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Bibliometric Analysis of the Prosthodontic Studies Used Finite Element Analysis in TR Index

TR Dizin'de Sonlu Elemanlar Stres Analizi Yöntemini Kullanan Protetik Diş Tedavisi Çalışmalarının Bibliyometrik Analizi

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ABSTRACT

Objective: Finite element stress analysis is a method in which stress formation on tissues and materials of any structure and shape can be analyzed. In this study, it is aimed to make a bibliometric analysis of studies in prosthetic dentistry using finite element stress analysis in TR Index.

Materials and Methods: Articles were obtained by searching the "finite element" keyword in the TR Index. Dentistry journals were filtered and studies were reduced to the field of dentistry. The publications were classified and recorded to include the journal name, publication year, author institutions, departments, article type, article language, and number of citations. Publications in the field of prosthetic dentistry were included in this study. Frequency analysis of the data, descriptive statistics and Mann–Whitney *U* test were performed ($\alpha = 0.05$).

Results: Twenty-seven studies, including 2 reviews and 25 research articles, were reached. It was seen that the most publications were in the *Journal of Dental Faculty of Atatürk University* and *Cumhuriyet Dental Journal*. Post core restorations, all-ceramic crowns, maxillofacial prostheses, and implant-supported prostheses were the subject of the studies, 13 of which were in Turkish and 14 in English.

Conclusion: Finite element stress analysis is a preferred method in prosthetic dentistry studies. The field of implantology stands out in this sense. National studies using this method have shown a significant increase in the last decade. The language had no significant effect on the number of citations of the publications.

Keywords: Bibliometrics, prosthodontics, finite element analysis, dentistry, database

ÖZ

Amaç: Sonlu elemanlar stres analizi (SESA) herhangi bir yapı ve şekle sahip dokular ve materyaller üzerindeki stres oluşumunun analiz edilebildiği bir yöntemdir. Bu çalışmada TR Dizin'de SESA kullanan Protetik Diş Tedavisi çalışmalarının bibliyometrik incelemesinin yapılması amaçlanmıştır.

Gereç ve Yöntem: TR Dizin'de 'sonlu elemanlar' ve 'finite element' anahtar kelimeleri aranarak yayınlar elde edilmiştir. Diş hekimliği dergileri filtrelenerek çalışmalar diş hekimliği alanına indirgenmiştir. Yayınlar dergi adı, yayın yılı, yazar kurumları, anabilim dalları, makale türü, makale dili, atıf sayısı bilgilerini içerecek şekilde sınıflandırılarak kaydedildi. Protetik Diş Tedavisi alanında yapılan yayınlar bu çalışmaya dahil edildi. Verilerin değerlendirilmesi için tanımlayıcı istatistik, frekans analizi ve Mann–Whitney U testi yapıldı ($\alpha = 0,05$).

Bulgular: İkisi derleme, yirmi beşi araştırma makalesi olmak üzere yirmi yedi çalışmaya ulaşıldı. En fazla yayının Atatürk Üniversitesi Diş Hekimliği Fakültesi Dergisi ve Cumhuriyet Dental Journal dergilerinde yer aldığı görüldü. On üçü Türkçe, on dördü İngilizce olarak hazırlanan çalışmalarda post core restorasyonlar, tam seramik kronlar, çene yüz protezleri ve implant üstü protezler konu edilmiştir.

Sonuç: SESA Protetik Diş Tedavisi çalışmalarında tercih edilen bir yöntemdir. İmplantoloji alanı bu anlamda öne çıkmaktadır. Bu yöntemi kullanan ulusal çalışmalar son on yılda önemli bir artış göstermiştir. Makale dilinin yayınların atıf sayısına anlamlı bir etkisi bulunamamıştır.

Anahtar Kelimeler: Bibliometri, protetik diş tedavisi, sonlu elemanlar analizi, diş Hekimliği, veri tabanı

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INTRODUCTION

The oral environment is a complex biomechanical system and has limited access. Therefore, studies in many fields such as prosthodontics, endodontics, and orthodontics are carried out under in vitro conditions.[1] Finite element stress analysis (FEA) is a method by which dental materials and stress formation in the orofacial region can be analyzed. This method can be used in the evaluation of restorations and complex treatments. Stress and deformations in structures of any geometric shape are examined with a numerical method. In this way, researchers can predict the stress distributions that may occur in dental prostheses, implants and abutments, bone structure, dental tissue, and periodontium.[2,3] The behavior of any structure or tissue under a certain stimulus could be evaluated using FEA and the biomechanical changes in the tissues could be analyzed. It allows the determination of stress distribution within bone during chewing and various dental implant designs.[4] In prosthetic dentistry, biomechanical behaviors, preparation types, and preparation properties of different dental ceramics can also be examined with this method.[5] It is feasible to predict the stresses that the substructure and veneer design will create in the restoration.[6] Changes that may occur in the muscles in response to chewing forces can be evaluated in implant-supported prostheses.[7] Finite element stress analysis, which is a non-invasive technique, can be used in linear and non-linear solid and liquid structures. Using this method, any biological state can be simulated before, during and after the procedure. In the method where static and dynamic analyses can be made, even complex operations can be performed in a short time and the research could be easily repeated.[1]

Bibliometric analysis has a significant role in assessing the scientific chain, with methods for measuring the scientific productivity of researchers and communities.[8] Publication-based data work is widely applied in assessment. Analysis of research results is the most common form of use. However, it also offers utility as a partial indicator of overall research results and the productivity and impact of research teams and centers. Some problems arise in the use of bibliometric measurements of research and development activities. A long period of time, 10 years or more, is required to fairly evaluate the results of studies. Also, in research and development activities, results are often correlated with results produced by other working groups and programs. It is often difficult to base all success on a single source.[9]

The TR Index was developed in accordance with international standards for researchers to access national and scientific data and functioned under the name of National Databases-UVT until the end of 2013. The TR Index which has content created by ULAKBİM, consists of journals in the main fields of science and social sciences and the sub-fields of dentistry, pharmacy, engineering, basic sciences, health sciences, veterinary, social sciences, and humanities.[10] The aim of this study is to evaluate the studies of prosthetic dentistry using FEA in the dental journals in TR Index.

MATERIALS AND METHODS

In the national database TR Index (https://trdizin.gov.tr/), all studies on this subject are listed with the keyword "finite element." Among all publication types in English and Turkish, between January 2000 and November 2022, only those in dentistry journals were filtered out. The publications were classified as including the journal name, publication year, author institutions, departments, article type, article language, and number of citations and saved in the Excel software package (Microsoft Office Professional Plus 2010, USA). As a result of the examination of the records obtained, publications in the field of prosthetic dentistry were included in this study (Figure 1). Frequency analysis, descriptive statistics, and Mann–Whitney *U* test of the data related to the studies were performed using IBM Statistical Package for the Social Sciences Statistics 23.0 program for Windows (IBM, NY, USA) ($\alpha = 0.05$).

RESULTS

Totally, 54 studies that used the FEA method were determined. They were analyzed according to their fields and 27 of them were excluded from the study. Excluded articles belong to oral and maxillofacial surgery (13), orthodontics (4), endodontics (1), pedodontics (1), and restorative dentistry (8). Twenty-seven studies related to the field of prosthodontics were reached. It was determined that 4 of these studies were carried out jointly with the departments of Pedodontics (1), Oral and Maxillofacial Surgery (2), Restorative Dentistry and Pedodontics (1), and Restorative Dentistry (1). All FEA studies in prosthodontics are shown in Table 1. Two of the 27 studies were prepared in review type. The remaining 25 studies are included as research articles.

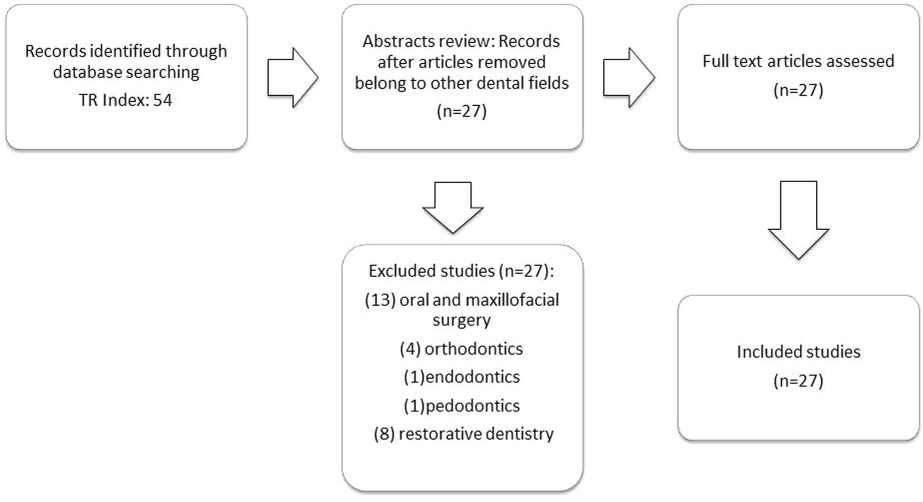

Figure 1. Flowchart of bibliometric analysis.

Table 1. Detailed Data Belong to the Studies with FEA in the Field of Prosthodontics in TR Index

Authors	Journal	Year	Research Type	Number of Citations	Institute
Akay C, Karakış D, Yaluğ S.	*Journal of Dental Faculty of Atatürk University*	2015	Original research	2	Gazi University
Aksan M. E., Atsü S., Bulut A. C	*Journal of Dental Faculty of Atatürk University*	2018	Review	1	Kırıkkale University
Asar NV, Burgaz Y.	*The Journal of Gazi University Faculty of Dentistry*	2009	Original research	1	Gazi University
Bölükbaşı N., Koçak A., Özdemir T	*Journal of Istanbul University Faculty of Dentistry*	2012	Original research	3	Yildiz Technical University İstanbul University
Çakan U, Saygili G	*Clinical Dentistry and Research*	2015	Original research	0	İstanbul Medipol University Hacettepe University
Çelik E, Özden AN	*Selçuk Dental Journal*	2019	Original research	1	Ordu University Near East University
Çulhaoğlu AK, Terzioğlu H	*Selçuk Dental Journal*	2020	Original research	1	Kırıkkale University Ankara University
Deste G, Durkan R	*Journal of Dental Faculty of Atatürk University*	2020	Original research	0	Bursa Uludağ University Afyonkarahisar Health Sciences University
Durkan R, Oyar P, Deste G	*Cumhuriyet Dental Journal*	2019	Original research	1	Afyonkarahisar Health Sciences University Hacettepe University
Egilmez F, Nalbant L*	*Cumhuriyet Dental Journal*	2012	Original research	5	Gazi University
Soğancı Ünsal G., Hasanoğlu Erbaşar G. N	*Journal of Dental Faculty of Atatürk University*	2020	Original research	0	Ankara Yıldırım Beyazıt University
Güler MS, Güler Ç, Şen S, Bayindir YZ	*Journal of Dental Faculty of Atatürk University*	2012	Original research	1	Atatürk University İnönü University
Guven S, Eratilla V, Beydemir K, Dundar S	*Cumhuriyet Dental Journal*	2015	Original research	3	Dicle University Fırat University Diyarbakır Oral Health and Care Center
Gündoğdu TM, Erkmen E, Öztürk Gündoğdu Ö	*ADO Journal of Clinical Sciences*	2022	Review	0	Gazi University
Karaoğlu Ç, Güngör MA, Dündar M, Artunç C	*Clinical Dentistry and Research*	2005	Original research	1	Ege University Dokuz Eylül University
Kaleli N, Ural Ç	*Journal of Dental Sciences*	2020	Original research	1	İstanbul Medeniyet University On Dokuz Mayıs University
Kaleli N, Ural Ç	*Journal of Dental Sciences*	2020	Original research	1	İstanbul Medeniyet University On Dokuz Mayıs University
Karaali A. E., Doğan M. S., Günay A	*Journal of Dental Faculty of Atatürk University*	2018	Original research	0	Harran University Dicle University
Karadayi Yüzükcü AE, YerlîYurt K	*Cumhuriyet Dental Journal*	2022	Original research	1	Gaziosmanpaşa University
LeblebiCiOğlu İ, EsiM E, Kiliç D, Kiliç K	*Selçuk Dental Journal*	2021	Original research	1	Erciyes University
Özkir SE, Çulhaoğlu AK, Şeker E, Ünal SM	*Clinical Dentistry and Research*	2017	Original research	0	Afyonkocatepe University Kırıkkale University Osmangazi University
Ramoglu S, Ozan O, Kurtulmuş Yılmaz S	*Cumhuriyet Dental Journal*	2014	Original research	3	Near East University
Sevimay M, Özyılmaz ÖY, Eraslan O	*Selçuk Dental Journal*	2015	Original research	0	Selçuk University Medipol University
S. Darendeliler Yaman And Ö. Karacaer	*Ankara University Faculty of Dentistry Journal*	2001	Original research	0	Gazi University
Sivrikaya EC, Güler MS, Bekçi ML	*Selçuk Dental journal*	2021	Original research	0	Ordu University Karadeniz Technical University
Tuzlali M, Öztürk C, Zortuk M	*Journal of Dental Sciences*	2018	Original research	2	İnönü University Mustafa Kemal University
Türk AG	*Cumhuriyet Dental Journal*	2017	Original research	1	Ege University

FEA, finite element stress analysis.
*Most cited article.

Between the years 2000 and 2022, it was seen that the most publications were made in 2020 (n = 6). While it was determined that 8 publications received no citations, it was determined that there were 12 publications with 1 citation, 3 with 2 citations, 3 with 3 citations, and 1 with 5 citations. The number of publications and citations by year are shown in Table 2.

When the number of publications and citations were examined according to the journal, it was seen that the most publications were in *Journal of Dental Faculty of Atatürk University* (n = 6) and *Cumhuriyet Dental Journal* (n = 6). It was determined that they were followed by *Selçuk Dental Journal* (n = 5), *Türkiye Klinikleri Journal of Dental Sciences* (n = 3), and *Clinical Dentistry and Research* (n = 3), respectively. Table 3 shows the number of publications and citations by journal. It was determined that *Cumhuriyet Dental Journal* was the journal with the most cited publications due to the reference to all publications in the field of prosthodontics related to FEA.

Thirteen of the studies were prepared in Turkish and 14 in English. When the number of citations was evaluated according to the language, it was seen that 69.2% of the Turkish studies and 71.4% of the English studies were cited. As a result of the Mann–Whitney *U* test, it was determined that the language did not

Table 2. Number of Publications and Citations by Year

Year		2001	2005	2009	2012	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Number of publications		1	1	1	3	2	3	1	1	3	2	5	3	1	27
Number of citations	0	1	0	0	0	0	2	0	1	1	0	2	0	1	8
	1	0	1	1	1	0	0	1	0	1	2	3	2	0	12
	2	0	0	0	0	1	0	0	0	1	0	0	1	0	3
	3	0	0	0	1	1	1	0	0	0	0	0	0	0	3
	5	0	0	0	1	0	0	0	0	0	0	0	0	0	1

Table 3. Number of Citations by Journals

Journals	Number of Citations					Total
	0	1	2	3	5	
Journal of Dental Faculty of Ankara University	1	0	0	0	0	1
The Journal of Gazi University Faculty of Dentistry	0	1	0	0	0	1
Türkiye Klinikleri Journal of Dental Sciences	0	2	1	0	0	3
Cumhuriyet Dental Journal	0	3	0	2	1	6
Journal of Istanbul University Faculty of Dentistry	0	0	0	1	0	1
Selçuk Dental Journal	1	3	1	0	0	5
Clinical Dentistry and Research	2	1	0	0	0	3
ADO Journal of Clinical Sciences	1	0	0	0	0	1
Journal of Dental Faculty of Atatürk University	3	2	1	0	0	6
Total	9	12	3	3	1	27

Table 4. Effect of Article Language on the Citation Counts (Z=−0.129; P > .05)

ArticleLanguage	n	Mean Rank	Sum of Ranks	U	*Z*	*P*
Turkish	13	14.19	184.50	88.500	−0.129	.897
English	14	13.82	193.50			

make a significant difference in the number of citations (P = .897) (Table 4).

All 27 studies were examined according to their subjects, 5 were on post-core restorations, 3 on full ceramic crowns, 1 on maxillofacial prostheses, and the remaining 18 on implant-supported fixed and removable prostheses. According to the institutions of the researchers participating in the studies, it was seen that the highest participation was from Gazi University (Figure 2).

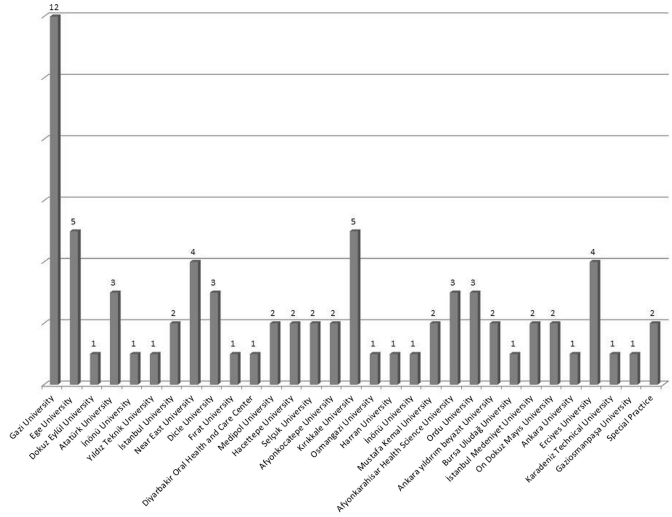

Figure 2. Researchers by institutions.

DISCUSSION

In this study, the publications made with FEA in the field of prosthodontics in the TR Index were examined. Prosthodontics with the impact of tooth or tissue damage and partial or complete loss of teeth on oral function. The discipline covers a large part of a dental school curriculum. As the main focus in prosthetic dentistry has changed from removable dentures to fixed dentures, implant-supported restorations have become highly popular. Another factor affecting prosthetic practice is patients' awareness of new technologies in aesthetic dentistry.[11] It is thought that the reason why 4 of the publications examined in this study were carried out jointly with other departments and the rest were carried out only in the field of prosthodontics, is due to the fact that the prosthodontics contains many areas within itself.

Finite element stress analysis has been used in determining stress analysis and researching dental implantology,[12] fixed and removable prosthetic restorations,[13] maxillofacial prostheses,[14] post-core structures,[15] and biomechanical properties of the dental materials[16] in prosthodontics. When the TR Index was examined, the publications on the aforementioned subjects were determined. The fact that dental implantology is the most used area suggests that FEA is very useful and facilitating despite the complexity of study planning in this field.[17] There are more possibilities for the other subjects of research to carry out compared to implantology, both clinically and in vitro.

National bibliometric studies provide benefits both for the analysis of current studies and for the creation of demographic data. Evaluation of the scientific effectiveness of a researcher or institution can be done through access to one of the national databases.[8] In this study, as a result of the publications examined in TR Index, it was seen that the most FEA-related publications in the field of prosthetic dentistry were made in 2020. The fact that studies using FEA have a significant increase in the second decade compared to the first decade in a 20-year period is beneficial both in terms of national academic effectiveness and in terms of the contribution of the obtained data to clinical applications. It is thought that the process of staying at home due to the coronavirus disease 2019 pandemic had a positive effect on academic production. The most publications were in *Journal of Dental Faculty of Atatürk University* (n = 6) which continues to be published under the name of *Current Research in Dental Sciences* and *Cumhuriyet Dental Journal* (n = 6). It is thought that these journals are more preferred by researchers in terms of academic success, article review, and publication processes.[18] While publication numbers measure production, citation counts go one step further and consider scientific impact based on how many times subsequent articles refer to the previous article.[9] When the number of citations was evaluated, the years with the highest number of cited publications (n = 3) were determined as 2020 and 2021. It was seen that *Cumhuriyet Dental Journal* was the journal which had the most cited publications. Although it was thought that publishing the article in English would increase accessibility, no difference was found between the number of citations of Turkish and English articles.

Two of the analyzed studies were published as reviews and the remaining 25 studies were published as research articles. It can be said that the acceptance of research articles for publication is effective in this regard and prevents the efforts of researchers to make reviews or case reports.[19]

Online resources are quite effective for collecting large publication data. However, it is necessary to be careful in the selection of the source. Google Scholar seems to be an easy tool for evaluation, as it offers a superior method of finding articles and is very easily accessible. However, it is structured with author information regardless of the institutional relationship. Therefore, Google Scholar does not aim to create accurate metadata.[9] In the current study, research was carried out in the TR Index national database and the information of the articles was evaluated.

The subject is 'bibliometric studies' that are carried out with at least 100 publications or studies published in at least 10 years and summarizes large amounts of bibliometric data to present the academic activity structure and emerging trends of a

research topic or field.[20] Although the number of data is more limited for the present study, academic data over a period of 20 years has been used. This study was carried out on the national database. Therefore, studies with international indexes will be useful for more comprehensive results regarding the use of FEA in prosthetic dentistry.

CONCLUSION

It was concluded that FEA was the preferred method for prosthodontic studies, the field of implantology stood out in this sense, and the national studies using this method increased significantly in the last 10 years. Most of the participants in the studies using this method are affiliated with Gazi University. The journals with the highest number of publications made with FEA are the *Journal of Dental Faculty of Atatürk University* which continues the publication process under the name of *Current Research in Dental Sciences* and *Cumhuriyet Dental Journal*. The language of the article did not affect the number of citations of the publications.

Peer-review: Externally peer-reviewed.

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