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Virdentopsy in Forensic Odontology: Current Concepts, Practical Workflow, and Future Directions

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Abstract: Background: Virdentopsy is a dental-focused extension of virtopsy that enables remote collection, transmission, and expert interpretation of post-mortem dental data when on-site forensic odontologists are unavailable. **Objective:** This narrative review summarizes the current concepts, workflow, advantages, limitations, and implementation barriers of virdentopsy in forensic odontology and disaster victim identification (DVI). **Review Approach:** Relevant literature on virtopsy, virdentopsy, teledentistry, forensic imaging, and digital dental identification published up to 2025 was narratively reviewed from major biomedical and forensic sources. Because this is a narrative review, no formal quality-scoring tool or quantitative meta-analysis was applied. **Results:** The available literature shows that remote dental evaluation can be supported by grouped digital inputs, including imaging (intraoral radiographs, panoramic imaging, CT/CBCT), photography (2D intraoral and extraoral images), scanning (photogrammetry, intraoral scanning, 3D surface capture), and communication tools (video review and live streaming). These methods can strengthen documentation, facilitate remote expert consultation, and support humanitarian identification work. However, the evidence remains heterogeneous and is limited by variable infrastructure, image quality, chain-of-custody requirements, and uneven legal readiness across jurisdictions. **Conclusion:** Virdentopsy is a promising but still evolving forensic workflow. It is best viewed as an adjunct to established dental autopsy practice rather than a universal replacement. Standardized capture protocols, secure data transfer, training, and validation studies are required before broad routine implementation.

Key Words: Virdentopsy, Virtopsy, Forensic Odontology, Disaster Victim Identification, Teledentistry, Photogrammetry, 3D Scanning, CT/MRI

INTRODUCTION

Human identification relies on the comparison of post-mortem and ante-mortem data, with dental evidence remaining one of the primary identifiers alongside fingerprints and DNA [1,2]. In many real-world settings, however, timely forensic odontological expertise is not available at the examination site. This shortage can delay the creation of a detailed dental profile, especially in DVI operations, humanitarian investigations, and cross-border identification efforts [3].

Virtopsy refers to whole-body, minimally invasive post-mortem examination using imaging modalities such as computed tomography, magnetic resonance imaging, and three-dimensional surface documentation [4-6]. Virdentopsy should be distinguished from virtopsy: it is a dental-focused remote workflow that applies digital capture and teleconsultation principles to teeth, jaws, and craniofacial structures for forensic odontology purposes [7]. This distinction is important because the evidentiary targets, technical requirements, and operator skill sets are not identical.

The current interest in virdentopsy has been driven by three intersecting needs: reduced dependence on invasive procedures, faster access to remote specialist input, and more standardized digital documentation that can be stored, re-reviewed, and shared securely [8,9]. At the same time, digital evidence must satisfy practical concerns related to authenticity, chain of custody, quality assurance, privacy, and legal admissibility. These issues make virdentopsy a promising but methodologically demanding field.

Objectives

- To describe the concept of virdentopsy and differentiate it from whole-body virtopsy

- To summarize the currently reported digital tools, workflows, and forensic applications relevant to remote dental post-mortem assessment
- To critically discuss current evidence, operational barriers, legal-ethical concerns, and future directions for implementation

Narrative Review Approach

This manuscript is presented as a narrative review. For transparency, the revised version was structured around literature relevant to forensic odontology, virtopsy, teledentistry, digital post-mortem documentation, and DVI workflows [7,9,11-16]. Sources published up to 2025 were considered from indexed biomedical databases, forensic journals, and major publisher platforms. Articles were selected for conceptual relevance to remote dental documentation, human identification, and digital forensic workflow. No formal PRISMA flowchart or study quality appraisal tool was applied; therefore, the conclusions should be interpreted as a narrative synthesis rather than graded evidence.

From Virtopsy to Virdentopsy

Virtopsy was introduced as a non-invasive alternative to conventional autopsy and has been supported by CT, MRI, photogrammetry, and optical scanning [4-6,17]. Its major strengths include preservation of body integrity, permanent digital archiving, and the ability to review findings repeatedly [5-6]. Virdentopsy extends these principles to forensic odontology by enabling remote expert analysis of dental and craniofacial data obtained on site by local teams [7].

The dental component is especially important because forensic dental autopsy is not equivalent to routine clinical examination. Restorations, implants, endodontic treatment, tooth morphology, prostheses, and jaw relationships must be recorded in a way that is compatible with forensic interpretation and, where applicable, DVI coding systems such as INTERPOL dental descriptors [2,18]. In this context, remote collection does not remove the need for expertise; rather, it redistributes it by separating data capture from expert interpretation [7,18].

Suggested Virdentopsy Workflow in DVI and Single-Body Cases

- **Step 1:** Structured on-site capture of dental arches, jaws, radiographs, and surrounding craniofacial structures using predefined protocols
- **Step 2:** Quality-control screening for completeness, labeling, image resolution, orientation, file integrity, and correspondence between image sets and case identifiers
- **Step 3:** Secure transfer of files to remote forensic odontologists using auditable platforms with controlled access
- **Step 4:** Remote forensic interpretation, generation of a dental profile, and reporting for comparison with ante-mortem information
- **Step 5:** Archiving of original files, review logs, and final interpretations to preserve traceability and support legal scrutiny

Digital Tools and their Forensic Role

Evidence, Opportunities, and Current Limitations: The published literature supports the conceptual feasibility of remote dental post-mortem evaluation, but the evidence base is still dominated by narrative reviews, technical descriptions, pilot applications, and conceptual workflow papers rather than large comparative validation studies [7-9,12-14]. This means that the field is promising, but not yet uniformly standardized or routine in all jurisdictions [15-16].

Reported advantages include preservation of evidence, remote collaboration across regions or countries, support in settings without on-site forensic odontologists, and the possibility of re-evaluation of stored digital files. These features are especially relevant in humanitarian forensic work, mass fatality incidents, and cases involving foreign nationals or unidentified migrants [3,7,11,15].

However, several limitations are repeatedly noted. Dental data can be degraded by burning, decomposition, fragmentation, metal artefacts, incomplete views, or poor image quality. Smartphone-based accessibility is attractive, but it does not eliminate the need for standardized angles, adequate illumination, minimum resolution, correct labeling, and secure transfer [8,19]. In legal settings, digital evidence may be challenged if metadata, operator identity, audit trails, or authenticity safeguards are incomplete [10] (Table 1).

Legal, Ethical, and Operational Considerations

For practical adoption, virdentopsy must be more than a technological idea; it requires governance. Digital evidence should be captured with case identifiers, time stamps where

Table 1: Summary of Digital Components Commonly Discussed in Virdentopsy Workflows [4-5,7-9,13-14,18-19]

Category	Examples	Practical role	Key limitations
Imaging	Periapical radiographs, panoramic imaging, CT/CBCT	Documents restorations, root fillings, implants, sinus and jaw relations, and supports comparison with ante-mortem radiographs	Metal artefacts, limited access to equipment, cost, and the need for proper labeling and calibration
Photography	2D intraoral/external photographs, smartphone capture, video	Rapid, accessible documentation of dentition, soft tissues, prostheses, and scene-linked findings	Lighting, distortion, focus errors, inconsistent angulation, and poor color standardization
Scanning	Photogrammetry, intraoral scanning, 3D surface scanning	Creates re-reviewable digital surface models and may improve documentation of dental arches and jaw morphology	Requires training, compatible formats, and can be affected by fragmented, burned, or contaminated remains
Communication	Secure upload portals, live streaming, remote consultation	Allows expert oversight, second opinions, and faster access to forensic odontology input	Bandwidth limitations, privacy risks, chain-of-custody concerns, and variable legal readiness

possible, access control, and documented transfer pathways. The forensic value of digital files depends not only on image content but also on authenticity, traceability, and expert verification [10].

Ethical issues include respectful handling of post-mortem data, jurisdiction-specific rules for post-mortem imaging and consultation, and protection against unauthorized dissemination of identifiable material. Equity is another concern: high-end imaging and storage infrastructure may be concentrated in well-funded centers, potentially widening disparities in forensic access unless scalable minimum-data protocols are [10,11].

Operational barriers include cost of imaging hardware, internet connectivity, secure storage, software compatibility, and training of local operators. Training should include not only device handling but also evidence labeling, required views, basic radiographic principles, quality checking, and communication with remote forensic odonatologists [7-9].

Practical Minimum Dataset for Field Use

- Case identifier on every image set and accompanying documentation
- High-resolution photographs of upper and lower arches, occlusion, and any distinctive prostheses or appliances
- At least basic radiographic documentation where feasible, preferably digital periapical and/or panoramic images, with DICOM retention for advanced imaging [18]
- 3D surface capture or photogrammetry when available for fragmented or complex craniofacial structures
- A capture log documenting operator, date, modality, file format, and any technical limitations [14]

Limitations of the Present Review

This article remains a narrative review and not a systematic review or scoping review with formal screening and quality appraisal. The current literature is heterogeneous, and measurable outcomes such as agreement with conventional dental autopsy, time-to-identification, and failure rates are not consistently reported across studies [18,19]. Accordingly, the present review synthesizes the field conceptually but cannot quantify comparative effectiveness with high certainty.

CONCLUSION

Virdentopsy is a useful and increasingly relevant extension of digital forensic odontology. Its greatest value lies in situations where expert dental input is needed but cannot be delivered on site, particularly in DVI operations, humanitarian identification, and geographically constrained settings. At present, it should be considered an evolving adjunctive workflow rather than a universal substitute for conventional dental autopsy. The next practical steps are clear: define a minimum dataset, standardize training and secure transfer protocols, strengthen chain-of-custody documentation, and generate validation studies that compare digital workflows with conventional forensic dental examination.

Conflict of interest

The authors declare no conflict of interest.

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