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RESEARCH ARTICLE

Effects of clear aligner treatment on periodontal health: a bibliometric study

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ABSTRACT

Objective: The purpose of this study was to present a bibliometric analysis of scientific articles on clear aligner treatment (CAT) on periodontal health.

Materials and Methods: Papers published through July 5, 2023, were searched on the Web of Science (WOS). From a total of 63 papers, the top 25 most cited and appropriate for the study topic were selected.

Results: The most cited article with 82 citations was the article published in the European Journal of Orthodontics in 2015. The American Journal of Orthodontics and Dentofacial Orthopedics had the highest publication rate, with three of the top 25 articles published. The first author of the first article was Gabriele Rossini, among the top 25 highly cited articles evaluating the effect of CAT on periodontal health. Italy stands out as the country with the highest number of first authors with 9 articles, followed by China with 7 authors.

Conclusions: The bibliometric analysis provides significant information regarding the total number of publications and citations on clear aligner treatment on periodontal health. This bibliometric analysis provides a perspective on the progress of research on clear aligner treatment on periodontal health.

Keywords: Bibliometric analysis, clear aligner treatment, orthodontics, periodontal health

INTRODUCTION

Clear Aligners (CA) have been used as orthodontic appliances for many years, and the use of CA in adult patients has been increasing with the rise in aesthetic concerns. In addition to the aesthetic benefits of CA, it allows patients to perform functions such as speaking and eating more comfortably. It has advantages for orthodontists such as reducing chair time and reducing the development of events requiring emergency intervention. On the other hand, the need for good patient cooperation and cost can be shown as disadvantages for orthodontists (1-3).

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The American Academy of Periodontology (AAP) defines periodontal health as follows: The ability of the patient to function without abnormalities. The AAP uses parameters such as attachment level, probing depth, and bone loss to determine periodontal health and defines a healthy or diseased periodontium. A healthy periodontium improves an individual's quality of life, both physically and psychologically (4).

Bibliometrics is a set of literature reviews that show the historical development of scientific articles published on a given topic, such as country of publication and authors. Bibliometric analyses aim to provide an up-to-date approach to a given topic and measure the number of citations of articles on that topic. (4,5). CA appliances affect the oral health of individuals. It may increase the plaque index of patients undergoing treatment. There are studies suggesting that CA treatment does not have a negative effect on the periodontal health of patients (5,6). The purpose of this study is to present a bibliometric analysis of scientific publications on this subject.

MATERIALS AND METHODS

The purpose of this study is to conduct a bibliometric analysis of articles published on the periodontal health of patients undergoing clear aligner treatment. The characteristics of the publications—such as authors, study design, publication years, and citation counts—are analyzed to illustrate the impact of clear aligner treatment on periodontal health.

Only one researcher collected all data on July 5, 2023. Before the data collection process, the 5 most frequently used words were determined in related articles. In this bibliometric analysis, the most frequently used keywords were selected by looking at their synonyms to determine the articles to be scanned. The synonyms and compatibility of the words were used from the website https://www.ncbi.nlm.nih.gov/mesh. Keywords were determined from the most cited articles.

Articles published until July 5, 2023 were searched in Web of Science (WOS) by a single researcher (F.A.) using the formulation ALL=(clear aligner) AND ALL=(periodontal health). A total of 63 articles published in WOS were identified. The first 25 articles with the highest number of citations were selected. The 2 articles in the top 25 most cited articles were not included in the study because they were in vitro studies.

RESULTS

The top 25 articles published in Web of Science before July 5, 2023 were selected in descending order of citation. The most cited article with 82 citations was the article published in the European Journal of Orthodontics in 2015. The least cited article, with 5 citations among the top 25 on the subject, was the article published in Medicine in 2021. The top 25 most cited articles evaluating the effect of CAT on periodontal health are shown in Table 1.

The American Journal of Orthodontics and Dentofacial Orthopedics had the highest publication rate with three of the top 25 articles published. The journal with the highest JCR®IF2022 rate was Progress in Orthodontics with a rate of 4.8. The journals in which the top 25 most cited articles evaluating the effect of CAT on periodontal health were published and the impact factor for 2022 are presented in Table 2.

Among the top 25 highly cited articles evaluating the effect of CAT on periodontal health, the first author of the 1st article was Gabriele Rossini (7), while the first author of the 25th article was Yuan Wu (8). In the top 25 articles, only Stefano Mummolo has 2 articles. The top 10 first authors are presented in Table 3.

Table 4 shows the number of countries of first authors. Italy stands out as the country with the highest number of first authors with 9 articles, followed by China with 7 authors.

Table 1. The 25 most cited articles on periodontal health in the treatment of clear aligners

Rank	Paper	Citation Count (WOS)	Citation count in all databases	Type of manuscript
1	Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi CL. Periodontal health during clear aligners treatment: a systematic review. Eur J Orthod. 2015 Oct;37(5):539-43.	82	87	Review
2	Jiang Q, Li J, Mei L, Du J, Levrini L, Abbate GM, Li H. Periodontal health during orthodontic treatment with clear aligners and fixed appliances: A meta-analysis. J Am Dent Assoc. 2018 Aug;149(8):712-720.e12	55	60	Review
3	Papageorgiou SN, Koletsi D, Iliadi A, Peltomaki T, Eliades T. Treatment outcome with orthodontic aligners and fixed appliances: a systematic review with meta-analyses. Eur J Orthod. 2020 Jun 23;42(3):331-343.	54	54	Review
4	Chhibber A, Agarwal S, Yadav S, Kuo CL, Upadhyay M. Which orthodontic appliance is best for oral hygiene? A randomized clinical trial. Am J Orthod Dentofacial Orthop. 2018 Feb;153(2):175-183.	39	42	Article
5	Contaldo M, Lucchese A, Lajolo C, Rupe C, Di Stasio D, Romano A, Petruzzi M, Serpico R. The Oral Microbiota Changes in Orthodontic Patients and Effects on Oral Health: An Overview. J Clin Med. 2021 Feb 16;10(4):780.	38	38	Review
6	Cassetta M, Altieri F, Pandolfi S, Giansanti M. The combined use of computer-guided, minimally invasive, flapless corticotomy and clear aligners as a novel approach to moderate crowding: A case report. Korean J Orthod. 2017 Mar;47(2):130-141.	24	25	Article
7	Mummolo S, Tieri M, Nota A, Caruso S, Darvizeh A, Albani F, Gatto R, Marzo G, Marchetti E, Quinzi V, Tecco S. Salivary concentrations of Streptococcus mutans and Lactobacilli during an orthodontic treatment. An observational study comparing fixed and removable orthodontic appliances. Clin Exp Dent Res. 2020 Apr;6(2):181-187.	23	27	Article
8	Mummolo S, Nota A, Albani F, Marchetti E, Gatto R, Marzo G, Quinzi V, Tecco S. Salivary levels of Streptococcus mutans and Lactobacilli and other salivary indices in patients wearing clear aligners versus fixed orthodontic appliances: An observational study. PLoS One. 2020 Apr 24;15(4): e0228798.	22	22	Article
9	Zhao R, Huang R, Long H, Li Y, Gao M, Lai W. The dynamics of the oral microbiome and oral health among patients receiving clear aligner orthodontic treatment. Oral Dis. 2020 Mar;26(2):473-483.	22	23	Article
10	Han JY. A comparative study of combined periodontal and orthodontic treatment with fixed appliances and clear aligners in patients with periodontitis. J Periodontal Implant Sci. 2015 Dec;45(6):193-204.	20	22	Article
11	Zhang B, Huang X, Huo S, Zhang C, Zhao S, Cen X, Zhao Z. Effect of clear aligners on oral health-related quality of life: A systematic review. Orthod Craniofac Res. 2020 Nov;23(4):363-370.	17	18	Review
12	Sifakakis I, Papaioannou W, Papadimitriou A, Kloukos D, Papageorgiou SN, Eliades T. Salivary levels of cariogenic bacterial species during orthodontic treatment with thermoplastic aligners or fixed appliances: a prospective cohort study. Prog Orthod. 2018 Aug 1;19(1):25.	17	19	Article

Table 1. Continued

Rank	Paper	Citation Count (WOS)	Citation count in all databases	Type of manuscript
13	Madariaga ACP, Bucci R, Rongo R, Simeon V, D'Antò V, Valletta R. Impact of Fixed Orthodontic Appliance and Clear Aligners on the Periodontal Health: A Prospective Clinical Study. Dent J (Basel). 2020 Jan 2;8(1):4.	15	15	Article
14	Guo R, Zheng Y, Liu H, Li X, Jia L, Li W. Profiling of subgingival plaque biofilm microbiota in female adult patients with clear aligners: a three-month prospective study. PeerJ. 2018 Jan 2;6: e4207. .	15	15	Article
15	Lin E, Julien K, Kesterke M, Buschang PH. Differences in finished case quality between Invisalign and traditional fixed appliances. Angle Orthod. 2022 Mar 1;92(2):173-179.	13	13	Article
16	Yassir YA, Nabbat SA, McIntyre GT, Bearn DR. Clinical effectiveness of clear aligner treatment compared to fixed appliance treatment: an overview of systematic reviews. Clin Oral Investig. 2022 Mar;26(3):2353-2370.	13	14	Review
17	Ma Y, Li S. The optimal orthodontic displacement of clear aligner for mild, moderate and severe periodontal conditions: an in vitro study in a periodontally compromised individual using the finite element model. BMC Oral Health. 2021 Mar 10;21(1):109.	13	15	Article
18	Sfondrini, Maria Francesca, et al. "Microbiological changes during orthodontic aligner therapy: A prospective clinical trial." Applied Sciences 11.15 (2021): 6758.	8	8	Article
19	Oikonomou E, Foros P, Tagkli A, Rahiotis C, Eliades T, Koletsi D. Impact of Aligners and Fixed Appliances on Oral Health during Orthodontic Treatment: A Systematic Review and Meta-Analysis. Oral Health Prev Dent. 2021 Jan 7;19(1):659-672.	8	8	Review
20	Levrini L, Mangano A, Margherini S, Tenconi C, Vigetti D, Muollo R, Marco Abbate G. ATP Bioluminometers Analysis on the Surfaces of Removable Orthodontic Aligners after the Use of Different Cleaning Methods. Int J Dent.2016:5926941.	8	9	Article
21	Miyamoto T, Lang M, Khan S, Kumagai K, Nunn ME. The clinical efficacy of deproteinized bovine bone mineral with 10% collagen in conjunction with localized piezosurgical decortication enhanced orthodontics: A prospective observational study. J Periodontol. 2019 Oct;90(10):1106-1115.	7	7	Article
22	Shokeen B, Viloria E, Duong E, Rizvi M, Murillo G, Mullen J, Shi B, Dinis M, Li H, Tran NC, Lux R, Wu T. The impact of fixed orthodontic appliances and clear aligners on the oral microbiome and the association with clinical parameters: A longitudinal comparative study. Am J Orthod Dentofacial Orthop. 2022 May;161(5): e475-e485	6	6	Article
23	Macrì, M., Murmura, G., Varvara, G., Traini, T., & Festa, F. Clinical performances and biological features of clear aligners materials in orthodontics. Frontiers in Materials, (2022): 819121	6	6	Review
24	Liu L, Song Q, Zhou J, Kuang Q, Yan X, Zhang X, Shan Y, Li X, Long H, Lai W. The effects of aligner overtreatment on torque control and intrusion of incisors for anterior retraction with clear aligners: A finite-element study. Am J Orthod Dentofacial Orthop. 2022 Jul;162(1):33-41.	5	5	Article
25	Wu Y, Cao L, Cong J. The periodontal status of removable appliances vs fixed appliances: A comparative meta-analysis. Medicine (Baltimore). 2020 Dec 11;99(50): e23165.	5	5	Review

Table 2. The journals and JCR®IF-2022 of the publications

	Paper Numbers	JCR® IF2022	Quartile Category
EUROPEAN JOURNAL OF ORTHODONTICS**	2	2.6	Q3
JOURNAL OF THE AMERICAN DENTAL ASSOCIATION**	1	3.9	Q1
AMERICAN JOURNAL OF ORTHODONTICS AND DENTOFACIAL ORTHOPEDICS**	3	3	Q2
JOURNAL OF CLINICAL MEDICINE**	1	3.9	Q2
KOREAN JOURNAL OF ORTHODONTICS**	1	1.9	Q2
CLINICAL AND EXPERIMENTAL DENTAL RESEARCH*	1	---	---
PLOS ONE**	1	3.2	Q2
ORAL DISEASES**	1	3.8	Q2
JOURNAL OF PERIODONTAL AND IMPLANT SCIENCE**	1	1.9	Q4
ORTHODONTICS & CRANIOFACIAL RESEARCH**	1	3.1	Q2
PROGRESS IN ORTHODONTICS**	1	4.8	Q1
DENTISTRY JOURNAL*	1	---	---
PEERJ**	1	2.7	Q2
ANGLE ORTHODONTIST**	1	3.4	Q2
CLINICAL ORAL INVESTIGATIONS**	1	3.4	Q2
BMC ORAL HEALTH**	1	2.9	Q2
APPLIED SCIENCES-BASEL**	1	2.7	Q2
ORAL HEALTH & PREVENTIVE DENTISTRY**	1	1.6	Q4
INTERNATIONAL JOURNAL OF DENTISTRY*	1	---	---
JOURNAL OF PERIODONTOLOGY**	1	4.3	Q1
FRONTIERS IN MATERIALS**	1	3.2	Q3
MEDICINE**	1	1.6	Q3

* The journals are ESCI categorization. ** The journals are SCI-Expanded Web of Science categorization.

Table 3. Contribution of top 10 authors country and university

First Author	Institution	Country	Number of citations
Gabriele Rossini	University of Turin	Italy	82
Qian Jiang	Southwest Forestry University	China	55
Spyridon N Papageorgiou	University of Zurich	Switzerland	54
Aditya Chhibber	137 Benedict Ave-Norwalk	US	39
Maria Contaldo	Universita della Campania Vanvitelli	Italy	38
Michele Cassetta	Sapienza University of Rome	Italy	24
Stefano Mummolo*	University of L'Aquila	Italy	23-22
Rui Zhao	Zhengzhou University	China	22
Ji-Young Han	Hanyang University	South Korea	20
Bo Zhang	Sichuan University	China	17

*There are two articles of the related author for the top 10 first-time authors whose article is most cited.

Table 4. Contribution of each country to research on clear aligner treatment on periodontal health

Country	Number
Italy	9
China	7
USA	4
Greece	2
Switzerland	1
South Korea	1
United Kingdom	1

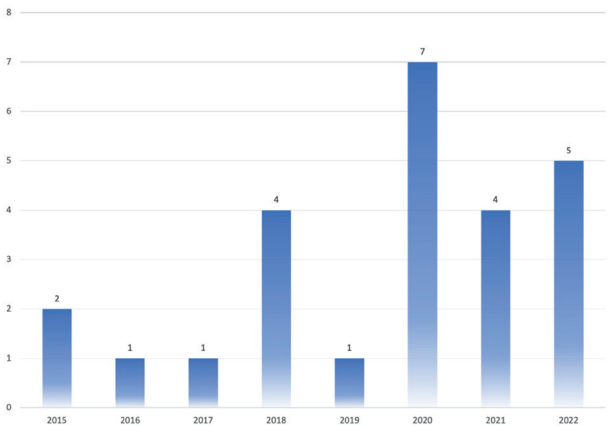

Figure 1. The annual number of publications.

Figure 2. Word cloud of countries where research has been conducted on the effects of clear aligners on periodontal tissues.

DISCUSSION

After the 2000s, the use of clear aligners became widespread due to intense commercialization. Particularly in recent years, the increased use of CA in orthodontic treatment has also played a major role in patients' preference for clear aligners due to improved aesthetics and comfort (9,10). This widespread clinical use has led researchers to focus on this popular topic, and in recent years, more than 600 articles on this subject have been published in the Web of Science Core Collection database (11). Bibliometric analysis is used to quantitatively and qualitatively examine this scientific research (12). Although this method of analysis is used in many areas of dentistry (13-15), there is no bibliometric study in the literature investigating the effect of CAT on periodontal health. The aim of this study was to evaluate the scientific studies carried out until July 5, 2023, in order to fill the gap in this field. This study was conducted by selecting the search terms "clear aligner" and "periodontal health" to find and evaluate relevant articles in the WOS database. It can be seen that in recent years there has been an increase in the years of the 25 most cited articles on the subject. The year with the highest number of publications was 2020 with 7 publications. At the same time, the most cited article was published in 2015 (Figure 1). Upon evaluating the countries of origin of the authors, it was found that Italy had the highest number of representation (Figure 2). The top three most cited articles originated from Italy, China, and Switzerland, respectively (Figure 3). While three journals were not classified within the Category Quartile of the Science Citation Index Expanded (SCIE), 44% of the articles were published in Q2 journals. Most of the published studies were research articles (64%) and review articles (36%). It is a natural process that the number of citations increases as the publication duration of an article extends. In this bibliometric study, the fact that the most cited article, published in 2015 with 82 citations, is from the earliest year among the 25 articles reviewed does not contradict the explanation regarding the relationship between citation rates and time. The fact that the most articles on the subject were 7 in 2020 and 4 in 2021 shows that there has been an increasing number of studies on the subject in recent years. It can be said that many

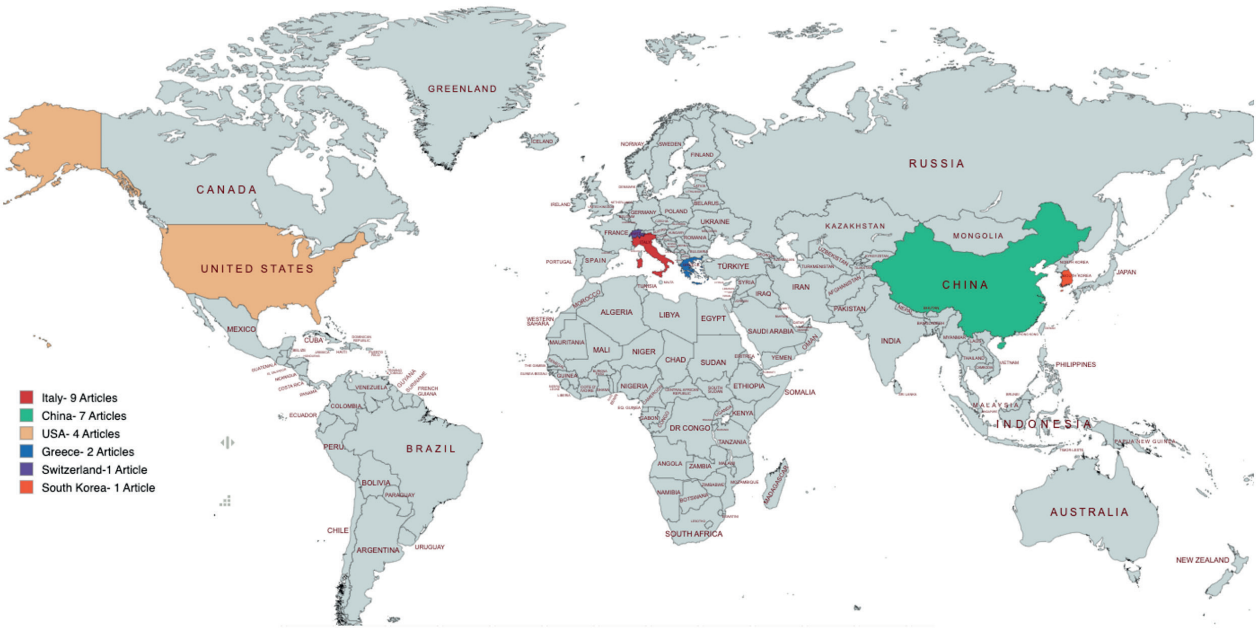

Figure 3. Global distribution of research on the effects of clear aligners on periodontal tissues.

issues such as the type of study and the method of the article influence the citation rates. Clear aligners have recently taken their place in clinical practice with rapidly developing technology. It is thought that since it has taken its place in clinical practice, it has caused academicians to focus on this field and conduct more studies. At the same time, the effects of various orthodontic treatment methods on periodontal health are always a subject worthy of research. For this reason, the effects of clear aligners on periodontal health have been a matter of curiosity. In the bibliometric analysis conducted by Bruni et al. on transparent aligners, one of the most searched keywords is "periodontal health" (12). Nevertheless, the fact that the most articles on this subject in this study are 7 in 2020 and 5 in 2022 indicates that although research on this topic has increased in recent years, well-designed studies on this subject are still lacking.

Limitations

The limitations of this study are that it provides data up to the date of data collection (July 5, 2023). Updated new studies should be conducted again for the research conducted after this date. Another limitation is that only the Web of Science database was used as the research platform, and using different keywords or databases may yield different results.

CONCLUSIONS

It is estimated that the use of clear aligners in clinical practice will increase day by day due to the growing aesthetic concerns of patients, the comfort of clear aligners, and the rapidly developing technology. With increasing clinical use, the effects of clear aligners on teeth and supporting tissues will also be discussed. Bibliometric analyses on various topics will draw researchers' attention to issues that have not been widely discussed in the literature. Thus, knowledge will be gained about many topics in literature. The aim is to ensure that the data provided is free of errors, especially by using developing artificial intelligence technologies both in clinical practice and in academic studies such as bibliometric analyses.

Ethical approval

Since this study is a bibliometric analysis, ethics committee permission is not required.

Author contribution

Concept: MT, SKB; Design: MT, SKB; Data Collection or Processing: HA, FA; Analysis or Interpretation: SKB; Literature Search: HA, FA; Writing: MT, SKB, HA. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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