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Disaster Victim Identification in Forensic Odontology – A Comprehensive Review

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Abstract:
Disaster Victim Identification (DVI) is a structured forensic process used to identify deceased individuals following mass fatality incidents. Forensic Odontology plays a key role in DVI due to the durability and uniqueness of dental structures and the availability of dental records. This review summarizes the role of dental evidence in identification, including comparative dental analysis, radiographic matching, age estimation, and DNA retrieval from dental tissues. It also outlines the standardized DVI framework established by the International Criminal Police Organization, which includes scene investigation, post-mortem examination, ante-mortem data collection, and reconciliation. The importance of accurate dental record maintenance and the integration of modern technologies such as digital radiography, CBCT, and computer-assisted identification systems are highlighted. Challenges including fragmented remains, absence of ante-mortem records, and cross-border coordination, are also discussed. Lessons from major disasters such as the Indian Ocean tsunami emphasise the importance of standardized protocols and multidisciplinary collaboration. Overall, forensic odontology remains an essential component of modern DVI systems.

I. Introduction

Disaster Victim Identification (DVI) refers to the systematic and scientific process of identifying deceased individuals following mass fatality incidents and represents both a humanitarian and legal responsibility of the forensic community.[1] Mass fatality incidents may arise from natural disasters such as tsunamis, earthquakes, and hurricanes, or from man-made events including airplane crashes, building collapses, and terrorist attacks.In such situations, the condition of remains is often severely compromised due to fragmentation, burning, decomposition, or commingling, rendering visual recognition unreliable.[1] Traditional identification methods such as fingerprinting, radiological comparison, assessment of unique medical features, and dental record analysis require relatively intact remains and available ante-mortem records, which may not always be accessible.[2] Consequently, scientific identification becomes essential, with DNA analysis playing a vital, though not solitary, role in modern DVI.[2]

The multidisciplinary nature of DVI incorporates forensic pathology, forensic odontology, forensic anthropology, fingerprint analysis, radiology, and molecular genetics to ensure accurate identification. Historically, while dental and fingerprint methods formed the backbone of identification procedures, the introduction of DNA typing in incidents such as the 1993 Waco siege and later large-scale disasters significantly transformed identification strategies, particularly in cases involving highly fragmented and degraded remains. [3] These advancements have established DNA analysis as a cornerstone of contemporary DVI, functioning alongside traditional forensic disciplines to achieve reliable and dignified identification of disaster victims.[3]

Evolution of Forensic Odontology in Mass Disasters

Forensic odontology's involvement in mass disasters has evolved considerably over time, transitioning from early descriptive uses of dental evidence to structured, internationally standardized practices. Dental identification was first widely recognized as a reliable tool in large-scale fatality events in the mid-20th century, with radiographic comparison applied as early as the 1949 *Noronic* liner disaster in Canada, where comparative dental radiography helped identify victims when other methods failed. [4] Landmark applications during war and aviation disasters, including airline crashes and ferry disasters, further demonstrated the value of dental records in identification, with several studies reporting high identification success rates when robust ante-mortem records were available. [5] Historical mass fatalities such as the 2004 Southeast Asia tsunami highlighted both the potential and limitations of odontological identification, leading to major reevaluations of protocols and practices. [6]

Responsive to these challenges, standardized Disaster Victim Identification (DVI) protocols were developed and refined

internationally. INTERPOL issued its first comprehensive DVI guidelines in 1984, establishing structured phases of identification and sets of forms for collecting and comparing ante-mortem and post-mortem data, with continuous revisions informed by lessons learned from large-scale operations and multi-nation collaborations. [7] As one of the primary identification modalities recognized under these protocols, forensic odontology's role became increasingly formalized, involving trained odontologists in all phases of DVI, from scene response through reconciliation. [8]

International organizations have further contributed to the discipline's evolution. The **International Organization for Forensic Odonto-Stomatology (IOFOS)** provides a global platform for education, standardization, and dissemination of best practices in forensic odontology, including specialized guidance on mass disaster DVI and the integration of advanced imaging and dental data handling into routine workflows. [9] Through these developments, forensic odontology has progressed from ad-hoc case involvement to a critical, standardized component of modern mass disaster identification, bridging traditional dental comparison with emerging technologies and international cooperation.[9]

Principles of Disaster Victim Identification

Disaster Victim Identification (DVI) relies on a combination of primary and secondary methods to achieve scientifically valid identification of deceased individuals in mass fatality events. According to systematic reviews and recent meta-analyses, comparative dental analysis is recognised as one of the core primary identification methods, alongside DNA profiling and fingerprint examination, because it can provide reliable individualisation when ante-mortem records are available. [10,11] Forensic odontology's scientific basis rests on detailed comparison between ante- and post-mortem dental data, including tooth morphology, restorations, radiographic landmarks, and dental anomalies, which are unique to each individual and unlikely to be duplicated even among close relatives. [12] Dental structures' **natural diversity** in shape, size, alignment, wear patterns, and treatment histories further underpins their suitability for identity confirmation, with no two dentitions exhibiting the same characteristics. The **durability of dental tissues and restorations** is another fundamental principle supporting odontology in DVI: teeth and restorative materials such as amalgam, ceramics, and implants are highly resistant to decomposition, heat, and physical trauma, often surviving destructive forces that obliterate soft tissues and fingerprints, making dental evidence accessible even in severely compromised remains. [12] While secondary identifiers such as clothing, personal effects, medical devices, and descriptive information can support identification, they are not sufficient to independently confirm identity without corroboration from one or more primary scientific methods. Collectively, these principles highlight why forensic odontology continues to play a key role in DVI protocols, particularly in scenarios where dental structures provide the strongest and most enduring biological evidence of identity[12]

INTERPOL DVI Protocol and Odontology

INTERPOL establishes the internationally accepted framework for Disaster Victim Identification (DVI) through its Disaster Victim Identification Guide. This protocol structures identification into four sequential and interrelated phases: Scene, Post-mortem (PM), Ante-mortem (AM), and Reconciliation.[13-15]

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DVI Phase	Primary Objective	Role of Forensic Odontology	Key Documentation Tools
1. Scene	Systematic recovery and labelling of remains	Recognition of dental structures; assistance in handling fragmented jaws/teeth	Scene tags, body numbering system
2. Post-mortem (PM)	Detailed examination of remains	Dental charting, radiographs, photography, recording restorations and anomalies	INTERPOL PM Odontology Form, standardized dental codes
3. Ante-mortem (AM)	Collection of dental records of presumed victims	Retrieval and transcription of dental charts, radiographs, treatment history	INTERPOL AM Odontology Form, FDI coding system
4. Reconciliation	Comparison of AM and PM data for identification	Comparative dental analysis; confirmation of concordant features	Reconciliation reports, identification board documentation

Table 1: *INTERPOL DVI Phases and Role of Forensic Odontology*

Role of Dental Evidence in DVI

Forensic odontology contributes significantly to Disaster Victim Identification (DVI) due to the durability and individuality of dental tissues, radiographic anatomical landmarks, and the availability of ante-mortem dental data. Dental evidence provides reliable biological information even in severely compromised remains and is routinely incorporated into standardized DVI protocols such as those recommended by INTERPOL.[16]

Comparative Dental Identification

Comparative dental identification remains one of the most frequently used primary methods in DVI. It involves systematic **ante-mortem (AM) and post-mortem (PM) record comparison**, where dental charts, radiographs, and treatment records are matched to establish concordant features unique to an individual.

AM and PM record comparison:

Forensic odontologists compare dental charts, clinical notes, dental radiographs, and photographic images from dental records with PM findings. Concordance in tooth morphology, restorations, prosthetic work, and unique anomalies contributes to identification. The method is especially useful when fingerprints and soft tissues are unavailable due to decomposition or trauma. The standardised use of FDI dental notation enhances consistency in comparison across international DVI teams.[17]

Radiographic matching:

Radiographs provide internal structural markers such as pulp chamber shape, root morphology, trabecular bone patterns, sinus outlines, and endodontic treatments. These features are highly distinctive and less prone to post-mortem alteration, making radiographic comparison a cornerstone of dental identification. High-resolution imaging such as digital panoramic and periapical radiographs increases accuracy in matching.[18]

Restorative and prosthetic markers:

Restorations, crowns, bridges, implants, and orthodontic appliances often contain material-specific characteristics such as shape, brand-related design, and placement pattern. These features add significant discriminatory value and improve confidence in identification, especially in populations with extensive dental treatment histories.[19]

Dental Age Estimation

In children and adults:

Dental tissues are reliable markers for estimating age in both children and adults. In children, developmental stages such as tooth eruption and mineralization follow well-documented chronologies that allow estimation with narrow confidence intervals. In adults, secondary dentin deposition, periodontal changes, and root translucency patterns are utilized for age estimation through established scoring methods (e.g., Demirjian's stages). Age estimation supports narrowing down the pool of missing persons and contributes to building biological profiles in DVI.[20]

Role in fragmented remains:

When remains are fragmented or commingled, age estimation from dental tissues

becomes particularly important. Dental elements often survive when skeletal components are compromised; therefore, age estimation from teeth can guide reconstruction of biological profiles and assist in PM data prioritization.[21]

DNA from Dental Structures

Pulp tissue as DNA source:

Dental pulp is a protected vascular soft tissue inside teeth that often retains viable genetic material even under extreme conditions such as fire, decomposition, or impact trauma.[22] Studies have demonstrated that pulp yields higher quality and quantity of nuclear DNA compared to bone in degraded remains, making it an excellent source for molecular identification.[23]

Comparison with skeletal DNA:

Although bone (especially dense cortical bone) also serves as a DNA source, teeth have an advantage in that they are encapsulated by enamel and dentin, which protect pulp DNA from environmental insults. Dental DNA extraction is therefore frequently used in combination with skeletal DNA to improve matching results when ante-mortem samples are available.[24]

Bite Marksin DVI

While bite mark analysis has historical application in individual casework, its role in large-scale DVI is limited due to issues of reliability and scientific consensus. Bite marks may have situational applicability in specific cases involving assault or patterned injuries, but they are not considered a primary tool for identification in mass disaster scenarios due to variability in skin elasticity, distortion of evidence, and inter-examiner inconsistency. Modern DVI protocols emphasize more objective dental markers and DNA evidence.[25]

Dental Records: Foundation of Identification

Dental records constitute the cornerstone of forensic dental identification and are indispensable in Disaster Victim Identification (DVI). Accurate, comprehensive, and contemporaneous dental documentation enables reliable ante-mortem (AM) and post-mortem (PM) comparison, facilitating positive identification even when remains are fragmented or decomposed. The quality and completeness of dental records directly influence the speed, accuracy, and legal defensibility of the identification process.[26]

Types of Dental Records

Clinical notes:

Detailed clinical records documenting examination findings, diagnoses, treatment plans, restorative procedures, periodontal status, extractions, and prosthetic work provide essential comparative data. Notations of anomalies, developmental variations, and occlusal characteristics add further discriminatory value.

Radiographs:

Intraoral (periapical, bitewing), extraoral (panoramic), and advanced imaging (CBCT where available) serve as highly reliable identifiers. Radiographs reveal internal morphological features such as pulp chamber configuration, root curvature, sinus patterns, trabecular bone structure, and endodontic treatments, which are often unique and resistant to post-mortem change.

Casts (Study Models):

Dental casts preserve three-dimensional representations of occlusion, alignment, spacing, and morphological characteristics. These are particularly valuable in orthodontic patients or individuals with distinctive malocclusion patterns.

Photographs:

Clinical photographs document tooth color, shape, diastema, restorations, prostheses, and smile characteristics. High-resolution images may also capture soft tissue features relevant for comparison.

Digital scans and electronic records:

Digital intraoral scans, electronic dental records (EDR), and digital radiography have enhanced accuracy, storage efficiency, and accessibility. Digital datasets allow rapid international sharing during multinational DVI operations and reduce transcription errors.

Importance of Proper Record Maintenance

Long-term retention of records is especially important, as mass disasters may occur many years after treatment. Digital backup systems, secure storage, and adherence to regulatory retention guidelines strengthen the forensic utility of dental documentation.

Legal and Ethical Responsibilities of Dentists

Dentists have both legal and ethical obligations to maintain comprehensive and accurate patient records. Proper documentation is not only a clinical necessity but also a professional duty that supports public safety and humanitarian efforts in DVI. Regulatory bodies and forensic literature emphasize that dentists must:[27,28]

- Maintain accurate, contemporaneous, and legible records
- Retain records for the legally mandated duration
- Ensure confidentiality while allowing lawful access during forensic investigations
- Cooperate with investigative authorities when dental records are requested for identification purposes

Failure to maintain adequate records may carry medico-legal consequences and can hinder identification processes in mass fatality incidents. Ethically, meticulous record-keeping reflects professional accountability and contributes significantly to societal responsibilities during disaster response.

Role of Technology in Modern DVI

Technological advancements have significantly enhanced the efficiency, accuracy, and reliability of Disaster Victim Identification (DVI). Modern imaging modalities, digital record systems, and computer-assisted comparison tools have transformed forensic odontology from manual chart-based comparison to highly standardized and data-driven identification processes.[29]

Digital Radiography

Digital radiography has replaced conventional film-based imaging in many forensic and clinical settings. It offers superior image resolution, enhanced contrast manipulation, and rapid acquisition, which are critical in post-mortem (PM) examinations. Digital periapical, bitewing, and panoramic radiographs allow precise comparison with ante-mortem (AM) records. Image enhancement tools (zooming, contrast adjustment, inversion filters) improve visualization of root morphology, endodontic fillings, trabecular patterns, and restorative margins. Additionally, digital images facilitate electronic storage and international data sharing during multinational DVI operations.[30]

Cone Beam Computed Tomography (CBCT)

Cone Beam Computed Tomography (CBCT) provides three-dimensional (3D) imaging of dental and maxillofacial structures. In DVI, CBCT is particularly useful when remains are fragmented, commingled, or structurally compromised. It enables detailed assessment of root morphology, sinus anatomy, impacted teeth, implants, and complex restorations. Three-dimensional reconstruction aids in accurate AM–PM comparison and may eliminate the need for destructive dissection in certain cases. CBCT also assists in evaluating skeletal relationships and craniofacial characteristics that contribute to identification.[31]

3D Facial Reconstruction

Three-dimensional facial reconstruction techniques are applied when traditional dental or fingerprint records are unavailable. Using cranial remains, forensic experts reconstruct facial features through digital modeling or additive techniques. Although not considered a primary method of identification, 3D reconstruction assists in generating public recognition and narrowing missing-person searches. Advances in computer modeling, stereophotogrammetry, and surface scanning have improved the anatomical accuracy and reproducibility of these reconstructions.[32,33]

Computer-Assisted Dental Identification Systems

Computer-assisted systems have streamlined the comparison of AM and PM dental data. Dedicated DVI software programs allow digital entry of odontological findings using standardized coding systems (e.g., FDI notation). These systems automatically search databases for concordant dental patterns, reducing manual errors and expediting reconciliation. Algorithms can compare restorative patterns, tooth status, and radiographic features, improving efficiency in large-scale disasters involving hundreds or thousands of victims.Examples include internationally utilized DVI management systems developed in collaboration with INTERPOL, which integrate dental, fingerprint, and DNA data into a unified reconciliation platform.[34]

Use of Dental Databases

National and regional dental databases enhance rapid identification by storing standardized dental information that can be accessed during mass disasters. Digital dental records, electronic health record systems, and implant registries provide traceable data that assist in narrowing victim pools. Implant serial numbers and manufacturer databases further contribute to identification when implants are present.The integration of centralized dental databases with DVI software improves cross-border collaboration, data standardization, and secure information exchange. However, the effectiveness of these systems depends on comprehensive record maintenance, data protection regulations, and interoperability between software platforms.[35,36]

Multidisciplinary Approach in DVI

Disaster Victim Identification (DVI) is inherently multidisciplinary, requiring coordinated collaboration among various forensic and

investigative specialties. International DVI protocols emphasize that no single discipline can independently ensure reliable identification, particularly in large-scale mass fatality incidents.[37]

Forensic Pathologists

Forensic pathologists are responsible for conducting post-mortem examinations, determining cause and manner of death, documenting injuries, and collecting biological samples for toxicology and DNA analysis. They ensure systematic autopsy procedures and proper evidence preservation during the post-mortem phase.

Forensic Anthropologists

Forensic anthropologists play a crucial role when remains are skeletal, fragmented, or commingled. They assist in sorting and re-association of remains, establishing biological profiles (age, sex, ancestry, stature), and distinguishing human from non-human material. Their expertise is particularly valuable in high-impact disasters and advanced decomposition cases.

Forensic Odontologists

Forensic odontologists are responsible for post-mortem dental examination, radiographic documentation, charting, and comparison with ante-mortem dental records. Given the durability of dental tissues, odontologists frequently provide primary identification in cases where fingerprints and facial recognition are not feasible.

DNA Experts

Forensic DNA analysts conduct genetic profiling using nuclear and mitochondrial DNA extracted from biological tissues. DNA analysis is particularly valuable in cases involving severe fragmentation, incineration, or absence of dental records. It also supports kinship analysis when direct ante-mortem samples are unavailable.

Law Enforcement Agencies

Law enforcement agencies coordinate scene management, data collection, victim tracking, and family liaison operations. They ensure chain of custody, manage missing persons databases, and facilitate international cooperation in cross-border disasters. Effective inter-agency communication is essential for timely and accurate reconciliation.

Challenges in Disaster Victim Identification

Despite advances in forensic science, DVI presents numerous operational and scientific challenges.[38]

Fragmented and Charred Remains

High-impact crashes, explosions, and fires often result in extensive fragmentation, commingling, and thermal destruction of tissues. Heat exposure may compromise DNA quality and alter morphological features, complicating identification efforts. Advanced imaging and molecular techniques have mitigated, but not eliminated, these challenges.

Absence of Ante-Mortem Records

Identification heavily depends on the availability of reliable ante-mortem (AM) records. In many regions, dental and medical documentation may be incomplete, inaccessible, or nonexistent, significantly delaying comparison and reconciliation processes.

Poor Record Maintenance

Illegible charting, inconsistent notation systems, lack of radiographs, and inadequate storage practices reduce the forensic value of dental records. Variability in international documentation standards further complicates AM–PM matching.

Cross-Border Disasters

International disasters involving victims from multiple countries present logistical and legal complexities. Differences in language, record systems, legal frameworks, and data protection regulations may delay information exchange. Harmonized international protocols such as those issued by INTERPOL aim to address these challenges.

Time Pressure and Emotional Sensitivity

Families expect rapid identification and repatriation of remains, creating significant operational pressure. Simultaneously, DVI teams must maintain scientific rigor and avoid premature conclusions. Emotional sensitivity, psychological stress among responders, and media scrutiny further complicate operations.

Ethical and Legal Considerations

DVI operations must adhere to strict ethical standards and legal frameworks to protect the dignity and rights of victims and their families.[39,40]

Consent and Confidentiality

Access to ante-mortem dental and medical records must comply with privacy laws and data protection regulations. Confidentiality must be preserved while ensuring lawful access for identification purposes. Secure data handling systems are essential to prevent unauthorized disclosure.

Cultural and Religious Sensitivities

Cultural and religious practices significantly influence handling of human remains.

Certain traditions mandate rapid burial or restrict invasive procedures. DVI teams must balance forensic requirements with respect for religious customs, ensuring dignity and sensitivity throughout the process.

International Legal Frameworks

International DVI operations are guided by standardized protocols, bilateral agreements, and human rights conventions. Clear legal authorization is necessary for cross-border data sharing, repatriation of remains, and issuance of death certificates.

Human Rights Perspectives

Accurate identification of disaster victims is recognized as a humanitarian obligation and a fundamental component of human rights. Families have the right to know the fate of missing relatives. Proper identification prevents misidentification, wrongful burial, and prolonged psychological distress, thereby upholding principles of dignity and justice.

Case Studies and Notable Mass Disasters

Major mass fatality incidents have significantly shaped the evolution of Disaster Victim Identification (DVI) protocols and strengthened the role of forensic odontology within multidisciplinary forensic frameworks. The experiences gained from these events contributed to improvements in standardized documentation, international cooperation, and integration of dental and DNA-based identification systems.

Indian Ocean Tsunami (2004)

The 2004 Indian Ocean tsunami was one of the largest multinational DVI operations in history, affecting multiple countries across South and Southeast Asia. Thousands of victims were foreign nationals, requiring coordinated international forensic collaboration under the guidance of INTERPOL. Studies published in forensic journals report that dental identification played a primary role in identifying a substantial proportion of victims, particularly in countries where dental record maintenance was well established. The disaster highlighted the importance of standardized ante-mortem (AM) data collection, harmonized dental charting systems, and digital record exchange. It also underscored challenges related to variable record quality and cross-border data sharing, ultimately leading to improvements in DVI software systems and reconciliation protocols.[41,42]

September 11 Attacks (2001)

The terrorist attacks on the World Trade Center in 2001 resulted in extreme fragmentation, commingling, and thermal destruction of remains. Forensic literature documents that the scale and severity of destruction necessitated extensive reliance on DNA analysis, although dental identification contributed significantly where viable structures were recovered. Peer-reviewed studies emphasize that the event accelerated advancements in DNA extraction techniques, including mini-STR methodologies for degraded samples, and reinforced the need for integrated DVI databases. The operation remains one of the most complex identification efforts in forensic history, demonstrating the importance of combining odontology, anthropology, pathology, and molecular genetics in large-scale disasters.[43,44]

Air India Flight 182 (1985)

The bombing of Air India Flight 182 over the Atlantic Ocean remains one of the deadliest aviation-related terrorist incidents. Recovery of remains from the ocean posed substantial challenges, including fragmentation and environmental degradation. Forensic reports describe the combined use of dental comparison, anthropological assessment, and DNA techniques to establish victim identities. The incident underscored the importance of meticulous documentation, underwater recovery protocols, and preservation of dental structures despite prolonged submersion. It also contributed to the development of more structured aviation disaster identification guidelines in Canada and internationally.[45]

Other Notable Disasters

Spitsbergen Aircraft Disaster (1996)

The crash of a Russian charter aircraft near Spitsbergen resulted in high levels of fragmentation. Published studies report that systematic dental examination combined with DNA profiling enabled successful identification of nearly all victims, demonstrating the effectiveness of coordinated DVI operations under cold environmental conditions.[46]

Madrid Train Bombings (2004)

The coordinated terrorist attacks in Madrid required rapid identification of victims in a densely populated urban setting. Literature highlights the importance of integrating dental comparison with fingerprint and DNA data under strict time constraints while maintaining scientific rigor.[47]

Swissair Flight 111 (1998)

The crash near Nova Scotia involved extensive marine recovery operations. Forensic case analyses indicate that dental identification played a critical role alongside DNA analysis in confirming victim identities, reinforcing the value of well-maintained ante-mortem dental records.[48]

Future Directions in Forensic Odontology and DVI

The future of forensic odontology in Disaster Victim Identification (DVI) is increasingly shaped by digital transformation, artificial intelligence, and global data integration. As mass disasters become more complex and multinational, technological innovation is central to improving speed, accuracy, and scalability of identification systems.[49]

Artificial Intelligence in Dental Comparison

Artificial intelligence (AI) and machine learning algorithms are being explored for automated analysis of dental radiographs and charting data. AI systems can detect morphological features, restorative patterns, and anatomical landmarks from digital radiographs, enhancing objectivity and reducing inter-examiner variability. Deep learning models trained on large dental datasets show promise in recognizing tooth morphology, endodontic treatments, and implant characteristics, potentially expediting AM–PM comparison in large-scale disasters.

Automated AM–PM Matching Systems

Next-generation DVI software platforms are being designed to automatically cross-match ante-mortem and post-mortem dental data using standardized coding systems. Automated algorithms can compare missing teeth patterns, restorations, prostheses, and radiographic landmarks, generating ranked match probabilities. Such systems reduce manual workload during reconciliation and improve efficiency in incidents involving hundreds or thousands of victims.

National Dental Record Registries

The establishment of centralized national dental registries could significantly enhance rapid identification in mass disasters. Standardized digital storage of dental charts, radiographs, and implant records would allow secure and rapid retrieval of ante-mortem data. Implant traceability systems and digital record interoperability are particularly valuable in cross-border disasters.

Integration with Biometric Databases

Future DVI systems may integrate dental databases with broader biometric platforms, including fingerprint and DNA databases. Unified identification systems could allow cross-referencing between dental, genetic, and fingerprint data, improving redundancy and reducing the risk of misidentification. Such integration, however, requires strict data protection policies and ethical safeguards.

II. Conclusion

Forensic odontology remains a cornerstone of Disaster Victim Identification due to the individuality, durability, and comparative reliability of dental evidence. Across historical and contemporary mass disasters, dental analysis has consistently contributed to accurate and dignified identification of victims.The increasing complexity of global disasters underscores the need for preparedness through standardised record maintenance, structured training, and multidisciplinary coordination. Emerging technologies, including artificial intelligence, automated AM–PM matching systems, and integrated biometric databasesto transform DVI operations by enhancing speed, objectivity, and scalability.Sustained investment in technological advancement, education, and international collaboration will ensure that forensic odontology continues to fulfil its humanitarian and scientific role in delivering accurate identification, closure for families, and justice within disaster response systems.

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