Scientific Research Report

The Application of Magnetic Resonance Imaging in Dentistry: A Bibliometric Analysis

Cuimei Huang [a,#], Guangwei Chen [b,#], Biyao Lu [a], Chengwei Li [a*], Xiange Sun [a*]

[a] Department of Stomatology, Zhuhai Hospital of Integrated Traditional Chinese and Western Medicine, Zhuhai, Guangdong, China

[b] Department of Oral and Maxillofacial Surgery, Affiliated Stomatology Hospital of Guangzhou Medical University, Guangdong Engineering Research Center of Oral Restoration and Reconstruction Guangzhou Key Laboratory of Basic and Applied Research of Oral Regenerative Medicine, Guangzhou, China

ARTICLE INFO

Article history:
Received 2 September 2025
Received in revised form
27 September 2025
Accepted 12 October 2025
Available online 6 November 2025

Keywords:
Magnetic Resonance Imaging
Dentistry
Bibliometric Analysis

ABSTRACT

Objectives: The aim of this analysis was to investigate the historical development, current status, and research hotspots related to the application of magnetic resonance imaging (MRI) in dentistry from 2000 to 2024.

Methods: Topic searches related to “MRI” and “dentistry” were used to retrieve articles from the Web of Science Core Collection. The results were analyzed using VOSviewer, CiteSpace, and the Bibliometrix R package, including the examination of annual publication trends and analysis of authors, countries, institutions, keyword co-occurrences, and research frontiers.

Results: A total of 2385 publications were included in this study. The annual publications showed an overall increasing trend, particularly after 2010. The top contributing countries were Japan, China, and the United States. The leading institutions included Shanghai Jiao Tong University and Tokyo Medical and Dental University. The most common research hotspots were temporomandibular joint disorders, oral and maxillofacial oncology, and dental implantology. Emerging trends highlighted the integration of artificial intelligence, radiomics, and multimodal imaging. International collaboration networks are expanding but remain uneven globally, with limited participation from low- and middle-income countries.

Conclusions: MRI in dentistry has evolved from an emergent topic into a maturing, multidisciplinary field of increasing clinical importance. Its benefits, however, are realized only within properly shielded, well-governed MR facilities staffed by trained personnel; accordingly, widespread installation of scanners in stand-alone dental clinics remains unlikely. Safe and scalable adoption will depend on strengthened international collaboration and the accelerated, evidence-based translation of technology within hospital-based services where infrastructure and safety governance are already established.

© 2025 The Authors. Published by Elsevier Inc. on behalf of FDI World Dental Federation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

Introduction

Magnetic Resonance Imaging (MRI) has emerged as a transformative imaging modality in the field of dentistry, offering superior soft tissue contrast, high spatial resolution, and the advantage of radiation-free imaging.[1,2] These characteristics have introduced new opportunities for dental diagnosis and treatment planning, particularly in cases requiring precise evaluation of soft tissue structures such as the temporomandibular joint (TMJ),[3] salivary glands,[4] and oral mucosa.[5] Unlike traditional imaging methods, MRI enables clinicians to

* Corresponding authors: Department of Stomatology, Zhuhai Hospital of Integrated Traditional Chinese and Western Medicine, No. 208, Yuehua Road, Zhuhai, Guangdong, China.
E-mail addresses: banehallow07@outlook.com (C. Li), sunxiange123@163.com (X. Sun).
Chengwei Li: http://orcid.org/0000-0002-9617-2602
Xiange Sun: http://orcid.org/0009-0005-3614-3382

# Cuimei Huang and Guangwei Chen contributed equally to this research.

https://doi.org/10.1016/j.identj.2025.104010
0020-6539/© 2025 The Authors. Published by Elsevier Inc. on behalf of FDI World Dental Federation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

visualize complex maxillofacial anatomy without exposing patients to ionizing radiation, which is especially beneficial for pediatric and radiation-sensitive populations.[6]

Despite these advantages, the clinical adoption of MRI in dentistry has been relatively slow compared to other imaging techniques such as cone-beam computed tomography (CBCT) and conventional computed tomography (CT).[7] CBCT has become widely utilized due to its excellent visualization of hard tissues and its utility in implant planning,[8] orthodontics,[9] and endodontics.[10] However, CBCT is inherently limited by poor soft tissue contrast, making MRI a more suitable modality for conditions involving soft tissue assessment and nerve pathologies.[7] Nevertheless, several challenges continue to hinder the widespread application of MRI in dental practice, including high costs, longer scanning durations, and the need for specialized radiological expertise.

MRI has found particular relevance in diagnosing temporomandibular disorders (TMD), where it offers detailed visualization of joint components including the articular disc and surrounding soft tissues.[11,12] Moreover, in the assessment of oral cancers, MRI provides superior contrast resolution, facilitating accurate tumor delineation and evaluation of invasion into adjacent structures.[13-15] Its applications are also expanding into areas such as periapical pathology, salivary gland disorders, and neural lesions, demonstrating the modality's versatility.

As the body of research on dental MRI continues to grow, a comprehensive bibliometric analysis is essential to systematically map the evolution of this field. Bibliometric analysis serves as a robust tool to quantify research outputs, identify influential studies, and reveal collaboration networks and research hotspots.[16-18] Prior bibliometric studies in medical imaging and dentistry have successfully illustrated global trends, research productivity, and interdisciplinary linkages.[19-21] As part of the broader dental bibliometrics literature, recent studies have mapped research frontiers in saliva biosensors and delineated "classic" publications in dentistry, providing methodological and comparative context for domain-focused analyses.[22,23] Therefore, this study aims to provide a detailed bibliometric analysis of MRI applications in dentistry, elucidating key research trends, major contributors, and interdisciplinary collaborations. The findings are expected to enrich the existing knowledge base, guide future research directions, and promote wider clinical integration of MRI within dental diagnostics and therapeutics.

Materials and methods

Data collection and extraction

This bibliometric analysis was conducted using data retrieved from the Web of Science Core Collection (WoSCC) database. A targeted search query was formulated to focus on the application of Magnetic Resonance Imaging in dentistry, employing the following search string: WC=("Dentistry oral surgery medicine") AND TS=("Magnetic Resonance Imaging*" OR "MRI*"). The search was confined to publications spanning the period from 2000 to 2024, with inclusion criteria restricted to articles and review papers written in English. As shown in Figure 1, a total of 2385 publications met these criteria, comprising 2,182 research articles and 203 review papers. Following the retrieval and initial screening, key metadata—including authors, titles, publication years, countries, institutions, abstracts, keywords, and journal names—were systematically extracted and stored. The dataset underwent meticulous filtering and verification by multiple researchers. Any inconsistencies were rigorously examined and resolved through team discussions, with expert guidance ensuring the accuracy and integrity of the dataset.

Bibliometric analysis and visualization

To conduct the bibliometric analysis, multiple software tools were utilized. VOSviewer (1.6.20, Leiden University) was used to analyze country contributions, institutional collaborations, author networks, and journal impact.[24] CiteSpace (6.4.R1, Drexel University) was utilized to construct visual representations of co-cited references and keywords, detect research fronts through citation burst analysis, and identify thematic structures within the domain through clustering techniques. The dual-map overlay feature provided insights into the disciplinary relationships between citing and cited journals.[25,26] Bibliometrix (4.3.0, University of Naples Federico II) facilitated comprehensive bibliometric indicators, topic evolution tracking, corresponding author country analysis, journal dynamics, and H-index assessments.[27]

Several key bibliometric metrics were considered in this study. Total Link Strength (TLS) represents the intensity of connections between elements in the bibliometric network, such as collaborations among authors, institutions, or countries. The H-index measures the scientific impact and productivity of authors, organizations, countries, and journals within the field. The Journal Citation Reports (JCR) and Impact Factor (IF) values for the journals mentioned in this study were sourced from the latest available data for 2025. The Q score, ranging from 0 to 1, assesses the structural quality of a network, with values above 0.3 indicating well-organized networks. The S score, ranging from -1 to 1, evaluates network reliability, with values exceeding 0.7 reflecting a highly trustworthy structure. Clusters within the network are visually distinguished by color variations. Timeline graphs and burst detection analyses are employed to identify significant research trends and emerging hotspots in MRI applications in dentistry.

All data used in this study were extracted from WoSCC and analyzed using VOSviewer. Descriptive statistics were generated using Microsoft Office 2021, providing a comprehensive overview of the bibliometric landscape of MRI applications in dental research.

Results

Figure 2A illustrates the annual and cumulative number of publications on the application of MRI in dentistry from 2000 to 2024. Annual publication output exhibits a general upward trend, rising from 53 in 2000 to 170 in 2024. Moderate growth was observed between 2000 and 2010, followed by a more pronounced increase from 2011 onward. The cumulative

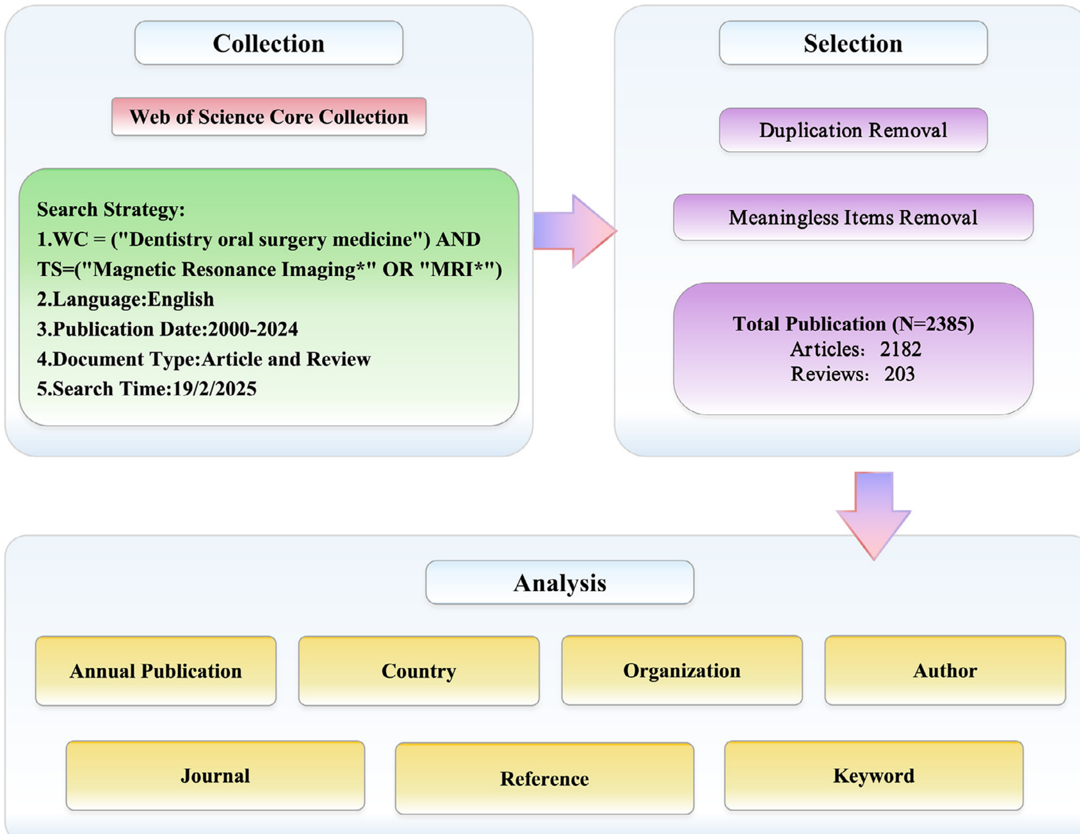

Fig. 1 – Flowchart of the bibliometric analysis process.

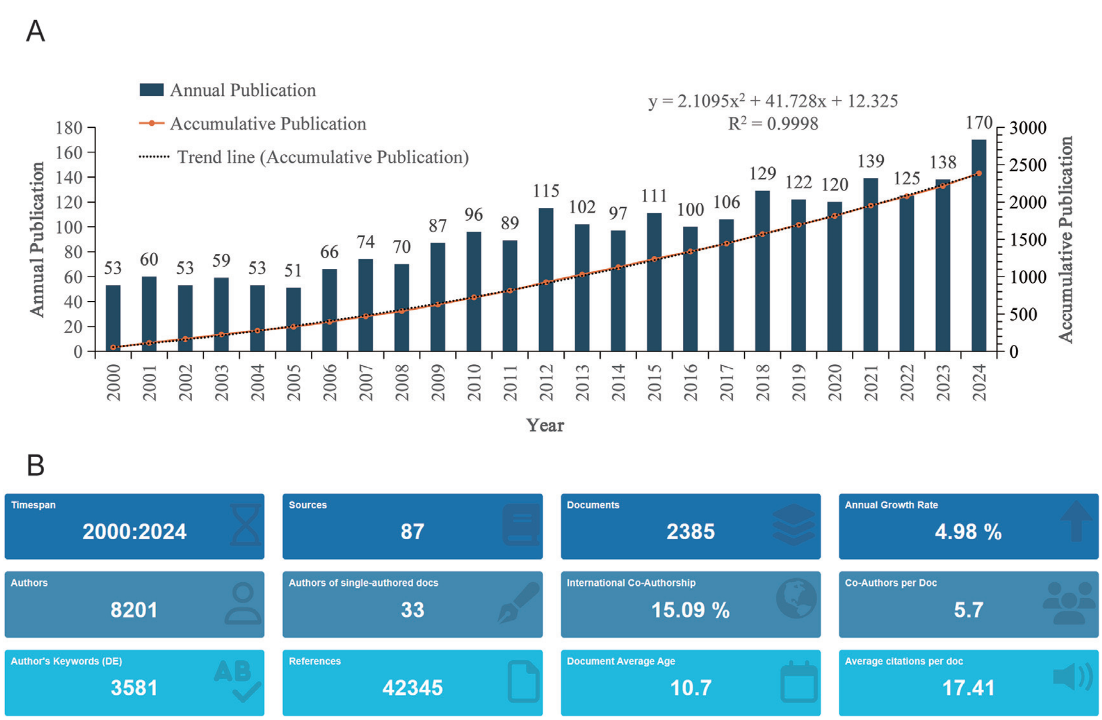

Fig. 2 – Analysis of dental MRI research publications from 2000 to 2024. (A) Annual and cumulative publication trends. (B) Summary of bibliometric data.

Table 1 – Top ten productive authors.

Rank	Author	Articles	Citations	Total Link Strength
1	Kurabayashi, Tohru	32	271	93
2	Sakamoto, Junichiro	18	98	55
3	Morimoto, Yasuhiro	14	93	145
4	Tanaka, Tatsurou	14	89	139
5	Oda, Masafumi	13	80	143
6	Ariji, Yoshiko	12	125	26
7	Otonari-Yamamoto, Mika	12	55	28
8	Sano, Tsukasa	12	74	36
9	Spin-Neto, Rubens	11	42	14
10	Wakasugi-Sato, Nao	11	69	135

publication count displays a quadratic growth pattern ($R^2 = 0.9998$), reflecting an accelerating pace of research activity. Figure 2B presents key bibliometric indicators, highlighting the field's high level of collaboration: 8,201 authors contributed to the literature, with an average of 5.7 co-authors per document. Additionally, 15.09% of the studies involved international collaboration.

Table 1 lists the top ten most productive authors in MRI-related dental research. Kurabayashi, Tohru leads with 32 publications and 271 citations. Despite having fewer publications, Yasuhiro Morimoto and Masafumi Oda demonstrate remarkable influence, with total link strengths of 145 and 143, respectively. Ariji, Yoshiko achieved a relatively high citation count (125) from just 12 articles. Figure 3A presents the co-authorship network among individual researchers. The visualization reveals distinct clusters of frequently collaborating authors, with node size proportional to each author's influence.

Table 2 lists the top ten most productive organizations in MRI-related dental research. Shanghai Jiao Tong University (China) ranks first with 95 publications and 1478 citations. Tokyo Medical and Dental University and Nihon University (Japan) follow with 70 and 67 articles, respectively. Other contributors include the University of São Paulo (Brazil) and Seoul National University (South Korea), both showing relatively high citation counts. Figure 3B shows the institutional collaboration network. Nihon University, Tokyo Medical and Dental University, and Shanghai Jiao Tong University appear as central nodes. The network displays dense inter-institutional links, indicating active research collaboration, including frequent international partnerships.

Table 3 summarizes national contributions to MRI-related dental research. Japan has the highest number of publications (541), followed by the United States (346) and China (342). The United States records the highest citation count (8041) and H-index (65). Germany, England, and the Netherlands show relatively high citation and H-index values. Figure 3C illustrates the evolution of international research collaboration in the application of MRI in dentistry. Countries such as Japan, China, the United States, and Germany emerge as central contributors, as indicated by their larger node sizes. The color gradient reflects the temporal progression of collaborations, highlighting the increasing global engagement over time.

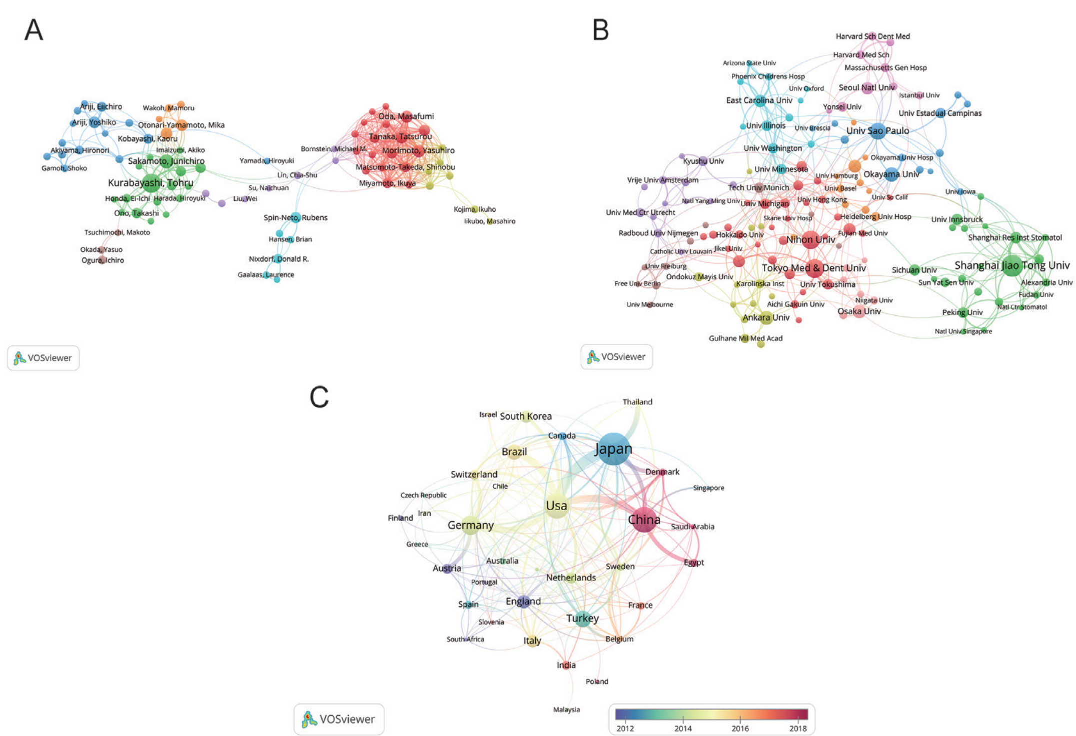

Fig. 3 – Network analysis of global research collaboration. (A) Author collaboration network. (B) Institution collaboration network. (C) Country collaboration network.

Table 2 – Top ten productive organizations.

Rank	Organization	Country	Articles	Citations	Total Link Strength
1	Shanghai Jiao Tong University	China	95	1478	86
2	Tokyo Medical and Dental University	Japan	70	1082	40
3	Nihon University	Japan	67	791	20
4	University of São Paulo	Brazil	57	771	36
5	Okayama University	Japan	42	814	24
6	Ankara University	Turkey	39	575	27
7	Osaka University	Japan	37	376	22
8	University of Zurich	Switzerland	32	689	18
9	East Carolina University	Usa	31	276	54
10	Seoul National University	South Korea	30	854	9

Table 3 – Top ten contributing countries.

Rank	Country	Articles	Citations	Total Link Strength	H-index
1	Japan	541	7562	107	47
2	USA	346	8041	189	65
3	China	342	4784	72	52
4	Germany	214	4531	74	51
5	Turkey	158	2141	36	34
6	Brazil	138	2354	50	34
7	England	107	2159	28	35
8	Italy	98	1840	35	37
9	South Korea	90	1661	16	37
10	Netherlands	80	1926	47	43

Figure 4A shows the distribution of corresponding authors' countries over time. Japan, China, and the United States exhibit a continuous increase in publication output. Other contributing countries include Germany, Brazil, Turkey, Italy, the Netherlands, the United Kingdom, and South Korea. The data indicate changing patterns of national participation over time. Figure 4B presents the cumulative percentage of publications by country from 2000 to 2024.

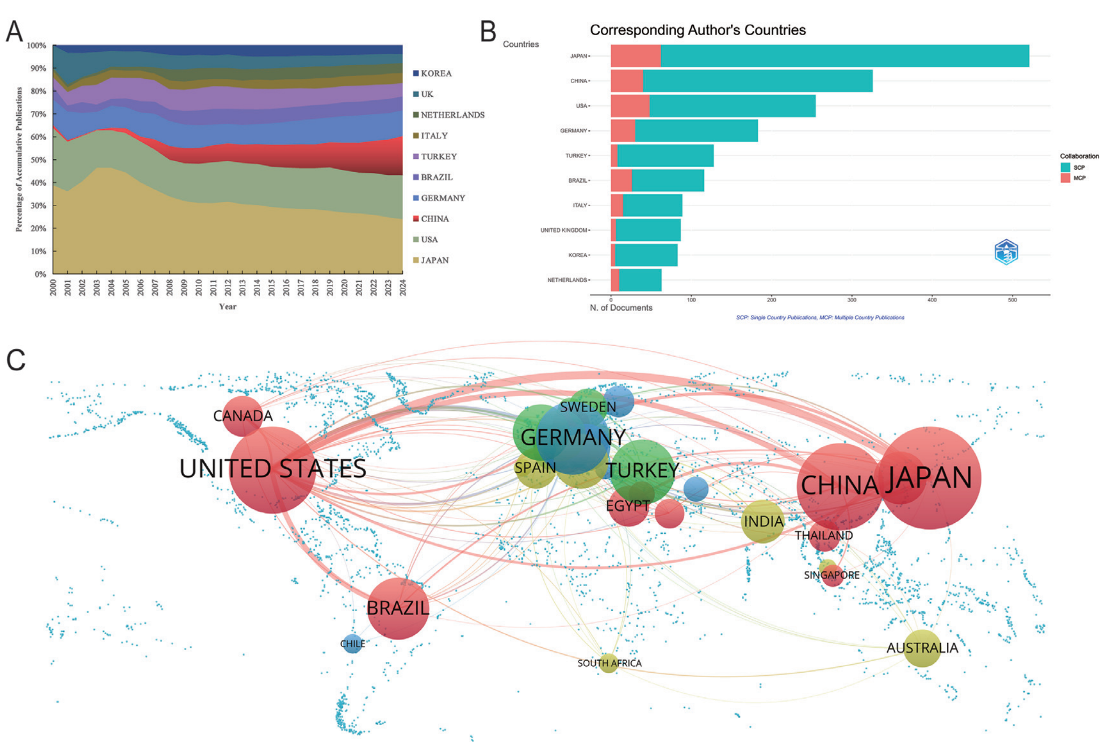

Fig. 4 – Analysis of research contributions by country. (A) Temporal distribution of publications. (B) Corresponding author's country distribution. (C) Country collaboration map.

Table 4 – Top ten contributing journals.

Rank	Journal	Articles	Citations	Total Link Strength	IF	JCR	H-index
1	Dentomaxillofacial Radiology	321	5214	1437	4.1	Q1	34
2	Journal Of Oral And Maxillofacial Surgery	180	3790	749	2.6	Q2	34
3	International Journal Of Oral And Maxillofacial Surgery	162	3748	882	2.7	Q1	33
4	Oral Radiology	150	593	530	1.7	Q3	11
5	Oral Surgery Oral Medicine Oral Pathology Oral Radiology	142	1373	648	1.9	Q2	19
6	Journal Of Cranio-Maxillofacial Surgery	133	2596	718	2.1	Q2	29
7	Oral Oncology	117	3231	247	3.9	Q1	36
8	Oral Surgery Oral Medicine Oral Pathology Oral Radiology And Endodontics	107	2987	702	N.A.	N.A.	29
9	Journal Of Oral Rehabilitation	92	1307	563	4.0	Q1	22
10	British Journal Of Oral & Maxillofacial Surgery	85	1164	245	1.9	Q2	18

Japan holds the largest overall share, followed by China and the United States. The cumulative shares of China and Germany show notable growth in recent years. Figure 4C provides a geographical overview of international collaborations. Larger nodes correspond to countries with higher research output, and connecting lines indicate collaborative relationships. The United States, China, Germany, and Japan appear as major hubs with frequent international cooperation.

Table 4 lists the top ten journals publishing MRI-related dental research. Dentomaxillofacial Radiology ranks first with 321 articles, highest total link strength (1437) and the highest impact factor (IF=4.1). The Journal of Oral and Maxillofacial Surgery and the International Journal of Oral and Maxillofacial Surgery also have high citation counts and link strengths. Figure 5A shows a steady increase in publication volume on MRI applications in dentistry from 2000 to 2024. Several journals have cumulative publication counts exceeding 300. An acceleration in growth is observed after 2010. Some journals maintain continuous growth, while others show periods of stagnation, suggesting variation in publication trends and journal focus. These trends reflect the increasing breadth of topics and the involvement of multiple disciplines in dental MRI research.

Figure 5B shows the thematic evolution of MRI-related dental research across disciplines. Early research is linked to foundational fields such as molecular biology, immunology, mathematics, and systems science. Over time, the focus shifts toward clinical fields including medicine, clinical medical sciences, health sciences, and nursing. Dentistry, dermatology, and surgery emerge as central themes, serving as

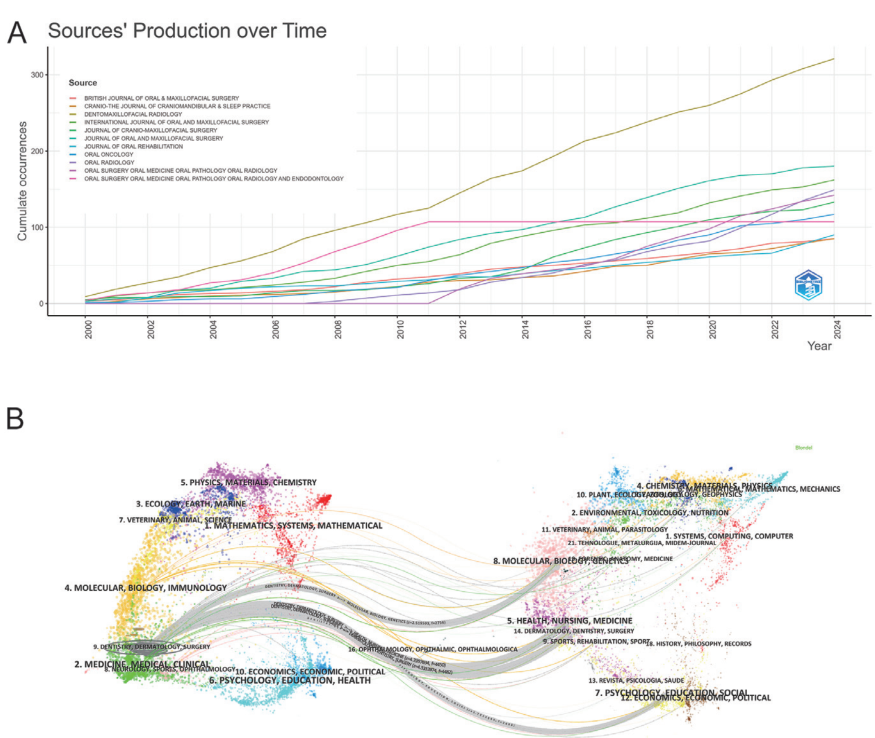

Fig. 5 – Analysis of journals. (A) Cumulative publication production over time. (B) Research topic evolution through a dual-layer overlay.

Fig. 6 – Analysis of references. (A) Co-citation reference network. (B) Burst analysis of top 25 references.

bridges between basic science and clinical application. Linkages between molecular biology, genetics, and dentistry suggest growing interest in the biological basis of dental imaging. The inclusion of ophthalmology and optometry indicates overlapping imaging methodologies.

Figure 6A presents a co-citation network of key publications. Larger nodes indicate higher citation frequency. Schiffman E (2014) is the most prominent node, followed by Ahmad M (2009), Roh HS (2012), and Ludwig U (2016). Citation bursts, shown as pink rings, mark publications with a sudden increase in citations, such as Dias IM (2016) and Hilgenfeld T (2020). Figure 6B shows citation burst analysis. The strongest burst is observed for Schiffman E (2014) (strength 20.49, 2016-2019). Ahmad M (2009) and Ludwig U (2016) also show high burst strengths (14.59 and 10.3, respectively). Earlier foundational studies, such as Katzberg RW (1996) and Tasaki MM (1996), show bursts in the early 2000s. More recent publications, including Juerchott A (2018) and Mao MH (2019), are undergoing ongoing bursts.

Figure 7A displays a keyword co-occurrence network. Magnetic resonance imaging is the central term. Closely linked keywords include temporomandibular joint, diagnosis, internal derangement, and computed tomography, indicating a concentration on TMD. Terms such as squamous cell carcinoma, tumor, and cancer point to oncological applications. Emerging terms like cone-beam computed tomography and functional MRI reflect growing interest in advanced imaging methods. The network shows the integration of clinical,

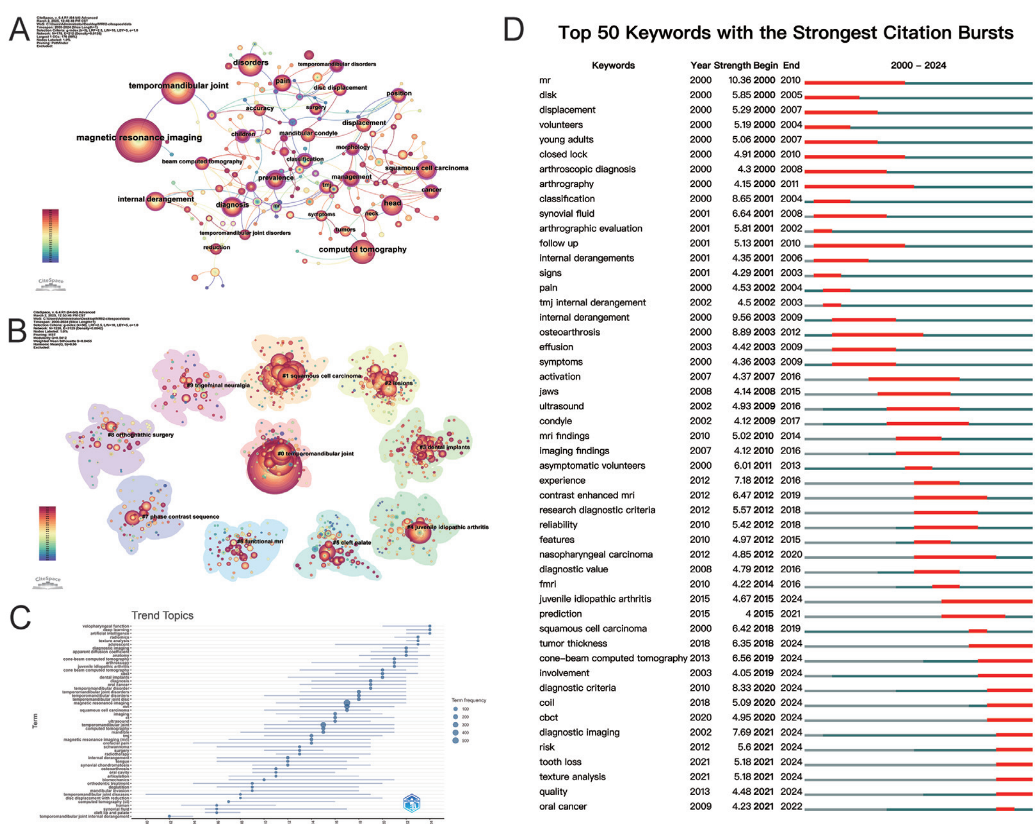

Fig. 7 – Analysis of keywords and topics. (A) Keyword co-occurrence network. (B) Cluster analysis of keywords. (C) Trend topics of author's keywords. (D) Burst analysis of top 50 keywords.

pathological, and technological domains. Figure 7B identifies thematic clusters. Cluster #0 (temporomandibular joint) is the largest. Cluster #1 focuses on squamous cell carcinoma, while other clusters cover dental implants (#3), juvenile idiopathic arthritis (#4), and cleft palate (#5). Technological topics are represented by functional MRI (#6) and phase contrast sequence (#7). The clusters show a broad range of research themes spanning clinical applications and imaging innovation. Figure 7C presents the temporal evolution of research topics from 2000 to 2024. Early research emphasized internal derangement, arthroscopy, and computed tomography. Recent trends focus on artificial intelligence, radiomics, and texture analysis. Topics such as CBCT, juvenile idiopathic arthritis, and dental implants reflect increasing clinical relevance. The emergence of deep learning and diagnostic imaging indicates a shift toward AI-driven diagnostic techniques. Figure 7D identifies the top 50 keywords with the strongest citation bursts. Early bursts include MR (2000-2010) and displacement (2000-2007). Recent bursts involve CBCT (2019-2024), diagnostic criteria (2020-2024), and texture analysis (2021-2024). Terms such as tumor thickness (2018-2024) and juvenile idiopathic arthritis (2015-2024) highlight emerging areas in oncology and pediatric imaging.

Discussion

This bibliometric study demonstrated a significant expansion of research in dental MRI from 2000 to 2024. In the early 2000s, only a limited number of studies explored the application of MRI in dentistry. Over the past decade, research activity has accelerated considerably, indicating that MRI has transitioned from a peripheral topic to a prominent research area within dental radiology.This trend has been driven by several key factors. Technological advancements, including optimized MRI sequences and specialized coils tailored for the craniofacial region, have significantly enhanced the ability to capture high-quality images of dental structures.[28-30] Meanwhile, ongoing concerns regarding cumulative radiation exposure from traditional dental imaging methods have made MRI's radiation-free nature especially attractive.[31]

The global distribution of research contributions in the field of dental MRI reveals a clear imbalance, though it is accompanied by a positive trend toward an expanding research landscape and increasingly dense collaboration networks. Early research efforts were concentrated in the United States and select European countries, including Germany, Belgium, and Italy, reflecting the significant technological advantages and academic infrastructure in these regions. This early pattern was characterized by multinational collaborations, particularly those led by US-Southern research teams around 2000, and continued European leadership throughout the 2000s, focusing on key innovations such as dental-specific MRI coil design[32,33] and sequence optimization.[34,35] These early efforts align with established theories in global knowledge networks, where initial research leadership is often tied to the availability of resources, institutional capacity, and early adoption of emerging technologies.[36]

Over the past decade, research activity in dental MRI has surged in East Asia, with Japan and China emerging as leaders alongside the United States and Europe, thus creating a tripolar research landscape. Japan ranks first with over 500 publications, followed by China (>400) and the United States (>300), while countries such as Germany, Turkey, Brazil, Italy, the United Kingdom, South Korea, and the Netherlands contribute substantially but with less global impact. Despite China's high output, its proportion of internationally collaborative publications remains relatively low, underscoring gaps in global integration. At the institutional level, the network demonstrates a multi-centric aggregation pattern, with Shanghai Jiao Tong University (95 publications, 1,478 citations, TLS = 86), Tokyo Medical and Dental University (70), and Nihon University (67) standing out as key hubs shaping international collaborations. Regional leaders such as the University of São Paulo in Brazil and Ankara University in Turkey further illustrate the geographic diversity of contributions.

A central focus in dental MRI research is temporomandibular joint disorders, where MRI's ability to visualize the articular disc, joint capsule, and soft tissues in both open and closed mouth positions has made it the preferred imaging modality for TMJ evaluation.[37-39] Between 2000 and 2024, a substantial portion of dental MRI publications has focused on TMJ and temporomandibular disorders diagnosis. These studies demonstrate MRI's precision in detecting disc displacement, degenerative changes, inflammation, and joint effusion—key factors in TMD diagnostics. Early studies established normative MRI anatomy of the TMJ, while later research optimized imaging protocols, such as real-time MRI,[40] and correlated findings with clinical symptoms. MRI's ability to depict internal TMJ disorders is frequently cited as a core strength in dentistry, given that traditional radiography cannot visualize soft tissue structures like the articular disc.[11,41,42]

Oral and maxillofacial oncology is another key area where MRI plays a vital role, particularly in diagnosing and planning treatment for oral cancers and head and neck tumors.[43-45] MRI's superior soft tissue contrast allows for clearer delineation of tumor margins, muscle invasion, and perineural spread compared to CT, which lacks soft tissue differentiation. Research has steadily increased in this area, particularly with the development of high-field MRI and advanced sequences like diffusion-weighted imaging (DWI).[46,47] MRI is also essential in assessing salivary gland tumors and jaw lesions with soft tissue components.[48,49] This trend underscores MRI's indispensable role in multimodal imaging strategies, particularly in pre-surgical or radiotherapy staging and planning for cancer patients.

A third hotspot is implantology and bone regeneration surgeries. MRI's application in implant treatment planning has grown, particularly with advancements in metal artifact suppression and its ability to assess soft tissues without radiation.[50,51] MRI is increasingly used to locate the mandibular nerve canal,[52] measure bone volume,[53] and evaluate pre- and post-surgical conditions.[50] MRI complements CBCT by offering insights into sinus membrane thickening or pathology, as well as monitoring peri-implant tissue inflammation and osseointegration. Over the past 5-10 years, there has been a marked increase in MRI-related implantology research, suggesting that MRI will play a key role in future implant patient care, offering radiation-free monitoring and reducing the need for repeated CT scans.[54]

Since the late 2010s, dental MRI has advanced substantially with the integration of artificial intelligence (AI) and deep learning. Recent studies have demonstrated that deep learning algorithms can automatically detect and classify temporomandibular joint (TMJ) disc displacement,[55-57] segment joint structures with high accuracy,[58] and support the diagnosis of osteoarthritis through classification models and enhanced image interpretation.[59,60] Image preprocessing and deep learning-based enhancement have further improved segmentation performance and diagnostic confidence in MRI,[60,61] while generative adversarial networks have been successfully applied to synthesize T2-weighted images from proton density protocols, reducing acquisition demands and broadening MRI applicability in dental imaging.[62] Collectively, these advances illustrate how AI-driven approaches can reduce noise, accelerate acquisition, enhance reconstruction, and expand diagnostic capability in dental MRI. The rapid increase in such studies between 2020 and 2024 highlights the emergence of a transformative research frontier, suggesting that AI innovations are likely to be pivotal in establishing MRI as a practical tool in routine dental practice.

Another emerging area is radiomics, which involves extracting quantitative features from medical images to correlate with clinical data. In dental MRI, radiomics is particularly applied in oncology, such as analyzing texture and signal intensity patterns in oral cancers to predict tumor aggressiveness or treatment response.[63,64] This technique is also being explored for TMJ disorder[65,66] s and periapical lesions.[67] Although dental radiomics studies are still modest in volume, there is a noticeable increase in keywords like "radiomics" and "texture analysis," indicating the growing use of data-driven approaches by dental researchers, often in collaboration with data scientists. Radiomics has the potential to uncover subtle biomarkers that could improve diagnosis and prognosis for conditions like oral cancer.

Advances in multimodal imaging represent another significant innovation in dental diagnostics. Increasingly, researchers are integrating MRI with complementary modalities, most notably cone-beam computed tomography (CBCT), to generate composite three-dimensional models that simultaneously depict hard and soft tissues.[68,69] Such fusion imaging is being applied in implant planning and the design of orthognathic surgery, where the combined structural information enhances surgical precision. Beyond dentistry, hybrid PET-MRI has demonstrated clinical utility in oncology, and early applications in oral cancer suggest that this technique may provide both metabolic and anatomical insights into head and neck tumors.[70,71] Alongside these multimodal strategies, dedicated dental MRI systems are being developed to optimize acquisition protocols for the oral and maxillofacial region. Moreover, novel MRI contrast agents and functional MRI (fMRI) applications are expanding the scope of dental imaging: fMRI has been employed to study brain activity associated with dental pain and mastication,[72,73] while MR angiography offers noninvasive visualization of vascular patterns in oral lesions. Emerging approaches such as MR elastography, which allows for in vivo assessment of oral tissue mechanical properties, further illustrate the growing versatility and potential of MRI in dental research and clinical practice.[74]

Although MRI eliminates exposure to ionizing radiation, it is not risk-free.[75] Reported adverse events in MR environments include projectile incidents precipitated by ferromagnetic objects, RF-related thermal injuries due to conductive loops or heating, and acoustic trauma.[76,77] These risks can be amplified at higher field strengths, particularly when safety protocols are not rigorously implemented.[78] Contemporary guidance emphasizes a four-zone architecture, standardized screening, ferromagnetic detection where appropriate, and staffing by trained MR personnel to mitigate these hazards.[79] In the dental context, these requirements indicate that clinical MRI is most appropriately delivered within properly shielded, hospital-based facilities, consistent with our bibliometric finding that output is concentrated in medical institutions.[80] Accordingly, while MRI is invaluable for selected dental and maxillofacial indications, safe implementation remains a primary determinant of adoption pathways and site-of-care decisions. Pragmatically, widespread installation of MR scanners in standalone dental clinics is unlikely; the feasible model is sustained collaboration with hospital-based MR services, where infrastructure and safety governance are already in place.

While WOSCC is a comprehensive and widely recognized database, it may not capture all relevant publications, particularly those from journals or conferences that are not indexed by this platform. As a result, some studies from lesser-known or region-specific journals, or those published in non-English languages, may be underrepresented. Additionally, WOSCC primarily includes scholarly articles, meaning non-peer-reviewed sources, such as preprints, reports, or patents, were not considered, potentially limiting the scope of the analysis. Moreover, the WOSCC database's indexing criteria and coverage vary over time, which might lead to inconsistencies in citation counts and publication trends across different years. Future research could benefit from cross-referencing multiple databases to provide a more comprehensive and robust overview of the literature in the field.

Conclusion

This bibliometric analysis demonstrates a sustained expansion of dental MRI research from 2000 to 2024, with output accelerating after 2010 and coalescing into a mature, multidisciplinary field. Japan, China, and the United States lead in productivity, anchored by institutions such as Shanghai Jiao Tong University and Tokyo Medical and Dental University. Collaboration networks are widening but remain uneven, underscoring underrepresentation of low- and middle-income countries and the need for more inclusive global partnerships. Research activity is centered on temporomandibular joint disorders, for which MRI's superior soft-tissue contrast and dynamic imaging make it the modality of choice. The scope is broadening to oral and maxillofacial oncology, implantology, and other clinical domains (periodontology, endodontics, orthodontics), driven by advances in dedicated coils, sequence optimization, metal-artifact reduction, and accelerated acquisitions. Emerging frontiers—including artificial intelligence, radiomics, and multimodal fusion with CBCT and other modalities—are reshaping image reconstruction, automated analysis, and decision support, with the potential to shorten scan times while enhancing diagnostic yield. At the same time, MRI's benefits in dentistry are realized only within properly shielded and well-run MR facilities staffed by trained personnel and governed by rigorous safety protocols. Consequently, routine placement of MRI units within standalone dental clinics is unlikely in the near term; the pragmatic model remains hospital-based services with structured collaboration between dentistry and radiology.

Author contributions

Conceptualization: Xiange Sun, Chengwei Li

Methodology: Biyao Lu

Formal analysis and original draft: Cuimei Huang, Guangwei Chen

Supervision and review: Xiange Sun, Chengwei Li

All authors have read and approved the final version of the manuscript.

Funding

This research did not receive any specific funding sources.

Data availability statements

The datasets analyzed in this study were obtained from the Web of Science Core Collection database. Access to these databases requires an institutional or personal subscription. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declare that they have no potential conflict of interest.

Acknowledgments

The author would like to thank all staff of the department of stomatology, Zhuhai Hospital of Integrated Traditional Chinese and Western Medicine for the support and assistance in this work.

REFERENCES

1. Han B, Chen N, Luo J, et al. Magnetic resonance imaging for dental pulp assessment: a comprehensive review. J Magn Reson Imaging JMRI 2025;62(2):362–88. doi: 10.1002/jmri.29742.
2. Ito K, Kuno H, Otsuka K, et al. Imaging findings, complications, and mimics after common and advanced dental procedures. Radiogr Rev Publ Radiol Soc N Am Inc 2025;45(2):e240072. doi: 10.1148/rg.240072.
3. Ha E, Jeon K, Lee C, et al. Magnetic resonance image generation using enhanced TransUNet in temporomandibular disorder patients. DENTOMAXILLOFACIAL Radiol 2025;54(5):357–63. doi: 10.1093/dmfr/twaf017.
4. Lee C, Lee A, Choi Y, et al. Quantitative evaluation of parotid gland dysfunction in patients with hyposalivation using magnetic resonance imaging mapping technique Quantification of Parotid gland function using MRI. BMC ORAL Health 2025;25(1). doi: 10.1186/s12903-025-05873-y.
5. Liu L, Li Y, Shi Y, et al. Dental implant in anterior mandible according to mandibular lingual foramens and lingual mucosal vessels: using fusion volumetric images from computed tomography and magnetic resonance imaging. BMC ORAL Health 2023;23(1). doi: 10.1186/s12903-023-03455-4.
6. Al-Haj Husain A, Lie SAN, Sandhu S, et al. Magnetic resonance imaging in dental, oral and maxillofacial trauma: a systematic review. J Cranio-Maxillo-fac Surg Off Publ Eur Assoc Cranio-Maxillo-fac Surg 2025;53(9):1438–54. doi: 10.1016/j.jcms.2025.05.016.
7. Flügge T, Gross C, Ludwig U, et al. Dental MRI—only a future vision or standard of care? A literature review on current indications and applications of MRI in dentistry. Dentomaxillofacial Radiol 2023;52(4). doi: 10.1259/dmfr.20220333.
8. Cai G, Wen B, Gong Z, et al. Intelligent virtual dental implant placement via 3D segmentation strategy. J Dent Res 2025:220345251332511. doi: 10.1177/00220345251332511.
9. Polizzi A, Serra S, Leonardi R. Use of CBCT in orthodontics: a scoping review. J Clin Med 2024;13(22):6941. doi: 10.3390/jcm13226941.
10. Kaur K, Saini RS, Vaddamanu SK, et al. Exploring technological progress in three-dimensional imaging for root canal treatments: a systematic review. Int Dent J 2025;75(2):1097–112. doi: 10.1016/j.identj.2024.05.014.
11. Liu X, Long X. Classification of the temporomandibular joint disc displacement without reduction using MRI in the mouth-opening position. Clin ORAL Investig 2025;29(6). doi: 10.1007/s00784-025-06408-z.
12. Nozawa M, Fukuda M, Kotaki S, et al. Evaluation of temporomandibular joint osteoarthritis using a new fracture sequence of 3.0T MRI. Dentomaxillofac Radiol 2024;54(1):64–9. doi: 10.1093/dmfr/twae065.
13. Lin B, Wang F, Shen S, et al. Imaging and pathology concordance in head and neck cancer: retrospective analysis. ORAL Dis 2025. doi: 10.1111/odi.15268.
14. Yuan J, Wu M, Qiu L, et al. Tumor habitat-based MRI Features assessing early response in locally advanced nasopharyngeal carcinoma. ORAL Oncol 2024;158. doi: 10.1016/j.oraloncology.2024.106980.
15. Boot P, Mes S, de Bloeme C, et al. Magnetic resonance imaging based radiomics prediction of Human Papillomavirus infection status and overall survival in oropharyngeal squamous cell carcinoma. ORAL Oncol 2023;137. doi: 10.1016/j.oraloncology.2023.106307.
16. Zheng Y, Lam XY, Wu M, et al. Acceleration of orthodontic tooth movement: a bibliometric and visual analysis. Int Dent J 2025;75(2):1223–33. doi: 10.1016/j.identj.2024.08.012.
17. Lo Giudice A, Boato M, Palazzo G. Research trends in class II malocclusion treatment in growing individuals: a bibliometric study. Int Dent J 2025;75(2):926–38. doi: 10.1016/j.identj.2024.09.014.
18. Qiu Y, Ding Z, Yang D. A bibliometric analysis of macrophage research associated with periodontitis over the past two decades. Int Dent J 2025;75(1):363–74. doi: 10.1016/j.identj.2024.11.016.
19. Sun X, Zhu J, Li R, et al. The global research of magnetic resonance imaging in Alzheimer's disease: a bibliometric analysis from 2004 to 2023. Front Neurol 2025;15. doi: 10.3389/fneur.2024.1510522.

20. Li J, Ye C, Li S, et al. Mapping the evolution of PET/MR research: a bibliometric analysis of publication trends, leading contributors, and conceptual frameworks (2011-2023). EJNMMI Rep 2024;8(1). doi: 10.1186/s41824-024-00224-6.
21. Chen J, Xu H, Zhou H, et al. Knowledge mapping and bibliometric analysis of medical knee magnetic resonance imaging for knee osteoarthritis (2004-2023). Front Surg 2024;11. doi: 10.3389/fsurg.2024.1387351.
22. Ho Y-S, Christidis N. Classic publications in the field of dentistry: a bibliometric analysis. Int Dent J 2025;75(5):100909. doi: 10.1016/j.identj.2025.100909.
23. Tang Q, Zhang F, Xu W, et al. Advancements and trends in electrochemical biosensors for saliva-based diagnosis of oral diseases: a bibliometric analysis (2000-2023). Int Dent J 2025;75(4):100840. doi: 10.1016/j.identj.2025.100840.
24. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics 2010;84(2):523–38. doi: 10.1007/s11192-009-0146-3.
25. Chen C, Song M. Visualizing a field of research: a methodology of systematic scientometric reviews. PLOS ONE 2019;14(10): e0223994. doi: 10.1371/journal.pone.0223994.
26. Chen C. Science mapping: a systematic review of the literature. J Data Inf Sci 2017;2:1–40. doi: 10.1515/jdis-2017-0006.
27. Aria M, Cuccurullo C. *bibliometrix*: An R-tool for comprehensive science mapping analysis. J Informetr 2017;11(4):959–75. doi: 10.1016/j.joi.2017.08.007.
28. Vaddi A, Parasher P, Khurana S. Beyond X-Rays: unveiling the future of dental diagnosis with dental magnetic resonance imaging. Diagnostics 2025;15(9):1153. doi: 10.3390/diagnostics15091153.
29. Al-Haj Husain A, Sekerci E, Schönegg D, et al. Dental MRI of oral soft-tissue tumors—optimized use of black bone mri sequences and a 15-channel mandibular coil. J Imaging 2022;8 (5):146. doi: 10.3390/jimaging8050146.
30. Sedlacik J, Kutzner D, Khokale A, et al. Optimized 14 + 1 receive coil array and position system for 3D high-resolution MRI of dental and maxillomandibular structures. Dentomaxillofacial Radiol 2016;45(1):20150177. doi: 10.1259/dmfr.20150177.
31. Luan F-J, Zhang J, Mak K-C, et al. Low radiation X-rays: benefiting people globally by reducing cancer risks. Int J Med Sci 2021;18(1):73–80. doi: 10.7150/ijms.48050.
32. Hilgenfeld T, Saleem MA, Schwindling FS, et al. High-resolution single tooth MRI with an inductively coupled intraoral coil-can MRI compete with CBCT? Invest Radiol 2022;57 (11):720–7. doi: 10.1097/RLI.0000000000000890.
33. Tesfai AS, Vollmer A, Özen AC, et al. Inductively coupled intraoral flexible coil for increased visibility of dental root canals in magnetic resonance imaging. Invest Radiol 2022;57 (3):163–70. doi: 10.1097/RLI.0000000000000826.
34. Assaf AT, Zrnc TA, Remus CC, et al. Evaluation of four different optimized magnetic-resonance-imaging sequences for visualization of dental and maxillo-mandibular structures at 3 T. J Cranio-Maxillo-fac Surg Off Publ Eur Assoc Cranio-Maxillo-fac Surg 2014;42(7):1356–63. doi: 10.1016/j.jcms.2014.03.026.
35. Deininger-Czermak E, Villefort C, von Knebel Doeberitz N, et al. Comparison of MR ultrashort echo time and optimized 3D-multiecho in-phase sequence to computed tomography for assessment of the osseous craniocervical junction. J Magn Reson Imaging JMRI 2021;53(4):1029–39. doi: 10.1002/jmri.27478.
36. Leydesdorff L, Wagner C. Is the United States losing ground in science? A global perspective on the world science system. Scientometrics 2009;78(1):23–36. doi: 10.1007/s11192-008-1830-4.
37. Zhang L, Shen L, Zhang L, et al. Dynamic 3D images fusion of the temporomandibular joints: a novel technique. J Dent 2022;126. doi: 10.1016/j.jdent.2022.104286.
38. Takaoka R, Koishi Y, Kuyama K, et al. Cross-sectional and longitudinal assessment of subchondral cysts in temporomandibular joints: Clinical and MRI study with a mean follow-up of 66 months. J Prosthodont Res 2023;67(3):392–9. doi: 10.2186/jpr.JPR_D_22_00089.
39. Qu G, Bu L, Li X, et al. Malocclusion associated with temporomandibular joint anterior disc displacement and condylar resorption in adolescents: a cross-sectional study. J ORAL Rehabil 2025;52(6):760–8. doi: 10.1111/joor.13924.
40. Mouchoux J, Meyer-Marcotty P, Sojka F, et al. Reliability of landmark identification for analysis of the temporomandibular joint in real-time MRI. Head Face Med 2024;20(1):10. doi: 10.1186/s13005-024-00411-7.
41. Zhou L, Tao K, Ma J, et al. Relationship between temporomandibular joint space and articular disc displacement. BMC ORAL Health 2025;25(1). doi: 10.1186/s12903-025-05991-7.
42. Özel S, Tunç S, Senol A. Association between clinical findings and 3T MRI features in temporomandibular joint disorders. BMC ORAL Health 2025;25(1). doi: 10.1186/s12903-025-06283-w.
43. Cao C, Gan X, He Y, et al. Diagnostic efficacy of PET-CT, CT, and MRI in preoperative assessment of mandibular invasion caused by head and neck cancer: a systematic review and meta-analysis. ORAL Oncol 2021;116. doi: 10.1016/j.oraloncology.2021.105264.
44. Park Y, Lim J, Koh Y, et al. Prediction of treatment outcome using MRI radiomics and machine learning in oropharyngeal cancer patients after surgical treatment. ORAL Oncol 2021;122. doi: 10.1016/j.oraloncology.2021.105559.
45. Voizard B, Khoury M, Saydy N, et al. Preoperative evaluation of depth of invasion in oral tongue squamous cell carcinoma: a systematic review and meta-analysis. ORAL Oncol 2023;136. doi: 10.1016/j.oraloncology.2022.106273.
46. Jajodia A, Mandal G, Yadav V, et al. Adding MR diffusion imaging and T2 signal intensity to neck imaging reporting and data system categories 2 and 3 in primary sites of postsurgical oral cavity carcinoma provides incremental diagnostic value. AJNR Am J Neuroradiol 2022;43(7):1018–23. doi: 10.3174/ajnr.A7553.
47. van der Hulst HJ, Braun L, Westerink B, et al. Comparison of diffusion-weighted MRI using single-shot echo-planar imaging and split acquisition of fast spin-echo signal imaging, a Non-EPI technique, in tumors of the head and neck. AJNR Am J Neuroradiol 2025;46(4):774–83. doi: 10.3174/ajnr.A8529.
48. Chen Y, Huang N, Zheng Y, et al. Characterization of parotid gland tumors: Whole-tumor histogram analysis of diffusion weighted imaging, diffusion kurtosis imaging, and intravoxel incoherent motion - A pilot study. Eur J Radiol 2024;170:111199. doi: 10.1016/j.ejrad.2023.111199.
49. Zhang R, King AD, Wong LM, et al. Discriminating between benign and malignant salivary gland tumors using diffusion-weighted imaging and intravoxel incoherent motion at 3 Tesla. Diagn Interv Imaging 2023;104(2):67–75. doi: 10.1016/j.diii.2022.08.003.
50. Parize H, Meier N, Kleinheinz J, et al. Effect of magnetic resonance imaging protocol on decision-making for positioning of dental implants in edentulous cases. J Prosthodont-IMPLANT Esthet Reconstr Dent 2024. doi: 10.1111/jopr.13975.
51. Husain A, Zollinger M, Stadlinger B, et al. Magnetic resonance imaging in dental implant surgery: a systematic review. Int J IMPLANT Dent 2024;10(1). doi: 10.1186/s40729-024-00532-3.
52. Alhyari R, Ross P, Sacco R, et al. Can magnetic resonance imaging (MRI) reduce lingual nerve injuries during mandibular third molar surgery? A scoping review. BMC ORAL Health 2025;25(1). doi: 10.1186/s12903-025-06589-9.
53. Lauer A, Schulte L, Skenderi A, et al. Dental magnetic resonance imaging for bone loss assessment and disease activity

classification in severe periodontitis. Insights Imaging 2025;16 (1):134. doi: 10.1186/s13244-025-02004-7.
54. Nakamura T. Dental MRI: a road beyond CBCT. Eur Radiol 2020;30(12):6389–91. doi: 10.1007/s00330-020-07321-7.
55. Lin B, Cheng M, Wang S, et al. Automatic detection of anteriorly displaced temporomandibular joint discs on magnetic resonance images using a deep learning algorithm. Dentomaxillofac Radiol 2022;51(3). doi: 10.1259/dmfr.20210341.
56. Azma R, Hareendranathan A, Li M, et al. Automated pediatric TMJ articular disk identification and displacement classification in MRI with machine learning. J Dent 2025;155. doi: 10.1016/j.jdent.2025.105622.
57. Min C, Jung W, Joo S. Enhanced multistage deep learning for diagnosing anterior disc displacement in the temporomandibular joint using MRI. Dentomaxillofac Radiol 2024;53 (7):488–96. doi: 10.1093/dmfr/twae033.
58. Li M, Punithakumar K, Major P, et al. Temporomandibular joint segmentation in MRI images using deep learning. J Dent 2022;127. doi: 10.1016/j.jdent.2022.104345.
59. Nozawa M, Fukuda M, Kotaki S, et al. Can temporomandibular joint osteoarthritis be diagnosed on MRI proton density-weighted images with diagnostic support from the latest deep learning classification models? Dentomaxillofac Radiol 2024;54(1):56–63. doi: 10.1093/dmfr/twae040.
60. Lee C, Lee J, Mandava S, et al. Deep learning image enhancement for confident diagnosis of TMJ osteoarthritis in zero-TE MR imaging. Dentomaxillofac Radiol 2025;54(4):302–6. doi: 10.1093/dmfr/twae063.
61. Yoshimi Y, Mine Y, Ito S, et al. Image preprocessing with contrast-limited adaptive histogram equalization improves the segmentation performance of deep learning for the articular disk of the temporomandibular joint on magnetic resonance images. ORAL Surg ORAL. Med ORAL Pathol ORAL Radiol 2024;138(1):128–41. doi: 10.1016/j.oooo.2023.01.016.
62. Lee C, Ha E, Choi Y, et al. Synthesis of T2-weighted images from proton density images using a generative adversarial network in a temporomandibular joint magnetic resonance imaging protocol. Imaging Sci Dent 2022;52(4):393–8. doi: 10.5624/isd.20220125.
63. Li Y, Li W, Xiao H, et al. Automated classification of pathological differentiation in head and neck squamous cell carcinoma using combined radiomics models from CET1WI and T2WI. Clin Oral Investig 2024;29(1). doi: 10.1007/s00784-024-06110-6.
64. Oki A, Nakamura S, Sakamoto J, et al. Can MRI radiomics predict neck metastasis at initial diagnosis in patients with squamous cell carcinoma of the tongue? Oral Radiol 2025;41 (3):388–95. doi: 10.1007/s11282-025-00810-9.
65. Farook T, Dudley J. Automation and deep (machine) learning in temporomandibular joint disorder radiomics: a systematic review. J Oral Rehabil 2023;50(6):501–21. doi: 10.1111/joor.13440.
66. Yüksel H, Orhan K, Evlice B, et al. Evaluation of temporomandibular joint disc displacement with MRI-based radiomics analysis. Dentomaxillofac Radiol 2024;54(1):19–27. doi: 10.1093/dmfr/twae066.
67. Muraoka H, Kaneda T, Ito K, et al. Diagnostic utility of magnetic resonance imaging texture analysis in suppurative osteomyelitis of the mandible. ORAL Radiol 2022;38(4):601–9. doi: 10.1007/s11282-022-00595-1.
68. Ren J, Eriksen J, Nijkamp J, et al. Comparing different CT, PET and MRI multi-modality image combinations for deep learning-based head and neck tumor segmentation. ACTA Oncol 2021;60(11):1399–406. doi: 10.1080/0284186X.2021.1949034.
69. Valdec S, Husain A, Winklhofer S, et al. Comparison of preoperative cone-beam computed tomography and 3D-double echo steady-state MRI in third molar surgery. J Clin Med 2021;10(20). doi: 10.3390/jcm10204768.
70. Wongsa P, Nantasuk M, Singhnoi S, et al. Assessing the variability and correlation between SUV and ADC parameters of head and neck cancers derived from simultaneous PET/MRI: A single-center study. J Appl Clin Med Phys 2023;24(5). doi: 10.1002/acm2.13928.
71. Mukherjee S, Fischbein N, Baugnon K, et al. Contemporary Imaging and Reporting Strategies for Head and Neck Cancer: MRI, FDG PET/MRI, NI- RADS, and Carcinoma of Unknown Primary. AJR Expert Panel Narrative Review. Am J Roentgenol 2023;220(2):160–72. doi: 10.2214/AJR.22.28120.
72. Padmanabhan H, Vijayakumar S, Parthasarathy N, et al. Comparison of the effect of conventional and implant-retained overdentures on brain activity and cognition in a geriatric population - A functional MRI study. J Prosthodont Res 2022;66(3):431–7. doi: 10.2186/jpr.JPR_D_21_00099.
73. Wang M, Tang X, Li B, et al. Dynamic local metrics changes in patients with toothache: A resting-state functional magnetic resonance imaging study. Front Neurol 2022;13. doi: 10.3389/fneur.2022.1077432.
74. Ro S, Loch F, Siegmund B, et al. Effects of oral contrast agent on the viscoelastic properties of the terminal ileum investigated using magnetic resonance elastography. Quant Imaging Med Surg 2024;14(8):5973–82. doi: 10.21037/qims-24-101.
75. Pedrosa I, Altman DA, Dillman JR, et al. American college of radiology manual on MR safety: 2024 update and revisions. Radiology 2025;315(1):e241405. doi: 10.1148/radiol.241405.
76. Delfino JG, Krainak DM, Flesher SA, et al. MRI-related FDA adverse event reports: A 10-yr review. Med Phys 2019;46 (12):5562–71. doi: 10.1002/mp.13768.
77. Durbridge G. Magnetic resonance imaging: fundamental safety issues. J Orthop Sports Phys Ther 2011;41(11):820–8. doi: 10.2519/jospt.2011.3906.
78. Safety AC on M, Greenberg TD, Hoff MN, et al. ACR guidance document on MR safe practices: Updates and critical information 2019. J Magn Reson Imaging 2020;51(2):331–8. doi: 10.1002/jmri.26880.
79. Baker C, Nugent B, Grainger D, et al. Systematic review of MRI safety literature in relation to radiofrequency thermal injury prevention. J Med Radiat Sci 2024;71(3):445–60. doi: 10.1002/jmrs.800.
80. Mittendorff L, Young A, Sim J. A narrative review of current and emerging MRI safety issues: What every MRI technologist (radiographer) needs to know. J Med Radiat Sci 2022;69(2):250–60. doi: 10.1002/jmrs.546.