

Commentary

Improving Postmortem Dental Profiling: The Integration of Intraoral Scanners in Dental Autopsies

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ABSTRACT: Forensic odontology plays a crucial role in human identification, particularly in cases where traditional identification methods face challenges such as severe trauma, decomposition, skeletonization, or carbonization. The evolution of digital dentistry has significantly advanced dental autopsies, particularly through the use of intraoral scanners (IOSs). These devices provide a non-invasive and efficient method for capturing detailed impressions of dentition and photographic images of teeth. The benefits of intraoral scanning in analyzing human remains in forensic odontology are endless. Digital impressions can be easily stored, shared, and transmitted electronically, eliminating the need for physical storage or transportation of dental models. This technology also enables remote postmortem dental profiling. By combining digital models with antemortem dental records, forensic odontologists can more efficiently identify matches and discrepancies, with the added benefit of future advancements in artificial intelligence (AI). Intraoral scanning should be considered a routine process in all dental autopsies to improve postmortem dental data collection and archive. Forensic odontologists should be equipped with a portable X-ray device, a digital sensor, and an IOS.

Keywords: Dental autopsy; Dental impression technique; Intraoral scanner; Identification; Forensic dentistry; Patient identification system; Forensic odontology



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1. Introduction

A dental autopsy is the complete collection of postmortem dental data for the purpose of personal identification. It encompasses an external and internal examination of the skull, oral cavity, jaws, teeth, and dental treatments, followed by a photographic collection, with and without a ruler, of teeth, dental arches, and any other relevant and related features and a complete radiologic collection of the jaws, including edentulous areas [1–3]. Data is recorded in the postmortem dental chart of the case and will lead to a report with dental profiling. Dental impressions of jaws are not performed routinely depending on the condition of the remains to be examined, as the use of impression material could alter or even destroy human remains and raise cross-contamination concerns. For this reason, this practice was considered an option to be evaluated case by case. Digital dentistry is undergoing a radical evolution with the use of intra-oral scanners (IOSs) instead of traditional silicon or alginate impressions. Its history dates back to 1973 when Dr. François Duret proposed the idea of optical impressions for application in dentistry [4]. The optical impression made by IOSs is obtained by scanning the dental arch with light projection and a sensor, which transmits the image to software that creates a three-dimensional (3D) representation of the teeth and gingiva. There are numerous benefits of intra-oral scanning compared with conventional impressions. These include improved clinical efficiency, greater patient comfort, and a faster, easier technique compared to traditional physical impressions. [5–7]. Today, an experienced dentist can carry out a full-arch intra-oral scan in less than a minute [8].

All disciplines of dentistry are facing a new era thanks to the use of IOSs with a multitude of advantages, including easier case documentation, particularly useful in dental litigation but also in forensic odontology. The identification of human remains relies on the comparison of primary identifiers—fingerprints, DNA, and dental data—with the equivalent data collected from the families of reported missing persons which include dental records obtained from oral

health professionals. With the advent of intra-oral scanners, the management of both postmortem and antemortem dental data has expanded beyond traditional resources—such as dental charts, intraoral photographs, dental technician certifications, and radiographs—to include 3D data, which can be efficiently archived and utilized for data mining and comparison purposes [9]. While postmortem dental data collection was traditionally avoided due to the risks associated with conventional impressions, the optical, no-touch impressions obtained with intra-oral scanners (IOS) can now be regarded as an essential component of a dental autopsy, alongside comprehensive X-ray imaging of the jaws and teeth [10]. The benefits of intra-oral scanning in the human identification process are endless and have already been explored [11–15]. Considering its application in dental autopsies of human remains, as well as the growing volume of antemortem dental data, it is notable that over 75% of dentists currently use intra-oral scanners (IOS) daily in their practice, a figure that is expected to increase in the near future [8]. The scope of this communication is to highlight the benefits of intraoral scanning in order to become a prerequisite of dental autopsies, similar to dental radiology.

2. Benefits of Intraoral Scanning

2.1. Dental Autopsies

The use of IOSs in dental autopsies offers several advantages that can significantly enhance the practice of forensic odontology. One key benefit is the ease of use and storage of digital impressions and repeatable comparisons between ante-mortem and postmortem data. Unlike conventional impressions, digital impressions can be easily stored electronically, eliminating the need for physical storage and allowing for easy worldwide sharing. This enables collaboration among forensic odontologists across different locations, including the opportunity for remote second expert opinions from odontologists of the same presumed nationality as the unidentified human remains [16]. This remote capability can greatly facilitate the identification process, especially in cases where on-site examination is challenging or not feasible. Another notable advantage is the increased accuracy of digital impressions compared to conventional impressions, as well as the time saved by not having to pour the impression in plaster, allowing a detailed visualization also of dental non-metric traits, like crown features, pits, pigmentations, and ridges, which can be crucial for personal identification.

There is still the option of 3D printing the model in resin if necessary for further analysis or Court presentation purposes. Additionally, the non-invasive nature of intraoral scanners ensures that there is no alteration, damage, or contact with the specimen. This allows for the preservation of the original condition of human remains, which is crucial in forensic investigations. IOSs can also record colors and images and can be used to archive 2D pictures of jaws and teeth for reference. They can also capture other identifying features, such as palatal rugae and empty alveoli resulting from teeth lost postmortem. This comprehensive data collection expands the possibilities for identification and strengthens forensic analysis.

2.2. Missing Persons Database

The integration of intraoral scans with electronic health records (EHRs) allows for a more streamlined and comprehensive approach to dental care. It enables the tracking of dental health over time, offering the potential to identify patterns or changes that may indicate broader health issues. Another benefit is the accessibility of dental information for forensic investigations related to the identification of missing persons.

Intraoral scanners provide detailed and accurate 3D representations of the oral cavity and capture all distinctive dental treatments and dental features, including crown morphology and palatal rugae. Even in the absence of dental treatments, these features can provide unique identifiers for an individual. The use of intraoral scanning offers dental clinics a method of dental record-keeping which is extremely useful for treating patients and potential medicolegal complaints, as it allows an objective documentation of the oral condition of the patient prior to any intervention. These 3D scans are of pivotal importance when families of missing persons or authorities contact dentists for the purpose of collecting antemortem dental data. The true potential benefit of intraoral scanning lies in its potential to contribute to a centralized, digital database of dental records. By comparing antemortem scans with postmortem dental remains, forensic odontologists can efficiently narrow down potential matches, thereby significantly reducing the time and resources required for identification. Antemortem dental information can be quickly and easily shared across different agencies and geographical locations, expediting the identification process and enabling more reliable odontogram recording, independent of the language used by the dentists [17,18].

This improves the efficiency of dental record-keeping and the management of dental data for forensic investigations. Dental practitioners contacted by the families of missing persons, forensic odontologists, or law

enforcement can easily share dental records, including intraoral scan files, which are typically in Standard Triangle Language (STL) format and can be read with any 3D software.

3. Discussion

Not all intra-oral scanners have the same level of accuracy or are capable of scanning edentulous arches, so the IOS selected for a dental autopsy should be carefully evaluated. Odontologists must also be aware that, although this device is easy to use, the procedure still requires proper training and practice. . However, scanning has already been made easier than ever before thanks to artificial intelligence (AI), which guides the operator and removes artefacts. New scanning protocols offered by some companies also allow sharing the 3D scanned images on a cloud to allow patients to be more involved in their oral health awareness. This feature allows for overcoming the potential limitations of storing and transmitting large files. It could also be used to involve forensic odontologists from other Countries and request a second expert opinion and a remote assessment, as proposed by the *viridentopsy* [19].

The 3D scanning of human remains should become part of the postmortem dental examination and collection, and we must expect more advancements in AI and identification through superimposition of dental, skull and facial features [20,21]. The evolution of digital dentistry is also providing a promising future for forensic odontology, creating new opportunities in the collection and integration of patients' dental records more than ever before, confirming the pivotal role of dental data in human identification and the distinct advantages over alternative identification methods, namely its timeliness, efficiency, and cost-effectiveness. Unlike physical dental models, digital files do not undergo physical deterioration and can be easily duplicated and transferred without risk of damage. This can also support the creation of a digital database of dental records as a source of antemortem dental data.

Comparing 2D (traditional dental radiographs and photographs) and 3D data (obtained via intraoral scanners) presents some technical and methodological challenges, as current available software programs may not be fully compatible. Advanced image processing tools will undoubtedly enhance the ability to measure and compare anatomical features in both 2D and 3D, provided that forensic odontologists will continue to visually interpret the similarities and differences between the datasets, in addition to using qualitative and quantitative analysis software.

Looking into the future of forensic odontology, every forensic odontologist should be equipped not only with a portable X-ray device coupled with a digital sensor and a laptop but also with an intra-oral scanner installed in the same laptop.

4. Conclusions

As technology continues to advance, forensic odontologists must invest in digital dentistry to improve the practice of forensic odontology further and be equipped not only with a portable X-ray device coupled with a digital sensor but also with an IOS. In the past decade, significant advancements have emerged in the field of digital dentistry, driven by the introduction of artificial intelligence (AI) diagnostics, intraoral scanning, 3D printing, and computer-aided design/computer-aided manufacturing (CAD/CAM) software. These technological breakthroughs also have a transformative impact on the practice of forensic odontology, particularly due to their non-invasive nature. The use of intraoral scanners in dental autopsies has become essential, as they allow for the collection, storage, transmission, and comparison of dental data. This technology is transforming the process of dental profiling for unidentified human remains, aiding both presumptive and definitive identification. For this reason, IOS should be considered a routine process and a prerequisite in all dental autopsies.

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Declaration of Competing Interest

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