Available online at https://www.mmpubl.com/

International Journal of Orthodontic Rehabilitation

Original Research

Bibliometric analysis on microbial corrosion in dentistry

Umarevathi Gopalakrishnan [1], R.Sudhakar[2], A. Sumathi Felicita[3], K. Manikandan[4], Vidhya Selvaraj[5]

[1] Professor, [5] Senior Lecturer, Department of Orthodontics, Sri Venkateswara dental College and Hospital

[2] Assc Professor, Dept of Pathology , Panimalar medical college, Hospital & Research Institute

[3]Professor, Department of Orthodontics, Saveetha dental College

[4] Professor, Dept of Public Health Dentistry, Sri Venkateswara Dental College and Hospital

How to cite: *Umarevathi et al, Bibliometric Analysis on Microbial dental Corrosion. Int J Orthod Rehabil 2022; 13(3):22-33.*

Received :05.09.2022 *Accepted:14.09.2022* *Web Published:29.09.2022*

Doi: *10.56501/intjorthodrehabil.v13i3.482*

Abstract:

Aim: The present bibliometric analysis was conducted to find the evidence regarding microbial corrosion in dentistry since corrosion by whatever means affect the intraoral performance of the metallic appliances.

Materials and methods:

Material and methods: Dimensions software was used to search for published literature pertaining to the keywords "microbial corrosion" AND "dentistry". Two reviewers assessed the articles in terms of year of publication, authors, country of origin, journal of publication, and the affiliated institutions of the authors as well as their collaborations and the most cited publications.

Results: The search revealed a total of 3,118 articles between the years 2000 to 2022. The number of publications was on the rising pattern with a spike between 2004-2007, again with a small spike between 2014 and 2016 and then a steep increase from 2017 onwards. The publications were almost equally split between Engineering science and Medical Sciences. United States topped the list of countries with 378 documents with total link strength of 106224. Sao Paulo University topped the list in terms of organizations with total link strength of 12722. The journal of Anatomia Histologia Embryologia topped with 136 publications followed by Materials with 94 publications. Valentim from Brazil topped the authors with 22 publications.

Conclusion:

Microbial corrosion is needs equal concentration as any other forms of intraoral corrosion given that oral cavity is loaded with huge varieties of microorganisms with some of them known to cause microbial corrosion like sulfate reducing bacteria. The recent decline in research and publications in this field especially in 2022 is concerning. More studies are needed to learn more on microbial corrosion and its effects in dentistry.

Keywords*: microbial corrosion, dentistry, sulfate reducing bacteria*

Address for Correspondence:
Umarevathi Gopalakrishnan,
Professor, Department of Orthodontics, Sri Venkateswara Dental College and Hospitals
Chennai – 600103,
Email: gopkr_uma@yahoo.com

Introduction:

Medline, Scopus database and Web of Science are the most common data bases to retrieve data related to citation of manuscripts as researched and doctors working in this field have published their data in journals that have been listed in the above-mentioned data bases. The authors will quote the published manuscripts in their peer-reviewed articles which is a measure of the number of times that article has been cited before.[1-3] Thus, the number of citations of a manuscript depicts the impact of distinction.[4] Thus, by recognizing top cited publications in a selected topic will aid the researcher and academicians to prioritize the bibliography for reference in the vast ocean of publications. In dentistry Bibliometric studies have been published in various topics.[5-12] Bibliometric analysis of microbial corrosion is available in other fields like engineering [13], marine [14], but not much literature related to microbial corrosion in dentistry. Corrosion of intra oral appliances is a hugely researched topic. But when it comes to corrosion due to microorganisms, the research is still lagging. The formation of intraoral biofilm on hard tissue and soft tissue structures of the oral cavity including the metallic appliances per se creates a favorable environment by formation of corrosive microcells due to oxygenation difference between the areas covered by biofilm and those not covered by the same. In addition to this, the microorganisms also cause corrosion as a result of their metabolic requirements. This has been less addressed in dentistry unlike in other fields like industrial science. The aim of this bibliometric analysis is to highlight the research in microbial corrosion in dentistry.

Materials and methods:

Data source

Dimensions database was used to retrieve data from published literature between 2000 and 2022 using the keywords "microbial corrosion" AND "dentistry". The data were fetched on 22nd April 2022. The filters were applied restricting the publication type to articles in English language. From the dimensions site, information regarding the year wise publication status and the journals were published.

Data extraction

The data from dimensions portal were extracted in .CSV file format for further processing. This was done by two investigators UG and SF. VOS viewer software (Version 1.6.13; Leiden University) was used for the analysis as VOS viewer assists in visualizing and surveying the trends in bibliometric format. Year wise pattern in publication from 2000 to 2022 was noted. In VOS software, bibliographic coupling related to analysis units of documents, sources, authors, organizations and countries were performed.

Results:

Analysis of publication pattern

The search using keywords gave a result of 8,950 documents which included chapters, articles, books and newsletters. Since we were interested in scientific articles, filters on publication type to articles were applied which restricted the number to 3,118 documents (Fig 1). The publication trend was in an increasing graph with characteristic spikes in 2004-2007, 2014-2016, 2017-2020 (Fig 2). There seemed to be decline after 2020 till date which indicated the need for more research in this field.

Fig 1: Number of documents after filters of publication type and language.

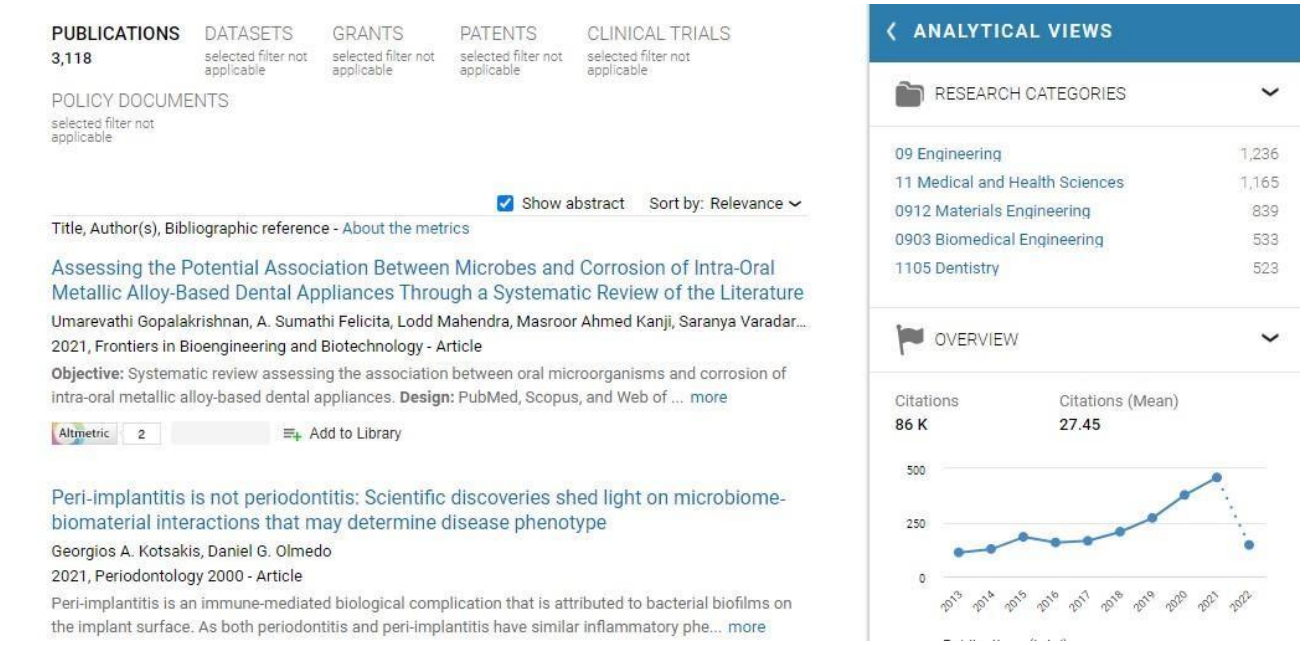
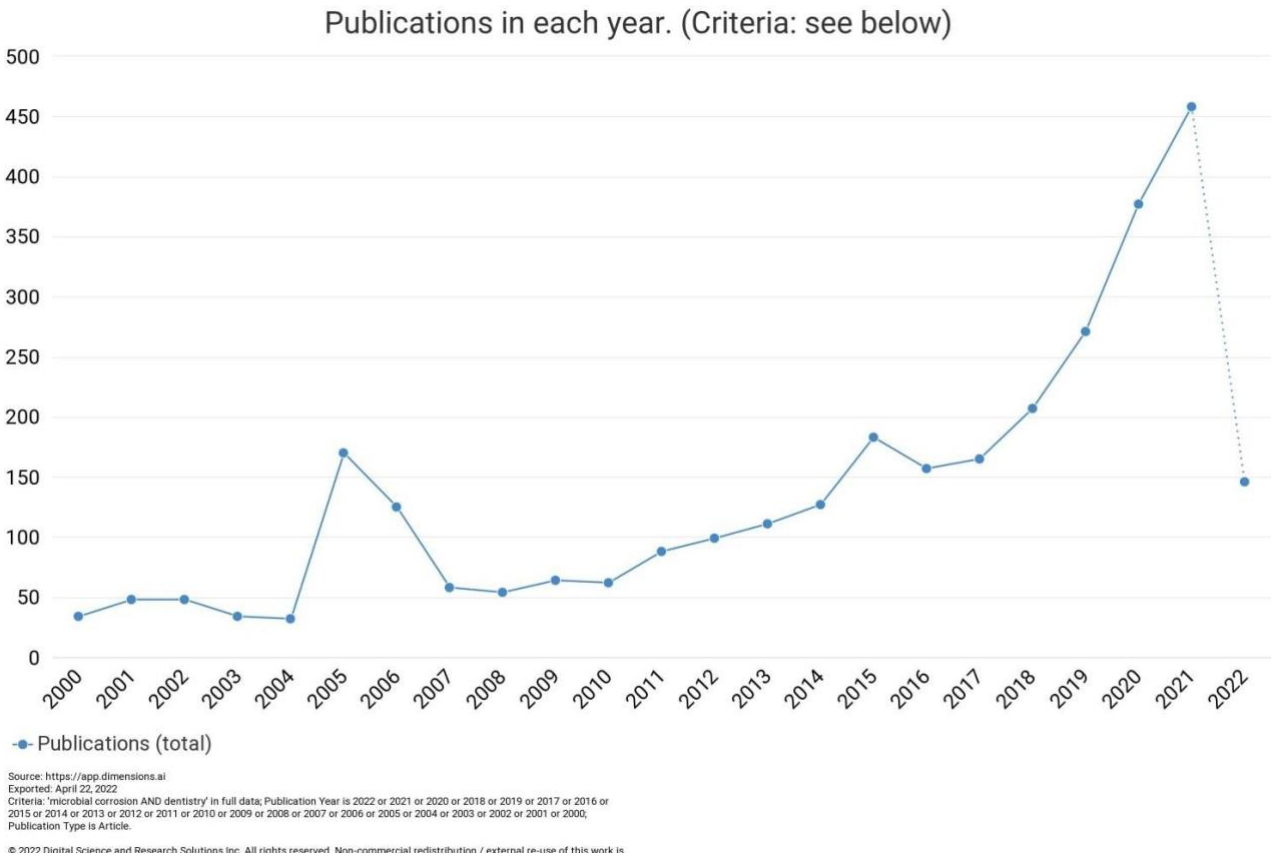


Fig 2: Publication pattern between 2000 and 2022



Analysis of countries

With regard to countries, United States topped the countries with 378 documents with 21610 citations with link strength of 106224 followed by China with 237 documents and 7035 citations with link strength of 66431 (Fig 3A). Brazil occupied 3rd position with 196 documents and 3707 citations with link strength of 62850. Though India had the 7th position, it had a greater number of publications (172) compared to Italy (105) which was in 6th place which was because of the lower citations with India having 3506 and Italy with 4148. Though Japan had almost equal publications as Italy, it occupied 15th place due to low citations with 2655. A minimum of 10 documents per country was kept as the threshold. The network mapping showed (Fig 3B) five clusters with the largest cluster shown in red with 13 items followed by second cluster in green with 11 items.

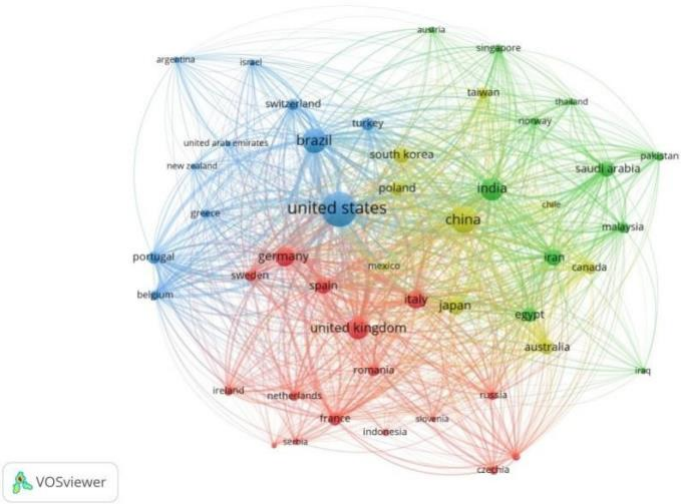
Fig 3A: Top listed countries as per citations and link strength

Create Map

Verify selected countries

Selected	Country	Documents	Citations	Total link strength
☑	united states	378	21610	106224
☑	china	237	7035	66431
☑	brazil	196	3707	62850
☑	united kingdom	152	5518	40335
☑	germany	124	7202	38546
☑	italy	105	4148	33242
☑	india	172	3506	32675
☑	spain	81	1449	30718
☑	australia	74	5310	24421
☑	portugal	47	1088	24286
☑	france	60	3128	22147
☑	iran	89	1952	21322
☑	saudi arabia	77	1000	20834
☑	south korea	81	2080	20593
☑	japan	104	2655	20317
☑	belgium	30	1921	17673
☑	poland	64	920	16074
☑	switzerland	44	4230	14969
☑	canada	49	1831	14226
☑	sweden	35	910	13913

Fig 3B: Bibliographic coupling of countries



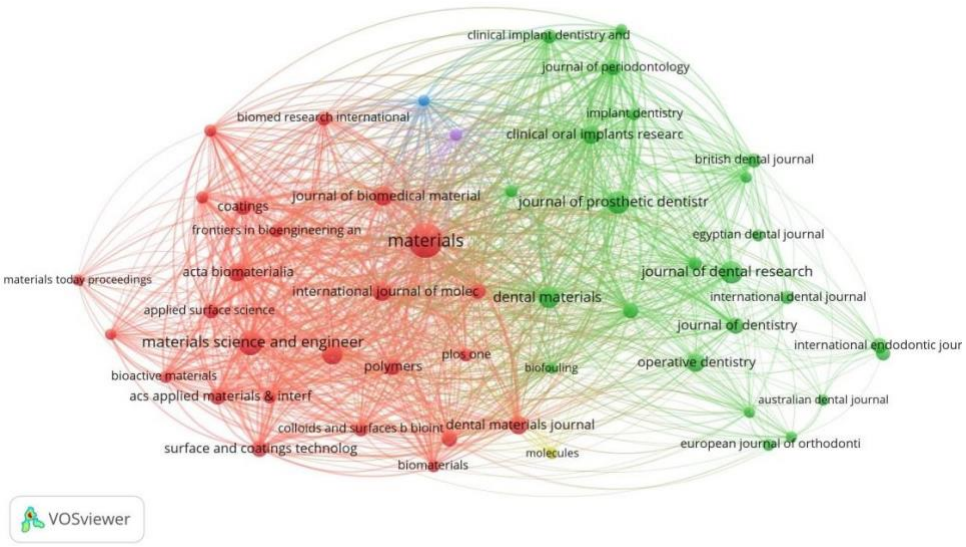
Sources/ Journal of Publication

With regard to sources, the Journal of Anatomia Histologia Embryologia topped with 136 publications followed by Materials with 94 documents with 2635 citations and link strength of 10070 and then by Dental Materials with 36 documents and 1152 citations with link strength of 5380 (Fig 4A) . Though material science and engineering had more documents than Dental Materials, it had less citations and link strength. Minimum number of documents for a source was set as 10. The network mapping (Fig 4B) showed 5 clusters with the largest cluster shown in red with 25 items. This was followed by the second largest cluster with 24 items shown in green.

Fig 4A: Sources of publications and their citations

Name	↓Publications	Citations	Citations mean
Anatomia Histologia Embryologia	136	45	0.33
Materials	94	2,635	28.03
Epilepsia	90	38	0.42
Materials Science and Engineering C	49	1,273	25.98
Journal of Dental Research	43	1,688	39.26
Journal of Prosthetic Dentistry	39	1,947	49.92
Dental Materials	36	1,152	32.00
Nanomaterials	33	1,090	33.03
Operative Dentistry	32	79	2.47
International Journal of Molecular Sciences	30	1,331	44.37
Coatings	30	418	13.93

Fig 4B: Network mapping of sources



Organizations

For organizations Sao Paulo University topped the list with 56 documents with 1003 citations and link strength of 12722 followed by University of Minho with 23 documents and 791 citations with link strength of 10189 (Fig 5A). The threshold was set as minimum of 10 documents per organization. Though University of Sao Paulo had 47 publications which are the highest of all, it had less citations and link strength. In network mapping, 7 clusters were seen with the largest cluster shown in red with 21 items. The second largest cluster is given in green with 12 items (Fig 5B).

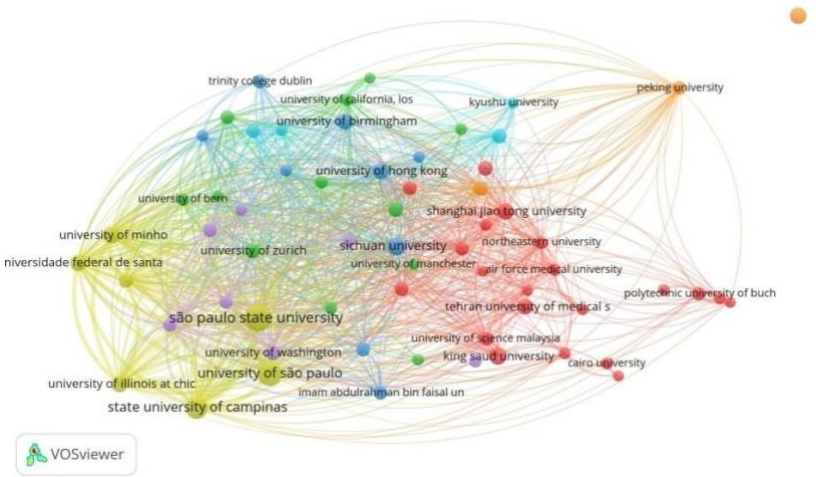
Fig 5A: Organizations and their citations

Create Map

Verify selected organizations

Selected	Organization	Documents	Citations	Total link strength
☑	são paulo state university	56	1003	12722
☑	university of minho	23	791	10189
☑	state university of campinas	37	863	9775
☑	universidade federal de santa catarina	21	727	9145
☑	university of illinois at chicago	20	864	7748
☑	university of são paulo	47	798	7006
☑	ku leuven	17	1585	6775
☑	the university of texas at dallas	14	174	4665
☑	sichuan university	26	372	4512
☑	university of washington	17	485	4269
☑	university of hong kong	20	358	3549
☑	university of queensland	16	343	3448
☑	international university of catalonia	13	157	3107
☑	tokyo medical and dental university	17	212	3001
☑	university of porto	14	153	2930
☑	university of california, los angeles	12	254	2926
☑	national university of singapore	17	1489	2905
☑	shanghai jiao tong university	20	241	2649
☑	seoul national university	14	337	2557
☑	the university of texas health science...	11	1300	2515

Fig 5B: Network mapping of organizations



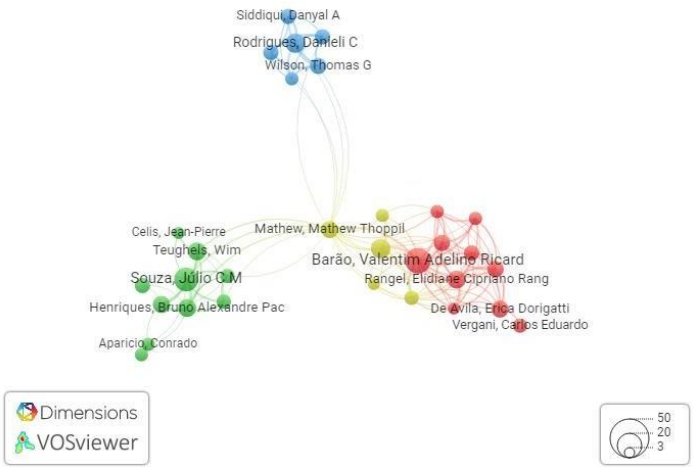
Authors

Figure 6 A and B gives the authorship pattern in publication. The top ten authors had more than 10 publications each. The top listed authors were Valentim Adelino from Brazil with 22 documents and 329 citations followed by Julio Souza with 19 publications. Interestingly the second top author had more citations compared to first with 802 citations. Author Karan Gulati from Australia had almost equal citations as the first author with just 13 publications. In network mapping, four clusters were seen. Intra cluster network was good in clusters but inter cluster networking was comparatively less (Fig 6B).

Fig 6A: Authorship pattern

Name Organization, Country	↓Publications	Citations	Citations mean
Valentim Adelino Ricardo Barão State University of Campinas, Brazil	22	329	14.95
Júlio C M Souza University of Minho, Portugal	19	802	42.21
Takao Hanawa Tokyo Medical and Dental University, Japan	14	264	18.86
Danieli C Rodrigues	13	174	13.38
Cortino Sukotjo University of Illinois at Chicago, United States	13	186	14.31
Karan Gulati University of Queensland, Australia	12	319	26.58
Xue-Dong Zhou Sichuan University, China	12	218	18.17
Saso Ivanovski University of Queensland, Australia	12	249	20.75
Bruno Alexandre Pacheco Decastro Henriqu... Universidade Federal de Santa Catarina, Brazil	11	477	43.36

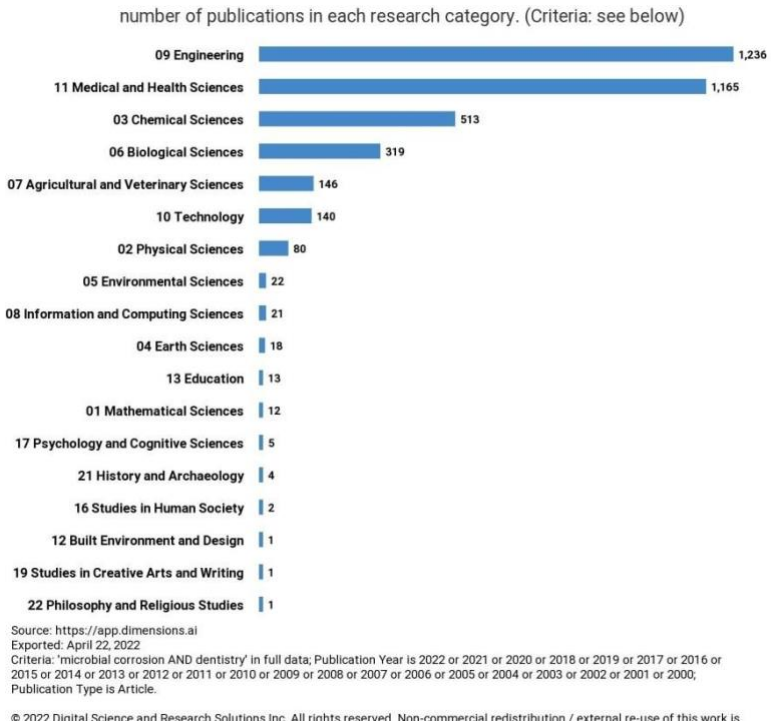
Fig 6 B: Network mapping of researcher coupling



Field of Research

Fig 7 gives the publications in various fields. It could be clearly seen how each field has contributed to the topic of interest with engineering and medical health sciences almost 75 percent of the entire publications. Engineering science with 1236 documents and Medical & Health sciences with 1165 publications followed by Chemical Sciences with 513 publications. Dentistry is included in this second top category of Medical & Health sciences.

Fig 7: Publications in various research categories



Discussion

Microbial corrosion is one of the vast researched topics in industrial science since majority of the corrosion in pipelines were caused by microorganisms. Large number of publications could be seen in relation to the organisms involved, their mechanism of action, causative factors, aggravating factors and solutions for combating the same. Publications related to microbial corrosion are minimal in dentistry. The current knowledge of the dental practitioners related to microbial corrosion in intra oral appliances is very limited. With an aim to provide precise scientific evidence in a systematic format for a particular topic a bibliometric analysis is often done.[15] In other words a bibliometric analysis gives a cross-sectional view and update in research pertaining to a specific topic, in this case the microbial corrosion in dentistry. Bibliometric analyses enlighten about the top authors, journals, organizations, countries which have been working or have worked on the given topic of interest. It can highlight the richness and deficiency with regard to topics of interest in relation to countries, organizations, year wise pattern of publication, etc. Also, the bibliometric analysis will assist Institutions and organizations to determine the quality of research work in this topic which can help with the further up gradation of research filling the lacunae. With the available information the present bibliometric analysis was done to analyze the articles published on microbial corrosion in dentistry.

The results revealed that the topic is addressed equally well in engineering and medical sciences. Dental materials, journal of prosthetic dentistry, journal of periodontology, Dental materials journal are the dental journals in the top 10 listed journals. When we observe from 2000 to 2022, there is a steady increase in publications. We could see three spikes

in this steady increase, one between 2004 and 2007 and other two between 2014 & 2016 and 2017 & 2020. But there is a steep decline after 2020 which indicates that more research needs to be encouraged in relation to microbial corrosion currently.

Considering the countries United States, China, Brazil, United Kingdom, Germany, Italy, India are top listed countries with maximum number of publications. From the above list we could infer that more publications are from developed countries compared to developing countries. Considering the widespread usage of metallic intraoral appliances, it has to be stressed that research related to microbial corrosion has to be uniform throughout the world. But we could appreciate that the interlinking between the countries with regard to citing each other's work is high as shown in network mapping (Fig 3B).

In this bibliometric analysis we could see that though we used keywords which had dentistry in it, the top four journals were still from other fields of science which was not part of dentistry. The topmost journal of Anatomia Histologia Embryologia had 136 publications, whereas the dental journal which topped the dental list had only 43 publications. This indicates that more research is needed in dentistry to address microbial corrosion. But one interesting part is that though Anatomia Histologia Embryologia had 136 publications it had only 45 citations whereas Journal of Dental research had 1688 citations with just 43 publications. But one disadvantage of this type of inference based on citations is that the snowball effect wherein the authors tend to cite the most cited articles without analyzing the content. When we want to evaluate the research system there are certain indicators or metrics which are followed. Traditionally peer review system was considered the golden standard whereas recently citations and other bibliometric measures are increasingly being used for research assessment and they are also considered superior to the conventional peer review system.[16] As per this evaluation the dental journal had more citations compared to the top listed journal. This reveals the fact that dentists who publish articles gather more data even from other fields related to their research which led to more cross citations. In Fig 4B, all the dental Journals are seen in the green cluster, and we could appreciate lot of interlinking between the dental journals. But it's a bibliographic finding that dental journals have cited from non-dental journals and vice versa. We could observe that journals from filed of engineering and medical and health sciences contribute equally with 1236 documents from engineering field and 1165 from medical and health sciences in which dentistry is also included. An interesting chunk of contribution from the chemical sciences field could be seen in Fig 7.

If we notice the top listing for all sections, we could observe that the item with the higher citations and link strength is given a top order despite with lower number of documents. In this analysis, we could observe that there is good citation network mapping in relation to countries involved (Fig 3B), Sources (Fig 4B), organizations (5B). The network mapping was slightly less dense with regard to researcher networks (Fig 6B). Here 4 clusters could be seen, and the common researcher cited by most other researchers from different fields is researcher Mathew Thoppil. His research was majorly on antimicrobial and antiviral materials for use as coatings to prevent microbial corrosion.[17] This kind of networking may mean that the common cluster could have been more popular which could have led to snowball citations, or it could have been a major discovery which could not go missed.

Most of the non-dental articles in engineering and other fields document on actual microbial corrosion discussing the bacteria involved, mechanism and methods on combating. Most of the articles in the dental journals are about corrosion of dental implants by biochemical means, cytotoxicity of metal elements that was leached out because of corrosion, nano materials used for combating corrosion by way of coatings, bacteria causing peri implantitis, properties affected by corrosion and their clinical implication, etc. Only a few articles deal with microbial corrosion but even those articles

concentrate on the biofilm formation and composition and their influence in causing the corrosion [18,19] and don't discuss on the actual mechanisms or the organisms involved. Some of the articles talk about individual bacteria which are capable of causing microbial corrosion as a product of their metabolism.[20,21] In the article by Gopalakrishnan U et al[20], the association between oral microorganisms and intra-oral metallic alloys-based dental appliances are dealt in a systematic review. Oral cavity is home to approximately 700 species of prokaryotes [22] which are both pathogenic and nonpathogenic. They alter the environment of the oral cavity making the tissue system vulnerable to various kinds of disease processes. It is interesting to note that these bacteria are capable of influencing not only the innate tissue systems but also the foreign components like dental prosthesis present in the oral cavity. Some groups of bacteria that are seemingly prevalent in the oral cavity are capable of causing microbial corrosion. They belong to the group of sulfates reducing bacteria, which are known to be prevalent in healthy individuals [23,24], periodontal patients [24] and patients with gastrointestinal issues.[25,26] Interestingly the top listed author Valentim Adelino Barao is a dentist from Brazil with 22 documents and 329 citations whose major work dealt with combating corrosion of dental implants. But precise documentation on the microorganisms involved in causing the corrosion, their mechanism of action, methods to prevent microbial corrosion is still lacking in dental literature. There is no documentation on the intraoral presence of organisms which are capable of causing corrosion as a result of their metabolic processes. This also needs to be addressed which can serve as a starting point for future research on intraoral microbial corrosion.

Conclusion

In today's world of digitalization where so much of data is easily accessible, most of them in free access, knowing the evidence in relation to our topic of interest becomes easier. But how far that can be used to further favor future research is by means of well written bibliometric analysis. Bibliometric analysis will help channelize the evidence towards further valid research with more precision. This particular analysis revealed that more research is needed in the field of dentistry on microbial corrosion with respect to the potential microorganisms causing the corrosion, mechanisms involved, and their prevention.

Source of Funding : None

Conflict of Interest: None

References:

1. Bornmann L, Daniel H. The state of h index research. EMBO Rep. 2009;10(1):2-6.
2. Kampmann U. Gestational diabetes: A clinical update. World J Diabetes. 2015;6(8):10
3. Moses RG, Cefalu WT. Considerations in the Management of Gestational Diabetes Mellitus:"You Are What Your Mother Ate!" Diabetes Care. 2016;39(1):13-15.
4. Hui J, Han Z, Geng G, Yan W, Shao P. The 100 top-cited articles in orthodontics from 1975 to 2011. Angle Orthod. 2013;83(3):491-499.
5. Gondivkar SM, Sarode SC, Gadbail AR, Gondivkar RS, Chole R, Sarode GS. Bibliometric analysis of 100 most cited articles on oral submucous fibrosis. J Oral Pathol Med. 2018;47(8):781-787.
6. Gondivkar SM, Sarode SC, Gadbail AR, et al. Top cited articles on ameloblastoma: A bibliometric analysis. Transl Res Oral Oncol. 2019;4:2057178X1882101.

7. Gadbail AR, Gondivkar S, Patil S. A Perspective on Bibliometric Analysis Papers in the Field of Dentistry. World J Dent. 2019;10(5):325-326.
8. Sarode GS, Gadbail AR, Gondivkar S, et al. Bibliometric Analysis of the 100 Most Cited Articles on Dental Stem Cells. World J Dent. 2020;11(4):274-283.
9. Sengupta N, Sarode SC, Sarode GS, et al. Analysis of 100 most cited articles on forensic odontology. Saudi Dent J. 2020;32(7):321-329.
10. Arakeri G, Patil S, Quadri MFA, et al. A bibliometric analysis of the top 100 most-cited articles in the Journal of Oral Pathology & Medicine (1972–2020). J Oral Pathol Med. 2021;50(7):649-659.
11. Patil S, Sarode SC, Baeshen HA, et al. Bibliographic Analysis of Oral Precancer and Cancer Research Papers from Saudi Arabia. Asian Pacific J Cancer Prev. 2020;21(1):13-18.
12. Jacimovic J, Jakovljevic A, Nagendrababu V, Duncan HF, Dummer PMH. A bibliometric analysis of the dental scientific literature on COVID-19. Clin Oral Investig. 2021;25(11):6171-6183.
13. Seyed Javad Hashemi, Nicholas Bak, Faisal Khan, Kelly Hawboldt, Lianne Lefsrud, John Wolodko; Bibliometric Analysis of Microbiologically Influenced Corrosion (MIC) of Oil and Gas Engineering Systems. Corrosion .April 2018; 74 (4): 468–486.
14. Wang, Zhengquan, et al. Research status and development trends in the field of marine environment corrosion: a new perspective. Environmental Science and Pollution Research 2021:28(39): 54403-54428.
15. Gadbail AR, Gondivkar S, Patil S. A Perspective on Bibliometric Analysis Papers in the Field of Dentistry. World J Dent. 2019;10(5):325-326.
16. Aksnes DW, Langfeldt L, Wouters P. Citations, Citation Indicators, and Research Quality: An Overview of Basic Concepts and Theories. SAGE Open. January 2019.
17. Nunthavarawong, Peerawatt, et al., eds. Antimicrobial and Antiviral Materials: Polymers, Metals, Ceramics, and Applications. CRC Press, 2022.
18. Li L, Liu L. Microbial corrosion of dental alloy. Journal of Biomedical Engineering 2004 Oct;21(5):864-866.
19. Costa, R.C., Abdo, V.L., Mendes, P.H.C. et al. Microbial Corrosion in Titanium-Based Dental Implants: How Tiny Bacteria Can Create a Big Problem? J Bio Tribo Corros 2021;7 (136).
20. Gopalakrishnan Umarevathi, Felicita A. Sumathi, Mahendra Lodd, Kanji Masroor Ahmed, Varadarajan Saranya, Raj A. Thirumal, Feroz Shaikh Mohammed Abdul, Mehta Deepak, Baeshen Hosam Ali, Patil Shankargouda. Assessing the Potential Association Between Microbes and Corrosion of Intra-Oral Metallic Alloy-Based Dental Appliances Through a Systematic Review of the Literature. Frontiers in Bioengineering and

Biotechnology.2021;9:1-9.

21. Fabiano Luiz Heggendorn, Aline Guerra Manssour Fraga, Dennis de Carvalho Ferreira, Lucio Souza Gonçalves, Viviane de Oliveira Freitas Lione, Márcia Teresa Soares Lutterbach. Sulfate-Reducing Bacteria: Biofilm Formation and Corrosive Activity in Endodontic Files. International Journal of Dentistry: 2018, Article ID 8303450, 12 pages.
22. Deo PN, Deshmukh R. Oral microbiome: Unveiling the fundamentals. J Oral Maxillofac Pathol. 2019;23(1):122-128.
23. Willis CL, Gibson GR, Allison C, Macfarlane S, Holt JS. Growth, incidence and actives of dissimilatory sulfatereducing bacteria in the human oral cavity. FEMS Microbiol Lett 1995;129:267–71.
24. Larry LB, Hamilton WA. Sulphate-reducing bacteria environmental and engineered systems. New York: Cambridge University Press; 2007.
25. Langendijk PS, Hagemann J, Van der Hoeven JS. Sulfate reducing bacteria in periodontal pockets and intraoral sites. J Clin Periodontol 1999;26:596–9.
26. Watanabe K, Mikamo H, Tanaka K. Clinical significance of sulfate-reducing bacteria for ulcerative colitis. Jpn J Clin Med 2007;7:1337–46.

Published by MM Publishers
https://www.mmpubl.com/ijorthrehab