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Mapping the Landscape of Artificial Intelligence in Prosthodontics: a Bibliometric overview of Current Research and Future Directions

SUMMARY

Artificial intelligence (AI) applications have become increasingly popular in our society, affecting a plethora of fields such as business, education, engineering and sciences. In the fields of Medicine and Dentistry, AI is expected to drive significant advancements, starting with improvements in imaging diagnostics. Prosthodontics, a key area within Dentistry, is also expected to benefit greatly from the innovations brought about by AI. In order to assess and analyze the current literature regarding the use of AI technologies in Prosthodontics, a bibliometric review was conducted. The objective was to not only showcase the current developments and upcoming trends in AI in Prosthodontics research, but also to familiarize the dental community with the bibliometric methods and outcomes. Web of Science was assessed and records were screened by two independent reviewers. VOSviewer and Biblioshiny were used for performing bibliometric analyses. After conducting electronic searches, we identified 166 records which were narrowed down to 51 articles following thorough screening. Co-word, citation, co-citation, co-authorship and bibliographic coupling analyses were carried out, along with selected performance and science mapping analyses. AI appears to be a promising area of study in Prosthodontics, as the interest in academic and research has increased significantly in the past few years. The incorporation of bibliometric analysis into the exploration of a scientific subject provides a more comprehensive understanding of the current state of knowledge.

Key words: Artificial Intelligence, Bibliometric Analysis, Performance Analysis, Prosthodontics, Science Mapping

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Introduction

The rapid development of technology is leading humanity towards the era of artificial intelligence (AI). In contrast to natural intelligence, which is demonstrated by living creatures, AI is defined as "the intelligence which is exhibited by machines"[1,2]. Starting from chess and checkers games of humans against a software[3,4], AI has nowadays a significant impact on various fields, such as business, education, engineering and sciences[3,5].

AI is encountered in two forms; physical, which refers to applications of medical devices and robots, and virtual, involving machine learning mathematical algorithms[5]. Both of them can be used τo benefit various fields of medicine[5]. The main medical applications of AI include imaging diagnostics/radiology, digital medical records, appointment scheduling, medication dosages and robotic assistance, the latter being a typical example of physica AI[5–8]. In Dentistry, the advancements remain up to now limited; however, many specific dental specialties, including Prosthodontics, could be possibly benefited[9–11].

Bibliometric analysis is considered one of the most interesting methods for analyzing data. It is defined as "the application of mathematical and statistical procedures to published written form of communication, such as books"[12,13]. The goal of the analysis is to inspect large

quantities of scientific data and to summarize research trends from emerging fields of interest[14,15]. The two main techniques of bibliometric analysis are performance analysis and science mapping, the later presenting the visualization of scientific contributions and/or collaborations in a specific topic[14] by means of various bibliometric tools[16].

A brief search of the scientific databases reveals the growing scientific interest in AI applications on Prosthodontics. Bibliometric analysis can be used to highlight the emerging trends on this topic, regarding influential authors, organizations and keywords. As dentists are not typically trained on analyzing bibliometric data during their undergraduate academic years, a general overview of such an analysis would be of great interest. Furthermore, there has not been any bibliometric study addressing the specific topic.

The aim of this review was to present information on the worldwide dissemination of research and of the current trends of AI applications in Prosthodontics. The data were extracted and organized using selected bibliometric tools and techniques, and a further goal was to introduce this type of analysis to the dental community.

Material and Methods

Web of Science (WoS) was the selected database for this bibliometric analysis, as the amount of missing metadata was negligible, compared to other commonly used databases (MEDLINE, Scopus). The time period of the search was from inception until 23rd November 2023, which was the day the search took place. The search query was the following one:

((artificial intelligence AND prosth*) AND dent*),

and was applied in all of the searchable fields. Two independent reviewers (IT, EK) screened the records in order to finally include only studies with a topic relevant to applications of AI on prosthodontics. This step was performed as a "data cleaning" process; any disagreements were resolved after discussion between the aforementioned reviewers.

The final selection of study records was extracted into .txt documents in order to be assessed by two bibliometric analysis tools, namely VOSviewer and Biblioshiny. VOSviewer version 1.6.19 was used for developing various bibliometric graphs. It provides detailed bibliometric maps, which are easy to interpret[17]. On the other hand, Biblioshiny provides a comprehensive approach, especially regarding science mapping[17–19]. Although it is an R-package software, Biblioshiny does not demand specific knowledge about programming codes. The commands used for initializing bibliometric analysis in Biblioshiny were the following:

- #install.packages("bibliometrix")
- library(bibliometrix) #to activate package
- biblioshiny()

Results and Discussion

Descriptive statistics

The electronic search in Web of Science yielded 166 results. After a thorough screening of the records, the two reviewers ended up selecting 51 articles which were closely relevant to the topic of interest (Table 1). These records were included for bibliometric analysis via VOSviewer and Biblioshiny. Table 2 shows the successful insertion of data into Biblioshiny, as the completeness of bibliographic metadata was characterized as "Excellent" in the majority of elements (Table 2). Only the keyword-related metrics and DOI were not considered excellent metadata by Biblioshiny, but they were rated good or acceptable for conducting bibliometric analyses.

Table 1: Studies included in bibliometric analysis.

	First author et al	Year	
1	Khanna	2010	Artificial intelligence: contemporary applications and future compass
2	Roy	2018	Design of patient specific dental implant using FE analysis and computational intelligence techniques
3	Blatz	2019	Evolution of aesthetic dentistry
4	Yamaguchi	2019	Predicting the debonding of CAD/CAM composite resin crowns with AI
5	Machoy	2020	The ways of using machine learning in dentistry
6	Martins	2020	An artificial-intelligence-based method for assessing service quality: insights from the prosthodontics sector
7	Prados-Privado	2020	Dental images recognition technology and applications: a literature review
8	Ahmed	2021	Artificial intelligence techniques: analysis, application, and outcome in dentistry-a systematic review
9	Bernauer	2021	The use and performance of artificial intelligence in prosthodontics: a systematic review
10	Burlui	2021	Interdisciplinary approach in digital dentistry planning
11	Mahri	2021	Osseointegration pharmacology: a systematic mapping using artificial intelligence
12	Mupparapu	2021	Novel 3D segmentation for reliable volumetric assessment of the nasal airway: a CBCT study
13	Brandenburg	2022	Reconstruction of dental roots for implant planning purposes: a feasibility study

	First author et al	Year	
14	Chau	2022	Artificial intelligence-designed single molar dental prostheses: a protocol of prospective experimental study
15	Choi	2022	Automatic detection of teeth and dental treatment patterns on dental panoramic radiographs using deep neural networks
16	de Angelis	2022	Artificial intelligence: a new diagnostic software in dentistry: a preliminary performance diagnostic study
17	Joda	2022	Personalized workflows in reconstructive dentistry-current possibilities and future opportunities
18	Kim	2022	A fully automated method of human identification based on dental panoramic radiographs using a convolutional neural network
19	Kochar	2022	The etiology and management of dental implant failure: a review
20	Kohinata	2022	Deep learning for preliminary profiling of panoramic images
21	Lee JD	2022	Facial scanners in dentistry: an overview
22	Lee SJ	2022	Diagnosis of tooth prognosis using artificial intelligence
23	Li H	2022	Interpretable AI explores effective components of CAD/CAM resin composites
24	Liu	2022	Reliability of cusp angulation using three-dimensional digital models: a preliminary in vitro study
25	Nota	2022	One-stage virtual plan of a complex orthodontic/prosthetic dental rehabilitation
26	Revilla-León	2022	Artificial intelligence applications in restorative dentistry: a systematic review
27	Saleh	2022	Texture-based neural network model for biometric dental applications
28	Singi	2022	Extended arm of precision in prosthodontics: artificial intelligence
29	Thurzo	2022	Where is the artificial intelligence applied in dentistry? Systematic review and literature analysis
30	Ali	2023	Applications and performance of artificial intelligence models in removable prosthodontics: a literature review
31	Alshadidi	2023	Investigation on the application of artificial intelligence in prosthodontics
32	Bornes	2023	Use of bioinformatic strategies as a predictive tool in implant-supported oral rehabilitation: a scoping review
33	Elgarba	2023	Deep learning-based segmentation of dental implants on cone-beam computed tomography images: a validation study
34	Farook	2023	Computer-aided design and 3-dimensional artificial/convolutional neural network for digital partial dental crown synthesis and validation
35	Hartshorn	2023	Dental innovations which will influence the oral health care of baby boomers
36	Li YJ	2023	Clinical application of robots in dentistry: a scoping review
37	Mahrous	2023	The use of artificial intelligence and game-based learning in removable partial denture design: a comparative study
38	Müller	2023	Digital innovations in implantology the prosthodontist's perspective from private practice
39	Ou-Yang	2023	The preliminary in vitro study and application of deep learning algorithm in cone beam computed tomography image implant recognition
40	Prados-Privado	2023	How to categorize a panoramic images database for automatically detection of dental treatments
41	Putra	2023	Convolutional neural networks for automated tooth numbering on panoramic radiographs: a scoping review
42	Ramachandran	2023	Machine learning model to predict the width of maxillary central incisor from anthropological measurements
43	Revilla-León	2023	Artificial intelligence applications in implant dentistry: a systematic review
44	Revilla-León	2023	Artificial intelligence models for tooth-supported fixed and removable prosthodontics: a systematic review
45	Revilla-León	2023	An overview of the digital occlusion technologies: intraoral scanners, jaw tracking systems, and computerized occlusal analysis devices
46	Sakai	2023	Development of artificial intelligence model for supporting implant drilling protocol decision making
47	Saleh	2023	Emergence angle: comprehensive analysis and machine learning prediction for clinical application
48	Singhal	2023	A literature review of the future of oral medicine and radiology, oral pathology, and oral surgery in the hands of technology
49	Son	2023	Requirements for dental CAD software: a survey of Korean dental personnel
50	Tabatabaian	2023	Applications, functions, and accuracy of artificial intelligence in restorative dentistry: a literature review
51	Vera	2023	Artificial intelligence techniques for automatic detection of peri-implant marginal bone remodeling in intraoral radiographs

Table 2: Completeness of bibliographic metadata. Source: Biblioshiny.

AB	Abstract	0	0.00	Excellent
C1	Affiliation	0	0.00	Excellent
AU	Author	0	0.00	Excellent
CR	Cited References	0	0.00	Excellent
RP	Corresponding Author	0	0.00	Excellent
DT	Document Type	0	0.00	Excellent
SO	Journal	0	0.00	Excellent
LA	Language	0	0.00	Excellent
NR	Number of Cited References	0	0.00	Excellent
PY	Publication Year	0	0.00	Excellent
WC	Science Categories	0	0.00	Excellent
TI	Title	0	0.00	Excellent
TC	Total Citation	0	0.00	Excellent
DI	DOI	2	3.92	Good
ID	Keywords Plus	4	7.84	Good
DE	Keywords	8	15.69	Acceptable

The main descriptive statistics of the bibliometric analysis in Biblioshiny are depicted in detail in Table 3 (Table 3). The 51 articles of interest were published between 2010 and 2023. AI and its applications in Prosthodontics, appear as an emerging field, continuously developing during the last decade, a fact that is clearly shown in the Table (Annual Growth Rate 26.84%). In addition, these articles have been published in 35 different sources (Journals, Books, etc.), with approximately nine average citations per document. This information highlights the dispersion of the documents in a large variety of sources, and the dissemination that they have in the academic community.

Table 3: Main information overview. Source: Biblioshiny.

MAIN INFORMATION ABOUT DATA	
Timespan	2010:2023
Sources (Journals, Books, etc.)	35
Documents	51
Annual Growth Rate %	26.84
Document Average Age	1.22
Average citations per doc	8.804
References	2541
DOCUMENTS CONTENTS	
Keywords Plus (ID)	177
Author's Keywords (DE)	173
AUTHORS	
Authors	284
Authors of single-authored docs	2
AUTHORS COLLABORATION	
Single-authored docs	2
Co-Authors per Doc	6.27
International co-authorships %	41.18
DOCUMENT TYPES	
article	27
article; early access	3
review	17
review; early access	4

Two publications were single-authored, and the average number of co-authors was 6.27, relatively high. 30 documents were identified as articles, as opposed to 21 characterized as reviews, of which 6 were systematic reviews and meta-analyses. Despite the short-time experimental production, many authors have presented reviews in an effort to gather, organize and summarize the AI elements that are in use or of benefit for Prosthodontics. According to their topic, studies can be classified into five main research categories (Table 4). As AI could be successfully applied to dental imaging and implant dentistry, it is reasonable that ten and nine articles correspondingly are associated with these topics.

Table 4: Classification of studies according to their research category.

Research categories	Studies
Dental imaging	7, 13, 15, 18, 20, 21, 27, 40, 41, 45
Implant dentistry	2, 19, 32, 33, 38, 39, 43, 46, 51
Restorative dentistry	3, 4, 23, 26, 34, 50
Diagnosis and treatment planning	10, 16, 22, 25, 37, 44, 49
Others	1, 5, 6, 8, 9, 11, 12, 14, 17, 24, 28, 29, 30, 31, 35, 36, 42, 47, 48

The numbers of this table correspond to the Table 1.

Performance analysis

Performance analysis is a descriptive analysis related to contributions of research constituents, such as institutions, authors and countries, providing detailed information about the profile of the research participants[14]. There are three subgroups of performance analysis, linked to publications, citations or both of them.

The annual scientific production per year, a publication-related metric, can be seen in Figure 1 (Figure 1). One article was published in 2010[20]; it is a single authored paper, published in the International Dental Journal and describing the potential of health sciences-related algorithms to assist dental practitioners in the decision-making tasks. However, the following seven years were totally unproductive in the field of AI on Prosthodontics, according to Web of Science records. A cumulative increase in scientific production is observed starting from 2018 and reaching 23 publications published in 2023 only (until November 2023). This observation confirms the novelty of the concept of AI in Prosthodontics, showcasing a surge in new scientific knowledge in this field, especially within the past two years.

Table 5 depicts the average citations per year, which is a citation-related metric (Table 5). Average citations provide an insight into the impact of the scientific documents on the development of new scientific knowledge. The key year is 2019, when average citations reached their highest value, equal to 9.08. The decline in average citations from 2019 to 2023 may be attributed to the recency of the publications, resulting in insufficient time for the papers to accumulate citations.

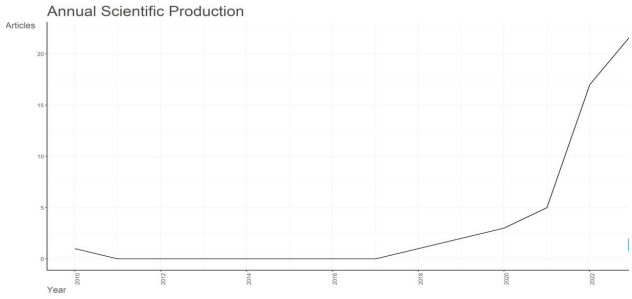

Figure 1: Annual scientific production. Source: Biblioshiny.

Table 5: Average citations per year. Source: Biblioshiny.

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
2010	12	1.00	0.80	15
2018	43	1.00	6.14	7
2019	54.5	2.00	9.08	6
2020	16.67	3.00	3.33	5
2021	13.8	5.00	3.45	4
2022	5.82	17.00	1.94	3
2023	3.05	22.00	1.52	2

Science Mapping

Science mapping is performed to investigate potential connections and/or interactions among research factors[14]; it embraces five subcategories, namely co-word, citation, co-citation, co-authorship and bibliographic coupling analyses.

Co-word analysis

Co-word analysis is defined as "the analysis of relationships among themes in a given research field, according to the written content of the scientific article"[14,17]. This technique relies primarily on article keywords, with the relevance of items determined by the frequency of their presence in documents.

Table 6 shows the keywords listed at least three times among the articles of interest (Table 6). The keywords 'classification' and 'accuracy' were met in documents eight and seven times correspondingly. This suggests that AI can assist in achieving a precise diagnosis by offering support in these areas.

Table 6: Co-word analysis (most relevant words). Source: Biblioshiny.

Words	Occurrences
classification	8
accuracy	7
artificial-intelligence	6
dentistry	6
diagnosis	6
system	6
teeth	6
design	5
performance	4
identification	3
neural-network	3
prediction	3

WordCloud is an effective tool for illustrating co-word analysis, easily understandable for readers, as larger font sizes indicate more common keywords. In the WordCloud generated from our data, the keywords 'classification' and 'accuracy' are written in larger font sizes, followed by the basic term of the current review, namely 'artificial intelligence' (Figure 2). A surprising fact is the absence of the term 'prosthodontics' in the first decade, despite being a major term for this review. However, there are terms that are directly or indirectly related to Prosthodontics, solving partially this confusion.

Figure 2: Co-word analysis (Wordcloud). Source: Biblioshiny.

Citation analysis

Citation analysis evaluates the relationships among publications, aiming to identify the most important ones. The more citations a document gathers, the more influential it is considered[14,17].

The 20 most cited papers can be seen in Table 7, along with the Total Citations that have received. The most influential article is that of Blatz *et al*, 2019 with 72 citations in total, published by the Journal of Dental Research[21]. It is a literature review about aesthetic dentistry, which includes the topic of AI in Prosthodontics. According to the authors, AI is considered the future of aesthetic dentistry, a fact that is in agreement with the existing literature.

It is important to highlight that among the ten most cited papers, five of them are systematic reviews. Being recognized as a documented and highly reliable source of scientific information, they have received a significant number of citations. Since the subject of artificial intelligence in Prosthodontics is relatively new, systematic reviews may serve as a trustworthy source of information.

The most cited sources are listed in Table 8. The Journal of Prosthetic Dentistry is clearly the most cited journal, as it has been cited by 157 articles, followed by the Journal of Dental Research with 80 articles. The Journal of Prosthetic Dentistry is one of the most important journals on the field of Prosthodontics, with an impact factor of 4.3, according to recent analytic reports. As the topic of this bibliometric analysis is related to Prosthodontics, it comes as no surprise that this journal is in the first place of the list.

Table 7: Citation analysis based on documents (most cited documents). Source: Biblioshiny.

Paper	DOI	Total Citations	TC per Year	Normalized TC
BLATZ MB, 2019, J DENT RES	10.1177/0022034519875450	72	12.00	1.32
ROY S, 2018, APPL SOFT COMPUT	10.1016/j.asoc.2018.01.025	43	6.14	1.00
AHMED N, 2021, BIOMED RES INT-UK	10.1155/2021/9751564	38	9.50	2.75
YAMAGUCHI S, 2019, J DENT RES	10.1177/0022034519867641	37	6.17	0.68
REVILLA-LEÓN M, 2023, J PROSTHET DENT-a	10.1016/j.prosdent.2021.05.008	29	14.50	9.52
REVILLA-LEÓN M, 2023, J PROSTHET DENT	10.1016/j.prosdent.2021.06.001	26	13.00	8.54
THURZO A, 2022, HEALTHCARE-BASEL	10.3390/healthcare10071269	25	8.33	4.29
MACHOY ME, 2020, ADV CLIN EXP MED	10.17219/acem/115083	24	4.80	1.44
BERNAUER SA, 2021, SENSORS-BASEL	10.3390/s21196628	20	5.00	1.45
REVILLA-LEÓN M, 2022, J PROSTHET DENT	10.1016/j.prosdent.2021.02.010	19	6.33	3.26
PRADOS-PRIVADO M, 2020, APPL SCI-BASEL	10.3390/app10082856	14	2.80	0.84
KHANNA S, 2010, INT DENT J	10.1922/IDJ_2422Khanna04	12	0.80	1.00
MARTINS SM, 2020, J SERV MANAGE	10.1108/JOSM-03-2019-0084	12	2.40	0.72
JODA T, 2022, CLIN ORAL INVEST	10.1007/s00784-022-04475-0	11	3.67	1.89
DE ANGELIS F, 2022, INT J ENV RES PUB HE	10.3390/ijerph19031728	7	2.33	1.20
MAHRI M, 2021, ACTA BIOMATER	10.1016/j.actbio.2020.11.011	7	1.75	0.51
CHOI HR, 2022, FOREN SCI RES	10.1080/20961790.2022.2034714	6	2.00	1.03
LI H, 2022, J DENT RES	10.1177/00220345221089251	6	2.00	1.03
LEE SJ, 2022, DIAGNOSTICS	10.3390/diagnostics12061422	5	1.67	0.86
SAKAI T, 2023, J PROSTHODONT RES	10.2186/jpr.JPR_D_22_00053	4	2.00	1.31

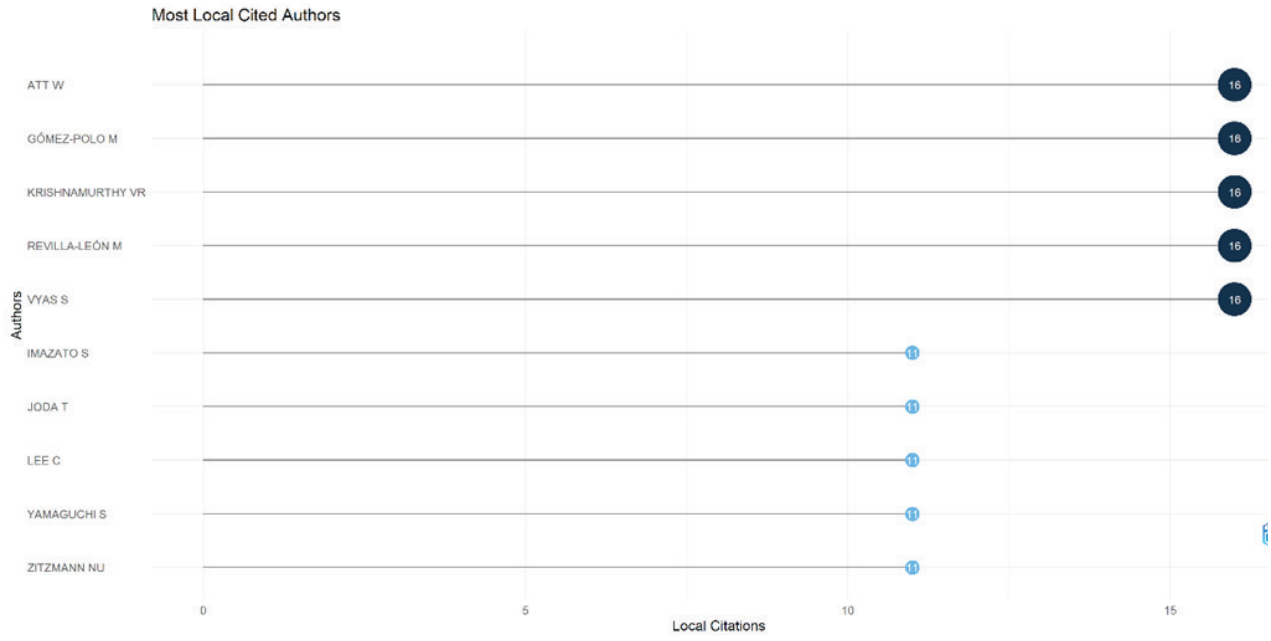

Figure 3: Citation analysis based on authors (most cited authors). Source: Biblioshiny.

Figure 3 depicts in detail the most cited authors, based on Biblioshiny analysis. As it is easily seen, five authors share the first place with 16 citations, with "Revilla-León M" being the first author in four out of the 51 records of this bibliometric analysis.

Figure 4 depicts which countries were more influential in terms of citation analysis (Figure 4).

USA is obviously the most cited country with 109 citations, followed by Spain and India (62 and 61 citations respectively). In addition, the most influential academic institutions regarding citation analysis are shown in Table 9. As the sum of articles citing Harvard School of Dental Medicine and Harvard University is equal to 14 (eight and six correspondingly), it is totally understandable why USA is the most cited country.

Table 8: Citation analysis based on sources (most cited sources). Source: Biblioshiny.

Sources	Articles
J PROSTHET DENT	157
J DENT RES	80
CLIN ORAL IMPLAN RES	65
J DENT	63
SCI REP-UK	46
CLIN ORAL INVEST	44
DENTOMAXILLOFAC RAD	43
DENT MATER	37
J PERIODONTOL	34
J AM DENT ASSOC	33
INT J ORAL MAX IMPL	32
QUINTESSENCE INT	31
INT J ENV RES PUB HE	30
J PROSTHODONT RES	28
J PROSTHODONT	27
J ORAL REHABIL	26
COMPUT BIOL MED	25
APPL SCI-BASEL	23
AM J ORTHOD DENTOFAC	22
J CLIN MED	22

Table 9: Citation analysis based on organizations (most relevant affiliations). Source: Biblioshiny.

Affiliation	Articles
HARVARD SCHOOL OF DENTAL MEDICINE	8
KYUNGPOOK NATIONAL UNIVERSITY	8
COMPLUTENSE UNIVERSITY OF MADRID	7
OSAKA UNIVERSITY	7
HARVARD UNIVERSITY	6
UNIVERSITY OF WASHINGTON SEATTLE	5
COMENIUS UNIVERSITY BRATISLAVA	4
IWATE MEDICAL UNIVERSITY	4
NIPPON DENTAL UNIVERSITY	4
TEXAS AANDM UNIVERSITY SYSTEM	4
TUFTS UNIVERSITY	4
TOKYO MEDICAL AND DENTAL UNIVERSITY (TMDU)	4
EGYPTIAN KNOWLEDGE BANK (EKB)	3
SHARAD PAWAR DENTAL COLLEGE AND HOSPITAL (SPDC)	3
TEXAS AANDM UNIVERSITY COLLEGE STATION	3
TOKYO MEDICAL AND DENTAL UNIVERSITY (TMDU)	3
UNIVERSITY OF FREIBURG	3
UNIVERSITY OF IOWA	3
UNIVERSITY OF ROCHESTER	3
OSAKA UNIVERSITY	3
UNIVERSITY OF WASHINGTON	3

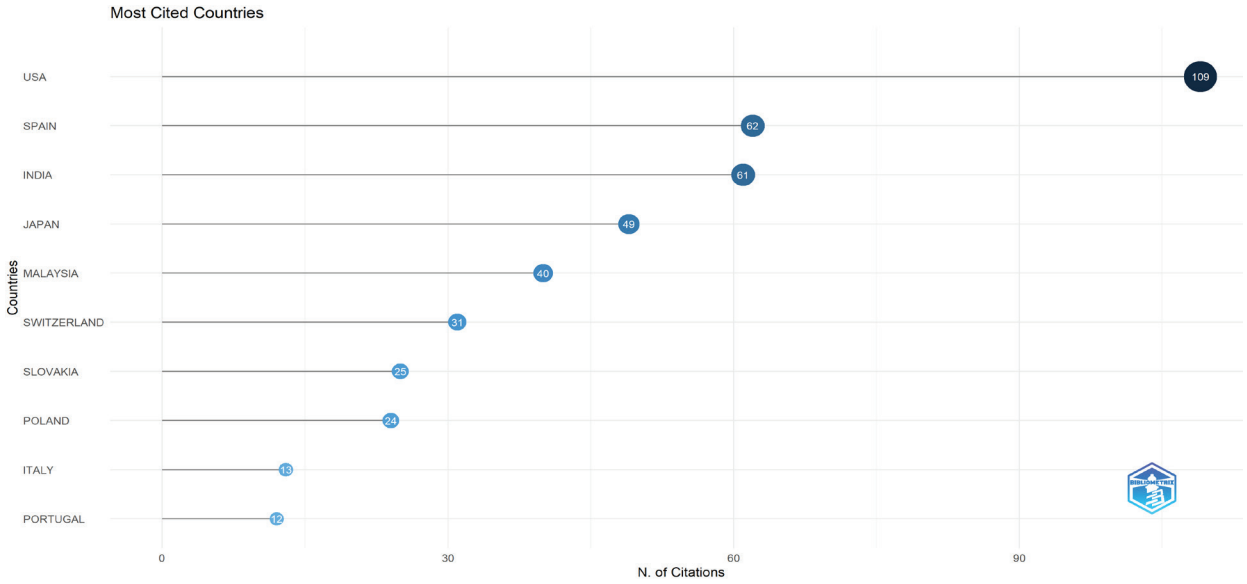

Figure 4: Citation analysis based on countries (most cited countries). Source: Biblioshiny.

Co-citation analysis

Co-citation analysis is based on the assumption that "two publications are thematically connected when they are cited together", revealing thematic clusters[14]. In the present overview, this analysis is presented via a heat map, where the frequency of publication cited together is shown by shades of yellow. With regards to cited sources (Figure 5), the Journal of Prosthetic Dentistry is clearly in the first position, followed by the Journal of Dental Research. This result is in agreement with the citation analysis (Table 8). This analysis was conducted using another bibliometric tool (VOSviewer); thus, both tools showed that the Journal of Prosthetic Dentistry is the most influential source in citation and co-citation analyses.

Co-authorship analysis

Co-authorship analysis investigates the interactions among scholars, including their affiliations and countries[14], and points out the academic partnerships and collaborations. USA, Japan and Spain are the countries with the most academic collaborations on the topic of AI on Prosthodontics, as it is shown in "Collaborations world map" diagram of Biblioshiny (Figure 6), where they are depicted with dark blue shade, but also are connected by lines. Combining these results with those of citation analysis, these three countries possess an important role in terms of providing significant academic knowledge to the scientific community.

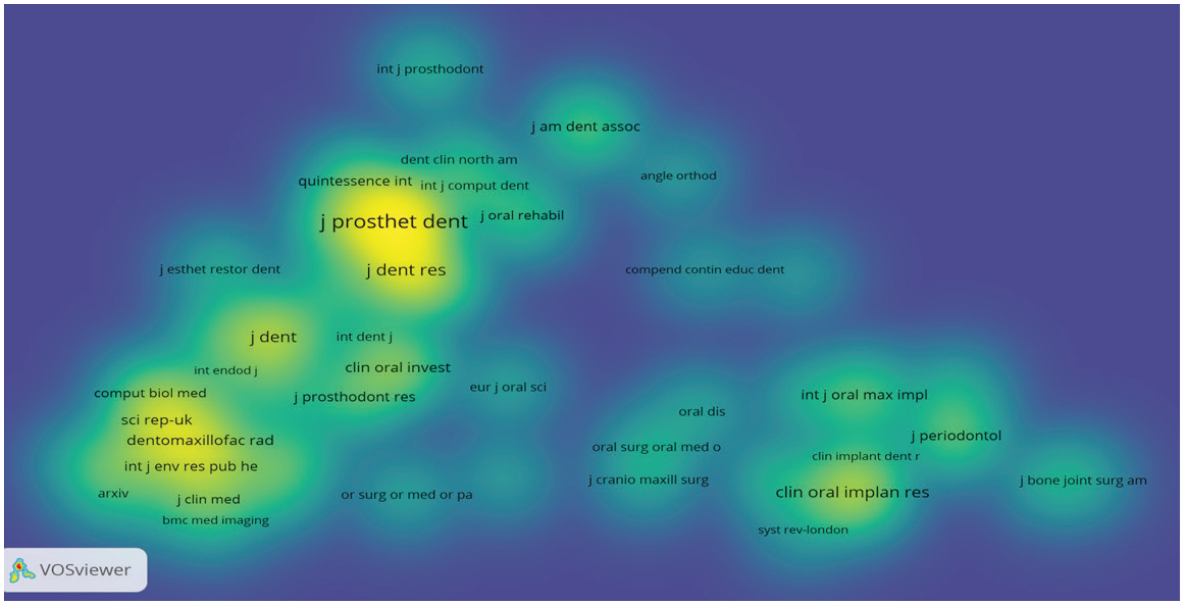

Figure 5: Co-citation analysis based on cited sources-minimum number of citations of a source equal to 10. Source: VOSviewer.

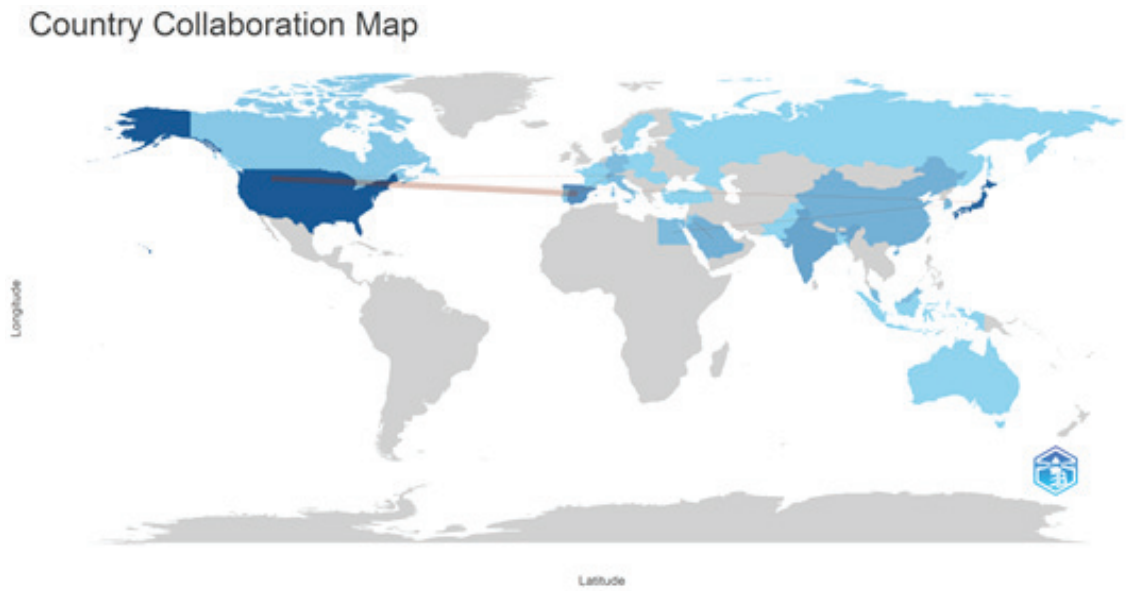

Figure 6: Co-authorship analysis based on countries (collaborations world map). Source: Biblioshiny.

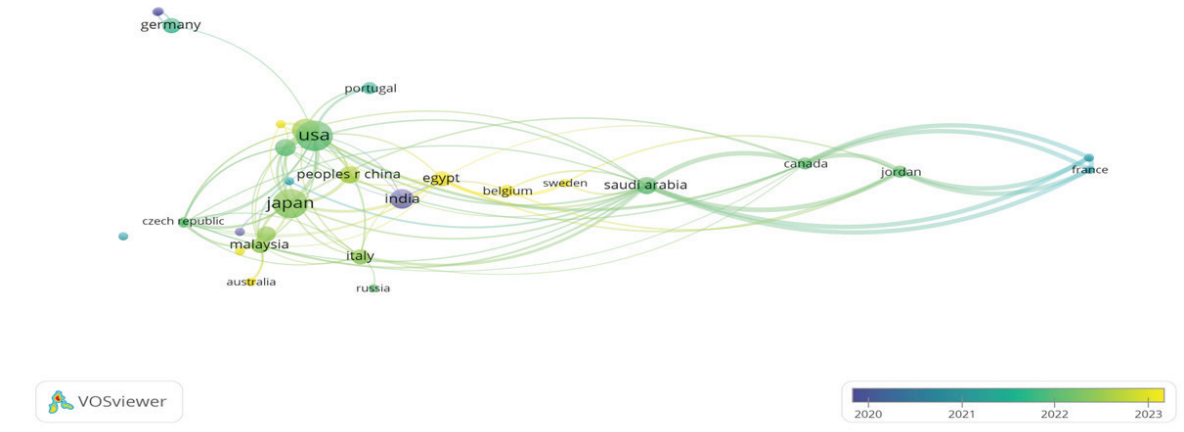

Figure 7: Bibliographic coupling analysis based on countries-minimum number of documents of a country equal to 1. Source: VOSviewer.

Bibliographic coupling

Bibliographic coupling is based on the premise that "two publications that are cited together they are possibly similar regarding their topic", implicating the development of a research theme[14]. Japan and USA are dominant in bibliographic coupling (Figure 7), in line with the results of co-authorship and citation analyses.

Additional science mapping data

Biblioshiny offers researchers additional science mapping graphs that focus on sources, authors, references and their impact, and are based on specific bibliometric laws and indices. "Three-field-plot" provides comprehensive information as it shows the inter-relationships among three of the following research constituents (fields): authors, affiliations, countries, keywords, sources and references. Figure 8 combines references, authors and keywords, 10 items in each category (Figure 8). "Three-field-plot" summarizes the findings of the whole bibliometric analysis, as it connects the most influential documents, authors and keywords that are related themselves to. A significant difference between co-word and "three-field-plot" analysis is the presence of the term 'prosthodontics' in the right column of "three-field-plot", being one of the two major pillars of the current bibliometric analysis.

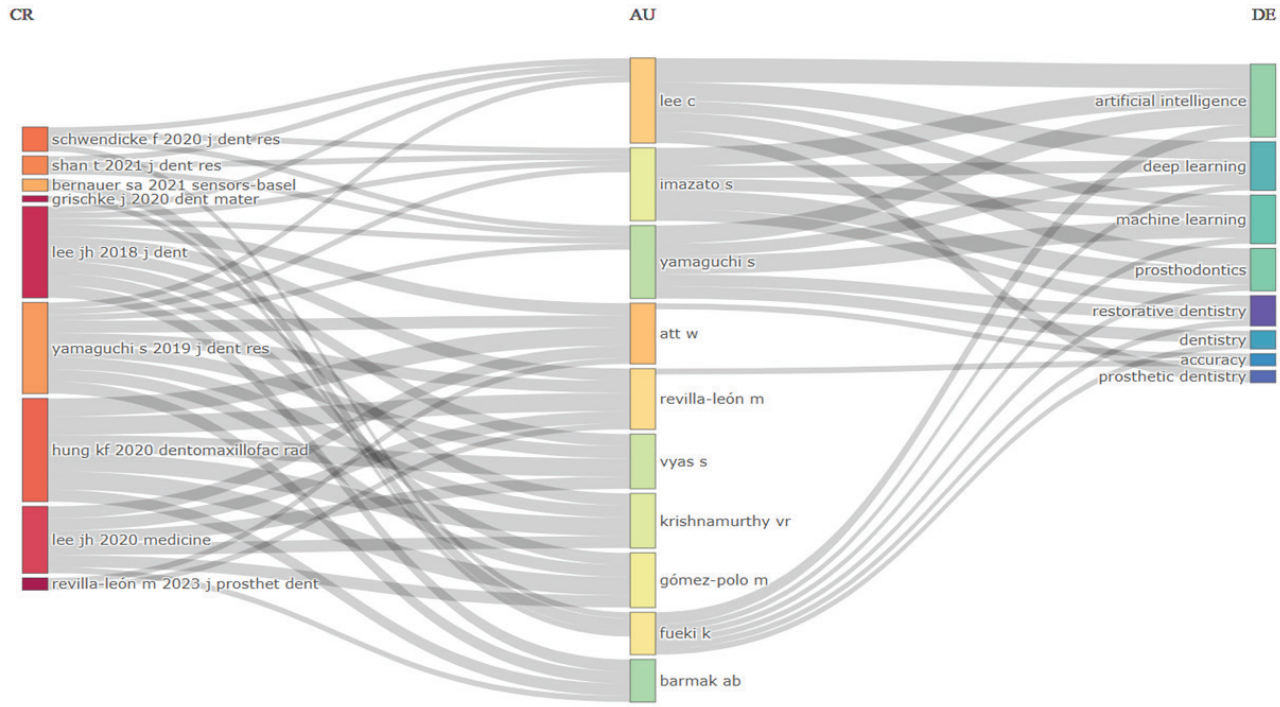

Figure 8: Three-field-plot. Source: Biblioshiny.

Strengths and weaknesses

Choosing Web of Science as the database for this bibliometric overview is considered a key strength of this review, as it provided more complete metadata than the rest of the databases. Furthermore, two bibliometric tools were used interchangeably, offering a comprehensive approach of science mapping. Gaining a broad insight of a cutting-edge subject like AI in Prosthodontics is a substantial asset, as this paper offers helpful insights into the research components that have shaped the field thus far.

The small amount of records extracted from the electronic searching could be considered as a limitation of the study. Based on the current literature, it is recommended to conduct bibliometric analysis on a larger number of articles, possibly hundreds or even thousands[14]. However, for a modern topic of emerging interest, such as the AI applications in Prosthodontics, it was expected that fewer documents would be found. The performance analysis that could be made by VOSviewer and Biblioshiny is clearly restricted, as both of them mostly focus on science mapping analyses.

Conclusions

The applications of AI on Prosthodontics are currently evolving as a dynamic area in the dental field, and have the potential to revolutionize the dental profession in the next few years. Consequently, the academic research on this area has dramatically increased in the recent years, with scholars by various institutions

presenting innovating investigations on this topic. Future bibliometric analyses should be carried out in conjunction with systematic reviews to assess the amount, patterns, and influence of research papers on AI and Prosthodontics. This will assist in guiding researchers, practitioners, and policymakers in making informed decisions and advancing the field. The development of a single bibliometric tool for both of the bibliometric analyses will benefit researchers, especially if it is user-friendly. Finally, it would be useful if popular databases like MEDLINE and Scopus provided more complete metadata, in order not only to perform robust bibliometric analyses, but also to facilitate data synthesis with other databases.

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