

Forensic Dental Evidence: An Investigator's Handbook

Second Edition

Forensic Dental Evidence: An Investigator's Handbook

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To my wife Cynthia: I could not have done this without you.

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Foreword

Forensic Odontology is a fascinating and challenging field. Technological and procedural advances coupled with the public's increased awareness through media such as *CSI* has made forensic sciences appealing to many, and seemingly infallible to others.

I have known Dr. Bowers for over twenty years, we first made acquaintance in Louisville, Kentucky in 1989 while challenging the ABFO dental certification board examination. Over these years he has earned the respect of all others in this field with his determined dedication to further forensic odontology into a respected discipline of the forensic sciences.

The second edition of *Forensic Dental Evidence: An Investigator's Handbook* edited by Dr. C. Michael Bowers is written for those whose desire the knowledge, background and understanding of forensic dentistry. This book is essential reading and a valuable asset for any investigator, lawyer, medical examiner, nurse, or dentist that has an interest or a role in a forensic dental case.

A highlight of this handbook is the discussion of the wrongful convictions due to erroneous bitemark opinions that have surfaced in the past decade. In the early 1990s Dr. Bowers and others become cautious in the manner in which bitemark opinions were being used to identify specific individuals in an open population. Currently there have been ten exonerations of individuals who have served many years in prison that were falsely imprisoned as a result of faulty bitemark evidence and incorrect opinions. These opinions were not based in science and were without validity or reliability. Dr. Bowers' work as an impartial dental expert coupled with DNA evidence resulted in the exoneration of these innocent individuals.

Dr. Bowers' determined work in educating and informing the forensic community of the need for scientifically validated opinions in the 1990s went largely neglected by board certified forensic dentists. In 1999, the ABFO performed a bitemark workshop to examine the ability of the expert to properly discern the biter from a lineup of unknowns. The ABFO published a paper with the results that reported the ability of the certified forensic dentists to identify the correct perpetrator with moderate accuracy of 86%. What was not reported was the high level of false positives that accompanied these findings. Dr. Bowers' high ethical standards compelled him to uncover the actual findings that revealed a high false positive rate which was not exposed in the scientific paper published by the ABFO.

Recognizing that improvements were necessary in the forensic sciences, Congress directed the National Academy of Science to study the problem. In 2009, the National Academy published a report called "Strengthening

Forensic Science in the United States: A Path Forward” which was a comprehensive review of all the forensic sciences, including bitemark analysis. The findings from this report were the same as Dr. Bowers had been teaching and writing about for years. It was not until after this report was published, did the certified forensic dental specialty group began to acknowledge the need for change. Fortunately, this process has begun and positive changes are currently being made. This handbook relates and discusses all the problems identified by the National Academy of Science.

In the handbook edited by Dr. Bowers, he has partnered himself with many of the world's foremost forensic scientists and dental experts. This handbook offers the latest information available to the forensic community and beyond. It will function to advance the profession and allow justice for all.

David C. Averill, DDS, DABFO

Past President, American Board of Forensic Odontology

Past President, American Society of Forensic Odontology

Preface to Second Edition

The 2010 edition of *Forensic Dental Evidence: An Investigator's Handbook* expands the scope of the 2004 edition with a compilation of new and “just off the press” information that is unparalleled in the forensic dental scientific literature. All chapters highlight forensic cases and technique with a direct emphasis on modern-day methods and protocols.

Forensic Dental Evidence, second edition, contains the compelling forensic issues that challenge investigators in cases dealing with domestic and international human identification, missing person investigations, violent crimes against persons, mass disaster planning, disaster response, and the new threats to urban centers from terrorist attacks. In addition, the text contains chapters on forensic photography, analysis, and legal issues regarding bitemark evidence. All of these topics demand special forensic expertise in forensic dentistry and its related sciences. This book demonstrates that expertise. New scientific topics which premiere in book form are *The Next Level in Victim Identification: Materials Properties as an Aid in Victim Identification* (Chapter 3) and *DNA for First Responders: Recognizing, Collecting, and Analyzing Biological Evidence Related to Dentistry* (Chapter 8). Notable updates are presented in each chapter.

Forensic Dental Evidence is the first book that places criminal investigators within the realm of dental forensics and offers the information necessary to effectively pursue and manage their casework. The advantage of this book over other texts on the subject is its unique timeline of information. It is contemporary in all aspects and intentionally avoids the stale and years-old references seen commonly in print today. Another unique opportunity for readers is its innovative and cutting-edge electronic version. This book contains active hyperlinks that allow the reader freedom to directly and easily travel from references within the text to a large hierarchy of online web-based material. In addition, many of these online references are updated by the accessed website. This self-updating nature of information is new in forensic dental literature and premieres in this book. Readers have access to the latest in reference documentation and now have the option to produce their own online archive of materials they deem important for their needs. In essence, *Forensic Dental Evidence* acts as a springboard into mainstream forensic dental information in real time. As added value, expanded educational information, including the *Atlas of Dental Identification* along with other updates for *Forensic Dental Evidence* are available at www.elsevierdirect.com/companions/9780123820006.

An international faculty of authors who encompass the best in the discipline contributed to this book. They address head-on the challenges of forensic investigation. These authors are seasoned veterans of investigations that span the globe. Highly publicized historic and contemporary cases of all types are presented as examples of real forensic techniques past and present. The authors also include practical suggestions for investigators. The emphasis throughout this book is the necessity of proper scientific methods, the knowledge of their limitations, and the necessity for team training, planning, and multilevel management. The subject matter is purposely presented from various viewpoints by multiple authors in order to glean the wisdom of these internationally recognized forensic experts.

Forensic Dental Evidence, Second Edition, continues its design for readers with an interest in the subject of forensic dentistry. It follows the first edition's precedent of giving up-to-date information and its high educational value through the generous use of high-resolution illustrations.

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February 12, 2010

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Preface to First Edition

This book's purpose is to act as a detailed overview of forensic dentistry as it is practiced in the twenty-first century, and it contains presentations of dental investigation methods. Law enforcement and legal professionals are, in the end result, the clients of the dental expert. This book is written for this audience. Wherever possible, the author has included casework examples to explain the multiple areas in which a forensic dentist can interact with police investigations. The reconstruction of prior events at a crime scene and the activities of the individuals involved is a daunting task. Forensic examiners use dental evidence in this process. Certain suggestions and guidelines are described to raise the certainty of successfully recognizing and capturing vital dental evidence in actual forensic casework.

The development of modern forensic dentistry can be seen in the dental and forensic literature over the last 50 years. Many of these cases are valuable for the innovative problem-based dental techniques used to compare known (K) and questioned (Q) dental evidence. They show considerable effort in answering questions asked by law enforcement and the courts. Interestingly, an independent body of forensic dental science didn't exist before dental identification and bitemark analysis became parts of contemporary forensic investigations. This follows the historical development of forensic pathology during the late nineteenth century in Britain, France, and Germany. Empirical studies in forensic dentistry do exist but still have not answered certain core questions involving human identification based on bitemark analysis that have been posed during the twenty-first century. DNA profiling and digital imaging are recent additions that are being used to increase the reliability of forensic dentists' bitemark opinions that previously used techniques that have varied only slightly during the last 40 years.

Apart from bitemark identification, the use of dental records and accompanying dental/medical radiographs to identify deceased individuals is a common event in the United States and abroad that provides considerable assistance in mass disaster recoveries and cases identifying unknown persons. Beyond this broad overview, the need to properly identify and analyze dental evidence is an ongoing request made of dentists throughout the world. The transient nature of crime scene evidence places considerable pressure on law enforcement to immediately establish possible links between crime and its perpetrators. Mistakes and errors of evidence collection will never be properly remedied by later scientific manipulations in the crime laboratory.

In any criminal investigation, the proof of guilt or innocence is the underpinning focus of forensic efforts. Correct human identification of

deceased individuals is vital to both law enforcement and family members. It is just as important to eliminate a homicide or assault case suspect as it is to strongly tip the scale of justice to charge a person with criminal conduct. The cases that are unclear as to guilt and innocence, or at least have weak connections between the crime scene and a suspect, rely even more heavily on physical evidence in order to give the justice system a chance to produce a reliable outcome. When the forensic dental evidence is clear and physically compelling, the truth seems obvious to the judicial system, judge, and jury. When the dental evidence is vague, ambiguous, or otherwise equivocal, it is important for law enforcement and the forensic expert to honestly weigh the value of the evidence against the potential for irrevocable harm to a defendant.

The management of the physical evidence of a crime falls to a series of actors during the entire course of a case. The beginning phase has the managers generally being police officers at a scene. Occasionally the first collection of dental evidence is through the efforts of the forensic pathologist or forensic dentist during a postmortem examination. In a mass disaster, recovery of human remains should be the job of a trained civilian, military staff, or government personnel. In all instances, the persons responsible for detecting, documenting, and collecting the physical evidence are the gatekeepers for the process that follows. The management at any scene should be under the control of prepared, experienced professionals. In the continuum of events after evidence recognition and collection, the forensic laboratory or forensic dentists will obtain control of the evidence and perform their analyses. These forensic opinions will be transferred to the legal arena, where attorneys will introduce the evidence. Their duty will be to translate to their judicial audience the importance of this evidence on the case at hand.

The Logic of Forensic Investigation

The aspects of proper forensic evidence recovery require a knowledge base in the following steps:

- *Recognition (detection)*: Teeth and related physical evidence derived from the oral cavity must be observed by responding crime scene and accident investigators. These professionals must also be familiar with common objects that may contain transfer evidence such as saliva or tooth impression evidence. These objects include human skin, clothing, duct tape, envelopes, chewing gum, telephone receivers, and foods such as cheese and various types of beverage containers.
- *Documentation (recording)*: Physical evidence obtained from a crime or accident scene should be left in place, properly lighted, and photographed. This establishes its condition and context with the location prior to investigative measures that may disturb or somehow alter its condition. The photographer must take the time to place size-reference scales or rulers in some of the evidence photos. This allows the pictures

and the evidence to be later made into life size via photographic or digital processing. Written notes or log sheets with pertinent descriptions should be kept by the investigator who is responsible for the evidence collection.

- *Collection:* The intent is to capture the dental evidence for later analysis. This commonly includes bagging biological objects (saliva stains, loose teeth, or foodstuffs) in labeled paper bags. Bitemarks in skin, if observed on a victim at a crime scene, should be rigorously photographed and then swabbed. Recreating the position or posture of the person bitten should be considered, but in the absence of a victim's statement or reliable witnesses, all alternatives should be considered.
- *Preservation:* Protocols for the capture and preservation of biological evidence (tissue, blood, semen, or saliva) must be stringently followed. Foodstuffs cannot be preserved for long periods of time without drying and deteriorating. The method of choice for preserving bite impressions in food is to take modeling impressions of the objects as soon as practical after swabbing for saliva. Bitemarks in skin can be impressed with dental molding materials. This permits later creation of a three-dimensional model of the bitten area.
- *Interpretation:* The recreation of a human's identity by their teeth or via DNA taken from a tooth or saliva requires scientific training and should be performed by a board-certified forensic dentist for the former and a biologist for the latter.

Categories of Dental Evidence

The various types of dental evidence can be described as they relate to questions being asked by the investigators.

"Is there direct dental evidence supporting human identification?"

The following types of evidence should be considered:

- A human tooth or tooth fragment
- A fragment of a human jawbone
- DNA obtained from a tooth, toothbrush, cigarette, and so on
- DNA obtained from a swabbing of a bitemark, foodstuff, or object that possesses saliva transfer evidence
- Dental restorations and appliances that can be associated to a particular person through name inscriptions, specific dental material type, composition, or unusual design characteristics

"Is there associative evidence of a person's past presence or activities at a crime scene?"

When investigators ask this question, it extends to the following:

- Does the bitemark in this apple indicate a specific person was present at a scene prior to or during the commission of a crime?
- Does the DNA obtained from this piece of bitten cheese belong to a specific person?

- Does the DNA obtained from the swabbing of this telephone belong to a specific person who was present at the scene?
- Can this “person of interest” be eliminated as a suspect?
- Does the suspect’s statement of consensual sexual contact with the victim seem appropriate with the severity of this bitemark?

The following transfer evidence corroboration should be considered:

- Does the saliva obtained from a glass that also has fingerprint evidence contain the DNA of the same individual matching the fingerprints?

This book presents concepts and protocols that are vital to a successful outcome to a criminal investigation that involves dental evidence. One basis for any proven forensic dental protocol is organization and regular utilization. These methods need to be practiced and protocols maintained in order to be available and successful under actual casework conditions. It is my wish that this book will help to improve the body of knowledge available on the uses and importance of forensic dental evidence.

Dr. Mike Bowers

October 1, 2003
Ventura, California, USA

Acknowledgments

I want to acknowledge all of the contributors to both *Forensic Dental Evidence* editions, as well as the following people, each a friend and a mentor, who have been instrumental in my arriving at this point in my professional career: the late Dr. Charles Meyer Goldstein, for setting an incredibly high standard of community and humanitarian service during his 34-year career at the Ostrow School of Dentistry of the University of Southern California; Dr. Warren Lovell, who almost 30 years ago provided the welcome that allowed my forensic science interest to develop; and Dr. Ron O'Halloran, who continues as Chief at the Ventura County Medical Examiner's Office. Finally, I have to thank Dr. Raymond Johansen for his dedicated interest in improving forensic dentistry and for his innovative spirit.

Introduction

Forensic Dental Evidence: An Investigator's Handbook (FDE) has achieved a remarkable readership since its first publication in 2004. Forensic scientists and medical-legal investigators have been amazed by the public's interest in forensics. Forensic dentistry is no exception. Readers of the first edition included college forensic students, high school and dental students, teachers, law enforcement, and forensic investigators. Television media and other entertainment writers used the book to properly insert dental evidence into their plots. The news media regularly refer to dentists evaluating evidence relating to crime, missing persons, and mass disasters. The concept of a "CSI dentist" has come of age in the first ten years of the new millennium.

Scope of Forensic Dentistry

Human identification is the forensic odontologist's primary duty: Who is the victim? This involves the dentist as a team member working along with law enforcement agencies. This team is charged with the responsibility of investigating the evidence from cases involving violent crime, child abuse, elder abuse, missing persons, and mass disaster scenarios. In each context, dental evidence may produce compelling associations to aid victim and suspect identity and to establish facts that can affect the direction and ultimate outcome of investigative casework. Dental evidence can be used to identify both the people who were present during the commission of a crime or witnesses to an accident. The forensic dentist interacts with other forensic and medical disciplines like anthropology, pathology, human anatomy, and biological science. The best international source for forensic dental information and international forensic certification is available at Forensic Dentistry Online (¹).

Forensic dentistry (aka *forensic odontology* in Europe) has a two-and-one-half-century history in the United States. It is the science and practice of dentistry and its role in modern society. Dental injuries from accidents or assaults must be assessed and treated. Occasionally, the treating dentist or attending forensic dental expert testifies in court proceedings for parties involved in civil litigation. Criminal cases use dentists to testify on dental evidence obtained from a crime scene or crime victims. Occasionally, a perpetrator of a crime leaves evidence at a scene. Bitten food, gum, or chewed objects may be recovered by law enforcement. Autopsy investigations may notice bitemarks on the skin of a deceased victim. Dental experts also testify regarding the quality of dental care (professional negligence) and in cases where dental fraud is an issue.

¹forensicdentistryonline.com

Teaming Law Enforcement Investigators with Forensic Dentistry

A crime scene will seldom have a dentist as a first responder, nor will one respond with the forensic evidence team or with a major crime or detective bureau. Therefore, it is up to the police to perform certain dental evaluations at a scene. The threshold question for any investigator at a crime scene or autopsy is “What is the dental evidence?” This might seem to be begging the obvious question, but the purpose of this book is to clearly describe the gamut of evidence that is either directly related to human dental anatomy or derived from the oral environment. The survivability of teeth in catastrophic conditions is the feature that makes forensic odontologists regular participants in the autopsy suite. Tooth shapes, appearances, tooth fragments, metal restorations, pieces of skulls, and jawbone fragments may possess features that can be associated with just one person. The robust identification value of DNA, obtained from the inside of teeth and oral fluids, has recently created an entirely new level of identification: the biomolecular identification of individuals.

Knowledge, training, and experience are the keys to successful law enforcement casework. What might be considered as plain good luck in an investigation is really the effect of hard work, thoroughness, and preparation. The purpose of this book is to provide the basis of knowledge and training in forensic odontology that will extend into crime scene investigations and the crime laboratory.

Evidence *identification, documentation, preservation, and collection* are the steps in this process. Identification technicians, crime scene evidence technicians, and investigators must achieve a functional knowledge and the necessary skills to connect this evidence to the case for later analysis by the certified odontologist. The evidence collection process includes knowing the physical parameters of dental evidence that demand special steps in preservation before transportation to the crime lab. If the evidence is properly identified, collected, preserved, and, finally, *transported*, it is also critical that the investigator properly document these steps to ensure *authentication* and a *chain of custody* for all interested parties. The success of later evidence analysis, whether *direct physical evidence* or even *circumstantial evidence*, is directly related to what happens during these first steps.

Specialized materials and methods are used to collect certain types of dental evidence. It is also important for the investigator to know what happens to evidence once it is transported to the forensic technician or forensic odontologist. In that regard, the latter section of this book will demonstrate specialized collection techniques, materials, photographic documentation, and analytical steps involved in laboratory processing and later comparison of physical and biological dental evidence.

Educational Objectives

The reader should learn the following knowledge and skills from this book:

- The ability to identify types of dental evidence. This includes the various transfer surfaces and materials that may capture dental evidence.
- An appreciation for forensic identification significance and the limitations of these categories of dental evidence.
- How to properly document, collect, and preserve these categories of dental physical and biological evidence.
- What dental materials and supplies are used in evidence collection and preservation.
- The scientific and evolving judicial requirements regarding evidence collection, storage, chain of custody, and forensic analysis.
- A familiarity with digital comparison techniques via Adobe Photoshop®.

Expanded educational information, including the
Atlas of Dental Identification along with other updates for
Forensic Dental Evidence are available at:

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