



Forensic Dental Photography

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ABSTRACT

Background

Forensic dental photography is a critical component of forensic odontology, aiding in individual identification, bite mark analysis, and documentation of dental evidence in criminal investigations. It provides a permanent and accurate visual record of dental structures, injuries, and forensic evidence.

Objective

This paper explores the techniques, applications, and legal implications of forensic dental photography, with a focus on how advancements like 3D printing and Alternate Light Imaging (ALI) enhance forensic dentistry.

Methods

Forensic dental photography relies on standardized imaging techniques, including proper lighting, scale calibration, and high-resolution imaging, to ensure accuracy and clarity. ALI improves visibility of bite marks and soft tissue injuries, while 3D printing enables precise reconstruction of dental structures and bite mark impressions. Digital photography advancements further enhance storage, sharing, and analysis of forensic images.

Results

The integration of ALI and 3D printing with forensic dental photography has led to improved evidence preservation, enhanced bite mark analysis, and greater accuracy in victim identification. These technologies assist forensic experts in comparing dental records, identifying victims in disasters or crimes, and presenting admissible evidence in court.

Conclusion

With continuous advancements in digital imaging, 3D printing, and ALI, forensic dental photography has become a vital tool in modern forensic science. These innovations strengthen forensic investigations by improving documentation accuracy, evidence reliability, and legal admissibility. Standardized imaging techniques ensure accuracy and reliability, while advancements like Alternate Light Imaging (ALI) and 3D printing enhance forensic investigations. ALI improves the visibility of bite marks and injuries, whereas 3D printing enables precise reconstruction of dental evidence. These technologies contribute to better evidence preservation, increased accuracy in victim identification, and stronger courtroom admissibility. With ongoing innovations in digital imaging and forensic methodologies, Forensic Dental Photography remains an essential tool for modern forensic science and criminal investigations.

Keywords: Forensic, Dental, Photography, Odontology

Introduction

Though most people agree that photography is the most accurate way of recording evidence, it wasn't until significant advancements in the late 1800s that photography was recognized as a crucial forensic tool for identification.¹ The strength of photographic realism and the modernity of criminal justice systems gave rise to forensic photography. It includes recording suspected and guilty offenders and victims, crime scenes, autopsies, and other evidence required for a conviction. As a result, it helps the departments of toxicology, forensic science, and medical examination.²

Forensic photography, also known as forensic imaging or

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crime scene photography, is the skill of creating a precise replica of a crime scene or disaster scene for use in court proceedings or investigative purposes. It is a step in the gathering of evidence procedure. It gives cops pictures of the victims, scenes, and objects used in the crime. Individuals other than a Forensic Dentist frequently take the crime scene photos.³ Since postmortem modifications, burial, and cremation eventually cause the original evidence in homicide cases to be lost, photography is extremely significant. Injuries in living patients heal and eventually become invisible. New developments in digital photographic technologies, ultraviolet and infrared photography, and alternate light photography have significantly improved the same.⁴ These photographic evidences may then be used in court to help with providing justice or in providing a summary of the case. Care should be taken by a forensic photographer as the photos that they capture may be held accountable for the investigation's success or failure.⁴

History

Alphonse Bertillon, a photographer, was the first to realise that shooting photos of criminals in a regular manner was necessary for the photos to be accurate. Using the proper lighting, scale, and angles was part of this. Bertillon's 1890 publication, *La Photographie Judiciaire*, provided guidelines for an identification photography method that was meticulous in science. He suggested that the subjects need to be well-lit, captured in both full face and profile shots, with the ears visible.¹ We identify these criteria since they are the same ones that are still in use today for passports, identification cards, and mugshots. The standards that Bertillon created also have a sordid history of pseudo-medical practice known as phrenology.¹

Phrenology, made popular by early psychiatrists, eugenicists, and Nazis, was the theory that one could infer a person's personality from their head shape. Phrenologists tended to hold that criminal behaviour was innate in criminals and that the brain contained evidence of this (i.e., the form of the skull as a result of an over- or underdeveloped brain). The finely crafted images of offenders served as both an archival record and "proof" of their innate criminality.⁵

Bertillon's measurements, photographs, and fingerprint analysis revealed how determined police forces were to make observation and detection as precise and scientific as possible. The efficiency of dental science in identifying unidentified human remains is surpassed only by fingerprint technology. The many permutations and combinations in

the patterns of decaying, missing, and filled teeth serve as the foundation for the validity and trustworthiness.⁶

When decomposition, burning, mutilation, and skeletisation erase fingerprints and visual approaches, dental identifications almost always become crucial. If there are any concerns about foul play, legal proceedings, or the unavailability of finger print records, dental verification of identity may be necessary even for an intact body.⁷

Photography primarily about teeth displays biting marks and tooth remnants. Forensic dentistry photography is beyond the training of police photographers. Furthermore, because the dentist overlays life-sized models of a suspect's teeth onto the evidence from the crime scene, bite mark analysis necessitates precise dimensional control of the things being photographed.⁸ Hence, rather than focusing on aesthetic appeal, forensic dentists should standardise their techniques to enable reproducibility. The anterior teeth become so weak after a strong fire that even the smallest touch might cause them to disintegrate.⁹

The dentition could be reduced to ashes by any attempt to remove the jaws. The original snapshot preserves this information in the event of future damage. In infrequent legal proceedings when the identity of the victim is contested, the forensic dentist could be summoned and asked to provide evidence supporting his conclusions. A set of images could support and reinforce the textual information record.⁸

Orientation Shot

Ensure to take an orientation picture before moving in close to capture a close-up of an injury pattern or tool mark on the camera (Figure 1). The images should also include the location, time, and associated structures in the vicinity of the crime. This not only helps directly for the purpose of producing evidence but also recreation of the crime scene if the need arises. For instance, while taking pictures of a bite mark, it is usually necessary to take a few preliminary pictures from a distance with a stationary reference object in place in order to capture the bite mark's location and orientation in relation to the body as well as the reference object when first found.¹⁰ This is to convey to any observers who come after you the precise location and orientation of the injury.¹¹

Final Shot

Capture plenty of close-up photos with a macro lens, both with and without a scale in place. Prior to exposing the film, make sure the scale is in the same focal plane as the subject being photographed. This image must precisely capture the colour and contrasting black and white characteristics of

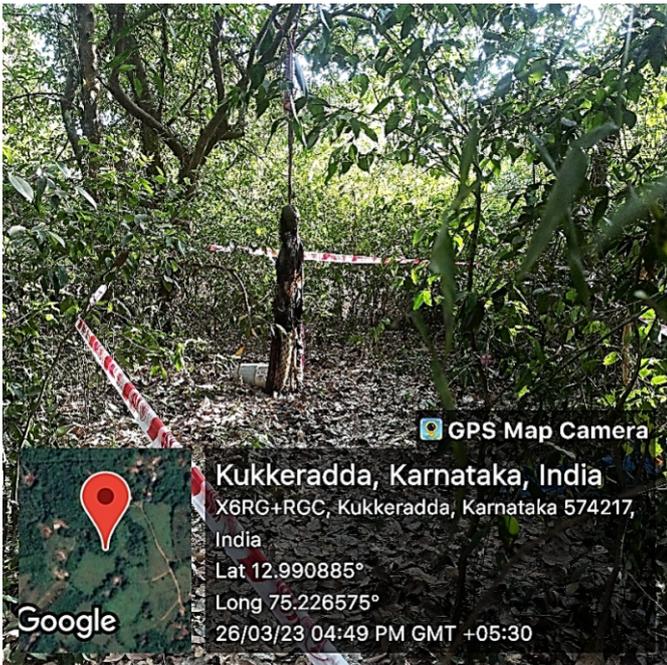


Figure 1: Orientation shot taken with Geotagged Camera confirming time and location.

the actual evidence because it will be used for forensic comparisons.^{10,11}

The important step is to avoid “burning out” the bite mark with excessive direct light, flash exposure, and reflections. It is especially crucial to use oblique lighting, or light that is 45 degrees from the surface, in order to accentuate the patches of light and shadow that correspond with three-dimensional, depth-containing structures.^{12,13}

Proper use of scales and measuring devices for close up photography:

Whenever the photo in forensic comparisons is used, it is crucial to have a scale, measuring tape, or ruler next to the evidence. Upon exposing the film, the scale must be in the same focal plane as the object being photographed. The capacity of the scale to properly display the evidence item’s circular reference targets and linear marks determines its proper size and two-dimensional detail. It is crucial that the scale line up with the skin or biting item.¹⁴

Recommended steps for shots of the deceased in frame:

a. Full-body Photography.

This shot is taken by the police. Through an autopsy, this image would depict the full body, untouched and untreated. Since these perspectives offer an unaltered version of the evidence and guarantee that any further tampering has not obscured or obliterated data, these may be of utmost significance (Figure 2). When attempting to recreate mass disaster and bite mark cases, these photos should be captured meticulously. Additionally, a photo of the visible



Figure 2: Orientation shot showing nearby associated structures in place

body is taken in case the family needs to visually identify it. A photo with a case card or number in the frame should be added thereafter.¹⁴

Recommendation: Ambient light exposure is controlled by the shutter speed and lens aperture whether be it in manual or automatic modes. Manually exposure may be made accurate by using an 18 percent gray card. As for the automatic mode, the ‘Automatic Exposure Lock’ option may be used appropriately.¹⁰⁻¹⁵

b. Close-up Facial and Profile Photography:

In circumstances where the body is somewhat well-preserved and potentially recognized physically, these photos may be helpful, before the autopsy begins. A picture of the deceased’s front face, lateral aspect, and head and neck in other possible angulations should be taken for a closer look at the details (Figure 3).^{14,15}

Recommendation: A macro lens should be used, for the finest factual details of color and contrast to be captured, with a standard scale in place, and in the same focal plane as that of the area being photographed. Care should be taken



Figure 3: Close Up photograph of the head and neck revealing missing lower jaw and throat structures



to avoid “burning out” of the bite mark with excessive direct light and/or exposure. The use of oblique lighting approximately at 45° to the surface is imperative to allow depth for 3-Dimensional features to be emphasized as areas of light and shadow for further advancement for 3D printing or other applications as required.^{14,16}

c. Close-up Anterior Teeth Photography

In the event that the victim’s smiling ante-mortem photo is the only record that emerges, close-up shots of the exposed anterior teeth are crucial. The value of Dental Symmetry Reference Diagrams is emphasized by a smile that can highlight dental axis, gum contours, interdental contacts, incisal margins, tooth proportions, and smile lines. The facial muscles must be removed in situations of burns and decomposition. The teeth might be destroyed during the autopsy if they are removed later and are also helpful in cases when the preservation of anterior teeth is threatened by carbonization.^{14,15}

Recommendation: Macro Photography helps to reveal the minute details by magnification which may be missed with other modes. Micro Photography is often used to document trace evidence like hair, nails, microfibers, etc.

d. Intraoral Photography -

If the rigor mortis has prevented the jaws of a visible body from opening fully, it is suggested to wait 12 to 24 hours instead of removing tissue. After the jaw muscles have relaxed, intraoral images can be taken, or the jaws should be freely photographed following dissection.^{10,12}

Recommendation: Photography may be made with an adequate light source, using intra-oral cameras whenever other methods cannot be availed or cannot be made in real time.¹⁶

e. Resected or Skeletonized Jaws Photography

Whenever jaws are taken away, an image of the mandible and maxilla that have recovered should be made.¹⁴

Recommendation: The jaws should be placed in occlusion which may simulate the best closing position of teeth followed by close-up views which may be made with macro or micro photography as applicable.¹⁴

f. Ante-mortem and Post-mortem Radiography

When the forensic dentist is unable to retain the original radiographic films or when radiographic replicas are not available, these photos come in handy.¹⁴

Recommendation: An efficient way for establishing concordance in court is to present images of the postmortem and antemortem radiographs placed juxtaposed on the same exposure.¹⁵

Managing the Chain of Evidence

For visuals to be used in court, each document must be deemed “accurate and representative” of the crime scene. They comprise the “evidentiary chain”. Accountability regarding who possessed the evidence from the moment it was obtained until it was labeled and entered into the court system is necessary for compliance. From the homicide location itself, the validity of the images may be verified. The photographer should always be in possession of both the raw images and print copies.¹⁷

Other types of Photographic Techniques:

1. **Ultraviolet photography:** Used to enhance the physical characteristics.¹⁸
eg: lacerations, contusions, abrasions, and bite marks
2. **Fluorescence photography:** must be performed in darkness.¹⁹
eg: Biological fluids, Fibres, fingerprints, gunshot residue, pigments, and inks
3. **Infrared photography:** made with specialized equipment using short wavelength infrared light to illuminate an area of interest; that can detect and capture infrared light, to visualize minutiae like concealed wounds or tampered evidence.²⁰
eg: Tattoos, gunshot residue, forgeries, counterfeiting, and even help retrieve documents.
4. **Macro/Microphotography:** Macro photography ranges between an image scale of 1:10 and 10:1- to increase magnification. An Image scale larger than 10:1 is referred to as Microphotography, used to document trace evidence.²¹
5. **Thermo graphic imaging:** Uses mid- or long wavelength IR energy. Thermal imagers are passive, and only sense differences in heat. They are composed of a black and white image with variations in brightness corresponding to the intensity of heat emitted from a human body. It is a non-invasive and non-destructive method.²²
eg: To identify concealed drug labs, illicit substances manufacturing unit, existence of human remains in concealed graves.
6. **Digital photography:** An important tool to gather and preserve evidence, as well as application for further investigation.²³
eg: Comparing 2D intra-oral and selfie photographs to 3D PM scans, 3D superimpositions, use of software to rotate, translate, and scale images to align ante- and post-mortem radiographs, etc.



7. **Panoramic photography:** To cover the larger area of a crime scene and derive a complete perspective of a region for future investigations.²⁴

eg: digital documentation of wide areas of crime scenes, mass disasters

Bite Mark Photography

Many a times, homicides, sexual assaults, and child abuse are accompanied by skin marks inflicted by human bites. In exceptional circumstances, a victim may bite the offender in defense of oneself. Regardless of the case, a dental “fingerprint” is taken and could be used as testimony to identify the attacker (Figure 4). Preserving the indentations’ size, shape, color, depth, and three-dimensional outlines is important. Dental impressions display the final two, although photographs can capture the first three. In the end, life-size copies of the photos will be compared with life-sized models of the suspect’s teeth. At present 3D models can be recreated using photography for 1:1 comparison.²⁵

Types of Photographic distortions in Bite Mark Photograph²⁵

Type I: The camera is not parallel to the bite mark and scale, but they are on the same plane.

Type II: The bite mark and the scale are not on the same plane.

Type III: A two-dimensional scale with perspective distortion in one leg and not in the other

Type IV: The scale is twisted or bent.

General Photographic distortion are usually seen in quality of the image like distortion in Lens, Barrel, Angulation, Viewpoint. Other distortions occur due to errors such as camera glitch, inappropriate tools, Incorrect placement of the scale, movement of the object, defective focal length of the lens, Inability to visualise, etc.

The Future of Forensic Photography²⁶



Figure 4: Close-up Bite Mark on cheek with one of the scale missing

The discipline of forensic photography is continually evolving due to the swift developments in technological innovation. These days, methods like the Alternate Light Imaging (ALI) technique—which uses ultraviolet and infrared light to detect specimens of blood, for example—are widely used and give detectives access to vital information that is very useful when looking into crimes.

Improved accuracy and precision are used to capture photos of victims, their wounds, and identifying marks, which makes it possible to see things that were previously omitted. It goes without saying that as technology advances, so too will the capacity to conduct prompt and impartial investigations. However, the camera still shows signs of possible prejudice in the legal system today.

As opposed to objective fact, depiction is the focus of photography. It has long been believed that the camera shields us from the worst aspects of humanity while giving us access to our deepest secrets. Among the essential and crucial tools in the forensics armory is crime scene/forensic photography. Although it is crucial in the battle against crime, discrimination always exists.

Legal Considerations Involving Photographic Evidence of Physical Injuries and Mortalities

Legal Considerations²⁷

Photographs showing bite marks are closely scrutinised in court and require meticulous technological management because they might be used as incriminating evidence in prosecutions.

Recommendations:

- The spot, time, date, matter, and photographer’s identity should be recorded on all photos meant to be used as evidence.
- In addition, information that may be included in the labelling process is the camera, lens, film, lens aperture, subject distance, shutter speed, or flash setting utilised.
- Film should change hands as seldom as possible to maintain an uninterrupted chain of evidence.
- A thorough list of the items received, complete with date, time, and location, should be attached with the signature of an authorised recipient with every transfer.

Acceptability of Photographic Evidence in Court²⁸

When testifying before a jury, appearance is crucial. It can be quite challenging to convey to a jury all of the conclusions reached in a case due to its complexity; nevertheless, displays allow for a comprehensive summary of a case utilizing both text and images. The photography department uses imaging and layout software to create



displays.

Recommendations:

- The finished product must be placed on poster board and printed on a 24-inch inkjet printer to produce a presentation of high calibre.
- Relevance and authenticity are the two main conditions for allowing a photograph—whether digitized or conventional—to be allowed as an evidence.
- To have the photo accepted into evidence, the person attempting must be ready to testify that the snapshot accurately captures the scene.
- This means that a witness must attest that the photo faithfully captures the incident as seen by them.

Acceptability of Photographic Evidence as evidence²⁷

An issue that frequently comes up when law enforcement considers digital imaging is whether or not digital photographic evidence is admissible in court as digital photos can be edited more readily than film-based ones. Hence there are some problems when Digital photos, are produced as evidence before the court. The reason being that some law personnel consider that they are not admissible in court. Forensic dental photography must adhere to strict standards to address challenges/issues such as photographic distortion and courtroom admissibility of digital images, the recommendations may be as follows:

1. Addressing Photographic Distortion²⁹

Photographic distortion can occur due to lens issues, improper angling, or inadequate scale reference, which can affect the accuracy of forensic dental images. To mitigate this:

Use of Standardized Techniques

- Proper Camera Equipment: Macro lenses and ring flashes ensure high-resolution, distortion-free images.
- Perpendicular Image Capture: Ensuring the camera sensor is parallel to the subject prevents perspective distortion.
- Use of Photographic Rulers and Scales: Inclusion of ABFO No. 2 scale (or similar forensic scales) provides an accurate size reference.

3D Imaging & Digital Correction

- 3D printing and photogrammetry help create precise models of dental structures, reducing reliance on 2D images prone to distortion.
- Software-Based Correction: Digital forensic tools can correct lens distortion and perspective errors while maintaining evidentiary integrity.

2. Ensuring Courtroom Admissibility of Digital Images³⁰

Forensic images must meet legal standards to be admissible in court, ensuring authenticity and preventing tampering claims.

Chain of Custody & Metadata Integrity

- Timestamping & Metadata Storage: Digital images should retain EXIF data, including date, time, and device details, to verify authenticity.
- Secure File Handling: Images should be stored in original RAW format with unaltered backups.

Validation of Image Authenticity

- Digital Watermarking & Hashing: Hash values (e.g., SHA-256) ensure that images remain unchanged from capture to courtroom presentation.
- Alternate Light Imaging (ALI) for Enhanced Visibility: ALI aids in non-invasive verification of dental injuries or bite marks, providing clear evidence without manipulation.

Expert Testimony & Standardized Procedures

- Forensic odontologists must follow American Board of Forensic Odontology (ABFO) and International Organization for Standardization (ISO) guidelines.
- Court-Recognized Validation: Techniques such as 3D-printed models and ALI-enhanced photography help in presenting objective, reproducible evidence.

Conclusion

Photographic documenting of crime scenes is arguably the most significant and verifiable component. An objective and theoretical description of an object or setting can be captured in time with just a shutter click.

In the field of Forensic Dentistry, photography is undoubtedly one of the most crucial applied protocols. The demands placed on the photographer might be high, particularly when the sole evidence linking an accused to the offense is an injury. Even though it can be time-consuming and stressful, when done correctly, the results produce solid evidence, giving the forensic dentist a sense of achievement and fulfilment that they have significantly contributed to the case. Instead of focusing on the culprit, forensic photography aims to capture the circumstances of the criminal act. Photographic replication is among the most important tools for accurately recording ephemeral evidence.

Future Directions and Challenges³¹

To further improve forensic dental photography, future research should focus on

Addressing Photographic Distortion:

- Standardizing calibration techniques, lens selection, and imaging angles to minimize perspective errors.



- Implementing 3D imaging and photogrammetry to create distortion-free reconstructions of dental evidence.

Enhancing Courtroom Admissibility of Digital Images:

- Strengthening chain of custody protocols and ensuring metadata integrity (e.g., timestamping and digital signatures).
- Utilizing forensic hashing techniques to verify that images remain unaltered.

Integrating Advanced Technologies:

- Expanding the use of Alternate Light Imaging (ALI) to improve visibility of bite marks and soft tissue injuries.
- Advancing 3D printing applications for more precise replication of dental structures in forensic cases.

By refining forensic dental photography techniques and integrating emerging technologies, the field can continue to enhance accuracy, reliability, and legal admissibility, ensuring that forensic evidence withstands scrutiny in criminal investigations and court proceedings.

Conflict of Interest: Nil

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