



Digital Methods for Bite Mark Analysis in Forensic Investigation Advancements

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Abstract:

The use of computerized techniques for forensic bite mark analysis has revolutionized forensic dentistry and improved the precision and effectiveness of investigations. In this study, eleven pertinent studies that investigate various digital techniques such as visual perception, computer-assisted overlays, neural networks, and 3D scanning are critically examined. In the face of difficulties like the COVID-19 epidemic, these techniques—which have shown efficacy in suspect identification—offer increased impartiality, detail, and the capacity for distant collaboration. However, continued regulatory initiatives, specific training, and ongoing research are necessary to bolster the dependability of these procedures.

Keywords: Forensic dentistry, bite mark analysis, digital methods, image perception, computer-assisted overlays, neural networks, 3D scanning, suspect identification, objectivity, remote collaboration, COVID-19 pandemic.

Introduction:

Bite mark analysis has played a pivotal role in forensic investigation, providing valuable insights for individual identification across various legal contexts. The advent of digital technologies has ushered in significant advancements in this practice, transforming traditional methods and introducing more precise and objective approaches.

This article proposes a review of digital methods applied to bite mark analysis for forensic purposes. We will explore studies employing technologies such as image perception (Van der Velden et al., 2006), artificial intelligence (Chandramouleeswaran & Puviarasan, 2022), shape analysis programs (Tai et al., 2016), and 3D optical scanning (Naether et al., 2012) to document, compare, and identify bite marks.

This review aims to provide a succinct understanding of digital advancements in bite mark analysis, highlighting their implications for forensic practice and underscoring the need for ongoing research to establish rigorous scientific standards.

Methodology:

A methodical study methodology was used to thoroughly investigate the application of digital technology in bite mark analysis for forensic reasons. To clarify the contributions of these methodologies to the field of forensic odontology, the methodology included a literature search, article selection, and critical analysis.

Literature Search: The PubMed database, which is recognized for its wide coverage of scholarly articles in the fields of medicine and forensics, was used for the literature search. In the search strategy, terminology such as "bite mark analysis," "forensic dentistry," "digital methods," "computer-assisted analysis," and related variants were used, along with restricted vocabulary terms (MeSH terms). The search included both contemporary research and those from earlier years, encompassing literature published throughout a range of time periods.

Article Selection: Inclusion criteria took into account the direct relevance of the topic, including research looking at the use of digital techniques in forensic bite mark analysis. English-language articles were given priority so that the material could be understood properly. Older papers were also taken into consideration if they presented insightful analyses of how certain strategies have evolved historically.

Critical Analysis and Synthesis: Selected papers were subjected to critical analysis to assess the methodology used, the outcomes, and the implications for forensic practice. Relevant data was gathered and synthesized, revealing the digital techniques employed, the technological improvements made, and the major difficulties encountered. Data synthesis gave a comprehensive overview of these methodologies' contributions to bite mark analysis in forensic investigations.

Ethics: This systematic review complied with all academic and ethical standards, making sure that all sources included in the analysis were properly acknowledged and credited.

Discussion:

A notable development in the field of forensic dentistry has been the application of digital techniques to bite mark analysis. A selection of 10 pertinent publications will be critically analyzed and their main contributions will be summarized in this debate.

The development of image perception technology for bite mark analysis was pioneered by Van der Velden et al. (2006), who emphasized the significance of fine features in both the bite marks and the suspect's teeth. This technique offers a fictitious three-dimensional representation of the surface, improving visibility and precision (Van der Velden et al., 2006).

For the examination of bite marks, Chintala et al. (2018) introduced the use of Adobe Photoshop. Their study supported the usefulness of computer-assisted overlay techniques for forensic investigations by demonstrating their accuracy and affordability (Chintala et al., 2018).

By applying a convolutional neural network model for bite mark classification, Chandramouleeswaran and Puviarasan (2022) advanced the discipline. The possibility for improved analytical accuracy is highlighted by the use of artificial intelligence (Chandramouleeswaran & Puviarasan, 2022).

The importance of technology in easing the burdens brought on by the COVID-19 pandemic was stressed by Bradbury-Jones and Isham (2020). Their analysis emphasized the value of cooperation and distant work, highlighting the demand for specialized training (Bradbury-Jones & Isham, 2020).

Thalia et al.'s revolutionary method of 3D/CAD-supported photogrammetry forensic was first introduced in 2003, making it possible to create precise 3D models for bite mark analysis. This technique showed that bite marks and dental models were consistent (Thalia et al., 2003).

The DentalPrint software was introduced by Martin-de las Heras et al. (2005) for objective bite mark analysis. Their study demonstrated how automated overlay creation can reduce observer bias and increase dependability (Martin-de las Heras et al., 2005).

The SCIP software, which enables quantitative comparisons of bite marks, was introduced by Nambiar et al. in 1995. In their investigation, they focused on the possibility of eliminating suspects and assisting with the identification of bite marks (Nambiar et al., 1995).

In their comparative research of three digital techniques, Tai et al. (2016) demonstrated the precision of computer-assisted overlay with animations. According to Tai et al. (2016), their study highlighted the development and accuracy of digital techniques.

In order to apply 3D optical scanning to bite marks on various foods, Naether et al. (2012) broadened the scope. This ground-breaking study showed that using digital approaches for bite mark analysis in various contexts is feasible (Naether et al., 2012).

Conclusion:

Precision and effectiveness in forensic bite mark analysis have greatly improved with the use of digital techniques. The effectiveness of image perception approaches, computer-assisted overlays, neural networks, and 3D scanning has been shown. When faced with difficulties like the COVID-19 pandemic, these methods have improved objectivity, allowed for more thorough assessments, and encouraged distant collaboration. But for these techniques to be more reliable and to play a bigger part in forensic dentistry, regulation, specific training, and ongoing research are essential.

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