



Review Article

Forensic dentistry's invaluable contribution to human identification

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ABSTRACT

Forensic dentistry, a vital discipline in forensic science, uses dental knowledge to examine crime scenes and locate human remains. It is crucial for maintaining fairness in court procedures, especially when others conclusive evidences are unavailable. In this review article we discussing the role of forensic dentistry in human identification and significance of dental DNA research, reconstructive identification, and comparative techniques.

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1. Introduction

Forensic dentistry, also known as forensic odontology, is a specialty that helps in crime scenes investigation, administration of justice and identifying human remains in decomposed bodies, human skeletal remains and identification of human bodies in large-scale after major disasters.¹ The teeth and jaws bones resist decomposition, making them useful in identifying victims when other features degrade over time.² They assist with diagnosis, monitoring, decontamination, infection control, observation, notification, immunizations, prescriptions, triage, and medical care in such scenario.³ While antemortem records are vital their reliabilities hinges on the accuracy, completeness and correctness.⁴ Essentially, Forensic expert gather, study and present dental data for legal use confirming identities and assisting officials in detecting neglect, fraud, or abuse, thus serving the three main purposes.

1.1. Important purposes served by dental identification

There are three purposes which are followings;

- Comparative identification:** This technique compares dental data from before and after death to verify if they belong to the same person, a strategy used in pediatric dentistry.⁵
- Finding Dental Information :** Forensic dentists can utilize dental information to concentrate their search for a person, even without identity-related data or antemortem records.
- Identification in Mass Disasters:** Dental forensics is crucial in identifying individuals after disasters. Application of traditional techniques like fillings, radiographic, and fractures of teeth and bones have decreased due to molecular biology advancements. Forensic dentists use methods like rugoscopy, cheiloscopy, impressions, and PCR to examine DNA in dental pulp tissue.¹

In this article, we are discussing advancements in Bucco-dental studies, DNA's role in forensic dentistry, dental evaluation's role in rehabilitation, and human

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bite mark application in identifying culprits. This article highlights how forensic dentistry is evolving with advanced technology, how it can be useful in designing a new sophisticated method for better and precise identification.

1.2. Materials and Methods

This study analyzed 774 papers on forensic dentistry and odontology from 2007 to 2023, focusing on human bite analysis, comparative Bucco-dental studies, reconstructive Bucco-dental evaluation, and DNA use in dental identification. The purpose was to compile the latest findings and developments in the field, providing a comprehensive analysis of its future aspects.

2. Discussion

2.1. Bucco-dental Study in Comparative Identification

Forensic dentistry is crucial in identifying people through dental identification techniques, including antemortem documents, radiographs, and dental procedures. The Intelligent Dental Identification System (IDIS) improves productivity and reduces error rates. Discrepancies between antemortem and postmortem records can be logical or illogical, leading to identification rejection. Up to 80% of cases involve dental procedures, with different percentages depending on the type of catastrophe, nationality, dental treatments, accessibility of records, and tooth state.

Table 1: Types of dental identification.⁶

Positive dental identity	-Sufficient agreement between the antemortem and postmortem data to establish that they correspond to the same individual - Absence of unexplainable discrepancies - At least 12 coincident features
Probable dental identity	Probability of coincidence with another person \leq 1/10,000 -Strong evidence, though other biological, physical, technical or tactic data are needed - Between 6 and 11 coincident features - Probability of coincidence with another person \leq 1/100
Possible dental identity	-No sufficient characteristics for positive identification - Existence of explainable discrepancies - Absence of excluding characteristics -If there are 5 coincidences or less, other techniques must be used to determine the identity of the individual
Discarded dental identity	- Existence of an unexplainable discrepancy. - Need for new data (such as X-rays) and definition of the identification technique used, in order to discard errors

3. Bucco-dental Study in Reconstructive Identification

3.1. Determination of age

Teeth examinations can reveal an individual's age without invasive treatments. Early techniques consider factors like occlusal wear, dentin layers, cement thickness, root resorption, root transparency, and gingival adhesion. Improved methods focus on single-root teeth and use software to reduce subjectivity and errors.⁷

3.2. Rugoscopy and cheiloscropy

Rugoscopy and cheiloscropy are identification techniques based on palatal prints and lip prints. Palatal prints which are unique to every individual, are studied from the third month of fetal development. Cheiloscropy analyses the unique and permanent ridges and grooves of the lips, akin to fingerprints. However, factors like surgery, trauma, or certain diseases can alter or remove these prints, making the process challenging.² Cheiloscropy is also notable for its ability to non-invasively detect potential gender differences, making it both convenient and cost effective. Nevertheless, its reliability in forensics is debated due to varying accuracy, making it suitable only in specific scenarios.⁸

3.3. Determination of gender

The gender of a person can be determined using different anatomical features and dental traits. It reveals that males have more circular ridge patterns and females have more convergent ones. Gender differences in palatal rugae length and number are significant, with a success rate of up to 99.2%. Lower canines are shorter in females and have narrower spaces. Lip print morphology and skull base differences also contribute to gender determination. The text presents various techniques for determining gender based on these data.²

3.4. Human bites as a Method for Identifying an Aggressor

The distinction between human dentition and skin reaction to biting action is debated among forensic dentists. Bite marks can appear on various body parts, with females more likely to have marks from sexual assault and males more likely to have traces on arms and shoulders. Documenting bite traits, such as fractures, dental rotations, attrition, wear, and genetic deformities, is crucial for identifying suspects. Saliva collected from bites should be tested for amylase. Accurate imprints are needed to preserve imperfections.⁶

3.5. The Role of DNA in Dental Identification

DNA can be found in various parts of the oral cavity, including teeth, saliva, and oral mucosal cells. Pulp tissue, which can survive environmental conditions, is a popular

source for DNA extraction. Techniques include crushing, tooth sectioning, and endodontic access. Cryogenization of crushed teeth is a cutting-edge method. However, certain teeth may lack pulp tissue, have endodontic treatments, be contaminated with bacteria, or have non-human DNA. Forensic dentists should adopt these methods.⁹

3.6. Importance of forensic odontology in large-scale Disasters or Catastrophes:

Dental records can be crucial in identifying victims after catastrophic events, especially when conventional methods are insufficient.¹⁰ PCR analysis can further enhance identifying proof. Forensic dentistry also uses bite marks to identify attackers, aiding criminal investigations.¹¹ The field's interdisciplinary approach and continually improving techniques make it relevant in human identification, supporting legal procedures and ensuring the truth prevails.¹²

3.7. Recent advancement in forensic odontology.

Research in Forensic dentistry emphasizes the value of cone beam computed tomography (CBCT) due to its precision, cost effectiveness and mobility. CBCT is endorsed for post-mortem imaging and for juxtaposing antemortem and post-mortem records, considering bone and dental details. It delivers detailed 3D visual of dental structures at an affordable cost.¹³ However, CBCT requires specialized equipment and qualified personnel, and radiation exposure needs careful control.

Franco et al. investigate the application of cheiloscopy in forensic dentistry to detect sexual dimorphism, highlighting its wide variations and heterogeneity.¹⁴

Mohammed et al. emphasize the critical role of dental forensics in locating human remains, particularly in bioterrorism and large-scale disasters.¹⁵

Another study focuses on the use of wisdom teeth to determine age, contrasting the precision of age estimation made by Demirjian staging and the use of mandibular wisdom teeth.¹⁶ Overall, forensic odontology research provides valuable insights into the role of dental forensics in human identification.

Practitioners may be hesitant to adopt new techniques due to a lack of standardized procedures and guidelines, and the forensic sciences can be conservative, leading to moral and legal concerns. Those accustomed to existing methods may reject new methods.

4. Limitation of Forensic Odontology

Forensic dentistry, despite its crucial role in the identification of individuals and resolution of criminal cases, grapples with various drawbacks and challenges that warrant careful consideration. One significant issue lies in the limitations of bite mark analysis, which has

faced criticism for its subjective nature and lack of standardization. The interpretative process of bite marks is susceptible to the examiner's experience, potentially leading to errors. Another challenge involves inconsistent record-keeping practices, where incomplete or inconsistent dental records can impede the identification process by limiting available information for comparison. Postmortem changes in dental structures, such as decomposition and modifications, pose difficulties in establishing accurate dental profiles for identification. The absence of universally accepted protocols and guidelines for forensic dental examinations contributes to inconsistencies and variations in practices among different forensic experts. Additionally, ethical concerns and legal challenges arise, particularly in cases of mass disasters, where the pressure to swiftly identify victims may conflict with the necessity for thorough and accurate examinations. Despite these drawbacks, ongoing research and advancements in forensic dentistry aim to address these challenges and enhance the reliability of dental evidence in forensic investigations.

5. Conclusion

In conclusion, by using dental DNA, reconstructive identification techniques, comparative identification, and other methods, forensic dentistry supports legal procedures and aids in human identification. The capacity to extract DNA from the mouth cavity increases the accuracy of identification, and developments in procedures like rugoscopy and cheiloscopy further boost its capabilities. While the initial findings emphasise the value of forensic dentistry for human identification, such as the application of dental documents and DNA, CBCT, and bite marks analysis, the additional texts offer complementary insights into particular facets of forensic dentistry, including the use of CBCT in forensic investigations and the determination of dental age through wisdom teeth analysis.

Collectively, these texts show how the discipline of forensic dentistry is diverse and constantly developing. It depends on the strength of the study, the applicability of the methodologies, the likelihood that they will enhance the precision and effectiveness of forensic investigations and whether the conclusions of the texts under review should be applied to forensic field practice. Before being included in accepted forensic practice, each novel approach or procedure must undergo thorough validation and testing to guarantee its dependability and efficacy in practical situations.

The unique requirements of the case, the accessibility of assets, and the potential effects on the precision and effectiveness of the investigation should all be taken into consideration when choosing a technique in forensic science. Each method has advantages and disadvantages, and forensic experts must carefully take these things into account when deciding which strategy is best for

a certain situation. Research evidence integration into forensic practice is a complex process driven by a mix of enablers and barriers. It frequently takes a team effort from forensic science investigators, practitioners, policymakers, and organizations to overcome these obstacles. Translation of research findings into real- world, everyday forensic applications require efficient distribution of evidence-based research, standardization of practices, and budget allocation.

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7. Conflict of Interest

None.

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