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A review on Identifying Human Bodies through the use of Forensic Dentistry

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ABSTRACT
Forensic Odontology is a specialized field in dentistry that helps in the identification of murder, abuse, or mass disaster victims by a thorough examination of the dental evidence. Teeth are considered as one of the hardest structures of the body, hence they are unaffected by harsh conditions such as trauma, mutilation, incineration, or decomposition. Keeping this basic principle in mind, Forensic odontology has gained its popularity in human identification through dental records. This article reviews the importance of forensic dental sciences, the methods used in human identification, and an insight into the recent concept of DNA profiling in forensic dentistry.
KEYWORDS: Forensic odontology, dental evidence, human identification, DNA profiling

I. INTRODUCTION

Forensic dentistry is that branch of forensic science that deals with comparing antemortem and postmortem dental records to identify dead individuals. The first documented case where a person was identified utilizing dental data was of Dr. Joseph Warren, who was killed in the 1775 Bunker Hill battle in New England. Paul Revere, an amateur dentist and renowned silversmith, who had done some dental treatment on Dr. Warren in 1773 and 1775 rightly identified the body through his work.

Furthermore, the first multiple body identification through the use of dental records dates back to the Bazar de la Charité fire on May 04, 1897, in Paris. All the burned bodies were identified through the matching of detailed dental records kept by the dentists with the evidence of extraction spaces, amalgam fillings, and crowns to that of the victim's oral cavity.

Up until the 1960s, Forensic dentistry was still in its neonatal stages. But after the emergence of the first official Forensic Dentistry program in the USA at the Armed Forces Institute of Pathology (AIFP), it expanded significantly. Through the contributions of the program, an understanding was developed that the tooth and its allied structures were a source of dependable information for forensic dentists as well as security organizations.

At times due to situations such as incineration or decomposition of the bodies, identification through visual inspection can be compromised, leading to an error. Hence in these circumstances, the oral cavity is an appropriate method of identification. Being resistant to harsh environmental conditions, teeth are considered an excellent source of evidence collection. The oral cavity of a victim provides a plethora of possibilities to help in their identification. For instance, information collected from lip prints, teeth, and bite marks plays a crucial part in criminal investigations.

Ante-mortem records play a crucial role in Forensic Dentistry, hence dentists need to examine, record, and manage all dental findings, study models, clinical photographs, and x-rays of the patients. These dental documentations can then be compared with those retrieved from the deceased person, also known as the post mortem records for further forensic evaluation and identification. In situations where pre-dental records aren't available, forensic dentistry still contributes to the identification of certain oral habits, age, socioeconomic status, and type of diet.

HUMAN IDENTIFICATION

Identification of the deceased through dental characteristics is carried out in the following ways:

- Dental identification through comparison: it is one of the commonest methods employed, in which the post mortem records extracted from the dead are compared with the antemortem records to find if they belong to the same individual.
- Dental profiling is done in cases where the antemortem records are unavailable. In this

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situation, the forensic odontologist creates a dental profile based on the post-mortem findings and then narrows down the search to find the correct identity.

Various techniques have been undertaken by forensic odontologists for human identification. These commonly include Cheiloscopy, Bite-mark analysis, Tooth prints, Rugoscopy, and Dental DNA analysis.

1. Cheiloscopy

Commonly referred to as Lip analysis, it involves the examination of the depressions and elevation on the lip known as lip prints. These lip paints like the fingerprints are unique to every individual. They develop by the sixth month of intrauterine life, and remain unchanged for the rest of the life, even so after death.

First described by Fischer, an anthropologist in 1902, as the furrows on the red part of the human lips. It was only in 1930 when lip print was used in criminology courtesy of some studies formulated by Diou de Lille.

Various patterns of lip prints were identified by Suzuki and Tsuchihashi between 1968 to 1971 at Tokyo University in the Department of Forensic Odontology. They examined 1364 individuals and concluded that patterns of lines and arrangements on the red part of the lips are unique for every person.

It is important to collect lip print within the first 24 hours of the death of a person to decrease any possibilities of error due to post-mortem alteration of the lip. They can frequently be obtained directly from the lips of the dead person or indirectly from cigarettes, glasses, cups, or any clothing such as a handkerchief.

2. Bite Mark analysis

Forceful injuries inflicted by teeth on surfaces such as skin, leave a characteristic pattern known as bite marks on the area. Bite marks usually depict a violent interaction between the malefactor and the sufferer, whether for sexual abuse or aggressive reasons.

The most famous case which led to the use of bite marks as a piece of evidence in courts was that of serial killer Ted Bundy, who based on the bite mark analysis was convicted by the United States judiciary.

Various dental features can be analyzed by studying the bite marks such as missing teeth, dental crowding or rotations, fractures, attrition of teeth, etc. Forensic odontologists based on the study of bite marks can rule out or take into consideration an accused.

Usually, bite marks are recorded by taking impressions or digital photographs. It is important to take accurate impressions of the biting surface using appropriate impression materials as soon as possible because the physical and biological detections of bite marks on the victim's body began degrading immediately after the actual bite.

3. Tooth Prints

The study of tooth prints is commonly known as Ameloglyphics. Certain patterns are formed on the outer enamel surface when ameloblasts lay the enamel rods in smoothly rising and falling outline. This study commonly requires antemortem records. Ameloglyphics is still in its preliminary stage, and it needs to be assessed with further research Acetate peeling is the frequently used technique for recording the surface details on teeth, but if the surface is attrited, abraded, fractures, or decayed then this technique is invalid.

4. Rugoscopy

Rugoscopy is the analysis and study of the shape, length, number, and directions of the intermixing pattern of the palatal rugae. It is formed by the third month of intrauterine life and the pattern directions develop by 12 to 14 weeks of prenatal life.

Allen in 1889 was the first to put forward the use of palatal rugae as a means of human identification. Palatal rugae are seen to be useful in situations where neither fingerprints nor dental records are available for the identification of the dead. The main advantage of rugae is that remains well protected within the mouth by teeth, lips, the buccal pad of fat, and maxillary bones.

Palatal rugae patterns have proven to be an important method of human identification in recent times. Several studies that were conducted to study these patterns have exhibited an association between shapes and ethnicity as well as gender, thus proving to be a dependable paradigm in Forensic dentistry.

5. DNA Analysis

The two main types of DNA which are useful in Forensic dentistry are genomic DNA and Mitochondrial DNA. Of the two, genomic DNA is found in the nucleus of each cell in the body and is

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the major source of DNA for forensic investigations. On the other hand mitochondrial DNA has a high copy number in each cell, hence is beneficial in circumstances where not enough Genomic DNA is available for examination. DNA map out helps in presenting an accurate identification of a person. It also provides information on gender, ethnicity, and physical characteristics.

The mouth is an important source of DNA, which can be retrieved from the teeth, oral mucosa, and saliva. From within the teeth, a DNA sample can be obtained from the pulp, cementum, dentin, periodontal ligament fibers, and the alveolar bone. The samples from the pulp tissue can be collected through Endodontics access preparations, tooth sectioning, and crushing technique. Sweet and Hildebrand were the pioneers in procuring DNA by tooth crushing through cryogenization.

The DNA profile tests performed in the present times include:

- STRs (Short stretches of DNA) typing: it is used for identification of old skeletal remains and in mass body identification of disaster victims.
- Restriction Fragment Length Polymorphism (RFLP): it cannot be carried out in situations where the samples are deteriorated because of environmental factors. It also requires large amounts of DNA for processing and the results take a long time as well.
- Y-chromosome Analysis: It is used for studying human evolution and in forensic science for paternity investigation.
- X-chromosome STR: because of the small size of the allele, it is easy to amplify and detect them with greater precision.
- Mitochondrial DNA (mtDNA) Analysis: it is an essential source in forensic dentistry due to its high copy number and maternal inheritance trait.
- Single nucleotide polymorphism (SNPs): they are making an appearance in the world of forensic sciences because of lower mutation rates and small amplicon size which makes it possible to profile even the degraded DNA samples. Also, they are present in a multitude within the human body and can provide thorough information about ancestry, lineage, phenotype, and gender determination.

II. CONCLUSION

Forensic dentistry can lead to the identification of deceased individuals, who otherwise cannot be identified by any other methods. The dentist plays an important role in ensuring that proper antemortem dental records are maintained for all patients, so if needed in the future can be beneficial for the identification of people. Furthermore, the advancements in DNA profiling have opened new doors in the world of forensic sciences for human identification. The teeth of a human body are an excellent source of DNA and with the ever-growing research-based technologies in forensic dentistry, it surely is emerging as the modern-day tool for forensic identification.

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