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Research Article

A BIBLIOMETRIC ANALYSIS OF CEM CEMENT: TRACING TRENDS AND IMPACT IN DENTAL RESEARCH

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ABSTRACT

The rapid development of dental biomaterials necessitates a comprehensive understanding of current trends and their impact. Conducting a bibliometric analysis becomes crucial to identify key research directions, influential researchers, and significant contributions in this dynamic field. Such insights will guide evidence-based decisions, foster collaborations, and shape the future of dental biomaterials for improved patient care and clinical outcomes. This study aimed to conduct a comprehensive bibliometric analysis of calcium-enriched mixture (CEM) cement as an endodontic biomaterial in dental literature. A comprehensive search of the Scopus database was performed using relevant keywords. The data collection period extended from 2010-2023. The collated data underwent thorough analysis to delineate publication trends, source distribution, document types, subject areas, geographical distribution, authorship, keywords, and citation impact associated with CEM cement research. The analysis demonstrated a marked rise in scholarly interest in CEM cement since 2010, with a peak noted in 2016. The "Iranian Endodontic Journal" surfaced as a significant platform for CEM cement research. Original research articles constituted the majority of the documents, emphasizing the value of primary research in this field. Although dentistry was the prevalent subject area, contributions were also discernible in fields such as medicine/materials science. Geographically, Iran led in terms of research contributions, followed by the USA. Prominent researchers' participation further underlined the scientific influence and specialized knowledge in this field. Keyword analysis provided insights into prevailing research themes, including endodontics and material properties. This analysis yielded valuable insights into the evolving research landscape of CEM cement in dental literature; it can inform/guide future research directions/collaborations in dental biomaterials science.

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INTRODUCTION

Bibliometric analysis is an effective approach for examining the scientific landscape of various research domains, providing insights into publication trends, authorship patterns, and the impact of specific topics within a field. In the dental research, bibliometric studies have shed light on diverse areas and the analysis of specific matters (1, 2). The methodology entails a comprehensive search of reputable scientific databases such as Scopus (3), employing a carefully crafted set of controlled keywords specifically tailored. The search results usually undergo meticulous screening and selection to include only peer-reviewed articles that are directly relevant to the matter (4, 5). Such bibliometric studies endeavors to contribute to the existing knowledge base and serve as a robust foundation for future research and advancements in the field of dental biomaterials science.

The field of dentistry continually strives to improve treatment outcomes through the exploration and development of novel dental (bio)materials (6, 7). Calcium Enriched Mixture (CEM) cement is a bioactive endodontic biomaterial that has gained significant recognition in dentistry/endodontics for its advantages(8); it has emerged as a promising biomaterial with diverse clinical applications and desirable properties. A comprehensive understanding of the research landscape surrounding CEM cement can be achieved through rigorous bibliometric analysis, offering valuable insights into publication patterns, citation patterns, influential authors, collaborative networks, and the overall scientific impact of this dental biomaterial. To assess the research productivity, influence, and interconnectivity of CEM cement with other domains of research, essential parameters such as the geographic distribution of research, publication counts, citation counts, h-index, and co-citation networks need to be analyzed.

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This analytic study aims to conduct an extensive bibliometric analysis of CEM cement in the dental/endodontic literature.

METHODOLOGY

The aim of the study was to investigate scholarly output related to Calcium-enriched Mixture (CEM) cement within the field of dentistry/endodontics.

Data Collection

To gather the necessary data, an exhaustive search was conducted on the Scopus database. The search was executed using pertinent keywords such as "CEM cement," "Calcium-enriched Mixture," and "Calcium-enriched Mixture Cement." The chosen timeframe for data collection spanned from 2010 to 2023, thereby encompassing a dynamic period characterized by advancements and emerging research in the field.

Data Analysis

The amassed data underwent detailed analysis to discern prevalent trends and patterns pertaining to scholarly output, publication sources, document types, subject areas, geographical distribution, authorship, and keyword usage in relation to CEM cement.

Trend Analysis

To identify significant publication trends, a systematic examination of the number of publications per year was conducted. By scrutinizing the publication frequency across different years, this analysis aimed to identify significant changes or discernible patterns in research output related to CEM cement.

Publication Sources

To gain insights into the dissemination of CEM cement-related research, a comprehensive examination of the journals and sources where these publications were housed was undertaken. This analysis aimed to identify the leading journals that have contributed significantly to the field and to reveal the interdisciplinary reach of CEM cement research.

Document Types

In order to understand the nature of scholarly outputs related to CEM cement, the various document types included in the dataset were scrutinized. The analysis focused on determining the proportion of research articles, review papers, and other document types, such as letters, which offer additional insights or critical evaluations of existing research.

Subject Areas

A critical aspect of the study involved examining the subject areas under which the publications were categorized. By investigating the interdisciplinary nature of CEM cement research, this analysis aimed to identify the dominant subject areas and explore the presence of research in related fields beyond dentistry, including medicine, materials science, and biology.

Geographical Distribution

To ascertain the global landscape of CEM cement research, the geographical distribution of the publications was evaluated. By examining the countries contributing most to the research output, this analysis aimed to provide insights into the global interest and geographical distribution of CEM cement research.

Authorship Analysis: The authorship data were subjected to detailed analysis to identify the key researchers in CEM cement research. Prominent authors, their publication counts, and their contributions to the field were closely examined to provide comprehensive insights into the individuals shaping the research landscape.

Keyword Analysis

The keywords associated with CEM cement research were rigorously analyzed to identify key topics and thematic areas of focus within the literature. Through an examination of the most frequently used keywords and their variations, this analysis aimed to provide a thorough understanding of the research themes and areas of emphasis.

Limitations

It is important to acknowledge the limitations of this study. The analysis was based solely on data retrieved from the Scopus database, and therefore, the findings are confined to the publications indexed within this specific database. Moreover, the study primarily focused on quantitative analysis and did not encompass a qualitative assessment of the content within the publications.

RESULTS

The analysis of CEM cement publications yielded several key insights. The dataset spanned from 2010 to 2023, offering a detailed view of the trends and characteristics of scholarly output related to CEM cement.

Publication Trends: The analysis revealed a significant increase in scholarly interest in CEM cement since 2010, with a peak of 27 publications in 2016 (Figure 1). The upward trend from 8 publications in 2010 to 27 in 2016 indicates heightened attention to the potential of CEM cement within the research community, likely motivated by its unique properties and applicability in endodontics. Following the peak in 2016, the publication frequency showed a moderate decline with yearly fluctuations. Nonetheless, the scholarly interest in CEM cement remained consistent, as shown by the double-digit publication counts each year, with the exception of the ongoing year of 2023 where the count is currently at 6, a number that may change as the year progresses.

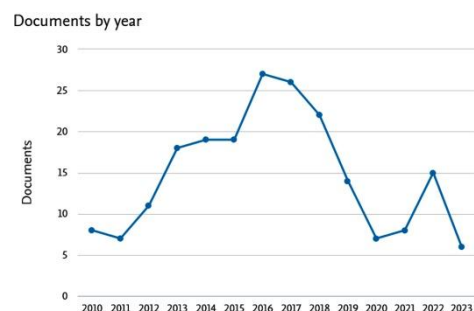


Figure 1 Publication trends of CEM cement research from 2010 until now

Source Distribution

The study identified a diverse range of publication sources, with 40 different sources in total (Figure 2). Notably, the "Iranian Endodontic Journal" emerged as a prominent platform with 93 documents attributed to it, underscoring focused research and innovation efforts in the field of endodontics within the region. Table 1 shows the top ten published articles in the Iranian Endodontic Journal. Other significant journals contributing to CEM cement research include the "Journal of Endodontics" (11

Table 1 Top ten published articles in the Iranian Endodontic Journal about CEM cement research

	Author	Title	Year	Citations
1	Asgary et al. ⁽⁹⁾	Outcomes of different vital pulp therapy techniques on symptomatic permanent teeth: A case series	2014	45
2	Yavari et al. ⁽¹⁰⁾	Microleakage comparison of four dental materials as intra-orifice barriers in endodontically treated teeth	2012	41
3	Fallahinejad et al. ⁽¹¹⁾	Treatment outcomes of primary molars direct pulp capping after 20 months: A randomized controlled trial	2013	37
4	Asgary et al. ⁽¹²⁾	Indications and case series of intentional replantation of teeth	2013	32
5	Yazdani et al. ⁽¹³⁾	Health technology assessment of CEM pulpotomy in permanent molars with irreversible pulpitis	2013	32
6	Saberi et al. ⁽¹⁴⁾	Cytotoxicity of various endodontic materials on stem cells of human apical papilla	2016	29
7	Milani et al. ⁽¹⁵⁾	Evaluating the effect of resection on the sealing ability of MTA and CEM cement	2012	27
8	Lotfi et al. ⁽¹⁶⁾	Effect of smear layer on the push-out bond strength of two endodontic biomaterials to radicular dentin	2013	26
9	Shahi et al. ⁽¹⁷⁾	The effect of different mixing methods on the flow rate and compressive strength of mineral trioxide aggregate and calcium-enriched mixture	2015	25
10	Hasheminia, et al. ⁽¹⁸⁾	Sealing ability of MTA and CEM cement as root-end fillings of human teeth in dry, saliva or bloodcontaminated conditions	2010	25

documents), "Dental Research Journal" (9 documents), "Clinical Oral Investigations" (6 documents), and "Journal of Conservative Dentistry" (6 documents). Table 2 demonstrated the top ten highly cited articles from various publication sources.

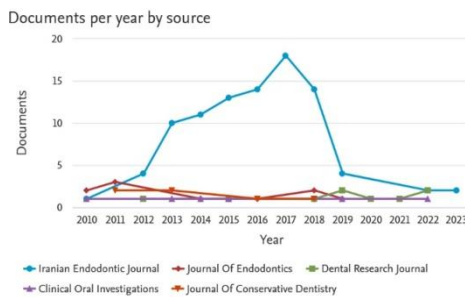


Figure 2 Source distribution of CEM cement research

Document Types

The bulk of the documents analyzed were articles (193), representing original research contributions to the field (Figure 3). There were also 10 review documents; (Table 3), which synthesize existing research on CEM cement, and 4 letters serving various purposes, such as commentary or brief findings. The distribution of document types emphasizes both primary research and various analyses, providing a holistic understanding of CEM cement.

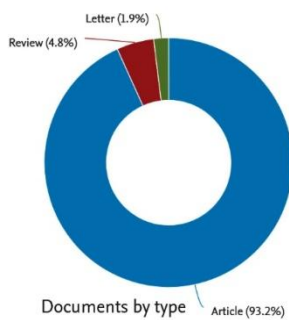


Figure 3 Document types of research regarding CEM cement

Subject Areas

The analysis of subject areas revealed a strong focus on Dentistry, with 187 documents in this category, highlighting the material's relevance in endodontics (Figure 4). Medicine,

the second most common subject area with 21 documents, indicates broader medical applications of CEM cement. Other subject areas such as Biochemistry, Genetics, Molecular Biology, and Materials Science demonstrate the interdisciplinary nature of CEM cement research.

Documents by subject area

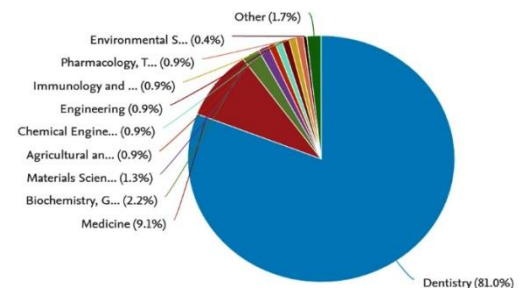


Figure 4 Subject areas of research regarding CEM cement

Geographical Distribution

Geographically, Iran led with the majority of publications (186 documents), emphasizing its primary role in CEM cement research (Figure 5). The United States followed with 16 documents, reflecting its significant research and development capabilities. Other countries, including India, Turkey, and the United Kingdom, also made noteworthy contributions, albeit with fewer publication counts.

Documents by country or territory

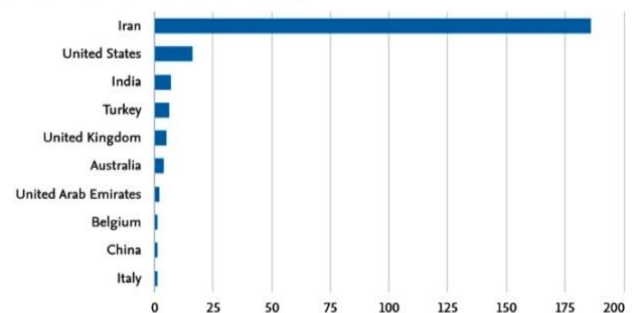


Figure 5 Geographical distribution of CEM cement research

Table 2 The top ten highly cited articles from various publication sources

	Author	Title	Journal	Year	Citations
1	Nosrat et al. ⁽¹⁹⁾	Regenerative endodontic treatment (revascularization) for necrotic immature permanent molars: A review and report of two cases with a new biomaterial	Journal of Endodontics	2011	197
2	Asgary et al. ⁽²⁰⁾	Five-year results of vital pulp therapy in permanent molars with irreversible pulpitis: a non-inferiority multicenter randomized clinical trial	Clinical Oral Investigations	2015	98
3	Tabarsi et al. ⁽²¹⁾	A comparative study of dental pulp response to several pulpotomy agents	International Endodontic Journal	2010	86
4	Samiee et al. ⁽²²⁾	Repair of furcal perforation using a new endodontic cement	Clinical Oral Investigations	2010	81
5	Asgary et al. ⁽²³⁾	Periradicular Regeneration after Endodontic Surgery with Calcium-enriched Mixture Cement in Dogs	Iranian Endodontic Journal	2010	80
6	Asgary & Eghbal ⁽²⁴⁾	Treatment outcomes of pulpotomy in permanent molars with irreversible pulpitis using biomaterials: A multi-center randomized controlled trial	Acta Odontologica Scandinavica	2013	78
7	Nosrat et al. ⁽²⁵⁾	Pulpotomy in caries-exposed immature permanent molars using calcium-enriched mixture cement or mineral trioxide aggregate: A randomized clinical trial	International Journal of Paediatric Dentistry	2013	74
8	Asgary et al. ⁽²⁶⁾	One-year results of vital pulp therapy in permanent molars with irreversible pulpitis: An ongoing multicenter, randomized, non-inferiority clinical trial	Clinical Oral Investigations	2013	71
9	Mozayeni et al. ⁽²⁷⁾	Cytotoxicity of calcium enriched mixture cement compared with mineral trioxide aggregate and intermediate restorative material	Australian Endodontic Journal	2012	71
10	Malekafzali et al. ⁽²⁸⁾	Treatment outcomes of pulpotomy in primary molars using two endodontic biomaterials. A 2-year randomised clinical trial	European Journal of Paediatric Dentistry	2011	71

Table 3 Top ten published review articles regarding CEM cement research

	Author	Title	Journal	Year	Citations
1	Parirokh et al. ⁽²⁹⁾	Mineral trioxide aggregate and other bioactive endodontic cements: an updated overview – part I: vital pulp therapy	International Endodontic Journal	2018	229
2	Torabinejad et al. ⁽³⁰⁾	Mineral trioxide aggregate and other bioactive endodontic cements: an updated overview – part II: other clinical applications and complications	International Endodontic Journal	2018	225
3	Dawood et al. ⁽³¹⁾	Calcium silicate-based cements: composition, properties, and clinical applications	Journal of investigative and clinical dentistry	2017	88
4	Asgary & Ahmadyar ⁽³²⁾	Vital pulp therapy using calcium-enriched mixture: An evidence-based review	Journal of Conservative Dentistry	2013	59
5	Rajasekharan et al. ⁽³³⁾	Biodentine™ material characteristics and clinical applications: a 3 year literature review and update	European Archives of Paediatric Dentistry	2018	55
6	Yazdani et al. ⁽¹³⁾	Health technology assessment of CEM pulpotomy in permanent molars with irreversible pulpitis	Iranian Endodontic Journal	2013	32
7	Zafar et al. ⁽³⁴⁾	Bio-active cements-mineral trioxide aggregate based calcium silicate materials: A narrative review	Journal of the Pakistan Medical Association	2020	15
8	Samiei et al. ⁽³⁵⁾	The effect of different mixing methods on the properties of calcium-enriched mixture cement: A systematic review of in vitro studies	Iranian Endodontic Journal	2019	7
9	Sujlana & Pannu ⁽³⁶⁾	Direct pulp capping: A treatment option in primary teeth	Pediatric Dental Journal	2017	6
10	Brzęcka & Staniowski ⁽³⁷⁾	Novel bioceramic root repair materials: Review of the literature	Dental and Medical Problems	2016	3

Authorship

Renowned researchers in the CEM cement research include Dr. Saeed Asgary (87 publications), Dr. Mohammad Jafar Eghbal (22 publications), and Dr. Mahta Fazlyab (15 publications). Several other researchers also made meaningful contributions to the field, underlining the collaborative nature of dental research (Figure 6).

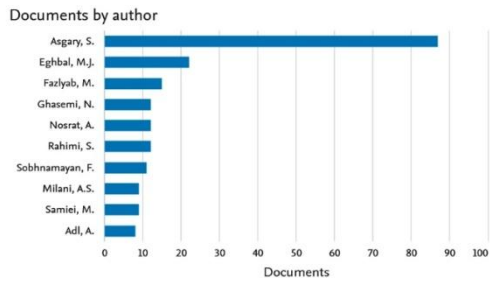


Figure 6 Top ten authors for CEM cement research

Keyword Analysis

The keyword analysis provided insights into various facets and topics associated with CEM cement research. Commonly used keywords included "Mineral Trioxide Aggregate," "CEM Cement," and "Human," indicating a broad interest in these topics. Keywords related to endodontics, root canal filling materials, material composition, clinical conditions, and material properties were also prevalent, emphasizing the expansive scope of research related to CEM cement.

Citation Analysis

The h-index for the analyzed documents was determined to be 32, signifying the existence of highly cited publications related to CEM cement in dental literature, which greatly contribute to the scientific impact and recognition of this field (Figure 7). It should be noted that a significant number of documents have not received any citations, possibly due to factors such as recency, niche topics, or limited visibility within the scientific community.

Overall, these findings underscore the increasing interest, interdisciplinary nature, and global impact of CEM cement in dental and related fields.

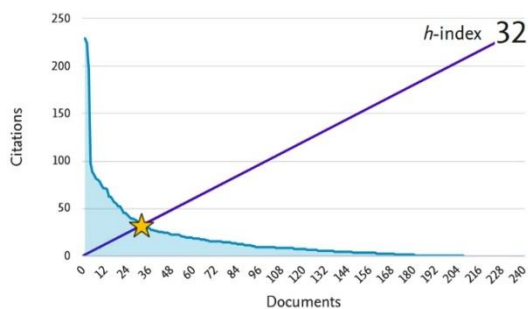


Figure 7 Citation analysis for researches regarding CEM cement

DISCUSSION

This bibliometric analysis of biomaterials such as calcium-enriched mixture (CEM) cement in dental/endodontic literature has offered valuable insights into this innovative dental biomaterial. The study conducted a rigorous methodology, involving database searches, screening and selection of pertinent articles, and the application of specialized software for bibliometric analysis. The findings provide useful insights into publication trends, source distribution, document types,

subject areas, geographical distribution, authorship, keywords, and citation impact.

The study discovered an increasing scholarly interest in CEM cement beginning in 2010, peaking in 2016, indicative of a growing acknowledgment of its potential within the research community. The unique properties and diverse clinical applications of CEM cement have likely contributed to this heightened interest (38-44). A variety of publication sources were identified, with the "Iranian Endodontic Journal" emerging as a significant platform, underlining concentrated research efforts in the endodontics sector. CEM cement research was also found in journals spanning various disciplines, emphasizing its interdisciplinary reach and impact beyond dentistry.

A review of the document types in CEM cement research demonstrated a significant majority of original research articles, indicating active research contributions to the field. Review papers and letters also provide critical evaluations and commentary, enhancing the academic discourse surrounding CEM cement.

The prominent focus on dentistry as the subject area for CEM cement research aligns with the material's relevance in endodontics and restorative treatments. Yet, the analysis also revealed contributions from other subject areas, including medicine, biochemistry, genetics, molecular biology, materials science, and engineering, underscoring the interdisciplinary nature of CEM cement research and its broad-ranging applications and potential collaborations.

From a geographical standpoint, Iran emerged as a significant contributor to CEM cement research, followed by the United States and several other nations. Iran's leading role in CEM cement research underlines its substantial scientific research and development capabilities in this field. The global interest and influence of CEM cement are further evidenced by contributions from other countries such as India, Turkey, the United Kingdom, and others, emphasizing the necessity of international collaborations and knowledge sharing in propelling the field forward.

The keyword analysis offered insights into the key topics and thematic areas of focus within CEM cement research. The frequent appearance of keywords such as "Mineral Trioxide Aggregate," "CEM Cement," and "Human" demonstrates widespread interest in these topics. The prevalence of keywords related to endodontics, root canal filling materials, material composition, clinical conditions, and material properties further accentuates the expansive scope of research tied to CEM cement. These research themes and areas of emphasis could guide future studies and advancements in the field.

The citation analysis unveiled highly cited publications connected to CEM cement, contributing to its scientific impact and recognition in dental literature. However, a significant number of documents have not received any citations, potentially due to factors such as recency or limited visibility. These uncited publications could represent emerging research yet to attract broader attention. Their inclusion in future analyses and broader dissemination within the scientific community could uncover hidden research potential.

The limitations of this bibliometric analysis should be acknowledged. The findings are based solely on data retrieved from the Scopus database, which may not encompass all

relevant publications. Additionally, the study focused primarily on quantitative metrics and did not include a qualitative assessment of the content within the publications. Future studies that incorporate qualitative analysis can offer a more profound understanding of the research landscape and specific research contributions.

CONCLUSIONS

In conclusion, the bibliometric analysis of CEM cement in dental literature has illuminated publication trends, source distribution, document types, subject areas, geographical distribution, authorship, keywords, and citation impact within this field. The findings underscore the escalating interest, interdisciplinary nature, and global impact of CEM cement in dental and associated fields. The insights gleaned from this analysis could inform future research directions, collaborations, and advancements in dental materials science. They could ultimately benefit researchers, clinicians, and industry professionals involved in the development, evaluation, and clinical application of CEM cement in dental practice.

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