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Forensic Dentistry

ROLE OF FORENSIC ODONTOLOGY AND ANTHROPOLOGY IN THE IDENTIFICATION OF HUMAN REMAINS: A CONTEMPORARY STUDY

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ABSTRACT Forensic odontology and anthropology are indispensable disciplines in the identification of human remains,particularly in mass disaster scenarios (e.g., aviation accidents, tsunamis, wildfires) and criminal investigations (e.g., homicide, abuse) where remains may be fragmentary or degraded. These fields facilitate the estimation of key biological parameters—age, sex, stature, and ancestry—through the analysis of dental features, craniofacial structures, and skeletal elements. Modalities include comparative dental analysis, radiographic imaging, bite mark assessment, cheiloscopy, rugoscopy, and dental DNA profiling. This review synthesizes the established and emerging methodologies in human identification. Recent technological advancements, particularly the integration of 3D imaging like cone-beam computed tomography (CBCT) and automated comparison software, have significantly enhanced the accuracy and efficiency of matching antemortem and postmortem records

KEYWORDS : Forensic Odontology, Anthropology, Cone-Beam Computed Tomography (CBCT), Bite Mark Assessment.

INTRODUCTION

The identification of human remains is a fundamental humanitarian and legal imperative.While fingerprints remain a gold standard, they are often unavailable in severely compromised remains. Consequently, the role of forensic odontology (the application of dental knowledge to legal matters) and forensic anthropology (the analysis of skeletal remains) has become increasingly critical. The term "forensic" derives from the Latin forensis, meaning "of or before the forum," reflecting its roots in public debate and legal proceedings [1]. Together, these disciplines provide a robust framework for establishing identity and contributing to the resolution of medicolegal cases. This article reviews the contemporary role and recent advancements in forensic odontology and anthropology for the identification of human remains.

DISCUSSION

Forensic Odontology

Formally recognized since Dr.Oscar Amoedo's work following the 1898 Paris fire, forensic odontology is defined by the FDI World Dental Federation as "that branch of dentistry which, in the interest of justice, deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings" [2]. Its applications are broadly categorized into civil (e.g., mass disaster victim identification (DVI), age estimation), criminal (e.g., bite mark analysis), and research domains [3]. The oral cavity provides a durable source of data through tooth morphology, restorations, root canal therapy, unique bone patterns, and prostheses, all of which are routinely documented by dental practitioners, creating valuable antemortem records.

Forensic Anthropology

Forensic anthropology is the application of biological anthropology to legal contexts.It focuses primarily on the analysis of skeletal remains to establish a biological profile (age, sex, stature, ancestry), interpret trauma, estimate time since death, and occasionally identify individualizing characteristics [4]. Techniques range from macroscopic morphological analysis to advanced imaging and chemical analysis of bones. Craniofacial superimposition and facial approximation (facial reconstruction) are specialized sub-disciplines that bridge anthropology and odontology.

Synergistic Identification Of Human Remains

The integration of odontological and anthropological methods creates a powerful tool for identification.The process typically involves:

1. Recovery and Preservation: Meticulous documentation of the scene and remains.
2. Postmortem Examination: Detailed recording of all dental and skeletal features.
3. Antemortem Data Collection: Retrieving dental records, medical radiographs, and photographs of the missing individual.
4. Comparison: A systematic analysis to find consistencies and explain any discrepancies between postmortem and antemortem data.
5. Reconciliation and Reporting: Formulating a conclusion regarding the identity.

The American Board of Forensic Odontology (ABFO) outlines standardized conclusions for dental identifications, as shown in Table 1 [5].

Establishing the Biological Profile

1. Age Estimation

- Age estimation is vital for narrowing the pool of potential matches. Techniques are multidisciplinary and vary by age group, as summarized in Table 2.
- Recent studies have refined these methods using panoramic radiographs and CBCT [6, 7].

2. Sex Determination

While the pelvis is the most reliable skeletal indicator,the skull and teeth provide key features. Dentally, sex can be inferred through morphometric analysis and DNA analysis. The amplification of sex-specific markers (AMELX/AMELY genes) via polymerase chain reaction (PCR) from dental pulp is now a highly reliable standard technique, even in degraded remains [8].

3. Stature Estimation

Stature is most accurately estimated from long bones using regression formulae.While teeth have a poor correlation with height, studies have explored using craniofacial measurements as supplementary indicators when long bones are absent, though with limited reliability [9].

4. Ancestry Estimation

Ancestry(often referred to as "race" in older literature) is estimated from cranial and dental morphology. It is crucial to recognize that these are population-level trends with significant intragroup variation, and conclusions must be stated probabilistically [10]. Key features are outlined in Table 3.

Methods of Human Identification

1. Comparative Dental Analysis

This is the cornerstone of forensic odontology.It involves a point-by-point comparison of antemortem dental records (charts, radiographs, models) with postmortem findings. Unique features like root canal morphology, implant design, and unusual restoration shapes are highly discriminatory.

2. Radiographs and Advanced Imaging

- CBCT: This technology has revolutionized forensic dentistry. It provides high-resolution 3D images with lower radiation than medical CT, allowing for exquisite detail of dental structures, sinus morphology, and even soft tissue thickness for facial

approximation [11].

- MSCT: Multi-Slice CT is invaluable in mass disaster scenarios for triaging remains and visualizing structures within intact bodies.

3. Bite Mark Analysis

The analysis of patterned injuries suspected to be caused by teeth remains one of the most complex and debated areas.The ABFO provides guidelines for documentation. Its application is now more conservative, often used only for exclusion rather than for positive identification due to questions about its scientific validity and subjectivity [12].

4. Cheiloscopy (Lip Print Analysis)

The study of lip grooves is based on their presumed uniqueness. Patterns are classified per Tsuchihashi's system, as shown in Table 4 [13]. Recent research focuses on digital pattern recognition algorithms to improve objectivity [14].

5. Rugoscopy (Palatal Rugae Analysis)

The ridges on the anterior palate are protected and resilient.Their patterns are unique and stable. Classifications by Lysell categorize them by shape and length, making them particularly useful in edentulous victims [15]. Digital models from intraoral scans and CBCT have made rugae comparison more efficient.

6. Dental DNA Analysis

Teeth are an excellent source of DNA,protected by enamel and dentin. Mitochondrial DNA (mtDNA) is ideal for analyzing degraded samples and identifying remains through maternal kinship. Nuclear DNA from pulp is used for direct identification and sex determination.

CONCLUSION

Forensic odontology and anthropology provide a critical,often last-resort, pathway to identity for the deceased. While traditional methods of morphological comparison remain foundational, the field is being transformed by technology. The adoption of CBCT, digital impression scanning, and automated comparison software has increased objectivity, speed, and the statistical weight of identification conclusions. Furthermore, DNA analysis provides a powerful molecular tool that can corroborate dental findings or serve as the primary identifier. For these disciplines to be most effective, the dental community must prioritize the creation of detailed, long-lasting, and retrievable antemortem records. Continued research, standardization of methods, and the development of robust population databases are essential for the future of human identification.

Table 1: Standardized Conclusions for Dental Identification (ABFO)

Conclusion	Description
Positive Identification	The antemortem and postmortem data are in sufficient agreement, with no unexplainable discrepancies.
Possible Identification	The antemortem and postmortem data share consistent features, but the quality is insufficient for a positive conclusion.
Insufficient Evidence	The available information is lacking to form a definitive conclusion.
Exclusion	The antemortem and postmortem data are clearly inconsistent.

Table 2: Age Estimation Methods Based on Dental Development

Age group	Primary method	Keywords indicators
Fetal to Newborn	Histology & Radiography	Presence of neonatal line, mineralization stages of tooth crowns.
Children & Adolescents	Radiographic (Panoramic/CBCT)	Tooth eruption sequence and stages of tooth calcification (e.g., Demirjian's method).
Adults	Radiographic & Histological	Gustafson's method (historical), root dentin transparency, secondary dentin deposition, cementum annulation, pulp-to-tooth volume ratio (via CBCT).

Table 3: Craniofacial and Dental Features Associated with Ancestral Groups

Feature	Caucasoid (European)	Mongoloid (Asian)	Negroid (African)
Skull Shape	Dolichocephalic (long)	Brachycephalic (round)	Dolichocephalic (long)
Nasal	Aperture	Narrow & high	Moderate Wide & low
Facial	Prognathism	Minimal	Minimal Prominent
Incisor	Shape	Spatulate	Shovel-shaped Spatulate

Table 4: Tsuchihashi's Classification of Lip Patterns

Type	Description
Type -I	Clear-cut vertical grooves running across the entire lip.
Type -I'	Similar to Type I but not covering the entire lip.
Type-II	Branched grooves.
Type-III	Intersected grooves.
Type-IV	Reticular pattern
Type-V	Grooves that do not fall into any other pattern.

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REFERENCES

1. Pretty IA, Sweet D. A look at forensic dentistry--Part 1: The role of teeth in the determination of human identity. Br Dent J. 2001;190(7):359-366.
2. FDI World Dental Federation. Recommendations for the Use of Forensic Odontology in DVI. 2018.
3. Avon SL. Forensic odontology: the roles and responsibilities of the dentist. J Can Dent Assoc. 2004;70(7):453-458.
4. Ubelaker DH. A history of forensic anthropology. Am J Phys Anthropol. 2018;165(4):915-923.
5. American Board of Forensic Odontology. ABFO Standards and Guidelines for Evaluating Dental Identifications. 2018.
6. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol. 1973;45(2):211-227.
7. Marroquin TY, Karkhanis S, Kvaal SI, et al. Age estimation in adults by dental imaging assessment systematic review. Forensic Sci Int. 2017;275:203-211.
8. Pilli E, Zampetti C, Giachetti C, et al. A novel method for sex estimation from tooth pulp using real-time PCR. J Forensic Sci. 2020;65(2):460-465.
9. Prabhu S, Acharya AB, Muddapur MV. Are teeth useful in estimating stature? J Forensic Leg Med. 2013;20(5):460-464.
10. Klales AR (ed.). Statistical Outline of Human Variation: A Companion to the Forensic Anthropology Manual. Springer; 2020.
11. Hwang HS, Park MK, Lee WJ, et al. Facial soft tissue thickness database for craniofacial reconstruction in Korean adults. J Forensic Sci. 2012;57(6):1442-1447.
12. National Academy of Sciences. Strengthening Forensic Science in the United States: A Path Forward. The National Academies Press; 2009.
13. Tsuchihashi Y. Studies on personal identification by means of lip prints. Forensic Sci. 1974;3(3):233-248.
14. Vats Y, Dhall JK, Kapoor A. Automation in cheiloscopy: A novel approach to lip print identification. Int J Forensic Sci. 2022;7(1):100064.
15. Thomas CJ, Kotze TJ. The palatal ruga pattern: a new classification. J Dent Assoc S Afr. 1983;38(3):153-157.