



The Evolution of Dental Radiology Applications in Forensic Odontology: A Bibliometric Study

Menduh Sercan KAYA

¹Specialist Dr., Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Dicle University.
Corresponding Author: Menduh Sercan Kaya

Date of Submission: 09-05-2026

Date of Acceptance: 19-05-2026

ABSTRACT: This study was conducted to analyze the bibliometric structure of the literature regarding the use of radiographic imaging methods in Forensic Odontology. Data were obtained from the Web of Science Core Collection database. Annual Scientific Production, Most Cited Documents, Trending Topics, Thematic Map, and Thematic Evolution analyses were performed. The findings demonstrated that scientific production in the field has increased, particularly in recent years. Research trends in the related field have evolved from classical identification methods toward cone-beam computed tomography, artificial intelligence, and deep learning-based applications in parallel with technological advancements and increasing digital transformation.

KEYWORDS: Age Estimation, Artificial Intelligence, Bibliometric Analysis, Cone-Beam Computed Tomography, Forensic Odontology.

I. INTRODUCTION

Forensic Odontology is a branch of dentistry that deals with legal issues [1]. This field analyzes the data obtained from the examination of the dentomaxillofacial region using scientific methods and presents the findings to the relevant legal authorities [2]. Basically, it aims to establish personal identification by comparing antemortem and postmortem records [3]. Dentistry has several advantages for identification purposes. First of all, the dentomaxillary structure of each individual is unique and provides information about the person's genetic characteristics, social life, and age [4]. Teeth are relatively more resistant to chemical, physical, and mechanical forces compared to other body structures. In addition, dental restorative and prosthetic materials vary from person to person and

may be useful for identification purposes [3, 4]. Although there are many methods used for identification in dentistry, one of the most advantageous approaches is radiographic evaluation [5]. Various identifying parameters can be evaluated using radiographic records. These include crown-root morphologies, dental pathologies, dental anomalies, structural characteristics of the periodontium, dental restorations, and anatomical structures in the dentomaxillofacial region [6, 7]. Forensic Odontology is an expanding field, and various radiographic techniques are used in this area [8].

The literature in this field is expanding, making it increasingly difficult to evaluate the evolution and main research themes of the related area. Therefore, it is necessary to examine the development of the literature, research trends, thematic changes, and conceptual structure. Bibliometric analysis is a highly useful method for performing these evaluations. In this way, Annual Scientific Production, Most Cited Documents, Trending Topics, and Thematic Evolution Analysis can be investigated [9-11]. Although several bibliometric studies related to Forensic Odontology have been reported, information regarding bibliometric analyses focusing on forensic odontology and radiographic techniques remains limited in the literature [12-14].

Therefore, the aim of this study is to investigate radiographic evaluation methods in Forensic Odontology. In the present study, Annual Scientific Production, Most Cited Documents, Trending Topics, Thematic Map, and Thematic Evolution Analysis were evaluated to examine the current structure of the literature, research trends, and the thematic evolution of the field over time.

II. MATERIALS AND METHODS

This study was designed as a bibliometric analysis evaluating dental radiographic techniques in terms of Forensic Odontology. The aim of this study was to perform descriptive, thematic, trend, and conceptual structure analyses of the literature

related to dental radiography in the field of forensic odontology. Since no human or animal subjects were involved in the present study, ethical approval was not required.



For data collection, the Web of Science Core Collection (WoSCC) database was searched using the following query: (("forensic odontology" OR "forensic dentistry") AND (radiology OR radiography OR imaging)). Articles indexed between 1995 and 2025 were evaluated. Editorial letters, conference proceedings, and publications not related to the use of dental radiology in the field of Forensic Odontology were excluded in order to increase the homogeneity of the dataset.

Bibliometric analyses related to the present topic were performed using the bibliometrix package (version 5.3.0) through R (version 4.6.0), RStudio, and Biblioshiny. Within the scope of descriptive bibliometric analyses, Annual Scientific Production and Most Cited Documents were

III. RESULTS

Considering the exclusion criteria, a total of 362 publications were identified. Evaluation of Annual Scientific Production revealed fluctuations between 1995 and 2005, with a relatively lower number of scientific publications in this field compared to subsequent years. Between 2006 and 2025, a generally higher level of scientific production related to the topic was observed, and the rate of increase became more pronounced after 2018. Due to this continuously increasing trend, the highest Annual Scientific Production was observed in 2025 (Figure 1).

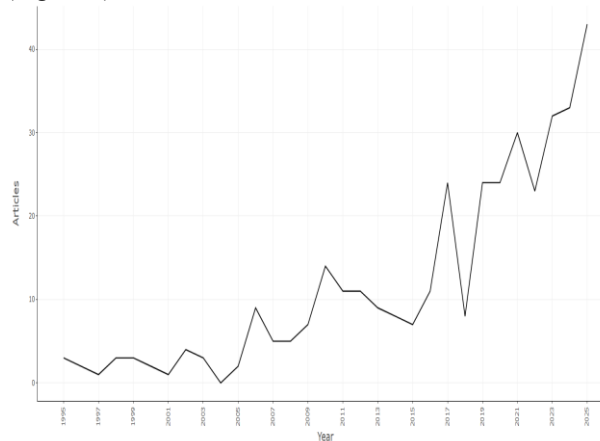


Figure 1. Annual Scientific Production related to forensic dental radiology between 1995 and 2025.

Evaluation of the Most Cited Documents revealed that the most highly cited scientific publication was the study by Cameriere et al. [15] with 135 citations, followed respectively by the studies of Yang et al. [16] with 133 citations and Marroquin et al. [17] with 90 citations.

Trending Topics analysis demonstrated that the dominant terms in the early period of the field

examined. Trending Topics were evaluated as part of the trend analyses. In addition, Thematic Map analysis and Thematic Evolution Analysis were performed within the scope of thematic analyses.

Network-based clustering approaches were used to investigate the conceptual structure and dominant themes related to the present topic. In this context, research trends and thematic changes in the literature were evaluated through Authors' Keywords. In the generated networks, color thickness represented co-occurrence strength, colors indicated different thematic clusters, and node size reflected keyword frequency. Within the scope of thematic analysis, basic themes, motor themes, niche themes, and emerging/declining themes were examined.

were "dental radiography," "bite mark," "dental identification," and "forensic science." In the middle period, the terms "forensic odontology," "identification," "human identification," "age estimation," and "tomography" became prominent. In recent years, "cone-beam computed tomography," "CBCT," "panoramic radiography," "dental age estimation," "deep learning," and "artificial intelligence" have emerged as the dominant topics (Figure 2).

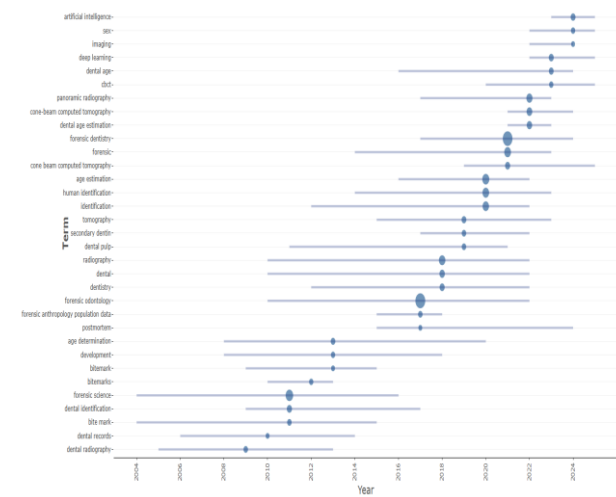


Figure 2. Trending Topics in the Literature of Forensic Odontology and Dental Radiology.

Evaluation of the Thematic Map analysis revealed that the terms "forensic odontology" and "identification" were located within the motor themes, whereas "third molar" and "age estimation" were identified as basic themes. In addition, "age determination" and "dental pulp" were categorized as niche themes, while "human identification" and "tomography" were positioned within the emerging/declining themes area.

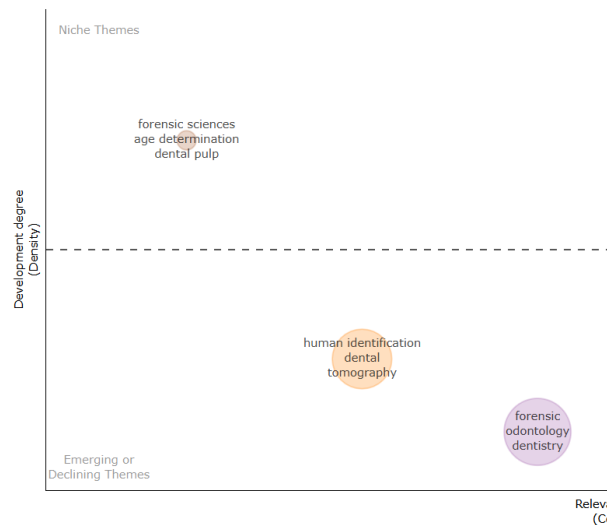


Figure 3. Thematic Map Analysis of the Literature Related to Forensic Odontology and Dental Radiology.

Evaluation of the thematic evolution analysis of the related field demonstrated that the terms “forensic odontology” and “dental identification” were predominant until 2008, whereas “bite mark” and “age determination” became prominent between 2008 and 2017. Finally, after 2017, terms such as “deep learning,” “tomography,” and “forensic sciences” emerged as the leading themes (Figure 4).

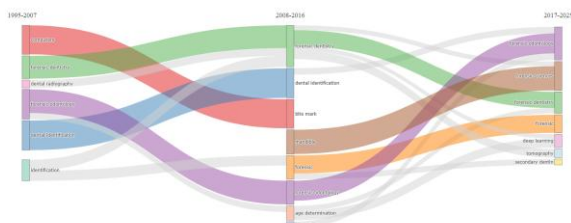


Figure 4. Thematic Evolution Analysis of the Literature Related to Forensic Odontology and Dental Radiology.

IV. DISCUSSION

In this study, the bibliometric structure of the literature regarding the impact of radiology in Forensic Odontology was evaluated. Examination of the Annual Scientific Production graph demonstrated that scientific production in the related research field remained relatively stable until 2005, whereas after 2005 it generally showed an increasing trend despite some fluctuations. This increase became even more pronounced after 2018. These findings indicate that the related field has attracted progressively greater attention in the literature. The marked increase in scientific publications in recent years may be associated with

advancements in imaging technologies and the growing digitalization of the field [18-20].

Evaluation of the Most Cited Documents analysis suggests that the most highly cited studies in this field have significantly contributed to the development of the related area and that the methodologies and approaches used in these studies have gained broad acceptance within the literature. A common feature of these three publications is that all of them focused on age estimation [15-17]. This finding indicates that age estimation through dental radiographic methods is one of the most dominant topics in this field.

Evaluation of the Trending Topics analysis demonstrated that research trends have changed over the years. The emphasis on the terms “dental radiography,” “bite mark,” “dental identification,” and “forensic science” during the early periods of the literature indicates that early studies in this field mainly focused on identification and classical forensic odontology. In the middle periods, the increasing interest in the terms “forensic odontology,” “human identification,” “age estimation,” and “tomography” suggests that the research field gradually evolved and began to focus on more specific topics such as age estimation and three-dimensional evaluation. This finding also indicates that the use of three-dimensional evaluation systems in Forensic Odontology research has progressively increased [21]. In recent years, the prominence of the terms “cone-beam computed tomography,” “CBCT,” “deep learning,” and “artificial intelligence” indicates that research trends have shifted toward digitalization and artificial intelligence-assisted analyses in parallel with technological advancements. The relatively low cost, reduced metal artifacts, and lower radiation exposure associated with cone-beam computed tomography may have contributed to its more frequent use in dentistry [22, 23]. In addition, the increasing focus on artificial intelligence and deep learning themes in recent years suggests that studies aimed at the automated analysis of dental radiological data may further increase in the future [24].

Evaluation of the Thematic Map analysis revealed that the themes “forensic odontology” and “identification” were located within the motor themes, indicating that these topics are central and well-developed themes in the related field. The placement of the “age estimation” theme within the basic themes suggests that research on age



estimation represents one of the fundamental research topics in the use of radiography in Forensic Odontology. In addition, the positioning of the “dental pulp” theme within the niche themes indicates that this topic represents a more specific and specialized area of research.

Evaluation of the thematic evolution analysis demonstrated that the prominence of the themes “forensic odontology” and “dental identification” until 2008 reflected a primary focus on fundamental topics in the field. Between 2008 and 2017, the increasing emphasis on the themes “bite mark” and “age determination” indicated that bite mark-based identification and age estimation gradually gained greater importance. After 2017, the emergence of themes such as “deep learning,” “tomography,” and “forensic sciences” suggests that the field of Forensic Odontology has progressively shifted toward digitalization, advanced imaging

V. CONCLUSION

As a result of this study, it was understood that the literature related to the use of radiological methods in Forensic Odontology has shown significant development over the years. The increase in scientific production in recent years indicates growing interest in the subject. While research in the early period mainly focused on fundamental topics, the field has gradually shifted toward more specific areas such as artificial intelligence and cone-beam computed tomography in parallel with technological advancements.

REFERENCES

- [1]. Sukul B, Deb U, Ghosh S: **Why a " dental surgeon" for identification in forensic science?** *Journal of the Indian Medical Association* 2010, **108**(11):769-770, 775.
- [2]. Stimson PG, Mertz CA: **Forensic dentistry:** CRC Press; 2002.
- [3]. Ata-Ali J, Ata-Ali F: **Forensic dentistry in human identification: A review of the literature.** *Journal of clinical and experimental dentistry* 2014, **6**(2):e162.
- [4]. DIAC MM, IOV T, KNIELING A, DAMIAN SI, TABIAN D, BULGARU ILIESCU D: **Dental Identification In Forensic Anthropology. A Literature Review.** *International journal of medical dentistry* 2020, **24**(3).
- [5]. Kaya MS: **The Role of Oral And Maxillofacial Radiology in Identification.** *Necmettin Erbakan Üniversitesi Diş Hekimliği Dergisi* 2023, **5**(3):217-223.
- [6]. Kaul B, Vaid V, Gupta S, Kaul S: **Forensic odontological parameters as biometric tool: A review.** *International Journal of Clinical Pediatric Dentistry* 2021, **14**(3):416.
- [7]. Afşin H, Karadayı B: **Felaket Kurbanlarının Kimliklendirilmesinde Diş Kayıtlarının Önemi.** *The Bulletin of Legal Medicine* 2012, **17**(2):31-37.
- [8]. Chandrasekhar T, Vennila P: **Role of radiology in forensic dentistry.** *Journal of Indian Academy of Oral Medicine and Radiology* 2011, **23**(3):229-231.
- [9]. Kumar M, George RJ, PS A: **Bibliometric analysis for medical research.** *Indian journal of psychological medicine* 2023, **45**(3):277-282.
- [10]. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM: **How to conduct a bibliometric analysis: An overview and guidelines.** *Journal of business research* 2021, **133**:285-296.
- [11]. Passas I: **Bibliometric analysis: the main steps.** *Encyclopedia* 2024, **4**(2).
- [12]. Liu F, Lei G, Jia X-D, He S-Y, Dang Y-H: **Worldwide trends of forensic dentistry: A 20-year bibliometric analysis in Pubmed.** *Rom J Leg Med* 2016, **24**(3):236-241.
- [13]. Angelakopoulos N, Boedi R: **Forensic odontology publications: insights into research trajectories and emerging trends through bibliometric study.** *Journal of Stomatology* 2025, **78**(1):64-74.



- [14]. Ren J, Meng H, Dai S, Tang Y, Wu D, Yang H, Zhan X, Zhang X, Guo Y-c, Guo Y: **The evolution of age estimation methods in forensic odontology: a bibliometric analysis from 2002 to 2024.** *International Journal of Legal Medicine* 2026, **140**(2):919-930.
- [15]. Cameriere R, Ferrante L, Belcastro MG, Bonfiglioli B, Rastelli E, Cingolani M: **Age estimation by pulp/tooth ratio in canines by peri-apical X-rays.** *Journal of forensic sciences* 2007, **52**(1):166-170.
- [16]. Yang F, Jacobs R, Willems G: **Dental age estimation through volume matching of teeth imaged by cone-beam CT.** *Forensic science international* 2006, **159**:S78-S83.
- [17]. Marroquin T, Karkhanis S, Kvaal S, Vasudavan S, Kruger E, Tennant M: **Age estimation in adults by dental imaging assessment systematic review.** *Forensic Science International* 2017, **275**:203-211.
- [18]. Kaasalainen T, Ekholm M, Siiskonen T, Kortensniemi M: **Dental cone beam CT: An updated review.** *Physica Medica* 2021, **88**:193-217.
- [19]. Nuzzolese E, Di Vella G: **Digital radiological research in forensic dental investigation: case studies.** *Minerva Stomatol* 2012, **61**(4):165-173.
- [20]. Wood R, Kogon S: **Dental radiology considerations in DVI incidents: A review.** *Forensic science international* 2010, **201**(1-3):27-32.
- [21]. Perkins H, Chiam TL, Forrest A, Higgins D: **3D dental images in forensic odontology: A scoping review of superimposition approaches utilizing 3D imaging.** *Forensic Imaging* 2025, **40**:200622.
- [22]. Soares CBRB, Almeida MSC, Lopes PdML, Beltrão RV, dos Anjos Pontual A, de Moraes Ramos-Perez FM, Figueroa JN, dos Anjos Pontual ML: **Human identification study by means of frontal sinus imaginological aspects.** *Forensic science international* 2016, **262**:183-189.
- [23]. Murphy M, Drage N, Carabott R, Adams C: **Accuracy and reliability of cone beam computed tomography of the jaws for comparative forensic identification: a preliminary study.** *Journal of forensic sciences* 2012, **57**(4):964-968.
- [24]. Mohammad N, Ahmad R, Kurniawan A, Mohd Yusof MYP: **Applications of contemporary artificial intelligence technology in forensic odontology as primary forensic identifier: A scoping review.** *Frontiers in artificial intelligence* 2022, **5**:1049584.