

## Forensic Dental Kit: A Comprehensive Review of Essential Equipments

Dharmesh Vasavada<sup>1</sup>, Prachi Sharma<sup>2</sup>, Rashmi GS Phulari<sup>3</sup>

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### Abstract

In order to handle forensic dental evidence and provide a report to a court of law, forensic odontology is a subdiscipline of dental science that employs a multidisciplinary approach. Dental science and forensic odontology are progressively gaining in prominence and applicability in the judicial system. In forensic casework of human identity, age estimation, and sexual assault cases with patterned injuries, there is a requirement for a specialist forensic kit by legal and forensic authorities.

The forensic kit contents should be in accordance of the crime scene whether indoor or outdoor. To handle the evidence, a set of armamentarium/equipment related to forensic odontology are needed for a specific purpose based on the place of application. This article is an attempt to provide a comprehensive review of the essential equipment needed in a Forensic Dental Kit at the crime scene for investigation by a forensic odontologist, which will aid in the collection of evidence, the transfer and maintenance of records, and the identification of the perpetrator.

**Keywords:** Forensic Odontology; Forensic Dentist; Crime Scene; Evidence Collection; Dental Investigation Kit.

### Introduction

Forensic odontology is defined by the Federation Dentaire Internationale as the branch of dentistry concerned with the proper management and examination of dental evidence, as well as the proper interpretation and presentation of dental evidence in the interest of justice.<sup>1</sup> It is a dental science subdiscipline that employs a multidisciplinary approach when dealing with forensic dental evidence and submitting a report to a court of law.<sup>2</sup> In the interest of justice,

forensic odontology involves the administration, examination, appraisal, and presentation of dental evidence in criminal and civil proceedings.

Forensic dentistry plays a major role in identification in man made or natural disasters. A dental expert's opinion is of foremost importance in identification of live as well as dead individuals and also in crime investigations. In forensic exams and in court, the use of distinctive traits and morphological variances of the teeth in personal identification is widely acknowledged. Despite advancements in leading identification techniques such as DNA profiling, fingerprints, and facial reconstruction, dental records (records in the form of dentist's observations and radiographs) play a significant role in the identification of the deceased in mass fatality incidents such as plane crashes, other major accidents, terrorist attacks, and natural disasters.

If ante mortem dental records are unavailable for comparison, a forensic anthropologist or odontologist can infer the deceased's age, race, and sex from dental evidence discovered at the crime

**Author Affiliation:** <sup>1</sup>Reader, <sup>2</sup>Student, <sup>3</sup>Professor and HOD, Department of Oral and Maxillofacial Pathology and Oral Microbiology, Manubhai Patel Dental College and Hospital and ORI, Vadodara, Gujarat 390011, India.

**Corresponding Author:** Dharmesh Vasavada, Reader, Department of Oral and Maxillofacial Pathology and Oral Microbiology, Manubhai Patel Dental College and Hospital and ORI, Vadodara, Gujarat 390011, India.

**E-mail:** dharmeshvasavada@gmail.com

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scene. When determining age and gender from teeth, it's important to keep in mind demographic specificity, as different population groups exhibit varying degrees of human diversity in dental features.<sup>3</sup>

The prime requirement of any investigation is the evidence which is a treasure of various data. Teeth, jaw bone, saliva, radiographs, bite marks, palatal rugae, dental records, dental casts, DNA, blood, lip prints, denture, and microscopic slides are some of the evidences used to identify victims and perpetrators. Because evidence is the foundation of all investigations, it must be collected and preserved using stringent procedures and methodologies. The basic goal is to keep evidence as similar to the state it was in when the incident occurred as possible. The chain of custody is an important aspect of proper evidence processing.<sup>4</sup> For the proper collection of evidence, a number of essential armamentarium is required at the time of investigation. These required elements if concised in a single kit will make the procedure of evidence collection and transportation hassle-free and will prevent delay.

A forensic dental kit is a set of articles needed by a forensic odontologist to detect, collect and process samples and evidence from crime scenes, suspects and victims at the time of investigation.

This article includes a thorough list of the items that must be included in a forensic dental kit and are required by the forensic odontologist at the time of the crime scene investigation.

### Forensic Dental Kit Armamentarium

*The proposed armamentarium for the forensic odontology department is categorized as follows:*

1. Investigative tools (table 1)
2. Illumination tools (table 2)
3. Personal protection equipment (PPE) kit
4. Documentation/stationery tools (table 3)
5. Craniofacial Anthropology kit (table 4)

#### *Investigative/Diagnostic tools*

**Diagnostic Instruments**<sup>5</sup> arranged in a simple tray setup consisting of mirror and explorer, tweezers, haemostats (tool for exposing, exploring, and visualizing the deeper areas of a wound), bristle and wire brushes (used to clean surfaces and to create a better vision), scaler, tongue blades, forceps, scalpel (blade and holder), and scissors is

essential. In addition, it is advisable to have x-ray sensor holders, cheek and lip retractors, ratchet jaw openers, gauze; **Chisel/mallat and strykar saw**<sup>5</sup> useful for identifying type of bone for facial reconstruction. Upper and lower jaw removal can be accomplished with either lopper or Stryker saw instrumentation.; **BP handle with blade, toothbrush** for taking biopsy specimens; **Cotton swabs** for microbial cultures for DNA analysis; **Formalin filled bottle** for keeping the biopsied specimen; **Slide** for blood smear collection; Syringe for aspiration of fluid for cytology; **ABFO No. 2 Scale**<sup>6</sup> to assess the size of the injury. Photo scales are used in forensic photography to provide a geometrical reference while photographing evidence. The inclusion of such scales in an image helps investigators to reconstruct the scene's three dimensional context and reproduce one to one images of tangible evidence. In some cases, information extracted from the reconstruction of a scene provides evidence in court. Other scales are, **photographic scale, NNDV(Nuzzolese-Neri DiVella) No. 2 bite mark scale (colorimetric scale) to establish the age of a bruise or bite mark on either living or deceased subjects; Saliva test strip**<sup>7</sup> to detect the amount of alcohol in saliva, for various marker identification for any disease as well as DNA analysis (provide information about the physical characteristics, ethnicity, place of origin, and sex of the person). Saliva is an easily obtainable biological fluid by means of noninvasive methods. It's made up of plasma and salivary acini-derived secretory materials. Identification tools used for screening, presumption, and confirmation of salivary constituents aid in Antemortem as well as Postmortem analysis; **Impression trays and materials**<sup>8</sup> Bite mark identification is based on the individuality of a dentition, which is used to match a bite mark to a suspect. Recognition of a patterned damage as a human bite mark is the most critical step in bite mark analysis, followed by pattern association and bite mark metric analysis. Making bite mark impressions is an important way for preserving bite mark evidence. When it looks that the surface of the bite mark may provide useful information, impressions should be taken. A distinctive bite pattern is produced by the incisal surfaces of the teeth. As a result, the imprint material utilised to record the case should precisely record the incisal surface area and perimeter, tooth rotations, alignment, and position of teeth in the arch. A variety of impression materials like silicon rubbers and polyether are used for impression making. Hydrophilic VPS impression material have better elasticity and dimensional stability compared

to other impression materials and is hence is the material of choice. Also, it is useful to record the hard tissues which are duplicated by preparing cast from the impression and can estimate age and gender.

Lip prints have unique markings that can be entered into a specific classification and can be an additional weapon for personal identification; **Cellophane tape, lipstick** for lip print lifting; **Black latent print lifting powder** for enhancing the print; **White hinge latent print lifter** for lifting the print from the specimen. Finger print is important in identifying unknown deceased, conducting background checks and in criminal justice realm. Lip prints do not change with time **Skull model with clay**<sup>9</sup> for facial reconstruction. Faces are peculiar to every human being and is crucial for human identity. Because the face of the deceased person remains intact and the identity of the individual can be easily determined, it plays an important function in forensic sciences. Forensic dentistry is used when a person's face has been destroyed by some methods. Most often in severe disasters and incidents where the corpse of the deceased individual is deteriorated or skeletonized, forensic professionals labour to identify the discovered human remains (identification of whole or fragmented bodies). In such circumstances, the skull and other bones may be the only parts that survive. Skulls can last millions of years unmodified and provide an unmistakable form of identification. The skull look is quite useful in detecting a person's gender.

**Table 1:** Investigative tools.

Diagnostic Tools
<b>Diagnostic Instruments</b>
Mirror, explorer, tweezer
Hemostats
Bristle and wire brushes
Scaler
Tongue blades
Forcep, scalpel
Scissor
<b>Strykar saw, chisel/mallet</b>
Bp handle with blade
Toothbrush
Cotton swabs
Formalin filled bottle
Slide
Syringe
<b>ABFO No 2 scale</b>
Colorimetric scale

6" Photographic scale

NNDV No. 2 bite mark scale

**Sliva Test Strip**

Impression trays and material

**Cellophane Tape**

Lipstic

Black power

White hinge latent print lifter

Skull model with clay

*Illumination tools*

**Digital Camera**—for high definition picture which can give idea for many traits. In forensic cases, photography is frequently the greatest method for collecting and preserving evidence. In forensic odontology, this is notably true in situations involving dental identification, human abuse, and, perhaps most importantly, bitemark cases. In most dental identification cases, basic visible light photography is sufficient; however, full spectrum digital photography is best used to acquire all relevant evidence in cases of human abuse and bitemarks.<sup>10</sup> Digital cameras provide an easy and quick method of recording images. The need to accurately photograph injury patterns as they appear on skin is paramount to the pathologists as well as legal experts. Photographs are the only permanent record of the injuries to the victims. Digital photography means that the images are stored in a computerized file format often referred to as a digital image file. A digital image file signifies any computer file format.<sup>11</sup> **Intraoral mirrors** have photographic purpose for viewing the intraoral condition of the suspect.

**Alternative light source (ALS) with filters**<sup>12</sup> will be helpful for viewing of pattern injuries. A basic way for locating biological evidence in crime scenes is to employ an alternate light source (ALS). ALS is a non invasive, non destructive method for detecting biological fluids, human remains, teeth and bones, and other evidence. The ALS technology is based on the absorptive and fluorescent properties of the item under examination. Fluorescent materials absorb light at low wavelengths and emit light at higher wavelengths than the absorbed ones and may assist forensic experts in identifying evidence at crime scenes; **yellow goggle and orange goggles** to view fresh bite mark and to view teeth and bone samples, respectively; **Headlight** will be useful to view the evidence in dark; **UV light**<sup>13</sup> tooth coloured resin filling form a part of the unique dentition of an individual, and recognition of the resins is important for forensic identification. In recent years small LED

flashlights emitting at specific wavelengths in the ultraviolet light (UV) range have been developed. Because of their inexpensive cost, compact size, and easy availability, they can be used in both forensic and clinical contexts. Because enamel, dentin, and dental materials all have different fluorescence characteristics when irradiated by UV light, UV inspection is of interest. Different resin brands glow at various wavelengths and intensities. The most useful excitation wavelengths for resin detection were in the UVA region, according to practical use and comparison of flashlights (365 and 380 nm). Porcelain restorations and composite resin fillings exhibited different responses to these two wavelengths and thus use of both is recommended for forensic dental inspection. It is also useful for invisible bite mark identification; **Handheld magnifier** for low vision viewing or viewing small evidences and for better magnification.

**Table 2:** Illumination Tools.

Digital Camera
Intraoral Mirror
Alternative light source with filters
Yellow and orange google
Headlight
UV light
Handheld Magnifier

**Table 3:** Documentation/Stationery tools.

Documentation Tools
Records
Portable X-ray machines
Antemortem and Postmortem Odontograms
Envelopes
Seal of forensic odontologist
Log book
Custody sheets
Stationery items
Digital memory cards
Identification labels

**Table 4:** Craniofacial Anthropology kit.

Tooth development charts
Osteometric board
Goniometer
ASUDAS plaques or Turner Scott
Dental anthropology system

Personal protective equipment (PPE)<sup>14</sup>

Important element which acts as a barrier for cross contamination. PPE comprises protective clothing,

helmets, goggles and/ or equipment designed to protect the wearer from health and safety hazards at work.

#### Documentation

Dental Identification Procedures essentially two forms of dental identification: the first known as dental identification attempts conclusive identification by comparing dead individuals' teeth with dental records of presumed individual. The second, reconstructive identification or dental profiling, attempts to elicit the population affinity or race, sex, age and occupation of the dead individual.

The circumstances of death may give adequate information of possible identity of the decedent. Scientific methods of identification are then employed to confirm the identification of dead individual from his or her teeth. Comparative dental identification is the conventional method of post mortem dental identification, and includes four steps, namely:

- Oral Autopsy
- Obtaining dental records
- Comparing post-mortem and antemortem data
- Writing a report and drawing a conclusion

*Oral Autopsy:* It is the examination of the deceased usually with dissection to expose the organs to determine the cause of death. Starting with oral examination which is the essential part of postmortem examination. It can be challenging at times owing to certain postmortem alterations, status of each tooth should be carefully noted. A thorough examination of soft tissue injuries, para oral hard tissue fractures and presence of foreign bodies is undertaken and samples of hard and soft tissues may be obtained for further investigations. All information pertaining to the body must be entered into the modified Interpol postmortem dental Odontogram.

*Obtaining dental records:* May be obtained from the treating dentist and hospital records which contain information of treatment undergone and dental status of a person and constitute the antemortem data. The records may be in the form of dental charts, radiographs, casts and/or photographs and these contents should be transcribed onto the modified Interpol antemortem Odontogram.

*Comparing post and antemortem dental data:* The evaluation of two odontograms include tooth morphology and associated bony structures,

pathology and dental restorations. A single point of concordance between post and antemortem data may be sufficient to establish identity, considering the uniqueness of such a feature and circumstances of the case.

*Writing a report and drawing conclusions:* Any attempt at establishing identity is addressed to the law enforcers or legal authorities. A detailed report and factual conclusion based on the comparison must be clearly stated. The identification can be positive, probable and possible identification.

A vital component of identification is image comparison with dental radiographs, which continues to provide the most valuable source of evidence. Radiographs as a graphic record of dental status contain more verifiable information and detail than written descriptions or charts.<sup>15</sup>

**Portable x-ray machine** for radiographs will be useful for instant viewing of the internal structures and injury and also for identification of gender. It is important in various criminal investigations which are helpful in determination of identity, evaluation of different injuries, various criminal and civil cases; **Antemortem and Postmortem odontograms**<sup>16</sup> Identification is based on comparison between known characteristics of a missing individual (termed ante-mortem data) with recovered characteristics from an unknown body (termed post mortem data). The postmortem dental remains are compared with antemortem dental records, including written notes, study casts, radiographs, etc. to confirm identity. Individuals with numerous and complex dental treatments are often easier to identify than those individuals with little or no restorative treatment. The teeth not only represent a suitable repository for such unique and identifying features, they also survive most postmortem events that can disrupt or change other body tissues; **Envelopes; Seal of forensic odontologist; Logbook; Custody sheets; Stationery items (pen, pencils, markers, templates for sketch, plastic rulers, protractors, magnetic compass, measuring tape, zipper closure bags etc.); digital memory card; identification labels** are the main tools useful in the documentation at the time of investigation.

#### *Craniofacial Anthropology kit*

**Tooth development charts**<sup>17</sup> Assessment of age is often required while administering justice to an individual involved in the civil and the criminal litigation. Teeth are recognised to assist in personal identity and age estimation due to their remarkable

durability and resistance to putrefaction, fire, chemicals, and other factors. The timing and sequence of specific growth stages of the growing dentition, as well as the sequence or alteration of features in the mature dentition and surrounding tissues, are primarily used to estimate dental age in live people. Charts and tables are used for the assessment of age during development period with the use of formation, eruption, and calcification of teeth; **Osteometric board.** The osteometric board is a common tool for measuring lengths of long bones such as the humerus or femur. These measurements can be used to estimate the age of a child or, in the case of adults, to determine stature (height); **Goniometer** A goniometer is a device used to measure angles, similar to a protractor, but more specifically designed for measuring body joint angles; **ASUDAS (Arizona State University Dental Anthropology System) plaques or Turner-Scott dental anthropology system** The Turner-Scott Dental Anthropology System dental plaques are a series of 27 reference plaques that highlight human tooth morphology and variation. This standardized collection of plaques showcases non-metric tooth crown and root traits that are found in a given human population, as well as showing the degree of expression of each trait. Included with the set of plaques are an annotated bibliography of references and a history of the dental plaque system.

#### **Conclusion**

Not only does a forensic dentist play an important role in mass disasters (terrorist attacks, earthquakes, Tsunamis), child/elder/spouse abuse, bite mark analysis, criminal/natural deaths and injuries, bioterrorism, and so on, but they also assist in the identification of decomposed and charred bodies such as drowned people, burn victims, and victims of motor vehicle accidents. Various methods have been employed in forensic odontology which include bite mark analysis, tooth prints, rugoscopy, cheiloscopy, DNA analysis, radiographs, etc. When all other avenues of identification have been tried, a forensic dentist bears a great deal of responsibility. In certain cases, teeth are the only intact human remains and the only means of identification, allowing a more effective search inside the missing person's file. In these cases, final identification may depend on specific odontological matching of pre and post mortem dental data, DNA typing etc. A forensic dental kit that is easily available and transportable, also which is completely handy/

feasible will be helpful in investigating the site and for collecting first hand information at the scene of crime or mass disaster.

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