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A Bibliometric Analysis of the Top 100 Most-Cited Articles on the Use of Intraoral Scanners in Dental Implants

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ABSTRACT

Objectives: The aim of this study is to conduct a bibliometric analysis of the studies obtained when searching with the keywords “intraoral scanner” and “dental implant”.

Materials and Methods: As a search strategy, a search was performed in the main categories of Web of Science (Emerging Sources Citation Index (ESCI), Social Science Citation Index (SSCI), Science Citation Index Expanded (SCI-Expanded)) with the terms “intraoral scanner (IOS)” and “dental implant”. The search was limited by document type to “articles” and “reviews” only and restricted to articles published until 2023. All articles were manually reviewed and standardized by 3 independent reviewers to avoid typos and duplication of author names or institutions.

Results: The 100 most cited articles were selected from 392 articles that met the criteria. There has been a significant increase in the number of published articles, especially in the last 10 years. The 3 most productive countries are the USA, Italy, and Spain. The continent with the highest number of publications is Europe. The most cited article on this topic has 401 citations, while the total number of articles with over 100 citations is 10.

Conclusions: IOSs are an important technology in terms of patient and dentist comfort, the use of which has increased over the years in dentistry. The use of IOSs with dental implants in prosthodontic treatment has become increasingly popular. In this bibliometric study, when the countries with the most publications were analyzed, it was determined that the USA, Spain, and Italy constituted the top 3 countries.

Keywords: Bibliometric analysis; Dental implant; Intraoral scanner

Dental Implantlarda Intraoral Tarayıcıların Kullanımıyla İlgili En Çok Atıf Alan Ilk 100 Makalenin Bibliyometrik Analizi

Araştırma Makalesi

Süreç

Geliş: 27/01/2025
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ÖZET

Amaç: Bu çalışmanın amacı, “intraoral scanner” ve “dental implant” anahtar sözcükleri ile arama yapıldığında elde edilen çalışmaların bibliyometrik analizini yapmaktır.

Gereç ve Yöntemler: Bir arama stratejisi olarak, Web of Science’ın ana kategorilerinde (Emerging Sources Citation Index (ESCI), Social Science Citation Index (SSCI), Science Citation Index Expanded (SCI-Expanded)) “intraoral scanner (IOS)” ve “dental implant” terimleri ile arama yapıldı. Arama, belge türüne göre yalnızca “makaleler” ve “derlemeler” ile sınırlandırıldı ve 2023’e kadar yayınlanmış makalelerle sınırlandırıldı. Tüm makaleler, yazım hatalarından ve yazar adlarının veya kurumlarının tekrarından kaçınmak için 3 bağımsız değerlendirici tarafından manuel olarak incelendi ve standartlaştırıldı.

Bulgular: Kriterleri karşılayan 392 makale arasından en çok atıf alan 100 makale seçildi. Özellikle son 10 yılda yayınlanan makale sayısında önemli bir artış oldu. En üretken 3 ülke ABD, İtalya ve İspanya’dır. En fazla yayına sahip kıta Avrupa'dır. Bu konuda en çok atıf alan makale 401 atıfa sahipken, 100'den fazla atıf alan toplam makale sayısı 10'dur.

Sonuçlar: IOS'lar hasta ve diş hekimi konforu açısından önemli bir teknolojidir ve diş hekimliğinde kullanımı yıllar geçtikçe artmıştır. Protetik diş hekimliğinde dental implantlarla birlikte IOS'ların kullanımı giderek daha popüler hale gelmiştir. Bu bibliyometrik çalışmada en fazla yayına sahip ülkeler incelendiğinde ilk 3 ülkeyi ABD, İspanya ve İtalya'nın oluşturduğu belirlenmiştir.

Anahtar Kelimeler: Bibliyometrik analiz; Dental implant; Ağız içi tarayıcı

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Introduction

The impression is a very important stage in implant dentistry.[1] The use of an intraoral scanner (IOS) allows instantaneous assessment of the scanned area; it also allows digital 3D models to be obtained, which can be transferred to a computer without casting a physical plaster model.[2-4] For both the dentists and the patients, this saves considerable time and storage space and allows the scanned models to be easily emailed to the laboratory. It has been reported that it is very difficult to ensure absolute passive fit of the manufactured substructure in implant-supported prostheses.[5]

Due to the many steps involved in the clinical and laboratory process of implant-supported prostheses, it has been reported that it is difficult to prevent potential complications.[6,7] Clinical situations, such as incorrect transfer of implant position, can lead to the production of maladjusted prostheses. And maladjusted prostheses are known to cause biological and mechanical complications.[8] These complications include screw deformation and loosening, abutment fracture, bone resorption and even implant failure.[9,10]

Digital impressions increase patient compliance with the treatment process, reduce the risk of deformation of impression materials, allow for three-dimensional design, reduce potential costs, and increase the clinical success of the prosthesis.[11] Digital impressions allow the dentist and the patient to virtually evaluate the implant prosthesis area before proceeding to the laboratory manufacturing stage for implant applications in dentistry. The use of digital impressions also enables the observation of the depth of the restoration interface and the configuration of the emergence profile.[12] There are studies reporting the clinical success of IOSs in single-tooth crowns and fixed partial dentures on implants.[13] Reports indicate that in these two cases, the success of IOSs for implant-supported single crowns is better than for implant-supported fixed partial dentures and for cases with long edentulous spaces. An increase in edentulous areas is known to decrease the success of the scanner, primarily due to a decrease in the reference point.[14]

Research in the field of prosthodontics has greatly increased due to the demand for scientific knowledge about clinical procedures and materials used.[15] This increase has been accompanied by an increase in the number of scientific journals publishing research in the field of prosthodontics.[16] The importance of an article is demonstrated by citations by other researchers, changes in clinical practice, the controversy it generates, or by revealing new research directions.[16] Bibliometric analysis studies are very important, showing the amount of published research in a particular field and providing an overview of research and scientific activity by calculating bibliometric indicators.[17] On the other hand, the citation index is an important parameter used to measure relevance in a particular field of knowledge.[15,16] The number of citations may not always reflect the quality or importance of an article or the importance of its authors, but frequently cited articles can lead to changes in clinical practice, stimulate debate, and enable further research in a particular area.[16]

The aim of this bibliometric study is to determine the 100 most cited articles about dental implant and IOSs, track the course and trend of these studies from the past to the present, and help researchers with their future studies.

Materials and Methods

In this study, a search was carried out in the main categories of Web of Science: Emerging Sources Citation Index (ESCI), Social Science Citation Index (SSCI), Science Citation Index Expanded (SCI-Expanded). This database is widely used for bibliometric studies due to its broad subject coverage, the number of citations articles receive, and the ability to identify the institutions involved in each article. The search strategy was based on the keywords “intraoral scanner” and “dental implant”. The search was limited to articles and reviews as document types, and the download was done on October, 2024. The search was limited to articles published between 2012 and 2023. Before 2012, only one article was identified in 2001, and therefore this article was not included. Without any filtering, the search produced a total of 399 articles. Filtering by year and article type reduced this number of articles to 392. This bibliographic study focused on 100 highly cited articles from the 392 total articles. Three independent observers reviewed and verified these 100 articles.

The statistical analysis of the current study was analyzed with the Shapiro Wilk test for the assumption of normal distribution and with the Mann Whitney U test for the comparison of two independent groups when the normality assumption was not met. The Kruskal-Wallis test was used to compare three or more independent groups that did not have a normal distribution. Post-hoc correction Bonferroni tests were performed to reveal the group or groups that made the difference. Analyses were performed in IBM SPSS 25 and R version 4.4.0 programs.

Results

Table 1 shows the distribution of publications according to their characteristics. The distribution of publications by countries, continents, years of publication, open access status, WoS category, and WoS index was analyzed in this table. The highest number of publications by country is in the USA with 19%, followed by Spain and Italy with 11% (Table 1). Analyzing the distribution by continents reveals that Europe produced 48% of all publications, followed by Asia with a 30% publication rate (Table 1 and Figure 1).

When the distribution of continents is analyzed based on the average number of citations, European publications have the highest average amount of citations (62.17±68.52), followed by North American publications at 59.58±50.22 (Table 2 and Figure 2). Upon analyzing the years, we found that 2019 had the highest number of published articles, with 15 articles, and we have observed

both a horizontal trend and decreases since this year (Figure 3). It was determined that 38% of all publications were Open Access. These publications were mostly published in the Dentistry Oral Surgery Medicine category with a rate of 88%, while 90% of all articles had SCI-Expanded WoS Index (Table 2).

The Mann-Whitney U and ANOVA tests were performed for the comparison of the distribution of the number of citations (Table 2). As a result of the analyses, statistically significant differences were found between the number of citations according to continents and year of publication ($p < 0.05$). According to Bonferroni tests for continents, statistically significant differences were found between Asia, Europe, and North America ($p = 0.016$ and $p = 0.015$).

The number of citations in Europe and North America is higher than in Asia. The citation numbers of studies with publication years 2012-2019 are higher than those with publication years 2020-2023. There were no statistically significant differences between the number of citations according to Open Access, WoS categories, and Web of Science indexes ($p < 0.05$).

The network analysis for the authors participating in the study is shown in Figure 4 for authors collaborating on the top 20 most cited articles. The size of the nodes indicates the productivity of the authors, and the thickness of the edges indicates the intensity of this scientific collaboration.

This bibliometric study reveals that the Journal of Prosthetic Dentistry published the most articles among the 100 most cited, with 21 publications, followed by the Journal of Clinical Oral Implants Research with 12 publications, and the International Journal of Oral Maxillofacial Implants with 9 publications (Table 3).

Table 1. The distribution of articles is based on their characteristics

		n	%
Country	Albania	1	1.0
	Brazil	4	4.0
	Canada	1	1.0
	China	8	8.0
	Germany	9	9.0
	Greece	1	1.0
	Hungary	1	1.0
	India	1	1.0
	Iran	2	2.0
	Italy	11	11.0
	Japan	3	3.0
	Lithuania	2	2.0
	Netherlands	1	1.0
	Norway	1	1.0
	Poland	1	1.0
	Russia	1	1.0
	Singapore	2	2.0
	South Korea	8	8.0
	Spain	11	11.0
	Sweden	1	1.0
	Switzerland	4	4.0
	Thailand	3	3.0
	Turkey	4	4.0
	Usa	19	19.0
Continent	Asia	30	30.0
	Europe	48	48.0
	North America	19	19.0
	South America	3	3.0
Publication Year	2012	1	1.0
	2013	3	3.0
	2014	3	3.0
	2015	9	9.0
	2016	4	4.0

	2017	10	10.0
	2018	10	10.0
	2019	15	15.0
	2020	12	12.0
	2021	12	12.0
	2022	13	13.0
	2023	8	8.0
Open Access	All Open Access	38	38.0
	Others	62	62.0
WoS Categories	Chemistry Physical	1	1.0
	Dentistry Oral Surgery Medicine	88	88.0
	Engineering Biomedical	1	1.0
	Public Environmental Occupational Health	5	5.0
Web of Science Index	Social Sciences Citation Index (SSCI)	6	6.0
	Emerging Sources Citation Index (ESCI)	4	4.0
	Science Citation Index Expanded (SCI-EXPANDED)	90	90.0

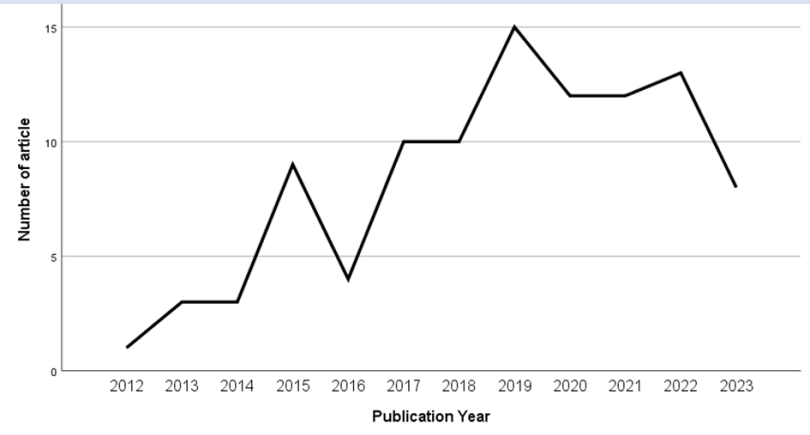

Figure 1. Distribution of articles in years

Table 2. The distribution and comparison of citation numbers are based on the characteristics of articles

		Min.-Max.	Mean±SD (Median)	Test Statistics	p-Value
Continent	Asia	14-82	32.47±20.58(26)	7.983	0.046*
	Europe	13-400	62.17±68.52(41.5)		
	North America	18-203	59.58±50.22(35)		
	South America	23-73	43.67±26.1(35)		
Publication Year	2012-2019	15-400	67.95±67.44(44)	-3.629	<0.001*
	2020-2023	13-116	32.98±22.11(25)		
Open Access	All Open Access	14-400	53.13±71.03(30)	-0.746	0.456
	Others	13-203	51.65±42.59(32.5)		
WoS Categories	Dentistry Oral Surgery Medicine	14-400	54.63±57.41(31)	-0.057	0.955
	Others	20-94	43±27.45(33)		
Web of Science Index	Social Sciences Citation Index	14-94	37.5±29.36(27)	0.535	0.765
	Emerging Sources Citation Index	22-43	31.75±8.77(31)		
	Science Citation Index Expanded	13-400	54.1±57.04(31)		

SD: Standart deviation, *p<0.05

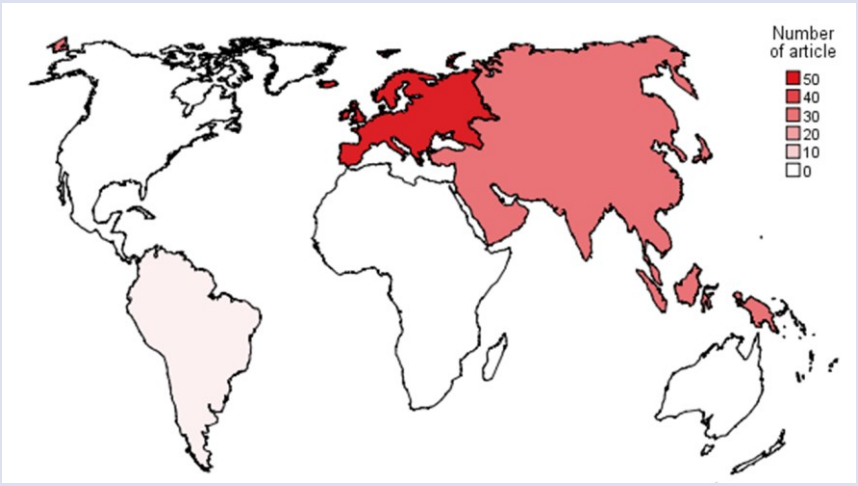

Figure 2. Distribution of number of articles by continent

Figure 3. Distribution of average citation numbers of publications by continent

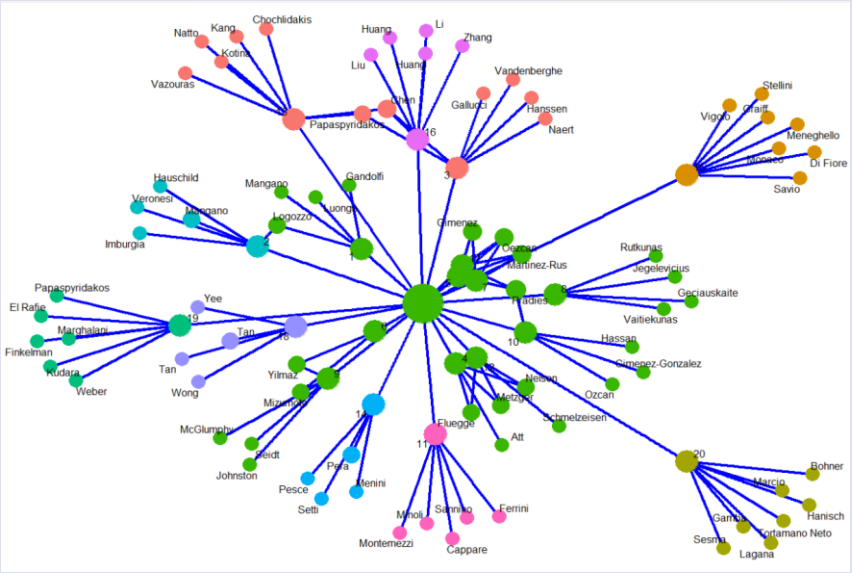

Figure 4. Author network analysis diagram for the first 20 articles

Table 3. Characteristics of the top 20 journals with the 100 most cited publications

Publication Title	Count	J.I.F	H-Index	Total Cited	Avarage per Cited
1- Journal of Prosthetic Dentistry	21	Q1	19	986	46.95
2- Clinical Oral Implants Research	12	Q1	12	603	50.25
3- International Journal of Oral Maxillofacial Implants	9	Q2	9	542	60.22
4- Journal of Dentistry	6	Q1	6	127	21.17
5- Journal of Prosthodontics Implant Esthetic and Reconstructive Dentistry	6	Q1	6	325	54.17
6- Bmc Oral Health	5	Q1	5	759	15.8
7- International Journal of Environmental Research and Public Health	5	Q2	5	197	39.4
8- International Journal of Prosthodontics	4	Q2	4	331	82.75
9- Clinical Implant Dentistry And Related Research	3	Q1	3	242	80.67
10- Dentıstry Journal	2	Q2	2	73	36.5
11- Implant Dentistry	2	Q2	2	52	26
12- International Journal of Implant Dentistry	2	Q1	2	48	24
13- International Journal of Oral Implantology	2	Q1	2	86	43
14- Journal of Advanced Prosthodontics	2	Q1	2	87	43.5
15- Journal of Oral and Maxillofacial Surgery	2	Q2	2	116	58
16- Journal of Oral Implantology	2	Q3	2	39	19.5
17- Journal of Prosthodontic Research	2	Q1	2	117	57.5
18- Clinical Epidemiology and Global Health	1	Q2	1	34	34
19- Clinical Oral Investigations	1	Q1	1	91	91
20- European Journal of Oral Implantology	1	Q2	1	137	137

J.I.F= Journal Impact Factor

Discussion

This study identified and analyzed the main features of the 100 most cited articles in the WoS-CC database by searching with the keywords “intraoral scanner” and “dental implant”. This type of analysis provides a perspective on the research area related to this topic. Moreover, analyzing the most influential articles can help researchers identify trends and deficiencies in the scientific

literature. The citations to an article indicate its academic importance and are also used to assess the impact of these articles on the scientific literature.[18]

For an article to be considered a classic, it must be cited at least 400 times.[19] However, an article can also be considered classic in some smaller research areas if it has been cited more than 100 times. In the WoS-CC database on “intraoral scanner” and “dental implant”,10 articles were cited more than 100 times and 1 article was cited more than 400 times. In the present study, the top 10 of the 100 most cited studies are classical and guiding in this field.

In studies on bibliometric analysis, WoS-CC, which is specifically designed based on citation analysis, is considered one of the most prestigious databases used to investigate scientific quality and impact.[20] While other databases may cite different sources, WoS and Scopus cite more articles published in selected peer-reviewed journals.[21,22] Scopus receives more citations from non-English sources and reviews, while Web of Science focuses more on indexed journals and editorial content.[22] Therefore, bibliometric analysis studies often use WoS-CC as the main database.[23] The Scopus database only measures citations from 1996 onwards. Also, the Google Scholar database only sorts of citations by publication date or relevance and includes citations from documents such as books and theses, which can be limiting. And these documents lack blind peer review.[20] In this research, 90% of the articles were found to be in the SCI-Expanded WoS-CC category.

Examining previous bibliometric studies on dental implants in the literature reveals research in a variety of fields, including risk factors for peri-implantitis in implantology,[24] dental implants in diabetic patients,[25] dental implant failures,[26] aesthetics in implant dentistry,[27] prosthetic complications in dental implants,[28] and implant-supported whole arch restorations.[29] There is bibliometric study on the use of digital scanning in various dental practices, such as prosthodontics, restorative dentistry, orthodontics, and implantology.[30] The difference of the present study is that it aims to analyze the most cited publications about the use of the scanner in implant prosthodontics, not its general use in dentistry.

In the present bibliometric study, the geographical results show that the USA is the country with the highest number of publications. It can be concluded that there are authors in the USA who tend to overpublish and that the use of dental implants as a routine treatment option and the use of iOS is widespread in the institutions where these authors are located. This country is considered an early adopter of technology, with a higher access and use of technological devices in daily life compared to other countries.

Additionally, it may be considered that the institutions in the USA, Spain, and Italy, which are the countries with the highest number of publications, have policies that financially support scientific studies. Comparing the continents, the most

research has been done on the European region. Despite the USA producing the majority of publications, the European continent has many countries with similar levels of development, which accounts for the high number of publications there. These results are similar to the results of the bibliometric analysis conducted by Saini *et al*. in 2024.[30]

In the present bibliometric analysis study, it was observed that the first publications on the use of IOS in dental implants were made in 2012.[31] This situation shows us that the use of IOSs in the field of implantology has become widespread, and researchers are working on this subject. After 2019, the Covid-19 pandemic, which had a global impact on the decline, caused the closure of institutions, a decrease in the number of patients, and changes in the working conditions of dentists. These circumstances may have negatively affected the volume of publications in the field.

The direction of current scientific research and the trend of studies is to minimize the risk of the occurrence of the problem instead of solving the problem. For this purpose, advanced digital technologies such as IOSs have been used to produce more successful prosthetic restorations.

When the network analysis of the authors was examined, it was determined that the studies were both single-center and multi-center studies. It was observed that some authors had a relationship with certain institutions or authors. As a result, these authors collaborated on various studies together.

In the present study, it was determined that 21 of the 100 most cited articles were published in the Journal of Prosthetic Dentistry, one of the prestigious journals for prosthodontics. The journal has a Q value of Q1 and an h index of 19, and the number of citations per publication is 46.95. It is quite usual for researchers to prefer a prestigious journal to make their publications more visible. The high number of publications can be interpreted as proof that the Journal of Prosthetic Dentistry considers dental implants and IOS as a current, interesting, and developing field. The Q values of the 2nd and 3rd ranked journals (Clinic Oral Implant Research and International Journal of Oral Maxillofacial Implants) are Q1 and Q2, respectively. The h index is 12 and 9, respectively. Similarly, these journals focus on dental implants, track current developments, and typically publish high-quality publications.

Conclusions

The majority of the 100 most cited articles on IOSs and dental implants are original articles. The quantity of reviews is limited. Mostly published in the USA and continental Europe. WoS-CC is a database that lists publications that meet certain criteria. The fact that 10% of the publications have received 100 or more citations shows the success of the Wos-CC database. Almost a third of published articles are open access. With the developments in dental implant applications, it is thought that the use of IOS will not lose its popularity and will even continue to increase with ever-changing clinical scenarios.

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