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EDITORIAL

Forensic Dentistry in Human Identification: From 2D Records to Artificial Intelligence

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Forensic dentistry plays a crucial role in human identification, especially in cases where traditional identifiers, such as fingerprints or facial features, are absent. Teeth and dental structures are highly resistant to post-mortem alterations and display notable individual variability, rendering them valuable biological indicators (1). Amid the continuous digital transformation in dentistry, forensic odontology is progressively incorporating advanced imaging technologies and computational tools, thereby broadening its scope beyond conventional methods.

Conventional two-dimensional (2D) dental records continue to serve as the fundamental basis for forensic dental identification. Intraoral photographs, dental charts, and radiographs facilitate the comparison of restorations, tooth morphology, developmental stages, and pathological findings (2). These records are habitually produced during dental procedures and are readily accessible, thereby increasing their practical utility in forensic investigations. Despite technological advancements, two-dimensional records remain a dependable and accessible foundation for comparative identification.

The application of 3D technologies has enhanced forensic dental analysis. Intraoral, cone-beam, and surface scanners provide realistic digital models of the teeth and jaws (3). Compared to 2D data, 3D files allow for volumetric, geographic, and tooth form inspection. Digital models promote documentation, reproducibility, and interdisciplinary collaboration by allowing for storage, sharing, and re-analysis without physical manipulation (4). Three-dimensional approaches allow for tooth volume assessment, virtual superimposition, and digital reconstruction in forensics. These methods are useful for fragmented remains or partial dentition, when traditional comparisons may be limited. Visualizing and analyzing dental features in 3D can help students understand complex anatomy and forensic contexts.

Artificial intelligence (AI) is now emerging as an additional analytical layer in forensic dentistry. Machine learning algorithms can assist in recognizing patterns, automating measurements, and supporting predictive analyses based on dental features. Applications, such as age estimation, sex prediction, and population-based assessment, have demonstrated the potential of AI when applied to dental datasets (5). When combined with 2D and 3D information, AI can streamline workflows and highlight subtle features that may not be readily apparent through manual evaluation. Importantly, AI is best viewed as a supportive tool rather than a replacement for forensic expertise. Human interpretation remains central to forensic conclusions, while AI enhances efficiency and consistency by handling large volumes of data. The integration of clinical judgement with digital imaging and computational analysis reflects a balanced and pragmatic approach to modern forensic dentistry (6).

The convergence of 2D records, 3D imaging, and AI highlights the ongoing evolution of forensic dentistry into a technologically enriched and multidisciplinary field. Increasing availability of affordable imaging

systems and open-source software has also improved accessibility, enabling wider adoption of digital forensic methods across institutions and regions. This accessibility supports research development, capacity building, and standardization of practices (7).

In conclusion, forensic dentistry adapts to technology while maintaining its principles. The employment of 2D documentation, 3D digital analysis, and AI for human identification is progressive and complementary. These integrated techniques should improve accuracy, documentation, and educational engagement, bolstering forensic dentistry's relevance in modern forensic science.

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