impression means that there was significant pressure; an **obvious** bite signifies medium pressure; and a **noticeable** impression means that the biter used violent pressure to bite down.

A forensic dentist can tell a lot about the teeth of the biter based on the bite mark. If there's a gap in the bite, the biter is probably missing a tooth. Crooked teeth leave crooked impressions, and chipped teeth leave jagged-looking impressions of varying depth. Braces and partials also leave distinctive impressions.

Once investigators have identified a suspect, they obtain a warrant to take a mold of his or her teeth as well as photos of the mouth in various stages of opening and biting. They then compare transparencies of the mold with those of the bite-mark cast, and photos of both the bite mark and the suspect's teeth are compared to look for similarities.

Bite-mark Analysis Controversy

In January 2007, prisoner Roy Brown, who had been convicted of murder in New York in 1992, was set free. Brown was one of many prisoners who have been released after

DNA analysis, not available or widely used during their trial, cleared them of their crimes. In Brown's case, bite-mark analysis was instrumental in his conviction. But DNA from saliva left on the bite matched with a different suspect. So what went wrong?

The bite mark in the Brown case showed six tooth impressions from the front teeth of the upper jaw, although he was missing two teeth at the time. The expert witness claimed that Brown could have moved the skin of the victim around when biting to make it appear that he wasn't missing any teeth. Although this testimony was not the only evidence used by the prosecution, it was instrumental in helping jurors reach a guilty verdict.

Just five years earlier, an Arizona man named Ray Krone was released from prison after 10 years of serving his murder sentence. The prosecution's witness claimed a perfect match between his teeth and a bite mark found on the victim. The witness stated that "a match is 100 percent" [source: New Scientist]. Krone was cleared after DNA belonging to another suspect was found on the victim's clothes.

Cases like these have led critics to speculate about the nature of bite-mark analysis. Rather than extrapolate based on the bite mark itself, forensic dentists often get a lot of information about the suspected biter before performing the analysis. This might lead them to look for evidence that isn't actually there to fit the need. In addition, forensic dentists may be giving juries the impression that bite marks are as unique as fingerprints or DNA -- and they're not. Despite what the witness in the Krone case stated, there is no evidence to show that you can state that an individual was responsible for a bite mark with complete certainty.

Now some critics feel that bite-mark analysis should be used only to eliminate, not to identify, a suspect. Others say that it's acceptable to state there is a **probability** that a suspect created the mark, but that it's important to clarify that bite marks can't be the only thing linking the suspect to the crime. Forensic dentist training as well as proper education of the jury are also factors.

After the Brown exoneration, Chief forensic dentist Richard Souviron of the Miami-Dade Medical Examiner's Office told the New York Times that, "If you say that this bite fits this person and nobody else in the world, and if you use the bite mark as the only piece of physical evidence linking an attacker to his victim, that's not science -- that's junk" [source: New York Times]. Anthony Cardoza, who co-authored a 1999 study showing that bite-mark analysis could be reliable under specific conditions, admitted, "The best bite mark is one you can swab for DNA" [source: New Scientist].