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Review

Orthodontics in Forensic Science: A Review of Its Contribution to Human Identification

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Abstract

This review explores the vital role of orthodontic specialty and orthodontic records in forensic investigations, emphasizing their contribution to human identification. It synthesizes current literature on methodologies, advantages, limitations, and future perspectives, positioning orthodontics as a valuable adjunct within the forensic toolkit. Collaboration between orthodontists, forensic scientists, and AI technologies will further strengthen the reliability and speed of human identification, reinforcing justice and humanitarian efforts worldwide.

Keywords: forensic odontology; forensic dentistry; orthodontics; human identification; dental records; post-mortem comparison

1. Introduction

Forensic science integrates multiple scientific disciplines to address legal questions related to criminal and civil investigations. Forensic odontology focuses on the examination, handling, and presentation of dental evidence in the interest of justice [1,2].

Forensic odontology is particularly important in identifying human remains in cases involving severe disfigurement due to fire, accidents, or mass disasters. The discipline is based on the principle that each individual's dentition is unique, even among twins. Core areas of forensic odontology include the identification of deceased individuals, assistance in legal proceedings such as malpractice or criminal cases, bite-mark analysis, and the use of dental records, radiographs, and DNA for identity and age determination [1,3,4].

Age estimation in living individuals has both legal and humanitarian significance, particularly in criminal proceedings, immigration cases, competitive sports, and human trafficking investigations. It is especially relevant in cases involving unaccompanied or asylum-seeking minors who lack valid identification documents. Accurate dental age estimation, therefore, remains a critical aspect of forensic practice [5,6]. Traditional age estimation methods rely on expert assessment of radiographic morphological features, such as tooth development stages and cervical vertebral maturation. These approaches do not always correlate with chronological age, are time-consuming and subject to observer

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variability. Recent advances in deep learning have enabled automated and objective methods that learn age-related patterns from large imaging datasets [7–12].

Teeth are the most durable structures in the human body and frequently survive decomposition, fire, and trauma. As a result, forensic odontology provides a cost-effective and rapid identification method when more definitive methods such as fingerprinting, visual recognition or DNA analysis are not feasible. Comparison of ante-mortem (AM) and post-mortem (PM) data may result in positive identification, possible identification, insufficient evidence, or exclusion [1].

Dental structures, restorations, and orthodontic appliances often withstand conditions that destroy other tissues [13]. Based on detailed AM records from general dentists and dental specialists, which are compared to PM data, forensic dentistry can serve as a reliable technique for identifying deceased individuals [3]. The unique morphology of the dental arch also plays a pivotal role in this process. Key parameters such as inter-canine width, intermolar width and arch length exhibit gender-specific variations that are crucial for individual identification [14–16] and provide a non-invasive and reliable means of forensic analysis, particularly in cases of mass disasters or unidentified human remains [17]. Forensic identification of unknown deceased individuals involves primary and secondary methods; primary identification relies on scientific evidence like DNA analysis, fingerprint analysis, and odontogram assessment, while secondary identification is a complementary method that includes examining physical characteristics [18].

Orthodontics, the specialized branch of dentistry dedicated to the diagnosis and correction of malocclusion and craniofacial irregularities, contributes uniquely to this field. Orthodontic records, including dental casts, radiographs, photographs, and digital treatment files, provide distinctive, longitudinal, and highly individualized information about a patient's craniofacial anatomy. These records are often meticulously maintained over extended treatment periods, offering a comprehensive archive that can be invaluable in forensic investigations [19–21]. The increasing frequency of disasters necessitates the importance of forensic dentistry in legal contexts, emphasizing the need for orthodontists to maintain comprehensive records [1,22].

The relevance of orthodontics in forensic contexts has increased with advances in imaging technology, the digitization of patient records, and the widespread use of fixed and removable appliances that leave identifiable markers on dentition and supporting bone. Such orthodontic documentation not only facilitates the positive identification of individuals but also contributes to age estimation and the reconstruction of biological profiles. For example, orthodontic treatment-induced changes in craniofacial structures can affect the accuracy of facial recognition methods; however, advanced three-dimensional model superimposition techniques remain reliable for forensic comparison [23].

This review explores the vital role of the orthodontic specialty and orthodontic records in forensic investigations, emphasizing their contribution to human identification. It discusses how detailed dental documentation, such as casts, radiographs, treatment notes, and digital files, can assist in identifying individuals when other methods fail. The paper highlights the importance of meticulous record-keeping by orthodontists to support forensic science in both legal and humanitarian contexts. It synthesizes current literature on methodologies, advantages, limitations, and future perspectives, positioning orthodontics as a valuable adjunct within the forensic toolkit.

2. Forensic Odontology: Scope and Applications

2.1. Human Identification and Forensic Workflows

In forensic practice, dental identification is implemented through structured workflows based on the systematic comparison of ante-mortem (AM) and post-mortem (PM) data. AM information may be obtained from dental practitioners, clinics, hospitals, or insurance databases and typically includes dental charts, radiographs, clinical photographs, study models, and orthodontic records. PM data are collected during forensic examination and involve detailed recording of dental status, restorations, appliances, and craniofacial features.

The identification process follows established protocols in which AM and PM datasets are independently compiled and subsequently compared. Concordant findings across multiple dental features may support positive identification, while partial concordance may lead to possible identification or exclusion. In cases where dental evidence is incomplete, odontological findings are integrated with other forensic identifiers to strengthen conclusions [18]. The quality, completeness, and availability of AM dental documentation remain critical determinants of the reliability of the identification outcome.

2.2. Disaster Victim Identification (DVI)

Forensic odontology constitutes a core component of disaster victim identification (DVI) operations and Interpol guidelines recognize dental and orthodontic records as primary identifiers in DVI protocols [17]. In mass fatality incidents, dental teams are responsible for the collection, documentation, and comparison of dental findings as part of multidisciplinary DVI frameworks. Standardized DVI procedures emphasize the separation of AM and PM teams, systematic data recording, and controlled reconciliation processes to ensure accuracy and transparency [1,17,22].

Orthodontic documentation is particularly valuable in DVI contexts due to its longitudinal nature and frequent inclusion of multiple diagnostic modalities. Records obtained over extended treatment periods increase the likelihood of identifying distinctive features that can support reconciliation, even when PM remains are fragmented or thermally altered [19–21]. The effectiveness of odontological identification in DVI scenarios is therefore closely linked to routine clinical record-keeping practices and long-term data preservation.

2.3. Age Estimation and Biological Profiling Applications

In forensic casework, dental age estimation is applied in both deceased and living individuals, depending on the legal or humanitarian context. In deceased individuals, age estimation contributes to the narrowing of missing-person lists and supports the construction of biological profiles. In living individuals, dental age assessment is frequently requested in judicial proceedings, immigration and asylum evaluations, and age-disputed cases involving minors [5,6].

Operationally, age estimation is performed using established radiographic and morphological criteria selected according to the individual's developmental stage and the available imaging data. Third-molar development and cervical vertebral maturation are commonly assessed in adolescent and young adult populations, while additional dental and craniofacial indicators may be used to support age classification [7–9]. The choice of method is influenced by case circumstances, image quality, and legal requirements.

Beyond age estimation, odontological findings may contribute to broader biological profiling through the assessment of sex-related dental and craniofacial characteristics. Measurements of dental arch dimensions and craniofacial morphology may assist forensic investigations when used in combination with other biological indicators [14–16]. These applications are supplementary in nature and are interpreted within a multidisciplinary forensic framework.

Reconstruction of the biological profile represents a central component of forensic identification. Mandibular morphology has been shown to contribute significantly to sex determination, with males typically exhibiting larger mandibles, higher rami, more pronounced gonial angles, greater inter-gonial widths, and more distinct ante-gonial notches, whereas females tend to present a more gracile mandibular body. A recent study reported high accuracy for sex classification based on mandibular morphometric features, ranging from 91% to 93%, supporting their forensic reliability when other methods are unavailable or impractical [24].

2.4. Bite Mark Analysis

Bite mark analysis involves the examination of both patterned injuries and contextual circumstances, combining morphological and positional data. Considering the uniqueness of human dentition, bite marks caused by teeth on skin or impressions on flexible surfaces may assist in human identification [25].

3. Orthodontic Records in Forensic Identification

3.1. Rationale for the Forensic Value of Orthodontic Records

Orthodontic records constitute a unique category of dental documentation due to their level of detail, longitudinal nature, and systematic collection over extended treatment periods. Unlike routine dental records, orthodontic documentation often captures progressive changes in dental alignment, occlusion, and craniofacial morphology, providing multiple reference points that may be used for forensic comparison [19–21]. The forensic value of orthodontic records lies not only in their descriptive richness but also in their frequent inclusion of multiple diagnostic modalities within a single patient archive.

3.2. Types of Orthodontic Records

3.2.1. Dental Casts/Study Models

Dental casts and study models provide three-dimensional representations of the dental arches, occlusal relationships, and individual tooth morphology. Subtle variations in tooth position, rotations, spacing, and arch form are highly individualized and may persist even after orthodontic treatment. These characteristics make dental casts valuable for forensic identification when suitable AM is available [19,23,25]. Dental casts have traditionally been fabricated in plaster and today they are commonly 3D-printed; however, their forensic utility remains independent of the fabrication method. When preserved adequately, casts may allow detailed morphological comparison with PM findings or digital reconstructions. Their value is further enhanced when serial models documenting different treatment stages are available.

3.2.2. Radiographic Records

Radiographic documentation forms a cornerstone of orthodontic diagnosis and has significant forensic applicability. Commonly used orthodontic radiographs include panoramic radiographs, lateral cephalograms, and periapical images, each providing distinct anatomical information relevant to identification.

Panoramic radiographs offer a comprehensive overview of dental development, tooth presence or absence, restorations, and pathological findings. Periapical radiographs provide high-resolution imaging of individual teeth and surrounding structures, supporting detailed morphological assessment. Lateral cephalometric radiographs document craniofacial relationships and skeletal morphology, enabling comparison of characteristic anatomical landmarks. [19,20,26–28].

In a recent study [26], a novel algorithm for extracting cranial patterns from digital lateral cephalometric radiographs was introduced and evaluated for identification purposes. Due to the unavailability of AM cephalograms from deceased individuals, the algorithm was tested using pre- and post-treatment cephalograms of living individuals from an orthodontic archive, considered as AM and PM data. The proposed algorithm encodes cranial patterns into a database for future identification. It matches PM cephalograms with AM records, accurately identifying individuals by comparing cranial features. The algorithm achieved an accuracy of 97.5%, a sensitivity of 97.7%, and a specificity of 95.2%, correctly identifying 350 out of 358 cases. The proposed algorithm shows promise for identity recognition based on cranial patterns and could be enhanced with artificial intelligence (AI) algorithms in future studies.

In addition to their clinical orthodontic applications, lateral cephalometric radiographs have demonstrated forensic utility. Mandibular morphometric measurements, including condylar height, projective ramus height, and ramus breadth, have shown correlations with sexual dimorphism, suggesting their potential role in biological sex determination when other methods are unavailable. Studies have further supported the forensic relevance of cephalometric measurements in children, emphasizing the need for validation across diverse populations [28,29].

Cone-beam computed tomography (CBCT) extends the forensic value of orthodontic radiography by enabling three-dimensional visualization of dental and craniofacial structures, allowing detection of anatomical details that may not be apparent on conventional two-dimensional imaging. CBCT datasets permit precise assessment of tooth morphology, root configuration, bone anatomy, and orthodontic or restorative materials, supporting forensic identification, age estimation, sex assessment, and evaluation of trauma or surgical interventions, particularly when conventional radiographs are unavailable or insufficient. When combined with complementary modalities such as clinical photography, intraoral and facial scanning, and jaw-tracking technologies, CBCT contributes to the creation of a comprehensive digital record, integrating anatomical, functional, and morphological data to enhance the accuracy, reproducibility, and forensic applicability of orthodontic records [23,29–31].

Beyond general dental assessment, CBCT has demonstrated value in the analysis of craniofacial morphological variation. A recent study highlighted population-specific differences in the mandibular coronoid process, condyle, and sigmoid notch, underscoring their potential contribution to personal identification. Expansion of such investigations to larger and more diverse populations is necessary to strengthen the forensic and anthropological applicability of these findings [32].

CBCT applications in forensic dentistry extend across multiple analytical domains. Age estimation may be supported through evaluation of dental features such as pulp volume and third-molar development, as well as assessment of spheno-occipital synchondrosis maturation [33]. Sex determination can be facilitated by analysis of sexually dimorphic craniofacial structures, including mandibular measurements, foramen magnum dimensions, paranasal sinuses, and mastoid process morphology [34].

In addition, CBCT enables implant backtracking through the identification of distinctive dental implant designs and configurations. The modality has also demonstrated high specificity in bite-mark analysis, including evaluation of bite marks on foodstuffs, while measurements of facial soft-tissue thickness derived from CBCT data contribute to reconstructive identification by supporting facial approximation techniques [34]. Furthermore, CBCT has proven useful in the assessment of cranial trauma and projectile injuries, offering detailed visualization of hard-tissue damage with fewer artifacts than conventional computed tomography in selected forensic scenarios [35].

Although CBCT offers high spatial resolution and three-dimensional reconstruction capabilities with a lower radiation dose compared to conventional CT, its forensic use remains subject to certain limitations. These include reduced soft-tissue contrast, susceptibility to motion artifacts, inability to provide reliable bone density measurements, and restriction primarily to cranial and extremity imaging rather than whole-body examination. Despite these constraints, CBCT is increasingly recognized as a valuable, non-invasive imaging modality in forensic dentistry, supporting identification and analytical procedures in legal and forensic contexts [34].

3.2.3. Photographic Records

Photographic documentation is routinely collected in orthodontic practice and includes both intraoral and extraoral images. Intraoral photographs capture tooth morphology, alignment, occlusion, and soft-tissue characteristics, while extraoral and smile photographs document facial features and dental display patterns. Smile photographs, in particular, have been shown to possess forensic relevance due to the reproducibility of dental exposure patterns and the visibility of distinctive dental features. When compared with PM images or AM facial photographs, orthodontic photographic records may support identification, especially in cases where radiographic or cast data are unavailable [27,30,36–38].

The increasing habit of posting photographs on social media can contribute to forensic analyses as well and human identification methods based on such photographs have been reported [39]. Similar to smile photographs, bitemarks usually register the anterior teeth and count on comparisons of dental anatomy to draw conclusions. Selfies may lead to possibly distinctive, but not necessarily unique, dental evidence [39]. The use of AM evidence from individuals with a history of orthodontic treatment in these cases is of reduced evidence since the morphological dental variables, like angulation and position, are altered with the alignment of the anterior teeth. Nevertheless, the method for human identification using smile photos can be combined with others for safer forensic practices [30].

3.2.4. Digital Orthodontic Records

The increasing adoption of digital workflows in orthodontics has introduced new forms of forensic-relevant documentation. Intraoral scanners generate precise three-dimensional digital models of the dentition, capturing surface morphology with high accuracy. These digital records eliminate issues related to physical storage and degradation while facilitating rapid sharing and comparison [32,33,37,38,40] (Figure 1).

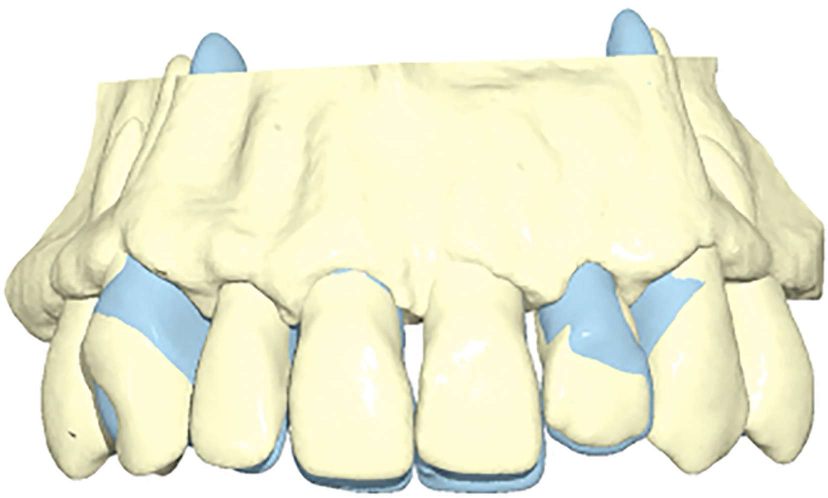

Figure 1. Superimposition of maxillary digital casts illustrating treatment changes.

Dental profiles derived from digital records can provide valuable insights into an individual's age and lifestyle, contributing to forensic investigations even when direct identification is challenging. Despite this potential, the forensic application of intraoral three-dimensional scans remains underexplored. One major challenge in automated comparison of AM and PM scans is the presence of soft tissue, which may differ substantially between datasets. The removal of soft tissue is therefore often necessary prior to analysis; however, existing methods demonstrate limitations when applied to scans from living individuals, cases involving missing teeth, or malocclusion. A recent study emphasized the importance of integrating advanced three-dimensional scanning techniques and automated solutions in forensic odontology to streamline identification processes [27]. The proposed grid-cutting method, which involves systematic division of dental images into standardized grid sections, enables detailed comparison of morphological features and shows potential to improve the accuracy and efficiency of dental comparisons in forensic contexts. In addition, analysis of mandibular morphometric indices using digital radiographs and specialized software has been shown to support sex prediction, with implications for both forensic anthropology and dental science [27].

In contemporary orthodontic workflows, cone-beam computed tomography data are frequently combined with intraoral scans and three-dimensional facial images to create a comprehensive digital representation of the patient, often referred to as the "digital patient." CBCT provides the skeletal and internal dental anatomy, while intraoral scans capture high-resolution crown morphology and facial scans document soft-tissue characteristics. The integration of these datasets allows precise spatial alignment of hard- and soft-tissue structures, enabling detailed morphological assessment and longitudinal comparison [24,31–38]. From a forensic perspective, such multimodal digital profiles enhance the robustness of AM records and may facilitate identification through three-dimensional superimposition and cross-modal comparison (Figure 2).

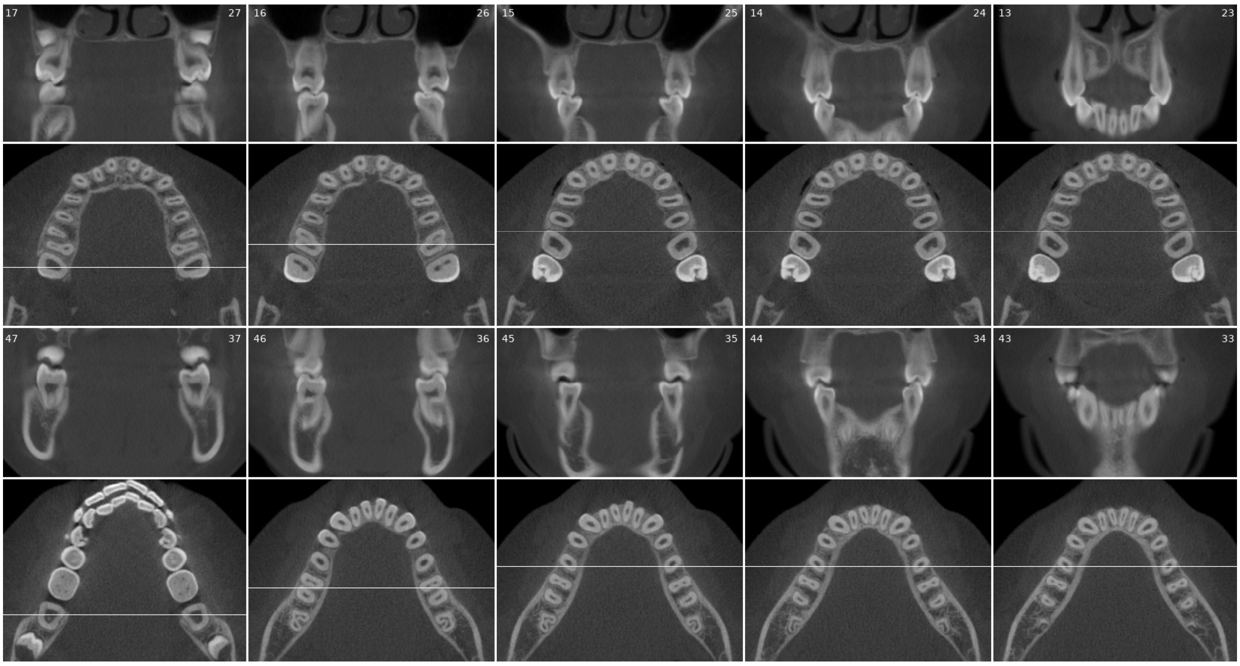

Figure 2. CBCT-based multimodal digital profiling of the dentition and maxillofacial structures. A panel of coronal CBCT slices with corresponding axial views, exported from Diagnocat™ (DGNCT LLC, Miami, FL, USA), is arranged across the maxillary and mandibular arches (indices correspond to FDI tooth numbering). The images document tooth position, root and canal morphology, sinus and fossa relationships, and eruptive status—features that are highly individualized and valuable for objective matching of ante-mortem and post-mortem dental records during human identification. The horizontal and vertical lines visible in the image represent the reference crosshair and slice navigation guides of the CBCT viewing software at the time of screenshot capture and are not anatomical or measurement indicators.

Three-dimensional facial scanning and jaw-motion recording systems further expand the scope of digital orthodontic documentation by providing dynamic and static representations of craniofacial structures. Digital datasets enable advanced analytical techniques, including three-dimensional superimposition, which allows quantitative comparison of craniofacial morphology across time points or between AM and PM records [31,36].

3.3. Palatoscopy as a Forensic Application of Orthodontic Records

Palatal (palatine) rugae are asymmetric ridges of fibrous mucous membrane located on the anterior region of the hard palate. Owing to their unique morphology and relative stability over time, palatal rugae have been proposed as a useful anatomical marker for forensic identification, a method commonly referred to as palatoscopy [41]. Their individualized configuration has been investigated for its potential contribution to human identification, including applications in sex and racial determination. Importantly, the protected intraoral position of palatal rugae renders them highly resistant to heat, chemical exposure, and mechanical stress, allowing their preservation in adverse conditions. As a result, rugae patterns may serve as an alternative identification aid in disaster victim identification scenarios and in edentulous individuals when conventional dental data are unavailable.

Advances in digital dentistry have enhanced the forensic applicability of palatal rugae analysis. Modern forensic odontology increasingly employs intraoral scanners to capture three-dimensional palatal morphology with high precision. Compared with traditional dental cast models, intraoral scanning offers superior accuracy, reproducibility, and ease of storage, while also facilitating rapid data sharing and longitudinal comparison. Digital acquisition enables detailed morphological analysis and supports the application of three-dimensional superimposition techniques, which have demonstrated value in human identification, even in individuals who have undergone specific orthodontic interventions such as slow maxillary expansion (SME) [42].

Although palatal rugae are generally regarded as stable anatomical landmarks, they are not immutable. Their morphology may be influenced by physiological factors such as growth and aging, as well as by clinical interventions, including periodontal surgery, cleft palate repair, and tooth extraction [3]. Orthodontic treatment represents a particularly relevant variable in the context of forensic identification [43]. Evidence suggests that extraction-based orthodontic therapies are associated with more pronounced alterations in rugae shape compared with non-extraction treatments, although the overall complexity and individual pattern characteristics often remain preserved. Additionally, maxillary expansion procedures have been shown to significantly affect inter-rugal distances and anterior palatal anatomy, potentially altering spatial relationships relevant to forensic comparison [44,45]. Consequently, careful consideration is required when utilizing palatal rugae for identification in individuals with a history of orthodontic expansion or extensive surgical procedures [46].

To enhance the reliability of rugae-based identification, forensic evaluations should integrate both dimensional and morphological analyses rather than relying on a single assessment approach [47]. Nevertheless, important limitations persist. Despite the growing availability of digital acquisition and analysis tools, the lack of dedicated, standardized, and certified software currently constrains the forensic validity and legal admissibility of palatal rugae analysis. Variability in analytical protocols and limited population-based validation further restrict its routine application in forensic casework [48]. Continued research is therefore required to standardize methodologies, validate rugae stability across diverse populations, and clarify the role of palatoscopy as a complementary tool within the broader framework of forensic odontology.

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4. Orthodontic Appliances as Forensic Identifiers

Orthodontic appliances may serve as valuable forensic identifiers due to their individualized characteristics, material composition, and, in some cases, traceable manufacturing features. Unlike natural dental morphology, orthodontic appliances are externally introduced elements whose design, placement, and modification reflect both clinician decisions and patient-specific anatomical constraints. When present, such appliances may provide distinctive AM markers that assist in human identification, particularly when combined with dental and radiographic records.

4.1. Fixed Orthodontic Appliances

Fixed orthodontic appliances, including brackets, bands, archwires, and auxiliary components, may serve as forensic identifiers due to variations in bracket prescription, slot dimensions, base design, and bonding patterns. Differences in appliance positioning, angulation, and torque expression can result in characteristic tooth movement patterns that are documented throughout treatment. In forensic investigations, remnants of fixed appliances or their effects on dental alignment may be compared with ante-mortem records to support identification, particularly when other identifiers are limited [21].

The materials commonly used in fixed orthodontic appliances, such as stainless steel, titanium, and ceramic components, demonstrate variable resistance to heat and environmental degradation. Although fixed appliances alone rarely constitute definitive forensic evidence, their presence may provide supportive information when correlated with comprehensive orthodontic documentation [21].

4.2. Removable and Aligner-Based Appliances

Removable orthodontic appliances, including plates and functional appliances, may contribute to forensic identification when they incorporate serial numbers, manufacturing codes, or individualized modifications that facilitate traceability [21]. The use of clear alignment appliances (CAAs) further expands the potential for identification in medicolegal investigations. Proper recognition of CAAs during the initial stages of forensic examination may allow investigators to obtain critical information regarding dental providers by contacting the relevant CAA companies.

Records obtained through CAA manufacturers, in combination with documentation from local orthodontists and dentists, may assist in securing identification through forensic odontology comparison. The extensive digital records generated during aligner-based treatment, including staged tooth movement data and appliance customization, may provide valuable AM information when appropriately accessed and correlated with PM findings [49]. Further to the above, although CAAs are fabricated from digital treatment records, access to these datasets may be impossible in forensic contexts due to inability to identify the manufacturer, practice closure, data-retention limits, or legal restrictions; in such cases, the appliance itself may be poured up in stone and used as supplementary AM material.

4.3. Skeletal Anchorage Systems

Skeletal anchorage systems, including orthodontic mini-screws and temporary anchorage devices, may provide supplementary forensic information when present. These devices are characterized by specific dimensions, thread designs, materials, and insertion sites, which are typically documented in clinical records and may be identifiable through PM radiographic examination. Their placement within alveolar or basal bone allows detection even when dental structures are compromised [19].

From a forensic perspective, skeletal anchorage systems may assist in narrowing identification by indicating a history of advanced or complex orthodontic treatment. Their evidentiary value is enhanced when correlated with AM radiographic documentation and treatment records. However, due to their limited prevalence and variability in design across manufacturers, skeletal anchorage devices are generally considered adjunctive identifiers and should be interpreted within a multidisciplinary forensic framework rather than as standalone evidence [19].

5. Artificial Intelligence in Forensic Odontology and Orthodontics

Artificial intelligence (AI) is increasingly transforming dentistry by enhancing diagnostic accuracy, treatment planning, and patient management across multiple disciplines, including pediatric dentistry, prosthodontics, orthodontics, oral medicine, radiology, periodontics, oral and maxillofacial surgery, and endodontics. AI applications support the detection of oral diseases, analysis of radiographic images, and identification of abnormalities such as dental caries, oral lesions, and soft tissue calcifications. In orthodontics, AI has been applied to cephalometric analysis, treatment planning, prediction of treatment outcomes, and customization of orthodontic therapy. Beyond clinical dentistry, AI has also been recognized as a valuable adjunct in forensic odontology, supporting identification and analytical tasks through automated and data-driven approaches [50].

AI is increasingly integrated into forensic medicine, where it enhances the accuracy, efficiency, and objectivity of investigations [51]. Reported applications include autopsy analysis, age and sex estimation, facial recognition, forensic toxicology, DNA analysis, fingerprint analysis, firearm-related investigations, and digital forensics. In forensic dentistry, AI primarily functions as a decision-support tool, assisting forensic experts in dental identification, age and sex estimation, facial reconstruction, bite mark analysis, and automation of repetitive analytical tasks. Deep neural networks and machine-learning techniques are increasingly utilized to improve the speed and consistency of forensic dental processes. In particular, AI-based models have demonstrated strong potential for age and sex estimation, with reported accuracies exceeding 90% in selected radiographic applications [52–55].

5.1. AI Architectures and Three-Dimensional Image Analysis

Among AI methodologies, three-dimensional convolutional neural networks (3D CNNs) have demonstrated particular relevance for forensic and orthodontic applications involving volumetric imaging. Unlike traditional two-dimensional approaches, 3D CNNs process three-dimensional input data, such as stacks of two-dimensional images or volumetric datasets derived from cone-beam computed tomography (CBCT). These networks can automatically extract salient features without human supervision, enabling both generative and descriptive analytical tasks. In forensic research, 3D CNNs have been applied to sex determination, biological age estimation, three-dimensional cephalometric landmark annotation, growth vector prediction, and facial soft-tissue estimation from skeletal data and vice versa [56].

5.2. AI in Orthodontic Diagnosis and Treatment Planning

Orthodontic diagnosis traditionally relies on complex cephalometric analyses that are time-consuming and subject to inter-operator variability. AI has substantially improved this process by enabling automated and accurate diagnostic assessments, optimization of personalized treatment plans, and prediction of treatment outcomes. Recent studies have demonstrated the effectiveness of AI in predicting the necessity of tooth extractions based on radiographic and clinical data, with promising results [51,57].

AI has also shown high performance in orthodontic landmark identification and treatment planning. Park et al. developed a deep-learning algorithm capable of precisely identifying cephalometric landmarks on radiographs [58], while Choi et al. reported a

96% success rate in distinguishing surgery versus non-surgery cases using AI analysis of lateral cephalometric radiographs [59]. Kok et al. demonstrated that AI algorithms could determine growth and developmental stages with 77.02% accuracy based on cervical vertebral maturation assessment, complementing traditional hand–wrist radiographs and cephalometric analyses [60]. Collectively, these studies highlight the transformative potential of AI in orthodontic diagnosis and treatment planning [61].

5.3. Automated Landmarking and Forensic Matching

Automated landmark detection represents one of the most mature AI applications in orthodontics and forensic dentistry. Deep neural networks can be trained to identify anatomical landmarks on radiographs, digital scans, and three-dimensional dental models, including teeth, roots, axes, and cusps. Automated landmarking reduces the need for manual annotation, increases reproducibility, and accelerates analytical workflows (Figures 2–6). One study proposed a neural network capable of detecting tooth landmarks and axes on three-dimensional tooth models with high accuracy, facilitating alignment, comparison, and matching of dental scans [62]. In forensic contexts, such approaches may enable faster and more objective matching of AM and PM dental records through direct AI-based alignment of anatomical landmarks.

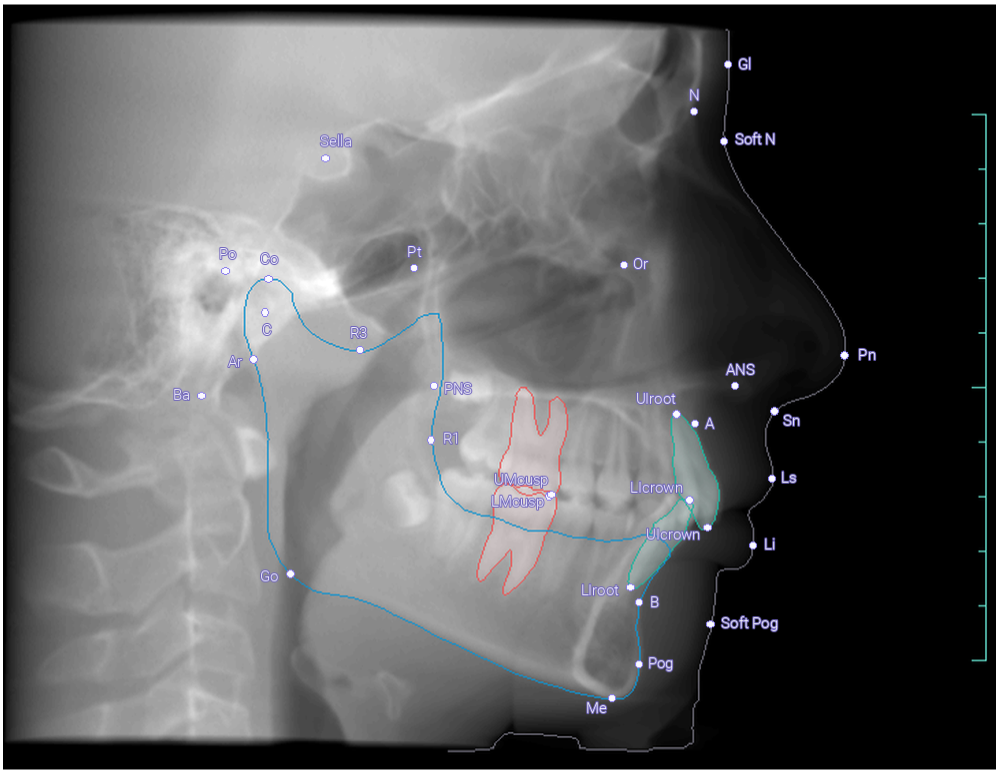
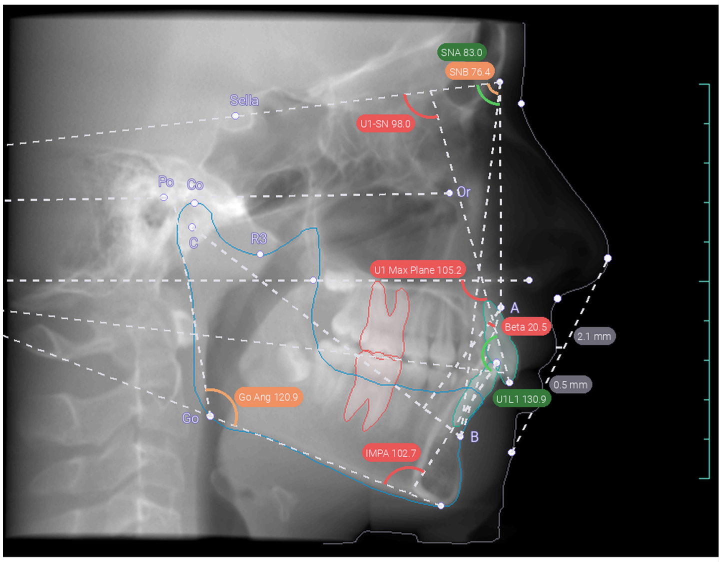


Figure 3. Lateral cephalogram with AI-assisted cephalometric landmarking (Diagnocat™, DGNCT LLC, Miami, FL, USA). The software automatically detects and labels key hard- and soft-tissue landmarks, traces maxillary/mandibular contours, and annotates the upper and lower incisor crown/root axes. The different colored contours represent automatically segmented anatomical structures generated by the Diagnocat software. Abbreviations: Gl, glabella; S (Sella), sella turcica; N, nasion; Soft N, soft-tissue nasion; Or, orbitale; Po, porion; Pt, pterygoid point; PNS, posterior nasal spine; ANS, anterior nasal spine; A, A-point; B, B-point; Pog, pogonion; Soft Pog, soft-tissue pogonion; Me, menton; Go, gonion; Co, condylion; Ar, articulare; Ba, basion; Pn, pronasale; Sn, subnasale; Ls, labrale superius; Li, labrale inferius; U1crown: upper central incisor incisal edge; U1root, upper central incisor root apex; L1crown: lower central incisor incisal edge; L1root, lower central incisor root apex.



	Name	Value R	Norm	Dev R
Vertical Relationship	SN-MP	28.4	32 ± 2	1.6
	FH-OP	8.0	9 ± 4	-
	Go Ang	120.9	130 ± 7	2.1
	Mid Height	46.8	49 ± 4	-
	Low Height	53.2	50 ± 5	-
A-Po Relationship	Beta	20.5	31 ± 2	8.5
	Wits	6.1	0 ± 1	5.1
	NSeAr	116.9	124 ± 5	2.1
	SNA	83.0	82 ± 2	-
	SNB	76.4	80 ± 2	1.6
	ANB	6.6	2 ± 2	2.6
	MP	63.0	71 ± 2	6.0
	S-N	67.9	70 ± 3	-
Soft	ULip to Eline	−2.1	−4 ± 2	-
	LLip to Eline	0.5	−2 ± 2	0.5
Incisor Relationship	Overjet	3.8	3 ± 1	-
	Overbite	5.1	3 ± 1	1.1
	U1-SN	98.0	105 ± 2	5.0
	U1-PP	105.2	110 ± 2	2.8
	U1-TVL (ANS)	−5.1	0 ± 1	4.1
	Interincisal	130.9	130 ± 6	-
	Li-MP	102.7	90 ± 5	7.7
	Shimbashi	13.5	18 ± 1	3.5

Moderate 1-2 deviations   Severe >2 deviations

Figure 4. Lateral cephalogram automatically landmarked and traced by the AI software Diagnocat™ (DGNCT LLC, Miami, FL, USA). The software computes skeletal (e.g., SNA, SNB, ANB; SN–MP; Go angle), dentoskeletal, dentoalveolar (e.g., U1–SN, U1–PP, IMPA, interincisal angle), and soft-tissue metrics (upper/lower lip to E-line), and displays each value alongside internal normative ranges and SD-based deviation flags (orange = moderate, red = severe). On the image, blue contours delineate the mandibular outline, red contours the maxillary and mandibular first molar, and green contours the maxillary and mandibular central incisors as automatically segmented by the software. White dashed lines represent cephalometric planes and lines, and colored angle arcs indicate computed angular values.

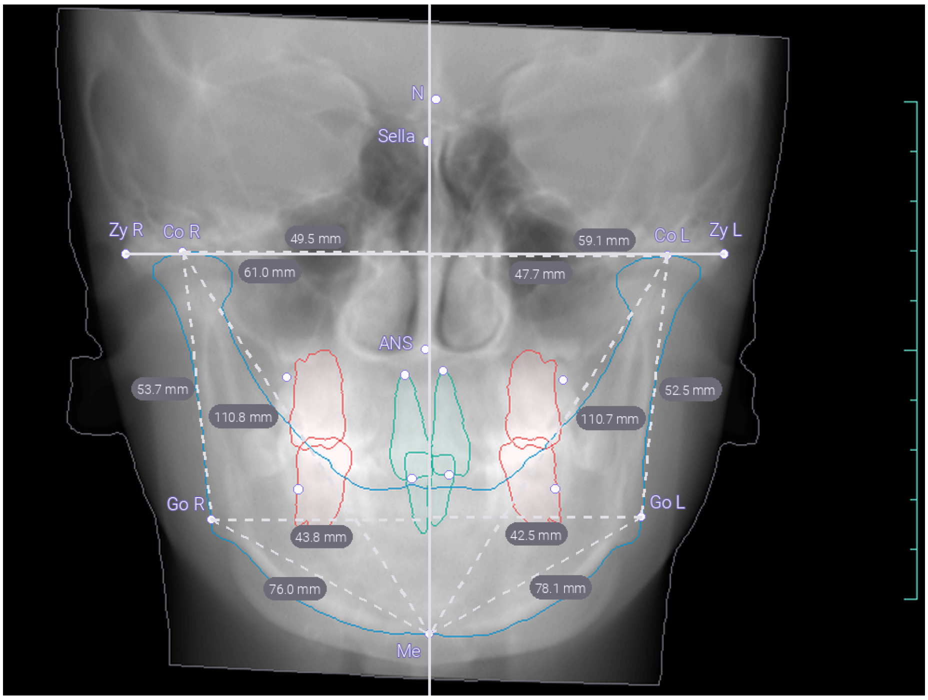


Figure 5. Frontal cephalometric image with automatic landmark recognition and tracing by AI (Diagnocat™, DGNCT LLC, Miami, FL, USA). Key bilateral points (Zy R/L, Co R/L, Go R/L) and midline references (N, Sella, ANS, Me) are detected and linear distances are displayed to assess transverse proportions and facial symmetry.

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Diagnocat Cephalometry (Comments) — Moderate 1-2 deviations; Severe >2 deviations

	Comments L	Deviation L	Value L	Name	Norm	Value R	Deviation R	Comments R	
Vertical Relationship	low angle	1.3	28.7	SN-MP	32 ± 2	28.4	1.6	low angle	Vertical Relationship
	normal growth pattern	-	7.9	FH-OP	9 ± 4	8.0	-	normal growth pattern	
	hypodivergent growth pattern	2.5	120.5	Go Ang	130 ± 7	120.9	2.1	hypodivergent growth pattern	
	normal mid height	-	46.8	Mid Height	49 ± 4	46.8	-	normal mid height	
	normal lower height	-	53.2	Low Height	50 ± 5	53.2	-	normal lower height	
A-Po Relationship	skeletal class II	8.8	20.2	Beta	31 ± 2	20.5	8.5	skeletal class II	A-Po Relationship
	skeletal class II	4.7	5.7	Wits	0 ± 1	6.1	5.1	skeletal class II	
	skeletal class I	-	122.1	NSeAr	124 ± 5	116.9	2.1	skeletal class II	
	normal maxillary position	-	83.0	SNA	82 ± 2	83.0	-	normal maxillary position	
	mandibular retroposition	1.6	76.4	SNB	80 ± 2	76.4	1.6	mandibular retroposition	
	skeletal class II	2.6	6.6	ANB	2 ± 2	6.6	2.6	skeletal class II	
	mandibular micrognathia	2.7	66.3	MP	71 ± 2	63.0	6.0	mandibular micrognathia	
	skull base length	-	67.9	S-N	70 ± 3	67.9	-	skull base length	
Soft	normal upper lip	-	−2.1	ULip to Eline	−4 ± 2	−2.1	-	normal upper lip	Soft
	protrusive lower lip	0.5	0.5	LLip to Eline	−2 ± 2	0.5	0.5	protrusive lower lip	
Incisor Relationship	normal overjet	-	3.5	Overjet	3 ± 1	3.8	-	normal overjet	Incisor Relationship
	normal overbite	-	3.6	Overbite	3 ± 1	5.1	1.1	excessive overbite	
	upper incisor retrusion	1.1	101.9	U1-SN	105 ± 2	98.0	5.0	upper incisor retrusion	
	normal inclination of the upper incisors	-	109.2	U1-PP	110 ± 2	105.2	2.8	upper incisor retrusion	
	upper incisor retrusion	2.9	−3.9	U1-TVL (ANS)	0 ± 1	−5.1	4.1	upper incisor retrusion	
	proclined incisors	5.5	118.5	Interincisal	130 ± 6	130.9	-	normal incisors inclination	
	lower incisor protrusion	15.8	110.8	Li-MP	90 ± 5	102.7	7.7	lower incisor protrusion	
		2.1	14.9	Shimbashi	18 ± 1	13.5	3.5		

Figure 6. Automated summary generated by the AI model (Diagnocat™, DGNCT LLC, Miami, FL, USA), pairing measured values with normative data and their interpretation. Deviation magnitude is color-coded (moderate/severe).

5.4. AI-Supported Age Estimation and Sex Prediction

AI has demonstrated strong performance in age and sex estimation using dental and craniofacial imaging. Convolutional neural networks developed for gender and age estimation from orthopantomograms have achieved prediction accuracies exceeding 95% for sex classification and age group differentiation, indicating their potential utility in forensic dentistry [63].

Sex determination remains a critical component of forensic identification. Lateral cephalometric radiographs provide a detailed representation of cranial morphology suitable for computational analysis. Handayani et al. developed and evaluated multiple CNN architectures—including VGG16, VGG19, MobileNetV2, ResNet50V2, InceptionV3, and InceptionResNetV2—using cephalometric radiographs of Indonesian individuals aged 18–40 years [64]. VGG19 and ResNet50V2 achieved high class-specific F1-scores, exceeding 90% overall accuracy, although performance decreased when applied to cranial photographs, highlighting challenges related to data imbalance and cross-modality generalization.

In addition to traditional developmental indicators of dentition and orthodontic treatment history, which assist in estimating chronological age in adolescents [19], AI systems can analyze dental metrics such as pulp-to-tooth ratios, tooth morphology, and bone structure from radiographs to predict age and sex with increasing accuracy [65,66] (Figure 7).

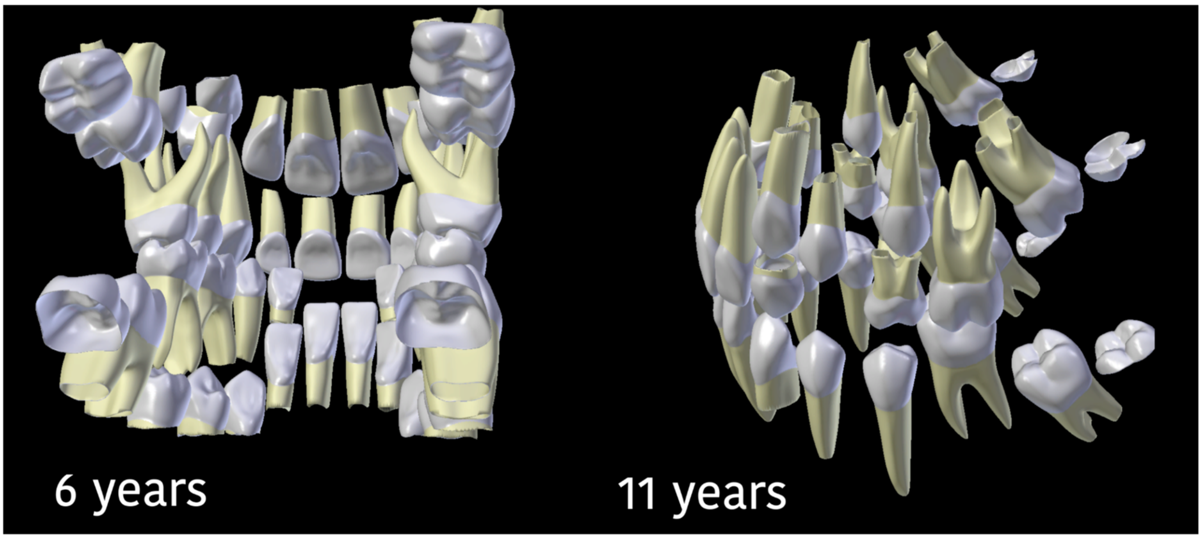

Figure 7. Three-dimensional tooth eruption sequence generated using eHuman Tooth Atlas 9™ digital anatomy software (eHuman Inc., Palo Alto, CA, USA). The left model represents the mixed dentition stage at approximately 6 years, while the right model depicts the same individual at around 11 years, illustrating the eruption of permanent incisors, canines, and premolars, as well as the exfoliation of deciduous teeth. The software allows continuous simulation of dental growth and eruption patterns, providing a valuable educational tool for studying age estimation and dental development. Colors indicate crown and root segmentation.

5.5. Pattern Matching, Record Linking, and Identification

AI techniques, particularly transfer learning, have been applied to pattern matching and record linking between AM and PM dental and craniofacial data. One study employed transfer learning for automatic human identification based on dental traits [67], while another introduced an algorithm for extracting cranial patterns from lateral cephalometric radiographs for identification purposes [26]. AI-assisted matching across large dental databases has the potential to enhance both the speed and objectivity of forensic identifications.

Tooth-based identification remains one of the most reliable methods in forensic odontology due to the individuality of dental structures. AI can further enhance this process by automating image analysis, supporting database matching, and improving the efficiency and accuracy of dental identification workflows [52].

5.6. AI and Bite Mark Analysis

AI has also been explored in bite mark analysis, where it may enhance image quality, automate comparison processes, and support the matching of bite patterns to dental records. These approaches aim to reduce subjectivity and human error while improving the efficiency of forensic investigations, although careful validation remains essential [52].

5.7. Disaster Victim Identification

In mass disaster victim identification (DVI), Interpol guidelines recognize dental and orthodontic records as primary identifiers [17]. Advances in AI-assisted superimposition techniques allow matching of AM three-dimensional skeletal reconstructions from CBCT data with corresponding scans, using alignment algorithms and distance color maps to support identification (Figure 8).

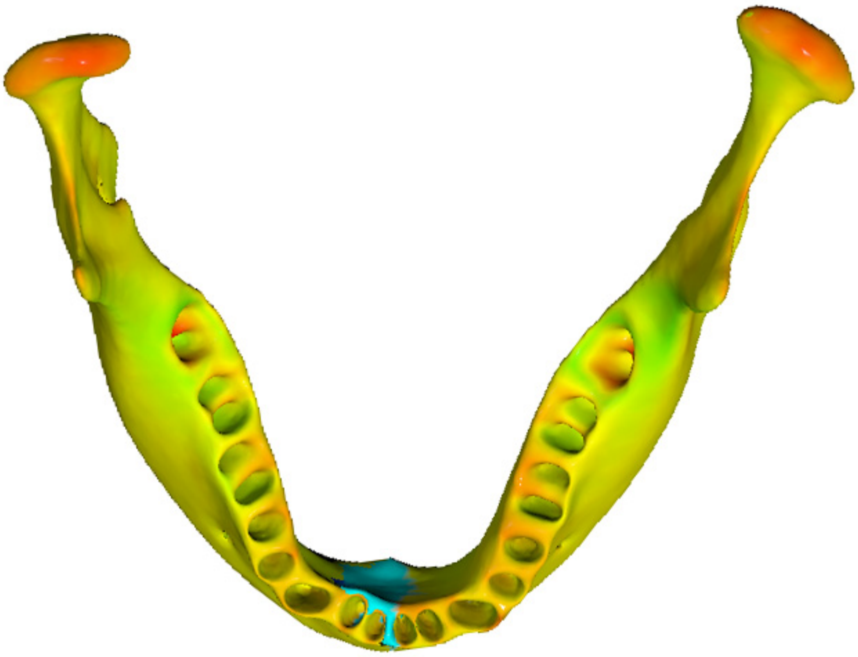

Figure 8. Superimposition of mandibular reconstructions from CBCTs taken at two different time points, illustrating growth changes in the condyle area. The color map represents surface deviation between the two time points, with warmer colors (yellow–red) indicating greater positive growth changes and cooler colors (green–blue) indicating minimal surface displacement.

5.8. Limitations, Ethics, and Forensic Admissibility

Despite the rapid advancement of artificial intelligence applications in forensic odontology and orthodontics, several limitations and ethical considerations constrain their routine forensic use. The performance of AI models is highly dependent on the quality, size, and representativeness of the training datasets. Biases related to population characteristics, imaging protocols, and data imbalance may limit generalizability and reduce reliability when models are applied outside their original development context [50–52].

Ethical issues, including patient consent, data privacy, and secure handling of sensitive dental and craniofacial information, are particularly relevant in forensic applications. The secondary use of clinical orthodontic records for forensic or research purposes requires clear regulatory frameworks and adherence to data protection principles. Additionally, many AI systems function as "black boxes," offering limited transparency regarding decision-making processes, which poses challenges for explainability and accountability in legal settings [51,52].

From a forensic standpoint, AI-based outputs should be regarded as decision-support tools rather than standalone evidence. The admissibility of AI-assisted analyses in court depends on method validation, reproducibility, and expert interpretability. Currently, the lack of standardized protocols, certified software, and universally accepted performance benchmarks limits the evidentiary weight of AI-generated results in forensic odontology. Consequently, AI-assisted findings must be interpreted by trained forensic experts and integrated with conventional odontological methods and multidisciplinary evidence [50–52].

6. Discussion

6.1. Forensic Value of Orthodontic Evidence: Strengths and Contributions

The integration of orthodontic data into forensic science enhances the reliability of human identification by providing durable and highly individualized records. Unlike fingerprints or DNA, which may degrade under extreme conditions, orthodontic appliances and dental records often survive and retain diagnostic value, particularly in mass disaster scenarios [17,19]. The increasing digitization of orthodontic records has further strengthened their forensic utility by improving accessibility, permanence, and the potential for rapid cross-matching across forensic databases [17,19].

The practical value of dental and orthodontic records in disaster victim identification has been demonstrated in multiple well-documented mass-fatality events. Following the M/S Estonia ferry disaster (1994), odontological evidence played a key role in identifying victims when other identifiers were unavailable, highlighting the robustness of dental comparisons in marine disasters [68]. In the Swissair Flight 111 crash (1998), dental records and radiographic comparisons were instrumental in victim identification due to the extensive fragmentation and thermal damage of remains [69]. Similarly, after the September 11 terrorist attacks (2001), forensic odontologists contributed substantially to victim identification through systematic comparison of dental records, often in combination with DNA analysis, owing to the extreme destruction of bodies [70]. During the Indian Ocean tsunami (2004), dental identification proved particularly effective for foreign victims, as pre-existing dental charts and radiographs enabled reliable ante-mortem and post-mortem matching [71]. While most mass-fatality identifications rely primarily on dental records, the Helios Airways Flight 522 disaster (Greece, 2005) illustrates the unique forensic value of orthodontic documentation and appliance configuration, with fixed appliances and extraction patterns contributing decisively to victim identification, including a pediatric case [72].

Orthodontic principles also contribute to archeological and anthropological interpretation of human remains. By examining how biomechanical forces influence jaw growth and occlusion, orthodontic analysis helps explain patterns of tooth wear, changes in jaw size, and the increasing prevalence of malocclusion and impacted third molars in modern populations. Differences in bite relationships—such as crowding, overbite, and crossbite—have been used to infer dietary and lifestyle transitions over time, with hunter-gatherer populations typically exhibiting larger jaws and less crowding compared with agricultural societies consuming softer diets. These observations link occlusion, function, and evolution across temporal contexts and provide insight into long-term shifts in human masticatory biology [73]. In addition, orthodontic cephalometric principles, including jaw relationships and facial proportions, are applied in facial reconstruction from skeletal remains, supporting both forensic identification and archeological or museum reconstructions [74].

Recent literature supports the growing recognition of orthodontics as a forensic resource. Thetakala et al. highlighted an increasing intersection between orthodontics and forensic applications through content analysis of national and international forensic odontology journals, reflecting expanding scholarly and clinical interest in this field [20]. In addition, Pires et al. systematically reviewed orthodontic records and confirmed their significant forensic value in human identification, noting that commonly used identifiers include intraoral photographs, panoramic radiographs, morphological characteristics (such as tooth rotation and crown shape), and therapeutic data related to orthodontic appliances [19].

Zhou et al. demonstrated that although orthodontic treatment alters craniofacial morphology, three-dimensional superimposition techniques remain reliable for facial recognition in forensic contexts [23]. Similarly, palatal rugae have shown remarkable stability and uniqueness, supporting their role as complementary identifiers when interpreted cautiously [41]. When combined with intraoral scans and other digital imaging modalities, CBCT datasets enable the construction of comprehensive three-dimensional anatomical profiles, supporting integrated digital and AI-assisted forensic analyses. The availability of quantitative and reproducible measurements supports biometric profiling and enhances the objectivity of human identification [32,34].

6.2. Limitations and Challenges in Forensic Application

Despite these strengths, several limitations constrain the forensic application of orthodontic evidence. Orthodontic treatment induces intentional morphological changes, and growth-related variation further complicates interpretation, particularly in younger individuals. Although studies indicate that orthodontic treatment does not invalidate forensic methods such as palatal rugae analysis, these structures may undergo measurable alterations, necessitating cautious interpretation and the use of supplementary identification techniques [43].

Variability in record-keeping practices represents a critical practical limitation. A survey among Croatian dentists revealed significant inconsistencies in the maintenance of dental records, limited awareness of legal obligations, and underestimation of their forensic importance, underscoring the gap between forensic potential and everyday clinical practice [75]. Differences in documentation standards across countries and clinics further limit the uniform forensic applicability of orthodontic records [20].

The increasing use of photographic evidence from social media introduces both opportunities and challenges. Smile photographs and selfies may contribute distinctive dental information, particularly involving the anterior dentition; however, orthodontic alignment may reduce the discriminative value of such images by altering tooth angulation and position. Consequently, smile-based identification should be combined with other forensic methods to enhance reliability [39].

6.3. Future Directions and Perspectives

Future developments in forensic odontology should prioritize the standardization of orthodontic record-keeping at national and international levels. The establishment of secure, standardized digital repositories within orthodontic clinics would facilitate the long-term preservation and forensic accessibility of AM data, enabling rapid comparison when conventional identification methods are unavailable [17,18]. Standardized, exportable digital outputs further facilitate long-term archiving and reliable ante-mortem/post-mortem comparison in forensic identification.

Emerging evidence suggests that orthodontic data may also support forensic age estimation. A recent study proposing a formula to predict the eruption timing of permanent canines and premolars in children aged 8–12 years demonstrated potential applicability beyond clinical orthodontics, extending to forensic age determination when interpreted within known biological variability [76].

Interdisciplinary collaboration between orthodontists, forensic odontologists, and forensic identification teams will be essential to translate these advances into routine forensic practice. Well-documented case reports and collaborative disaster victim identification exercises can further normalize orthodontics as a dependable forensic resource [21].

6.4. Practical, Educational, and Ethical Implications

As highlighted by Reddy et al., orthodontic records constitute a social responsibility within forensic odontology due to their high evidentiary value [1]. The forensic utility of orthodontic records is ultimately dependent on clinician awareness and documentation quality. Given the demonstrated deficiencies in record-keeping practices [75], there is a clear need to integrate forensic odontology into compulsory undergraduate and postgraduate dental curricula, complemented by continuing professional development [77–79]. Standardized photography, complete digital records, appliance documentation, and secure archiving should be emphasized as core elements of forensic readiness. Facial photographs, including smile images that capture distinctive dental and facial characteristics, may serve as a valuable adjunct in forensic identification when properly documented and archived [80,81].

Exceptional forensic scenarios further illustrate the importance of orthodontic documentation. In cases involving identical twins, where genetic and conventional identifiers may fail, orthodontic records have proven decisive for human identification, highlighting their unique discriminatory potential [72]. Machine-readable forensic reports enhance standardization, auditability, and rapid comparison of ante-mortem and post-mortem records, which is particularly relevant in large-scale forensic investigations.

Artificial intelligence introduces additional ethical and practical considerations. AI-based systems can integrate dental images, CBCT data, three-dimensional facial scans, and jaw-motion trajectories to enhance forensic identification [53]. However, concerns regarding data privacy, algorithmic bias, transparency, and over-reliance on automated outputs remain significant. Explainable AI is essential to ensure that forensic experts can interpret and critically evaluate algorithmic results. Consistent with current recommendations, AI should be regarded strictly as a supportive tool rather than a replacement for expert forensic judgment [51,82,83]. From a forensic perspective, the validation and reproducibility of artificial intelligence systems remain critical challenges. Many AI-based tools used in forensic dentistry and orthodontics are trained on institution-specific or retrospective datasets, which may limit generalizability across populations, imaging protocols, and acquisition devices. Reproducibility may also be affected by software updates, model retraining, and proprietary algorithms, making independent verification difficult in judicial contexts. These factors underscore the necessity for transparent reporting, external validation, and population-specific performance assessment before AI tools can be reliably integrated into routine forensic practice.

Despite the advances brought by digital technologies and AI, challenges remain regarding methodological standardization, population-specific validation, ethical safeguards, and legal admissibility in forensic practice [82].

7. Conclusions

Orthodontics constitutes a valuable and increasingly recognized forensic resource, offering detailed, longitudinal, and highly individualized records that can significantly support human identification. Orthodontic documentation—including dental records, radiographs, digital scans, appliances, and palatal rugae—may retain diagnostic value even when conventional identifiers are unavailable or compromised, reinforcing its relevance in forensic investigations [17,19].

The expanding digitization of orthodontic records and the integration of three-dimensional imaging and artificial intelligence further enhance the forensic applicability of orthodontic data by improving accessibility, analytical precision, and comparability across datasets [17,53,83]. At the same time, the forensic value of orthodontic evidence is highly dependent on clinician awareness, meticulous record-keeping, and adherence to ethical and legal standards, underscoring the medico-legal responsibilities of orthodontists [20,76].

When supported by standardized documentation practices, appropriate education, and responsible technological integration, orthodontics can function as a reliable adjunct within contemporary forensic odontology, contributing to accurate identification processes and supporting broader justice and humanitarian efforts worldwide [17,18,21].

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References

1. Reddy, G.; Reddy, V.P.; Sharma, M.; Aggarwal, M. Role of Orthodontics in Forensic Odontology—A Social Responsibility. *J. Clin. Diagn. Res.* **2016**, *10*, ZE01-3. [CrossRef] [PubMed] [PubMed Central]
2. Pittayapat, P.; Jacobs, R.; De Valck, E.; Vandermeulen, D.; Willems, G. Forensic odontology in the disaster victim identification process. *J. Forensic Odontostomatol.* **2012**, *30*, 1–12. [PubMed] [PubMed Central]
3. Emam, N.M. Role of Forensic Odontology in Identification of Persons: A Review Article. *Cureus* **2024**, *16*, e56570. [CrossRef] [PubMed] [PubMed Central]
4. Kataria, S.; Shinkre, R.; Jain, S.; Saraswathy, K.N.; Sachdeva, M.P.; Kumar, K.M. From teeth to ethnicity: A neural network approach to predicting population of origin through dental traits and anomalies. *J. Oral Maxillofac. Pathol.* **2024**, *28*, 515–525. [CrossRef] [PubMed] [PubMed Central]
5. Angelakopoulos, N.; Sharma, S.; Balla, S.B.; Zolotenkova, G.; De Luca, S. Assessing the accuracy of the third molar eruption as an indicator of adulthood: Findings from a black South African sample using the Gambier method. *Int. J. Leg. Med.* **2025**, *139*, 2313–2322. [CrossRef] [PubMed] [PubMed Central]
6. Ruder, T.D.; Kuhnen, S.C.; Zech, W.D.; Klaus, J.B.; Lombardo, P.; Ith, M. Standards of practice in forensic age estimation with CT of the medial clavicular epiphysis-a systematic review. *Int. J. Leg. Med.* **2023**, *137*, 1757–1766. [CrossRef] [PubMed] [PubMed Central]
7. Tokinaga, R.; Mine, Y.; Yoshimi, Y.; Okazaki, S.; Ito, S.; Takeda, S.; Ogawa, S.; Peng, T.Y.; Kakimoto, N.; Tanimoto, K.; et al. Age Estimation from Lateral Cephalograms Using Deep Learning: A Pilot Study from Early Childhood to Older Adults. *J. Clin. Med.* **2025**, *14*, 7084. [CrossRef] [PubMed] [PubMed Central]
8. Lahza, H.; Alsheikhy, A.A.; Said, Y.; Shawly, T. A Deep Learning Approach to Predict Chronological Age. *Healthcare* **2023**, *11*, 448. [CrossRef] [PubMed] [PubMed Central]
9. Kvaal, S.I.; Kolltveit, K.M.; Thomsen, I.O.; Solheim, T. Age estimation of adults from dental radiographs. *Forensic Sci. Int.* **1995**, *74*, 175–185. [CrossRef] [PubMed]
10. Schmeling, A.; Grundmann, C.; Fuhrmann, A.; Kaatsch, H.J.; Knell, B.; Ramsthaler, F.; Reisinger, W.; Riepert, T.; Ritz-Timme, S.; Rösing, F.W.; et al. Criteria for age estimation in living individuals. *Int. J. Leg. Med.* **2008**, *122*, 457–460. [CrossRef] [PubMed]
11. Khatam-Lashgari, A.; Harving, M.L.; Villa, C.; Lynnerup, N.; Larsen, S.T. Forensic age estimation of the knee by post-mortem DR, CT, and MR imaging: A comparative study. *Int. J. Leg. Med.* **2024**, *138*, 971–981. [CrossRef] [PubMed] [PubMed Central]
12. De Donno, A.; Angrisani, C.; Mele, F.; Introna, F.; Santoro, V. Dental age estimation: Demirjian's versus the other methods in different populations. A literature review. *Med. Sci. Law* **2021**, *61*, 125–129. [CrossRef] [PubMed]
13. Senn, D.R.; Stimson, P.G. (Eds.) *Forensic Dentistry*, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2010; ISBN 9781420078367.
14. Kartheek, G.; Singh, R.; Penigalapati, D.C.; Gupta, M.; Singh, J.R.; Chaudhary, V. Dental arch structure as a potential tool in forensic individual identification. *Front. Health Inform.* **2024**, *13*, 8693–8697.
15. Sributsayakarn, N.; Intharah, T.; Hirunchavarod, N.; Pornprasertsuk-Damrongsri, S.; Jirarattanasopha, V. Automated Age and Sex Estimation from Dental Panoramic Radiographs. *Int. Dent. J.* **2025**, *75*, 103967. [CrossRef] [PubMed] [PubMed Central]
16. Tajik, M.; Movahhedian, N. Canine sexual dimorphism in crown and root dimensions: A cone-beam computed tomographic study. *J. Forensic Odontostomatol.* **2024**, *42*, 12–21. [CrossRef] [PubMed] [PubMed Central]
17. INTERPOL. *Disaster Victim Identification Guide*; International Criminal Police Organization (INTERPOL): Lyon, France, 2023; Available online: https://www.interpol.int/content/download/589/file/DVI_DVI%20Guide%202023.pdf (accessed on 29 January 2026).
18. Hanafi, M.G.S.; Utsuno, H.; Namiki, S.; Aoki, N.; Saitoh, H.; Minegishi, S.; Yamada, S.; Makino, Y.; Iwase, H.; Sakurada, K. Assessing the contribution of orthodontic profiles in predicting facial soft tissue thickness for forensic facial approximation. *Int. J. Leg. Med.* **2025**, *139*, 2951–2964. [CrossRef] [PubMed] [PubMed Central]
19. Pires, C.D.; da Silva, D.T.; Paranhos, L.R.; Franco, A. Forensic value of orthodontic records for human identification: A systematic review. *Acta Sci. Health Sci.* **2024**, *46*, e64703. [CrossRef]
20. Thetakala, R.K.; Chandrashekar, B.R.; Sunitha, S.; Sharma, P. The relationship of forensic odontology with various dental specialties in the articles published in a National and an International Forensic Odontology Journal: A 5-year content analysis. *J. Forensic Dent. Sci.* **2017**, *9*, 65–72. [CrossRef] [PubMed] [PubMed Central]

21. Rath, S.K.; Panda, S.M. Orthodontic Forensic Science: The Unseen Part of our Profession. *J. Forensic Res.* **2017**, *8*, 378. [CrossRef]
22. Nestman, T.S.; Marshall, S.D.; Qian, F.; Holton, N.; Franciscus, R.G.; Southard, T.E. Cervical vertebrae maturation method morphologic criteria: Poor reproducibility. *Am. J. Orthod. Dentofac. Orthop.* **2011**, *140*, 182–188. [CrossRef] [PubMed]
23. Zhou, Q.; Wang, J.; Tang, Y.; Bu, W.; Gao, J.; Du, S.; Guo, Y.; Guo, Y.; Meng, H. Evaluation of the effect of orthodontic treatment on the reliability of facial recognition by using three-dimensional model superimposition technique. *Forensic Sci. Int.* **2024**, *364*, 112253. [CrossRef] [PubMed]
24. Chalazoniti, A.; Lattanzi, W.; Halazonetis, D.J. Shape variation and sex differences of the adult human mandible evaluated by geometric morphometrics. *Sci. Rep.* **2024**, *14*, 8546. [CrossRef] [PubMed] [PubMed Central]
25. Christoloukas, N.; Mitsea, A.; Rontogianni, A.; Papadakis, E.; Angelopoulos, C. Evaluation of Bitemark Analysis's Potential Application in Forensic Identification: A Systematic Review. *Diagnostics* **2024**, *14*, 1180. [CrossRef] [PubMed] [PubMed Central]
26. Kavousinejad, S.; Yazdanian, M.; Kanafi, M.M.; Tahmasebi, E. A Novel Algorithm for Forensic Identification Using Geometric Cranial Patterns in Digital Lateral Cephalometric Radiographs in Forensic Dentistry. *Diagnostics* **2024**, *14*, 1840. [CrossRef] [PubMed] [PubMed Central]
27. Kofod Petersen, A.; Forgie, A.; Bindslev, D.A.; Villesen, P.; Staun Larsen, L. Automatic removal of soft tissue from 3D dental photo scans; an important step in automating future forensic odontology identification. *Sci. Rep.* **2024**, *14*, 12421. [CrossRef] [PubMed] [PubMed Central]
28. Thube, H.R.; Vaswani, V.; Chandwani, N.; Shrigiriwar, M. Morphometric Analysis of Mandibular Ramus Indices for Sex Prediction Using Digital Orthopantomograms (OPGs) and the GNU Image Manipulation Program (GIMP) Software. *Cureus* **2025**, *17*, e93520. [CrossRef] [PubMed] [PubMed Central]
29. Sagarika, P.; Ponraj, S.; Ramar, K.; S, R. Assessment of Sexual Dimorphism Through Lateral Cephalogram in Children Aged 10-12 Years. *Cureus* **2024**, *16*, e64107. [CrossRef] [PubMed] [PubMed Central]
30. De Sousa, D.R.A.M.; Lisboa, C.P.R.; Franco, A.; Junqueira, J.L.C.; Oenning, A.C.; Nascimento Narchini, M.D.C.; Soares, M.Q.S. Human identification through smile photographs: Comparison of two methods based on selfies. *J. Forensic Sci.* **2025**, *70*, 1181–1187. [CrossRef] [PubMed]
31. Nagy, Z.; Mikolicz, A.; Vag, J. In-vitro accuracy of a novel jaw-tracking technology. *J. Dent.* **2023**, *138*, 104730. [CrossRef] [PubMed]
32. Umamaheswari, T.N.; Evanjelin, P.J. Distinctive Anatomical Patterns of the Mandibular Coronoid Process, Condyle, and Sigmoid Notch: Cone Beam Computed Tomography (CBCT) Imaging for Advanced Personal Identification. *Cureus* **2024**, *16*, e60978. [CrossRef]
33. Yüksel, İ.B.; Altındağ, A. Age estimation based on pulp/tooth volume ratio using CBCT: A study on mandibular canines. *BMC Oral Health* **2025**, *25*, 1248. [CrossRef] [PubMed] [PubMed Central]
34. Issrani, R.; Prabhu, N.; Sghaireen, M.G.; Ganji, K.K.; Alqahtani, A.M.A.; ALJamaan, T.S.; Alanazi, A.M.; Alanazi, S.H.; Alam, M.K.; Munisekhar, M.S. Cone-Beam Computed Tomography: A New Tool on the Horizon for Forensic Dentistry. *Int. J. Environ. Res. Public. Health* **2022**, *19*, 5352. [CrossRef] [PubMed] [PubMed Central]
35. von See, C.; Bormann, K.H.; Schumann, P.; Goetz, F.; Gellrich, N.C.; Rücker, M. Forensic imaging of projectiles using cone-beam computed tomography. *Forensic Sci. Int.* **2009**, *190*, 38–41. [CrossRef] [PubMed]
36. Bapelle, M.; Dubromez, J.; Savoldelli, C.; Tillier, Y.; Ehrmann, E. Modjaw® device: Analysis of mandibular kinematics recorded for a group of asymptomatic subjects. *Cranio* **2024**, *42*, 483–489. [CrossRef] [PubMed]
37. Kumar, L.; Maiti, S. Comparative evaluation of the accuracy of three different three-dimensional facial scanning systems: An observational crossover study. *J. Indian Prosthodont. Soc.* **2025**, *25*, 220–228. [CrossRef] [PubMed] [PubMed Central]
38. Shuto, T.; Mine, Y.; Tani, A.; Taji, T.; Murayama, T. Facial Scans in Clinical Dentistry and Related Research: A Scoping Review. *Cureus* **2025**, *17*, e81662. [CrossRef] [PubMed] [PubMed Central]
39. Miranda, G.E.; Freitas, S.G.; Maia, L.V.A.; Melani, R.F.H. An unusual method of forensic human identification: Use of selfie photographs. *Forensic Sci. Int.* **2016**, *263*, e14–e17. [CrossRef] [PubMed]
40. Mikó, S.; Shahbazi, A.; Pellei, D.; Simon, B.; Vág, J. Development of an experimental model for assessment of palatal tissue decomposition by intraoral scanner. *Forensic Sci. Int.* **2025**, *366*, 112303. [CrossRef] [PubMed]
41. Caldas, I.M.; Magalhães, T.; Afonso, A. Establishing identity using cheiloscopy and palatoscopy. *Forensic Sci. Int.* **2007**, *165*, 1–9. [CrossRef] [PubMed]
42. Lanteri, V.; Cossellu, G.; Farronato, M.; Ugolini, A.; Leonardi, R.; Rusconi, F.; De Luca, S.; Biagi, R.; Maspero, C. Assessment of the Stability of the Palatal Rugae in a 3D-3D Superimposition Technique Following Slow Maxillary Expansion (SME). *Sci. Rep.* **2020**, *10*, 2676. [CrossRef] [PubMed] [PubMed Central]
43. Spindola, M.O.P.; Gatis, M.C.d.Q.; Sousa, E.H.A.d.; Andrade, E.S.d.S. Interference of Orthodontic Treatment in the Human Identification Process by the Palatine Rugae. *Rev. DCS* **2025**, *22*, e3005. [CrossRef]
44. Shailaja, A.M.; Romana, I.R.U.; Narayanappa, G.; Smitha, T.; Gowda, N.C.; Vedavathi, H.K. Assessment of palatal rugae pattern and its significance in orthodontics and forensic odontology. *J. Oral Maxillofac. Pathol.* **2018**, *22*, 430–435. [CrossRef] [PubMed] [PubMed Central]

45. Santhosh Kumar, S.; Chacko, R.; Kaur, A.; Ibrahim, G.; Ye, D. A Systematic Review of the Use of Intraoral Scanning for Human Identification Based on Palatal Morphology. *Diagnostics* **2024**, *14*, 531. [CrossRef] [PubMed] [PubMed Central]
46. Makrygiannakis, M.A.; Konstantonis, D.; Vastardis, H.; Athanasiou, A.E.; Halazonetis, D.J. Palatal rugae change shape following orthodontic treatment: A comparison between extraction and non-extraction borderline cases using fractal analysis and 3D superimposition. *Eur. J. Orthod.* **2024**, *47*, cjae070. [CrossRef] [PubMed] [PubMed Central]
47. Gupta, A.A.; Kheur, S.; Alshehri, A.; Awadh, W.; Ahmed, Z.H.; Feroz, S.M.A.; Khan, S.S.; Mushtaq, S.; Dewan, H.; Khurshid, Z.; et al. Is Palatal Rugae Pattern a Reliable Tool for Personal Identification following Orthodontic Treatment? A Systematic Review and Meta-Analysis. *Diagnostics* **2022**, *12*, 418. [CrossRef] [PubMed] [PubMed Central]
48. Trizzino, A.; Messina, P.; Sciarra, F.M.; Zerbo, S.; Argo, A.; Scardina, G.A. Palatal Rugae as a Discriminating Factor in Determining Sex: A New Method Applicable in Forensic Odontology? *Dent. J.* **2023**, *11*, 204. [CrossRef] [PubMed] [PubMed Central]
49. Rippy, M. A clear new way to identify decedents: The role of clear orthodontic appliances in forensic identification. *J. Forensic Ident.* **2021**, *71*, 263–274.
50. Mallineni, S.K.; Sethi, M.; Punugoti, D.; Kotha, S.B.; Alkhayal, Z.; Mubaraki, S.; Almotawah, F.N.; Kotha, S.L.; Sajja, R.; Nettam, V.; et al. Artificial Intelligence in Dentistry: A Descriptive Review. *Bioengineering* **2024**, *11*, 1267. [CrossRef] [PubMed] [PubMed Central]
51. Piraianu, A.I.; Fulga, A.; Musat, C.L.; Ciobotaru, O.R.; Poalelungi, D.G.; Stamate, E.; Ciobotaru, O.; Fulga, I. Enhancing the Evidence with Algorithms: How Artificial Intelligence Is Transforming Forensic Medicine. *Diagnostics* **2023**, *13*, 2992. [CrossRef] [PubMed] [PubMed Central]
52. Vodanović, M.; Subašić, M.; Milošević, D.P.; Galić, I.; Brkić, H. Artificial intelligence in forensic medicine and forensic dentistry. *J. Forensic Odontostomatol.* **2023**, *41*, 30–41. [PubMed] [PubMed Central]
53. Khanagar, S.B.; Albalawi, F.; Alshehri, A.; Awawdeh, M.; Iyer, K.; Alsomaie, B.; Aldhebaib, A.; Singh, O.G.; Alfadley, A. Performance of Artificial Intelligence Models Designed for Automated Estimation of Age Using Dento-Maxillofacial Radiographs-A Systematic Review. *Diagnostics* **2024**, *14*, 1079. [CrossRef] [PubMed] [PubMed Central]
54. Bağ, İ.; Bilgir, E.; Bayrakdar, İ.Ş.; Baydar, O.; Atak, F.M.; Çelik, Ö.; Orhan, K. An artificial intelligence study: Automatic description of anatomic landmarks on panoramic radiographs in the pediatric population. *BMC Oral Health* **2023**, *23*, 764. [CrossRef] [PubMed] [PubMed Central]
55. Wesp, P.; Schachtner, B.M.; Jeblick, K.; Topalis, J.; Weber, M.; Fischer, F.; Penning, R.; Ricke, J.; Ingrisch, M.; Sabel, B.O. Radiological age assessment based on clavicle ossification in CT: Enhanced accuracy through deep learning. *Int. J. Leg. Med.* **2024**, *138*, 1497–1507. [CrossRef] [PubMed] [PubMed Central]
56. Thurzo, A.; Kosnáčová, H.S.; Kurilová, V.; Kosmeľ, S.; Beňuš, R.; Moravanský, N.; Kováč, P.; Kuracinová, K.M.; Palkovič, M.; Varga, I. Use of Advanced Artificial Intelligence in Forensic Medicine, Forensic Anthropology and Clinical Anatomy. *Healthcare* **2021**, *9*, 1545. [CrossRef] [PubMed] [PubMed Central]
57. Jung, S.K.; Kim, T.W. New approach for the diagnosis of extractions with neural network machine learning. *Am. J. Orthod. Dentofac. Orthop.* **2016**, *149*, 127–133. [CrossRef] [PubMed]
58. Park, J.H.; Hwang, H.W.; Moon, J.H.; Yu, Y.; Kim, H.; Her, S.B.; Srinivasan, G.; Aljanabi, M.N.A.; Donatelli, R.E.; Lee, S.J. Automated identification of cephalometric landmarks: Part. 1-Comparisons between the latest deep-learning methods YOLOV3 and SSD. *Angle Orthod.* **2019**, *89*, 903–909. [CrossRef] [PubMed] [PubMed Central]
59. Choi, H.I.; Jung, S.K.; Baek, S.H.; Lim, W.H.; Ahn, S.J.; Yang, I.H.; Kim, T.W. Artificial Intelligent Model with Neural Network Machine Learning for the Diagnosis of Orthognathic Surgery. *J. Craniofac. Surg.* **2019**, *30*, 1986–1989, Erratum in *J. Craniofac. Surg.* **2020**, *31*, 1156. https://doi.org/10.1097/SCS.0000000000006531. [CrossRef] [PubMed]
60. Kök, H.; Acilar, A.M.; İzgi, M.S. Usage and comparison of artificial intelligence algorithms for determination of growth and development by cervical vertebrae stages in orthodontics. *Prog. Orthod.* **2019**, *20*, 41. [CrossRef] [PubMed] [PubMed Central]
61. Prabhu, V.D.; Saidath, K.; Suvarna, N.; Mohtesham, I.; Shenoy, S.; Prabhu, R.V. Artificial Intelligence and Dentistry: The Future. *J. Pharm. Bioallied Sci.* **2024**, *16*, S4257–S4261. [CrossRef] [PubMed] [PubMed Central]
62. Wei, G.; Cui, Z.; Zhu, J.; Yang, L.; Zhou, Y.; Singh, P.; Gu, M.; Wang, W. Dense representative tooth landmark/axis detection network on 3D model. *Comput. Aided Geom. Des.* **2022**, *94*, 102077. [CrossRef]
63. Hundur Hiyari, M.; Pasic, M.; Zukic, S. Application of Convolutional Neural Networks for Determining Gender and Age in Forensic Dentistry. *Cureus* **2024**, *16*, e73028. [CrossRef] [PubMed] [PubMed Central]
64. Handayani, V.W.; Margareth Amiatun Ruth, M.S.; Rulaningtyas, R.; Caesarardhi, M.R.; Yudhantorro, B.A.; Yudianto, A. Development and evaluation of a convolutional neural network model for sex prediction using cephalometric radiographs and cranial photographs. *BMC Med. Imaging* **2025**, *25*, 348. [CrossRef] [PubMed] [PubMed Central]
65. Ali, M.; Raza, H.; Gan, J.Q.; Pokhojaev, A.; Katz, M.; Kosan, E.; Wahjuningrum, D.A.; Saleh, O.; Sarig, R.; Chaurasia, A. An explainable machine learning approach for age and gender estimation in living individuals using dental biometrics. *arXiv* **2024**, arXiv:2411.08195. [CrossRef]

66. Rokhshad, R.; Nasiri, F.; Saberi, N.; Shoorgashti, R.; Ehsani, S.S.; Nasiri, Z.; Azadi, A.; Schwendicke, F. Deep learning for age estimation from panoramic radiographs: A systematic review and meta-analysis. *J. Dent.* **2025**, *154*, 105560. [CrossRef] [PubMed]
67. Sathya, B.; Neelaveni, R. Transfer Learning Based Automatic Human Identification using Dental Traits- An Aid to Forensic Odontology. *J. Forensic Leg. Med.* **2020**, *76*, 102066. [CrossRef] [PubMed]
68. Soomer, H.; Ranta, H.; Penttilä, A. Identification of victims from the M/S Estonia. *Int. J. Leg. Med.* **2001**, *114*, 259–262. [CrossRef] [PubMed]
69. Robb, N. 229 people, 15,000 body parts: Pathologists help solve Swissair 111's grisly puzzles. *CMAJ* **1999**, *160*, 241–243.
70. Miller, R.G. Forensic odontology in disaster victim identification. *J. Forensic Sci.* **2024**, *69*, 1630–1636. [CrossRef] [PubMed]
71. Schuller-Götzburg, P.; Suchanek, J. Forensic odontologists successfully identify tsunami victims in Phuket, Thailand. *Forensic Sci. Int.* **2007**, *171*, 204–207. [CrossRef] [PubMed]
72. Rontogianni, A.; Mitsea, A.; Karayianni, K. The role of orthodontics in children identification: A case report of two victims of mass disaster. *J. Forensic Odontostomatol.* **2024**, *42*, 2–11. [CrossRef] [PubMed] [PubMed Central]
73. Fiorin, E.; Cadafalch, J.; Ceperuelo, D.; Adserias Adserias, M.J.; Chimenos-Küstner, E.; Malgosa, A. Study of dental occlusion in ancient human remains: A methodological approach. *Coll. Antropol.* **2014**, *38*, 993–1000. [PubMed]
74. Dias, P.E.; Miranda, G.E.; Beaini, T.L.; Melani, R.F. Practical Application of Anatomy of the Oral Cavity in Forensic Facial Reconstruction. *PLoS ONE* **2016**, *11*, e0162732. [CrossRef] [PubMed] [PubMed Central]
75. Savić Pavičin, I.; Jonjić, A.; Maretić, I.; Dumančić, J.; Zymber Çeshko, A. Maintenance of Dental Records and Forensic Odontology Awareness: A Survey of Croatian Dentists with Implications for Dental Education. *Dent. J.* **2021**, *9*, 37. [CrossRef] [PubMed] [PubMed Central]
76. Djaharu'ddin, I. Prediction Formula of Permanent Canine and Premolar Eruption in Mixed Dentition Patients at Universitas Airlangga, Dental Hospital Surabaya, Indonesia. *Contemp. Clin. Dent.* **2019**, *10*, 105–109. [CrossRef] [PubMed] [PubMed Central]
77. Giannakopoulos, K.; Lambrou-Christodoulou, P.; Kaklamanos, E.G. Awareness of Forensic Odontology among Dental Students and Faculty in Cyprus: A Survey-Based Study. *Dent. J.* **2023**, *12*, 6. [CrossRef] [PubMed] [PubMed Central]
78. Giannakopoulos, K.; Lambrou, P.; Kaklamanos, E.G.; Aristotelous, A. The anthropological process of identifying missing persons as a teaching method for increasing awareness in legal and forensic dentistry in the Republic of Cyprus. *Forensic Sci.* **2024**, *4*, 598–603. [CrossRef]
79. Gupta, S.; Sikka, N.; Kamboj, M.; Hooda, A.; Devi, A.; Narwal, A. Dental professional's perspective regarding knowledge, awareness, and attitude towards the importance of charting dental anomalies: A cross-sectional study. *J. Forensic Odontostomatol.* **2023**, *41*, 52–61. [PubMed] [PubMed Central]
80. Terada, A.S.; Araujo, L.G.; Paranhos, L.R.; Silveira, T.C.; Guimarães, M.A.; Silva, R.H. Orthodontic use of documentation in identification of a skeletonized body in legal dental practice. *Int. J. Odontostomatol.* **2014**, *8*, 41–46. [CrossRef]
81. Anees, W.; Riaz, F.; Franco, A. Use of artificial intelligence in forensic dentistry: A review of literature. *Rev. Bras. Odontol. Leg.* **2024**, *11*, 81–95.
82. Jeddy, N.; Ravi, S.; Radhika, T. Current trends in forensic odontology. *J. Forensic Dent. Sci.* **2017**, *9*, 115–119.
83. Radu, C.C.; Hogea, T.; Carașca, C.; Radu, C.M. Forensic Odontology in the Digital Era: A Narrative Review of Current Methods and Emerging Trends. *Diagnostics* **2025**, *15*, 2550. [CrossRef] [PubMed] [PubMed Central]