TOP 100 MOST CITED ARTICLES ON THE USE OF OZONE IN DENTISTRY: BIBLIOMETRIC ANALYSIS

ABSTRACT

Introdution: Bibliometric analysis have been used to examine research trends and emphases in various disciplines besides to explore the productivity of researchers, institutions, and countries within given subject areas. **Objectives**: Identify and classify the 100 most cited articles related to the clinical use of ozone in dentistry. **Methodology:** The studies were selected from titles and scopes at Web of Science Core Collection database up to October 2022. Some bibliometric parameters were extracted as follows: title, number of citations, citation density (number of citations per year), first author's country, year of publication, study design and subject. VOSviewer software was used to create graphical bibliometric maps. **Results:** The total number of citations papers which from 13 to 180, and only eight were cited more than 100 times. Papers were published from 1997 to 2022, mainly in dentistry journals. The studies originated from 30 different countries and the most papers were from Germany

(16%) and Turkey (15%). In total, 250 keywords were used and the most used were ozone 50 (20%), dentistry 8 (3,2%) and periodontitis 7 (2,8%). **Conclusions:** 1) Germany was the main country that contributed to field research on the use of ozone in dentistry 2) The University of Basel was the most productive university in the researched field; 3) Clinical Oral Investigations was the journal that led the ranking with the most articles published, 4) The keyword ozone was the most used in the articles; 5) Oral and maxillofacial surgery was the research area most addressed by the 100 most cited articles.

Keywords: Bibliometrics; Citation analysis; Ozone; Dentistry.

INTRODUCTION

Ozone is immunostimulant, antimicrobial, biocompatible [1] and there is evidence of its use as a useful therapeutic agent in treatments in medicine and dentistry [2].

Specifically in dentistry, its use includes indirect application methods of this compound, including the gaseous ozone generator, ozonated water and ozonated oil [3]. These diversities of applications are being studied in several specialties such as: endodontics [4, 5, 6], restorative dentistry [2, 7, 8], oral medicine [9, 10, 11], surgery [12, 13, 14], periodontics [3, 15, 16], implantology [17, 18, 19], among others.

Although laboratory studies suggest a favorable potential for the use of ozone in dentistry, clinical evidence for its application in routine use as a treatment modality is still limited. Thus, well-designed studies are essential to respond to the efficacy and safety of this therapeutic modality [20].

In general, studies with the highest methodological rigor are published in journals with the greatest impact. Thus, bibliometric analyzes emerged to identify important articles that influence medical practice and are capable of boosting new research ideas [21]. These bibliometric methods allow evaluating the quality, credibility and impact of a study [22, 23] through citation analyzes that assess the performance of the research [24] and determine whether it has reached its goal in a given field of health research [25]. Consequently, they evaluate numerous publications from institutions in different countries [26].

In 2021, considering the PubMed database, more than three hundred bibliometric review articles were published in the health area, with the purpose of evaluating the top 100 articles cited in their areas of interest, and many were related to Dentistry [27]. In this same database, no results were found in a search for the MeSH descriptors 'Bibliometrics' AND 'ozone therapy' AND 'dentistry'. Therefore, a bibliometric study related to the use of ozone therapy in the area of dentistry can contribute to the scientific literature, as it serves to guide future research and publications by allowing researchers the possibility of detecting the progress of studies carried out in this area and deepening your knowledge.

Therefore, the objective of the present bibliometric analysis was to identify and classify the 100 most cited articles related to the clinical use of ozone in dentistry.

MATERIAL AND METHODS

The literature research was performed according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines in the Clarivate Analytics' Web of Science database, using a similar methodology described in a previous study [28], whose objective was to analyze the ranking of the 100 most cited articles involving orthognathic surgery and [27], whose objective was to analyze the ranking of the 100 most cited articles involving third molar surgery. As a review, this study is exempt from research ethics board approval.

Search strategy

A search was performed on October 10, 2022, using Clarivate Analytics' Web of Science database. A search was performed using terms “ozone” or “ozone therapy” or “ozonized” and “dentistry” or “dental” in the title and/or abstract. The results were extracted into a table in Microsoft Excel software, organized in descending order of citation count. The paired selection of manuscripts was performed by two researchers independently and previously calibrated.

To be included in this study sample, publications should cite ozone in the title and/or abstract. Publications that did not refer to the topic were excluded. There was no restriction regarding the year of publication, journal impact factor, study design or language of the manuscripts.

The most cited articles were manually stratified against the following information retrieved from the Clarivate Analytics Web of Science database: number of citations, year of publication, journals, keywords, authors, contributing institution, country and research field in dentistry. The country of origin and contributing institution of the article was defined by the address provided to the first corresponding author.

Number of articles and citations per article were graphed using the Statistical Package for the Social Sciences software (SPSS version 22.0). The relationship between the authors is determined based on the number of times they cite each other, using a network visualization made with the VOSviewer software (Leiden University, Netherlands).

RESULTS

The initial search identified 743 articles in the database. After matching titles and abstracts, the 100 most cited manuscripts involving ozone in dentistry are listed by classification order based on the number of citations in Table 1. The process of study selection including the search strategy used in database is summarized in a flow diagram (Figure 1).

Authors publications and citations

The number of authors ranged between one and 12 (mean 4.80±2.23). The authors and coauthors with the highest number of publications in the top 100, followed by the respective score, were Edward Lynch (8), Reinhard Hickel (5) and Hakki Oguz Kazancioglu (5). Figure 2 shows a graphical representation regarding the network between the authors.

The most article citations in the top 100 were by Fliefel R, 2015, with a total of 180 citations, Azarpazhooh A, 2008, with 158 occurrences and Baysan A, 2000, with 146 occurrences. The number of citations ranged between 13 and 180 (mean 38,56±33,06). Only 8 articles reached to 100 citations (Table 1).

The first manuscript in this bibliometric analysis was published in 1997 by Filippi A, in Ozone-Science & Engineering (OSE) and was cited 15 times, while the most recent was published in 2022 by Rapone B in International Journal of Environmental Research and Public Health (IJER) and was cited 33 times.

Figure 3 shows the correlation between the number of citations and the year of publication of the studies. The citation distribution line shows high peaks in the years 2008 and 2015, with higher citations added to the top 100 studies, with 436 and 413 respectively.

Institutions and countries

A total of 76 different international institutions are related to these studies. The University of Basel led the list, with 5 manuscripts published among the top 100 most cited; followed by Bezmialem Vakif University with 4 articles.

The studies originated from 30 different countries. The leading countries were Germany with 16 manuscripts, followed by Turkey with 15 articles, Italy with 12 articles, Switzerland with 11 manuscripts. England, Japan and USA contributed with eight manuscripts each among to the top 100 articles published (Figure 4 and 5).

Journals

The 100 most cited articles involving ozone in dentistry were published in 59 different journals. Clinical Oral Investigations (COI) lead of the rank, with 7 articles published, followed by American Journal of Dentistry (AJD) with 5 articles and European Journal of Oral Sciences (EJPS), Journal of Craniofacial Surgery (JCS), Journal of Endodontics (JE) and Lasers in Medical Science (LMS) with four articles (Figure 6).

Keywords

In total, 250 keywords were used. The five most used keywords in this list of top 100 articles were: ozone 50 (20%), dentistry 8 (3,2%), periodontitis 7 (2,8%), ozone therapy 6 (2,4%) and disinfection 5 (2%). The most used keyword was repeated in 50 studies, and the frequency of use of keywords ranged from one to fifty repetitions. Figure 7 shows a graphical representation in map form of the keywords.

Research Field

Figure 8 shows the fields of research addressed by the 100 most cited articles on ozone in dentistry, leading the ranks in the field of Oral and Maxillofacial Surgery (OMFS) and Operative Dentistry, both with 19 studies each, followed by Microbiology, with 18 studies.

Another important finding found in this bibliometric analysis was that 9 studies in the Top 100 evaluated ozone as an alternative treatment in medication-related osteonecrosis of the jaw (MRONJ).

Time-pattern of publications

Based on the distribution of 100 articles over the years, the years 2008 followed by 2009 and 2012 were the years with the highest concentration of publications and the most productive, with 12, 10 and 9 studies respectively (Figure 9).

DISCUSSION

This paper aims to carry out a bibliometric analysis of ozone therapy in dentistry. Once there has been considerable growth in scientific publications over time, bibliometric methods can guide researchers and clinicians in elucidating the most important factors to consider when deciding where to publish their work or where to search about a field. Thus, a list of top 100 most-cited articles on ozone therapy in dentistry was created with some graphic data visualization enabling researchers and academics a better understanding on the subject.

One of the important parameters in bibliometric analyzes is the total number of citations in which articles that reach more than 100 citations are classified as classics [25]. These studies with high citation rates can be seen as a favorable article in a field of interest, but the opposite does not indicate to be a work of poor quality [29] since, citation patterns vary greatly between types of publication, type of research, disciplines and will depend on its significance over time [26].

The two most cited articles, involving ozone in dentistry, had a systematic review as a study design, where the most cited study brought ozone as an adjuvant treatment available for osteonecrosis of the jaws related to bisphosphonates and its results [9] and the second most cited article, sought to systematically review the clinical application and potentials of ozone remineralization in dentistry [20]. The third most cited article had, as a study design, an in vitro assay, whose objective was to evaluate the antimicrobial effect of ozone from a new ozone-generating device in primary root caries lesions, evaluating the effectiveness of this compound specifically in Streptococcus mutans and Streptococcus sobrinus [2].

With regard to disciplines, OMFS and Operative Dentistry lead the ranking. The success obtained in decontaminating the environment, be it surgical or clinical, is one of the reasons that could explain this higher

number of citations. Ozone therapy has been consolidating as an extremely effective alternative therapy in difficult to manage situations such as medication-induced osteonecrosis of the jaws (MRONJ) [9, 30, 31, 32, 33, 34]. Other surgical procedures also benefit from ozone therapy such as third molar surgeries [13, 14], oral pathology [11], temporomandibular disorders [35], and dental implants [17, 18, 19, 36].

Caries decontamination are also another well succeeded procedure [7, 37, 38, 39, 40, 41, 42, 43] even root caries decontamination or as an endodontic solution irrigation [2, 4, 5, 6, 44, 45, 46, 47, 48, 49].

Bibliometrics offers a tool that can be readily scaled from the micro level (institution) to the macro level (countries) [26]. And in the present analysis, the diversified scenario in which the studies were produced is noticeable, consisting of more than 70 institutions, with emphasis on the University of Basel, and 30 different countries, with emphasis on Germany.

Ozone generation can be considered a cheap and effective method. Although majority of leading countries are high-income economies, Turkey, a middle-income country, stands out among the main research countries on the subject. The subject of ozone therapy is treated very seriously by researchers. This can be explained by the high impact factor of several journals present in the top 100 list, such as Clinical Oral Investigations [17, 50, 51, 52, 53, 54, 55] and Journal of Endodontics [47, 50, 56, 57]. International collaborations through an increased use of the Internet could considerably expand the number of publications on the topic. In addition to the knowledge that could be gained from the exchange of different researchers.

As stated in the literature, the use of suitable keywords is a cornerstone to an extensive article dissemination [28, 58]. The use of ozone keyword was performed only by half of the most-cited articles, together with involved area i.e dentistry or periodontitis. Ozone therapy, a common keyword is not listed in MeSH keywords. The authors suggest the use of MeSH keywords as a keyword standardization and widespread [59].

Finally, the application of ozone in dentistry and medicine has increased in recent years, due to its various beneficial properties already recognized [36], however, the bibliometric data of the present study, for the field of dentistry, showed that the years 2008, 2009 and 2012 showed the highest concentration of publications and were considered the most productive, and even when considering the number of citations there were two peaks in the years 2008 and 2015, where a large number of publications in the last 05 years was expected. The oldest article included in the analysis was published in 1997 [60] and the most recent was published in 2022 [7]. All interpretations generated by the study must take into account that the ranking of the 100 most cited articles on the use of ozone in dentistry represents the current scenario and, due to constant scientific change, future studies are necessary to carry out the updating of periodic reviews.

The main limitation related to the study is the search using only the Web of Science for our bibliometric analysis. There are other public and commercially available bibliometric databases, such as Medline, Embase, and Cochrane Library. However, Web of Science is widely used in bibliometric analysis because it has an established metric that allows for comparison of journal impact within disciplines: the Journal Citation Reports (JCR; Clarivate Analytics). In addition, there are many factors that affect citation rates like journal and author self-citations, incomplete citing, and the availability of the manuscript to the scientific community. Thus, the many journals dedicated to report ozone in dentistry does not prove high-quality research but shows at least a large and growing interest in this research topic.

CONCLUSIONS

This bibliometric analysis can lead us to conclude that: 1) Germany was the main country that contributed to field research on the use of ozone in dentistry 2) The University of Basel was the most productive university in the researched field; 3) Clinical Oral Investigations was the journal that led the ranking with the most articles published, 4) The keyword ozone was the most used in the articles; 5) Oral and maxillofacial surgery was the research area most addressed by the 100 most cited articles. The bibliometric list facilitates the location of studies on a specific topic, in addition to enabling the demonstration of trends in studies on the topic over the years. Thus, these results may provide some guidance to authors regarding where they may wish to consider submitting their research in ozone therapy in dentistry.

ABBREVIATIONS

AD: Annals of Dermatology; ADJ: Australian Dental Journal; AJD: American Journal of Dentistry; AMR: Archives of Medical Research; AMS: Advances in Medical Sciences; AO: Angle Orthodontist; ASB: Applied Sciences-Basel; B: Biomaterials; BF: Biofactors; BOH: Bmc Oral Health; BOR: Brazilian Oral Research; BRI: Biomed Research International; CA: Collegium Antropologicum; CDSR: Cochrane Database Of Systematic Reviews; COI: Clinical Oral Investigations; COIR: Clinical Oral Implants Research; CR: Caries Research; DM: Dental Materials; DMJ: Dental Materials Journal; DT: Dental Traumatology; EJPS: European Journal of Oral Sciences; HTA: Health Technology Assessment; IEJ: International Endodontic Journal; IJER: International Journal of Environmental Research and Public Health; IJOMI: International Journal of Oral & Maxillofacial Implants; IJOMS: International Journal of Oral and Maxillofacial Surgery; IJP: International Journal of Prosthodontics; IN: Interventional Neuroradiology; JAD: Journal of Adhesive Dentistry; JAOS: Journal of Applied Oral Science; JBO: Journal of Bone Oncology; JCPD: Journal of Clinical Pediatric Dentistry; JCS: Journal of Craniofacial Surgery; JD: Journal of Dentistry; JDR: Journal of Dental Research; JDS: Journal of Dental Sciences; JE: Journal of Endodontics; JERD: Journal of Esthetic And Restorative Dentistry; JFMA: Journal of the Formosan Medical Association; JP: Journal of Periodontology; JPIERD: Journal of Prosthodontics-Implant Esthetic and Reconstructive Dentistry; JPIS: Journal of Periodontal and Implant Science; JPR: Journal of Periodontal Research; JPRE: Journal of Pain Research; LMS: Lasers in Medical Science; LSM: Lasers in Surgery And Medicine; MGR: Medical Gas Research; MSE: Materials Science & Engineering C-Materials for Biological Applications; NM: New Microbiologica; O: Odontology; OMI: Oral Microbiology and Immunology; OO: Oral Oncology; OSE: Ozone-Science & Engineering; QUAD O: Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology; PLS: Photomedicine and Laser Surgery; PPT: Photodiagnosis and Photodynamic Therapy; QI: Quintessence International; SDJ: Swedish Dental Journal; SR: Scientific Reports; STAM: Science and Technology of Advanced Materials.

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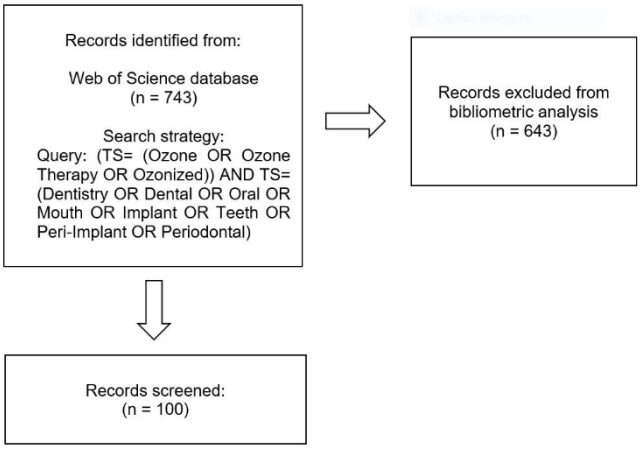

FIGURE 1. Flow diagram of the study selection process and search strategy.

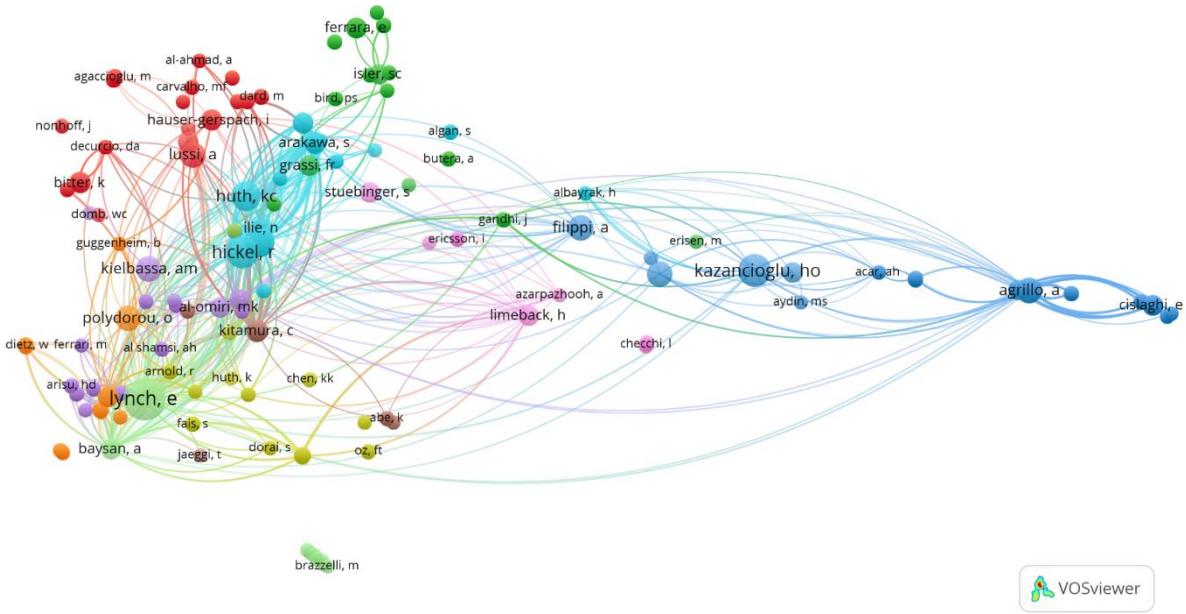

FIGURE 2. The network of authors and citations of the bibliographic research “ozone in dentistry”.

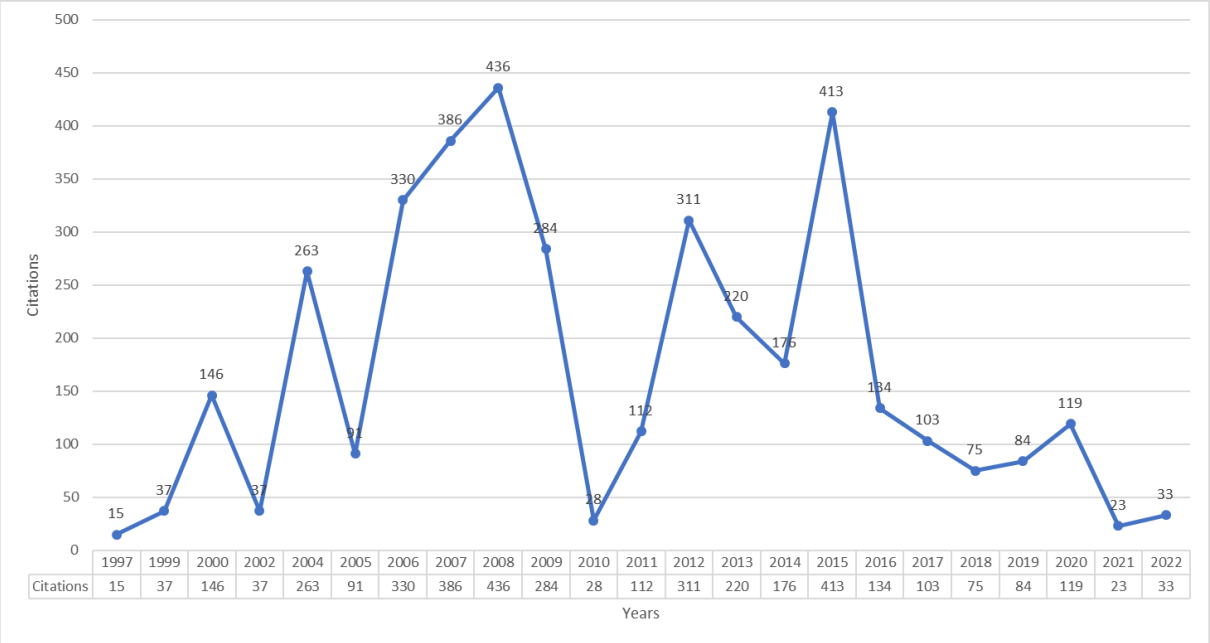

FIGURE 3. Correlation between the number of citations and the year of publication of the studies.

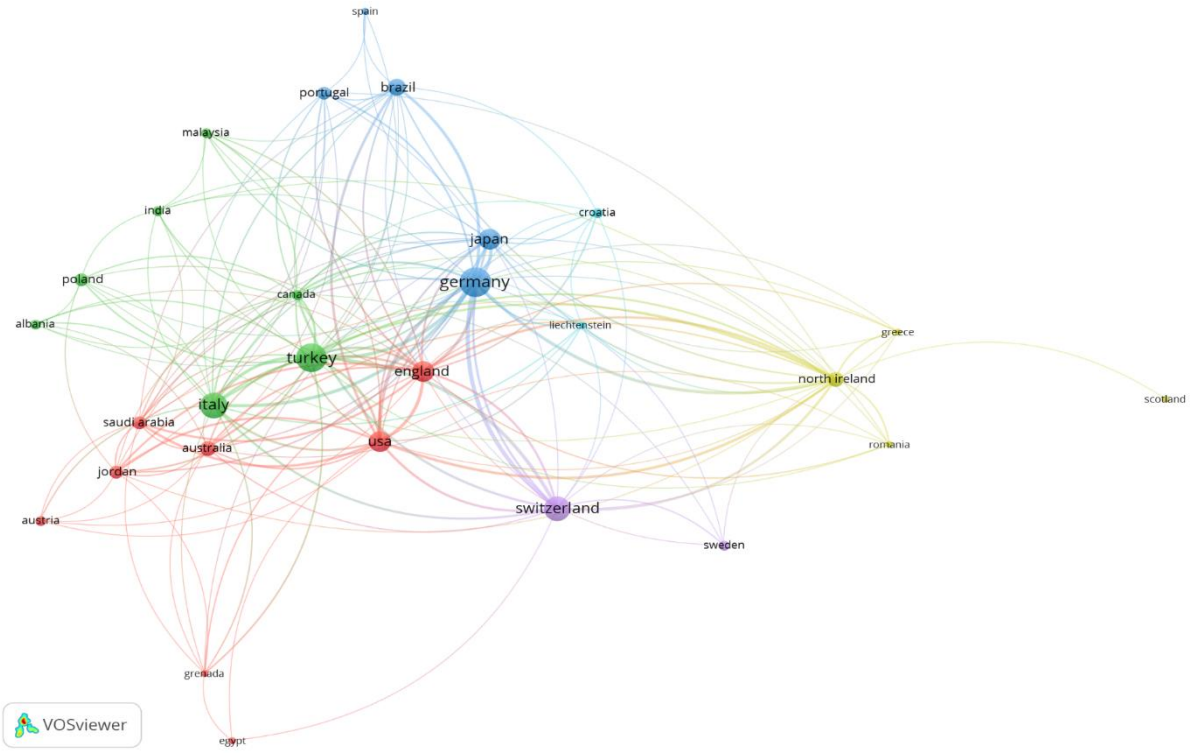

FIGURE 4. Network analysis of countries from “ozone in dentistry” bibliographic search. Circle sizes are related to countries and their number of publications.

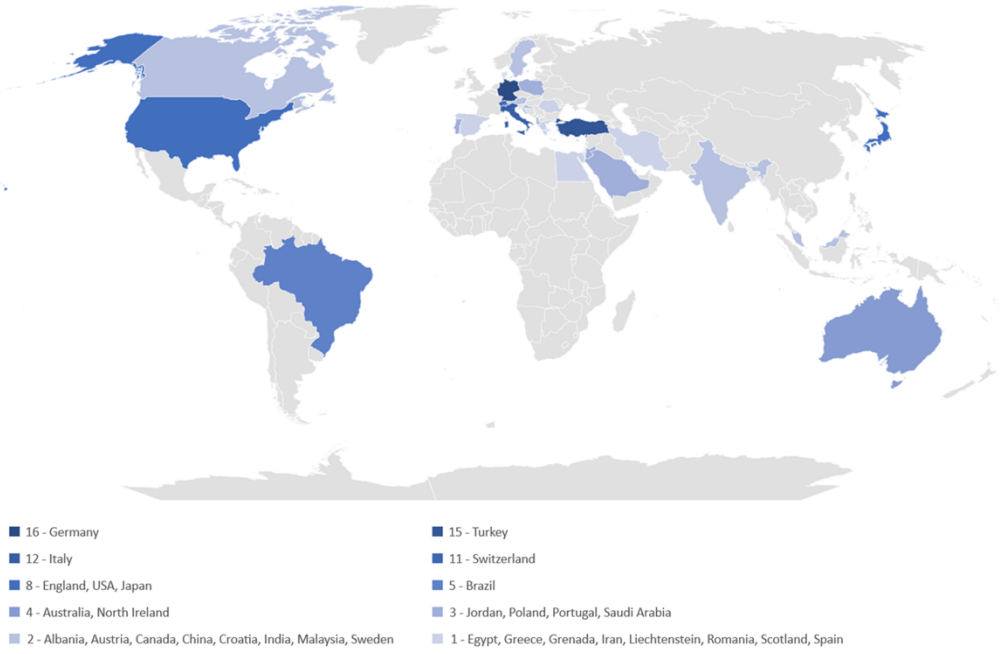

FIGURE 5. Countries of origin of top 100 articles.

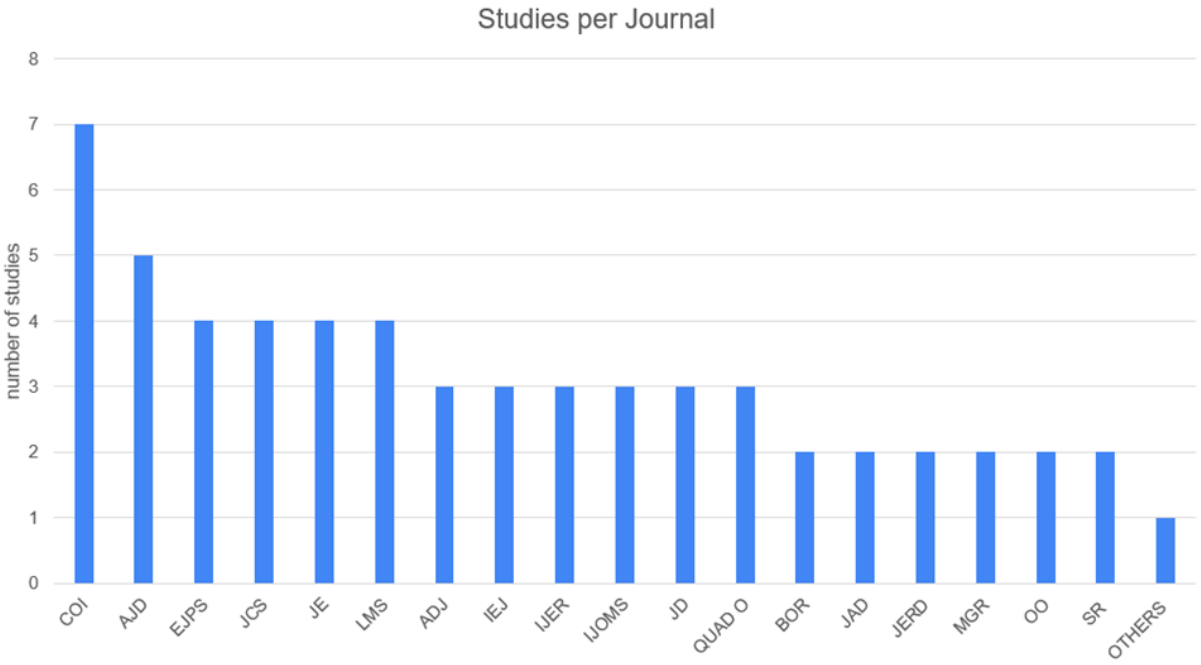

FIGURE 6. Most frequently cited journal.

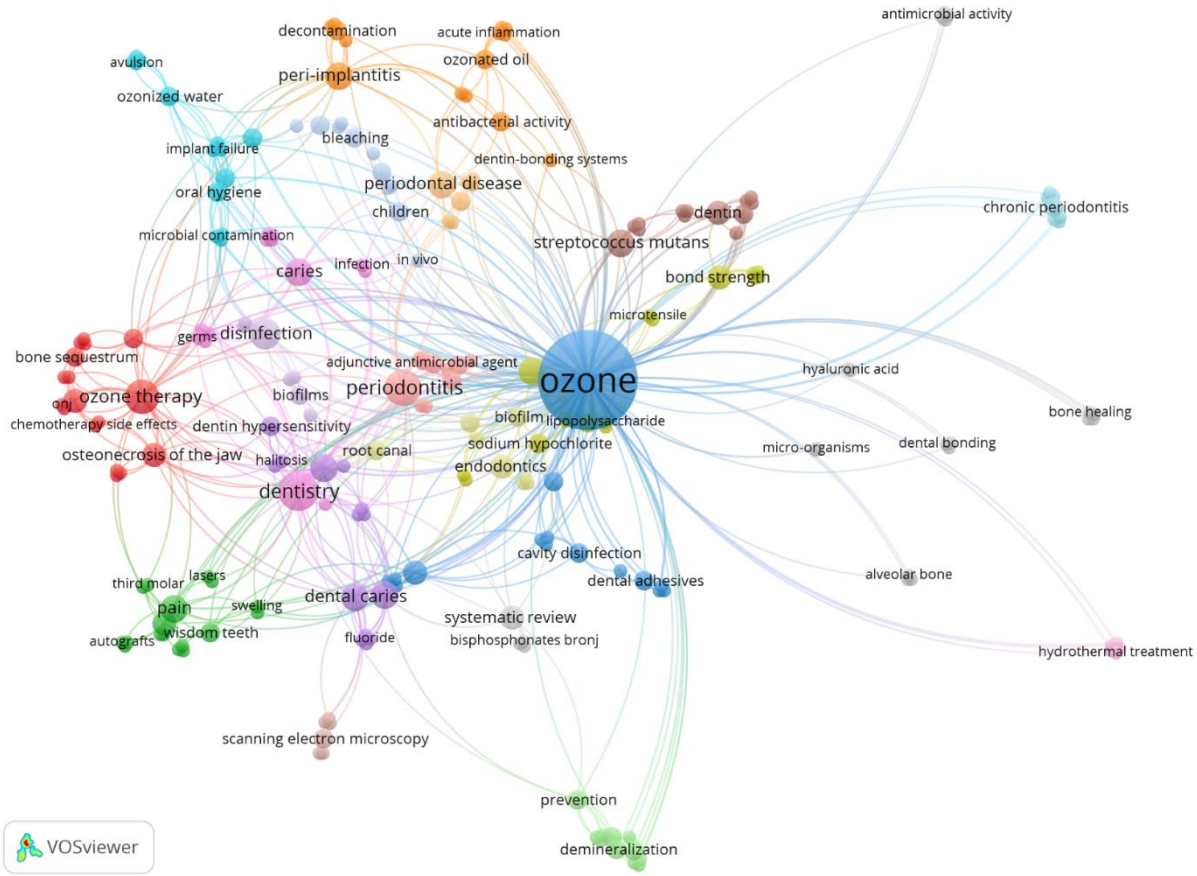

FIGURE 7. Network analysis of keywords from “ozone in dentistry” bibliographic search. Circle sizes are related to the number of citations for each keyword used.

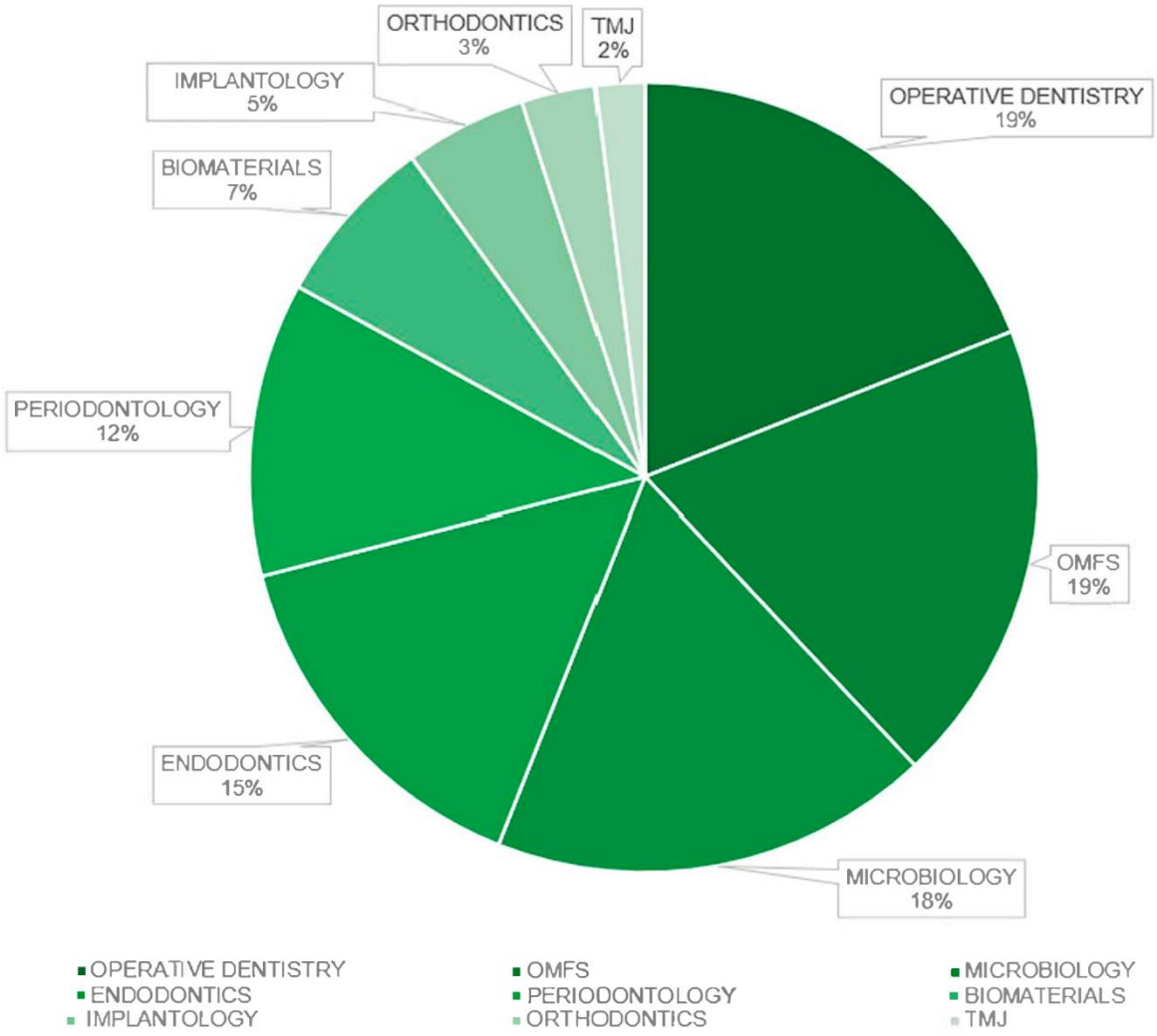

FIGURE 8. Top-100 ozone in dentistry - research fields of included studies.

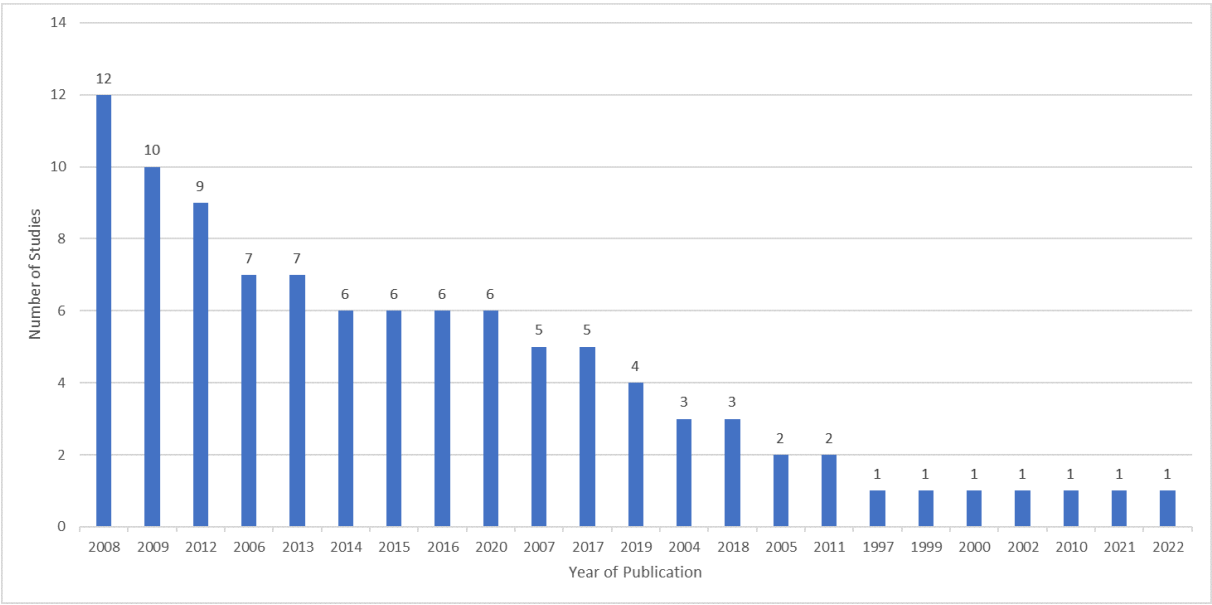

FIGURE 9. Time-pattern distribution of the 100 most-cited studies on ozone in dentistry over the years.

Table 1. The top 100 cited studies about ozone in dentistry

Rank	Author	Title	Publication year	Journal	Institution	Citations
1	Fliefel R et al	Treatment strategies and outcomes of bisphosphonate-related osteonecrosis of the jaw (BRONJ) with characterization of patients: a systematic review	2015	IJOMS	Universitat Munich	180
2	Azarpazhooh A, Limeback H	The application of ozone in dentistry: A systematic review of literature	2008	JD	University Toronto	158
3	Baysan A et al	Antimicrobial effect of a novel ozone-generating device on micro-organisms associated with primary root carious lesions in vitro	2000	CR	Royal London School of Medicine and Dentistry	146
4	Nagayoshi M et al	Efficacy of ozone on survival and permeability of oral microorganisms	2004	OMI	Kyushu Dental College	136
5	Muller P et al	Efficacy of gasiform ozone and photodynamic therapy on a multispecies oral biofilm in vitro	2007	EJPS	University of Zurich	113
6	Kuhl S et al	Bisphosphonate-related osteonecrosis of the jaws - A review	2012	OO	University of Basel	104
7	Wierichs R, Meyer-Lueckel H	Systematic Review on Noninvasive Treatment of Root Caries Lesions	2015	JDR	RWTH Aachen University	104
8	Huth KC et al	Effect of ozone on oral cells compared with established antimicrobials	2006	EJPS	Ludwig-Maximilians University	101
9	Estrela C et al	Antimicrobial efficacy of ozonated water, gaseous ozone, sodium hypochlorite and chlorhexidine in infected human root canals	2007	IEJ	Universidade Federal de Goiás	99
10	Baysan, A; Lynch, E	Effect of ozone on the oral microbiota and clinical severity of primary root caries	2004	AJD	University Birmingham	97
11	Foschi F et al	Photodynamic inactivation of Enterococcus faecalis in dental root canals in vitro	2007	LSM	The Forsyth Institute	97
12	Ripamonti CI et al	Efficacy and safety of medical ozone (O-3) delivered in oil suspension applications for the treatment of osteonecrosis of the jaw in patients with bone metastases treated with bisphosphonates: Preliminary results of a phase I-II study	2011	OO	National Cancer Institute of Milan	78

13	Huth KC et al	Effectiveness of ozone against endodontopathogenic microorganisms in a root canal biofilm model	2009	IEJ	Ludwig-Maximilians University	65
14	Polydorou O et al	Antibacterial effect of an ozone device and its comparison with two dentin-bonding systems	2006	EJPS	Albert-Ludwigs University Freiburg	59
15	Stubinger S et al	The use of ozone in dentistry and maxillofacial surgery: A review	2006	QI	University of Basel	59
16	Agrillo A et al	Ozone therapy in the treatment of avascular bisphosphonate-related jaw osteonecrosis	2007	JCS	University of Rome La Sapienza	56
17	Huth KC et al	Effect of ozone on non-cavitated fissure carious lesions in permanent molars. A controlled prospective clinical study	2005	AJD	University Munich	50
18	Kazancioglu HO et al	Comparison of the influence of ozone and laser therapies on pain, swelling, and trismus following impacted third-molar surgery	2014	LMS	Bezmialem Vakif University	49
19	Rapone B et al	The Effect of Gaseous Ozone Therapy in Conjunction with Periodontal Treatment on Glycated Hemoglobin Level in Subjects with Type 2 Diabetes Mellitus: An Unmasked Randomized Controlled Trial	2020	IJER	Aldo Moro University of Bari	46
20	Duangthip D et al	Non-surgical treatment of dentin caries in preschool children - systematic review	2015	BOH	University of Hong Kong	42
21	Cardoso MG et al	Effectiveness of ozonated water on Candida albicans, Enterococcus faecalis, and endotoxins in root canals	2008	QUADO	University of Taubaté	42
22	Hayakumo S et al	Clinical and microbiological effects of ozone nano-bubble water irrigation as an adjunct to mechanical subgingival debridement in periodontitis patients in a randomized controlled trial	2013	COI	Tokyo Medical and Dental University	41
23	Bitter K et al	Bond strength of fiber posts after the application of erbium: yttrium-aluminum-garnet laser treatment and gaseous ozone to the root canal	2008	JE	Charité-Universitätsmedizin Berlin	41
24	Polydorou O et al	The antibacterial effect of gas ozone after 2 months of in vitro evaluation	2012	COI	University Medical Center Freiburg	41
25	Agrillo A et al	New therapeutic protocol in the treatment of avascular necrosis of the jaws	2006	JCS	University of Rome La Sapienza	41

26	Case PD et al	Treatment of Root Canal Biofilms of Enterococcus faecalis with Ozone Gas and Passive Ultrasound Activation	2012	JE	The University of Queensland	41
27	Schmidlin PR et al	Effect of ozone on enamel and dentin bond strength	2005	JAD	University of Zurich	41
28	Kazancioglu HO et al	Effects of ozone therapy on pain, swelling, and trismus following third molar surgery	2014	IJOMS	Bezmialem Vakif University	39
29	Kazancioglu HO et al	Effects of Laser and Ozone Therapies on Bone Healing in the Calvarial Defects	2013	JCS	Bezmialem Vakif University	38
30	Hayakumo S et al	Effects of ozone nano-bubble water on periodontopathic bacteria and oral cells - in vitro studies	2014	STAM	Tokyo Medical and Dental University	37
31	Krozer A et al	Chemical treatment of machined titanium surfaces - An in vitro study	1999	COIR	Lund University	37
32	Al Habashneh R et al	Ozone as an adjunct to conventional nonsurgical therapy in chronic periodontitis: a randomized controlled clinical trial	2015	JPR	Jordan University of Science and Technology	37
33	Ebensberger U et al	PCNA-expression of cementoblasts and fibroblasts on the root surface after extraoral rinsing for decontamination	2002	DT	University of Basel	37
34	Ozgul BM et al	Clinical Evaluation of Desensitizing Treatment for Incisor Teeth Affected by Molar-Incisor Hypomineralization	2013	JCPD	Ankara University	36
35	Raeissadat SA et al	Intra-articular ozone or hyaluronic acid injection: Which one is superior in patients with knee osteoarthritis? A 6-month randomized clinical trial	2018	JPRE	Shahid Beheshti University	35
36	Cho H et al	Postoperative interventions to reduce inflammatory complications after third molar surgery: review of the current evidence	2017	ADJ	The University of Queensland	35
37	Kustarci A et al	Bactericidal effect of KTP laser irradiation against Enterococcus faecalis compared with gaseous ozone: an ex vivo study	2009	QUADO	Cumhuriyet University	34
38	Rollason V et al	Interventions for treating bisphosphonate-related osteonecrosis of the jaw (BRONJ)	2016	CDSR	Geneva University Hospitals	34
39	Yilmaz S et al	Evaluation of the Clinical and Antimicrobial Effects of the Er:YAG Laser or Topical Gaseous Ozone as Adjuncts to Initial Periodontal Therapy	2013	PLS	Yeditepe University	34

40	Kronenberg O et al	Preventive Effect of Ozone on the Development of White Spot Lesions during Multibracket Appliance Therapy	2009	AO	University of Bern	34
41	Huth KC et al	Effectiveness of ozone against periodontal pathogenic microorganisms	2011	EJPS	Ludwig-Maximilians University	34
42	Rapone B et al	The Gaseous Ozone Therapy as a Promising Antiseptic Adjuvant of Periodontal Treatment: A Randomized Controlled Clinical Trial	2022	IJER	Aldo Moro University of Bari	33
43	Dahnhardt JE et al	Treating open carious lesions in anxious children with ozone. A prospective controlled clinical study	2006	AJD	University of Bern	33
44	Hauser-Gerspach I et al	Influence of gaseous ozone in peri-implantitis: bactericidal efficacy and cellular response. An in vitro study using titanium and zirconia	2012	COI	University of Basel	32
45	Shi XL et al	Partial oxidation of TiN coating by hydrothermal treatment and ozone treatment to improve its osteoconductivity	2016	MSE	Jiangsu University of Science and Technology	31
46	Chidambaranathan AS et al	Comprehensive Review and Comparison of the Disinfection Techniques Currently Available in the Literature	2019	JPIERD	SRM Dental College	30
47	Matsumura,K et al	Surface modification of poly(ethylene-co-vinyl alcohol): hydroxyapatite immobilization and control of periodontal ligament cells differentiation	2004	B	Kyoto University	30
48	Bezirtzoglou E et al	A quantitative approach to the effectiveness of ozone against microbiota organisms colonizing toothbrushes	2008	JD	Democritus University of Thrace	30
49	Manton DJ et al	Effect of ozone and Tooth Mousse (TM) on the efficacy of peroxide bleaching	2008	ADJ	The University of Melbourne	30
50	Magni E et al	Effect of ozone gas application on the mechanical properties of dental adhesives bonded to dentin	2008	DM	University of Siena	29
51	Montevecchi M et al	Comparison of the antibacterial activity of an ozonated oil with chlorhexidine digluconate and povidone-iodine. A disk diffusion test	2013	NM	University of Bologna	29
52	Kazancioglu HO, Erisen M	Comparison of Low-Level Laser Therapy versus Ozone Therapy in the Treatment of Oral Lichen Planus	2015	AD	Bezmialem Vakif University	28

53	Azarpazhoob A et al	Evaluating the Effect of an Ozone Delivery System on the Reversal of Dentin Hypersensitivity: A Randomized, Double-blinded Clinical Trial	2009	JE	University of Toronto	28
54	Skurska A et al	Evaluation of the influence of ozonotherapy on the clinical parameters and MMP levels in patients with chronic and aggressive periodontitis	2010	AMS	Medical University of Bialystok	28
55	Hauser-Gerspach I et al	Comparison of the immediate effects of gaseous ozone and chlorhexidine gel on bacteria in cavitated carious lesions in children in vivo	2009	COI	University of Basel	25
56	Suh Y et al	Clinical utility of ozone therapy in dental and oral medicine	2019	MGR	Stony Brook University Renaissance School of Medicine	25
57	Noguchi F et al	Ozonated Water Improves Lipopolysaccharide-induced Responses of an Odontoblast-like Cell Line	2009	JE	Kyushu Dental College	24
58	McKenna DF et al	The Effect of Subgingival Ozone and/or Hydrogen Peroxide on the Development of Peri-implant Mucositis: A Double-Blind Randomized Controlled Trial	2013	IJOMI	University of Warwick	24
59	Cadenaro M et al	Enamel and Dentin Bond Strength Following Gaseous Ozone Application	2009	JAD	University of Trieste	24
60	Butera A et al	Ozonized Water Administration in Peri-Implant Mucositis Sites: A Randomized Clinical Trial	2021	ASB	University of Pavia	23
61	Tasdemir Z et al	Effects of Ozone Therapy on the Early Healing Period of Deepithelialized Gingival Grafts: A Randomized Placebo-Controlled Clinical Trial	2016	JP	Erciyes University	23
62	Al-Omiri MK et al	Randomized controlled clinical trial on bleaching sensitivity and whitening efficacy of hydrogen peroxide versus combinations of hydrogen peroxide and ozone	2018	SR	University of Jordan	22
63	Almaz ME, Sonmez IS	Ozone therapy in the management and prevention of caries	2015	JFMA	Kırıkkale University	22
64	Knight GM et al	The inability of Streptococcus mutans and Lactobacillus acidophilus to form a biofilm in vitro on dentine pretreated with ozone	2008	ADJ	The University of Adelaide	22
65	Sadatullah S et al	The antimicrobial effect of 0.1 ppm ozonated water on 24-hour plaque microorganisms in situ	2012	BOR	King Khalid University	21
66	Agrillo A et al	Ozone therapy in extractive surgery on patients treated with bisphosphonates	2007	JCS	University of Rome La Sapienza	21

67	Lynch E, Swift EJ	EVIDENCE-BASED EFFICACY OF OZONE FOR ROOT CANAL IRRIGATION	2008	JERD	Queen's University	20
68	Daif ET	Role of intra-articular ozone gas injection in the management of internal derangement of the temporomandibular joint	2012	QUADO	Cairo University	20
69	Samuel SR et al	Effect of ozone to remineralize initial enamel caries: in situ study	2016	COI	Thai Moogambigai Dental College	19
70	Brazzelli M et al	Systematic review of the effectiveness and cost-effectiveness of HealOzone for the treatment of occlusal pit/fissure caries and root caries	2006	HTA	University of Aberdeen	19
71	Bayer S et al	Comparison of laser and ozone treatments on oral mucositis in an experimental model	2017	LMS	Bezmialem Vakif University	18
72	Pires PT et al	Effect of ozone gas on the shear bond strength to enamel	2013	JAOS	University of Porto	18
73	Dalkilic EE et al	Effect of different disinfectant methods on the initial microtensile bond strength of a self-etch adhesive to dentin	2012	LMS	Yuzuncu Yil University	18
74	Swift, EJ	Evidence-based caries reversal using ozone	2008	JERD	Queen's University	18
75	Isler SC et al	The effects of ozone therapy as an adjunct to the surgical treatment of peri-implantitis	2018	JPIS	Gazi University	18
76	Tasaki T et al	Plasma-treated water eliminates Streptococcus mutans in infected dentin model	2017	DMJ	Tsurumi University School of Dental Medicine	18
77	Noites R et al	Synergistic Antimicrobial Action of Chlorhexidine and Ozone in Endodontic Treatment	2014	BRI	Catholic University of Portugal	18
78	Ripamonti CI et al	Efficacy and tolerability of medical ozone gas insufflations in patients with osteonecrosis of the jaw treated with bisphosphonates-Preliminary data Medical ozone gas insufflation in treating ONJ lesions	2012	JBO	Istituto Nazionale dei Tumori	18
79	Grootveld M et al	High resolution H-1 NMR investigations of the oxidative consumption of salivary biomolecules by ozone: Relevance to the therapeutic applications of this agent in clinical dentistry	2006	BF	London South Bank University	18
80	Dukic W et al	The Influence of Healozone on Microleakage and Fissure Penetration of Different Sealing Materials	2009	CA	University of Zagreb	17
81	Anzolin AP et al	Ozonated oil in wound healing: what has already been proven?	2020	MGR	Universidade de Passo Fundo	17

82	Ximenes M et al	Antimicrobial activity of ozone and NaF-chlorhexidine on early childhood caries	2017	BOR	Universidade Federal de Santa Catarina	17
83	Noetzel J et al	Efficacy of calcium hydroxide, Er:YAG laser or gaseous ozone against Enterococcus faecalis in root canals	2009	AJD	Charité-Universitätsmedizin Berlin	17
84	Domb WC	Ozone Therapy in Dentistry A Brief Review for Physicians	2014	IN	Inland Institute of Aesthetic Dentistry	17
85	Erdemci F et al	Histomorphometric evaluation of the effect of systemic and topical ozone on alveolar bone healing following tooth extraction in rats	2014	IJOMS	Akdeniz University	16
86	Loncar B et al	Ozone Application in Dentistry	2009	AMR	University Zagreb	16
87	Al Shamsi AH et al	The effects of ozone gas application on shear bond strength of orthodontic brackets to enamel	2008	AJD	Queen’s University	16
88	Eick S et al	Effect of ozone on periodontopathogenic species-an in vitro study	2012	COI	University of Bern	16
89	Grocholewicz K et al	Effect of nano-hydroxyapatite and ozone on approximal initial caries: a randomized clinical trial	2020	SR	Pomeranian Medical University	15
90	Matys J et al	Effect of ozone and diode laser (635 nm) in reducing orthodontic pain in the maxillary arch-a randomized clinical controlled trial	2020	LMS	Medical University	15
91	Egusa H et al	Clinical Evaluation of the Efficacy of Removing Microorganisms to Disinfect Patient-Derived Dental Impressions	2008	IJP	Osaka University Graduate School of Dentistry	15
92	Filippi, A	Ozone in oral surgery - Current status and prospects	1997	OSE	Justus-Liebig-Universität Gießen	15
93	Camacho-Alonso, F et al	Effects of photodynamic therapy, 2 % chlorhexidine, triantibiotic mixture, propolis and ozone on root canals experimentally infected with Enterococcus faecalis: an in vitro study	2017	O	University of Murcia	15
94	Fagrell TG et al	Effect of ozone treatment on different cariogenic microorganisms in vitro	2008	SDJ	University of Gothenburg	15
95	Uraz A et al	Ozone application as adjunctive therapy in chronic periodontitis: Clinical, microbiological and biochemical aspects	2019	JDS	Gazi University	15

96	Bal FA et al	Effects of photodynamic therapy with indocyanine green on Streptococcus mutans biofilm	2019	PPT	Abant Izzet Baysal University	14
97	Al-Omiri MK et al	Improved tooth bleaching combining ozone and hydrogen peroxide-A blinded study	2016	JD	The University of Jordan	14
98	Nardi G et al	Mouthwash Based on Ozonated Olive Oil in Caries Prevention: A Preliminary In-Vitro Study	2020	IJER	Sapienza University of Rome	13
99	Silva E et al	The effect of ozone therapy in root canal disinfection: a systematic review	2020	IEJ	Universidade Grande Rio	13
100	Boch T et al	Effect of gaseous ozone on Enterococcus faecalis biofilm-an in vitro study	2016	COI	University Medical Center Freiburg	13