

## Original paper

# Ozone therapy in Dentistry - Where we are and where we are going to?

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## Abstract

There has been very little research to support clinical practices in dental ozone therapies. The protocols used in dental ozone therapy should fulfill the general guidelines and requirements commonly recognized by healthcare professionals and authorities as evidence-based medicine. To meet these criteria, both ozone dental research and the clinical practice of dentistry should converge. The positive results and advantages of dental ozone therapy should define standard parameters that the dental ozone equipment manufacturers need to follow to develop ozone systems that meet the requirements of both dentists and researchers.

The aim of this paper is to review the available published research and to compare it to what the majority of practicing dentists are applying in their practice. Four databases (PubMed; Ovid Medline; Cochrane; ISCO3) were used to search for articles covering the use of ozone in dentistry. Using the key words “ozone in dentistry” on PubMed (last accessed November 2017) retrieved 295 articles. Articles not related to dental ozone and general reviews were excluded (70). The resulting sample size of 225 articles, as well as the retrieved analysis results, are highly indicative to be able to draw conclusions and to formulate future recommendations.

To our knowledge, this is the first attempt to perform such an analysis. It is not the aim of this paper to critique the published research or the clinical practice of dental ozone therapy. The aim is to elicit the required modifications to research protocols and to evaluate whether dental ozone manufacturers provide the required equipment.

This review study used different groupings to evaluate the results. In the “ozone gas only group”, a clear deviation between research and clinical practice was noted. In all the other groups, the results were, in general, more congruent. Most of the current dental ozone research has focused on the antimicrobial effects of ozone, using either just ozone gas only, ozonated water only or ozonated oils only.

It is highly recommended that dental ozone research change its path. Clinicians have expectations that research will support their clinical uses of ozone. We need to meet the expectations of clinicians through adopting new and different studies. We need to create research that goes past the conventional and well-studied antimicrobial potential of ozone and by using ozone both in gas and water, not separately, plus ozonated oils when applicable...

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## 1. Introduction

Since the early pioneering days of the Swiss dentist Dr. E Fisch (1899-1966), ozone application in dentistry has evolved and now is being used by a growing number of dentists worldwide.

Due to the high disinfection and oxidation properties of ozone, scientists studied the use of ozone in various applications, mainly in water treatment, where the bulk of the fundamental ozone science as we know it today emerged. The promising results from the use of ozone in water treatment encouraged the expansion of its use to other applications, e.g. air and surface treatments, which are more relevant to healthcare and medical professionals.

In parallel to the use of ozone in industry in the early twentieth century, scientists and physicians also introduced the use of ozone in medical and dental applications. It was not until the last two decades of the 20th century that researchers studied the biological effects of ozone more in depth. Then, the clinical guidelines became more relevant and precise. This better understanding of ozone reactions and its biological effects led clinicians and researchers to re-study its use in dental medicine as well.

During this period, several national and international medical ozone associations were formed, the International Scientific Committee of Ozone therapy (ISCO3) was established, and a multitude of scientific congresses and courses were held. Ozone therapy is now legally practiced in several countries around the world. ISCO3 published the "Madrid Declaration on Ozone Therapy"<sup>1</sup> which is considered an international reference for both clinicians and legal authorities.

Even though there has been a steady increase of healthcare professionals using ozone, ozone therapy has not yet reached the point where it is considered a mainstream treatment modality. Consequently, it is not reimbursed by social security programs or by private insurance companies. Two large issues that pose major obstacles to ozone therapy advancement are the shortage of public research funds and the reticence of pharmaceutical companies to invest in non-patentable modalities. However, some of the many indications of ozone therapy are now classified as evidence-based medicine. Some high quality published clinical trials, meta-analyses, and the gathered clinical experience have proved ozone's efficacy in certain medical applications.<sup>1-5</sup>

With the collaborative contribution and coordination of both research and clinical practice, the well-studied medical indications of ozone have reached the level of evidence-based science. Very clear guidelines and protocols were established and are constantly updated with new scientifically supported findings.

Dental ozone therapy constitutes the number one topical administration in medicine. Research and clinical applications in medical ozone therapy can be a reference to follow for dental

research and its applications.

Even though there are published general reviews of available literature with conflicting findings and recommendations, there is a need to examine whether dentists are following the research methodology and if the protocols used are similar. There is also a need to evaluate the technical specifications of commercially available dental ozone systems. Such comparative analyses have not been carried out yet. We believe that the findings of these analyses will aid in highlighting any potential deviation that may exist between research and clinical practice and help direct future research. It is not within the objectives of this paper to evaluate or critique published literature, nor to assess the suitability of the protocols used by practicing dentists. The goals are both to reach a synergistic and common path in dental ozone therapy leading to evidence-based medicine as well as to provide standard requirements for the manufacture of ozone generators to meet the needs of dental practice. This would set more definitive guidelines to apply in general dental practices.

## **2. Material and Method**

### **2.1 Dental ozone published articles: Data collection**

Four databases (PubMed; Ovid Medline; Cochrane; ISCO3) were used to search for articles covering the use of ozone in dentistry. Using the key words “ozone in dentistry” on PubMed (last accessed November 2017) retrieved 295 articles, some of which were not related to dental ozone uses. In addition, selected unpublished articles collected over the years from scientific ozone meetings were also used in this study. In total, 225 articles were included. This sample size of 225 articles, as well as the retrieved analysis results, are highly indicative to be able to develop conclusions and future recommendations as needed.

All 225 articles were used in this comparative analysis, irrespective of ozone form (gas, ozonated water or ozonated oil) or fields of application (in vitro, pre-clinical and clinical studies) were all included. Whenever possible, full text articles were retrieved. Otherwise abstracts were used – Included in Table 1.

As mentioned earlier, the aim is not to critique the studies, but to look at the “Materials and Methods” and the applied ozone parameters and compare them to those applied by the dentists in their practice. Percent of results (G/S Good/Significant, G/NS Good/non-significant, NS non-significant) was stabilized as criterion of clinical efficiency.

Table 1. Frequency distribution of articles by group classification pre-clinical- in vitro-clinical.

Group	Number of Articles	Type of article		Stage of the investigation		
		Abstracts	Full Text	<i>In vitro</i>	Pre-clinical	<i>Clinical trials</i>
I. O <sub>3</sub> Gas	118	59	59	72	39	7
II. O <sub>3</sub> Water	53	10	43	39	11	3
III. O <sub>3</sub> Oil	30	8	22	10	15	5
IV. O <sub>3</sub> Gas-Water	14	3	11	9	4	1
V. O <sub>3</sub> Topical-Systemic	6	2	4	-	3	3
VI. O <sub>3</sub> Injection	4	-	4	-	3	1
<b>TOTAL</b>	<b>225</b>	<b>82</b>	<b>143</b>	<b>130</b>	<b>20</b>	<b>75</b>

Sidebar I. Classification of articles.

Group	Ozone mode of application
I. Ozone Gas	Ozone gas only was used in the research
II. Ozonated Water	Ozonated water only was used in the research
III. Ozonated Oil	Ozonated oil only was used in the research
IV. Ozone Gas-Water	Combined or Separate administration of ozone gas and ozonated water were used, plus ozonated oil when applicable
V. Ozone Topical-Systemic	Topical and/or Systemic ozone administration was used
VI. Ozone Injection	Ozone gas and/or ozonated water was injected sub-cutaneous or intra-articular

**Classification of articles** – Appendix: Reviewed Articles List. Articles were classified into six groups as listed in sidebar I.

## 2.2 Retrieved Data

Articles from each classification group were categorized according to different criteria: 1) country and period of research (Table 2), 2) field of research i.e. caries, periodontics, endodontic, soft tissue lesions, etc. (Table 3), 3) Ozone equipment/generator and technical specifications (Table 4).

Table 2. Classification of manuscript according to: County and period of research.

Country	1985 2004	2005 2010	2011 2015	2016 2017	N
Turkey	-	4	28	13	45
U.K.	20	4	3	1	28
Germany	7	6	3	3	19
Egypt	1	3	9	4	17
Brazil	-	3	9	4	16
Italy	2	7	3	2	14
India	-	1	9	4	14
Japan	7	5	2	-	14
Switzerland	1	6	2	-	9
Cuba	-	5	2	-	7
Sweden	1	2	2	1	6
Other countries	<i>Countries with less than 5 articles</i>				36

Legend: N, total number of manuscripts. Total number of revised manuscript was 225.

Table 3. Classification of manuscript according to: Fields of research.

Field	N	%
Caries	46	20.5
Materials	36	16
Endodontic	34	15
Surgery	29	12.5
General	34	14.5
Periodontics	17	7.5
Soft Tissue Lesions	8	3.5
Dental unit water lines (DUWL)	4	1.7
Temporomandibular joint (TMJ)	6	2.5
Whitening	4	2
Orthodontics	3	1.8
Cytotoxicity	4	1.8

Legend: N, total number of manuscripts. Total number of revised manuscript was 225.

Table 4. Frequency distribution of articles by ozone generators and specifications.

Generator	N	%	O <sub>3</sub> (µg/mL)	O <sub>2</sub>	Flow Rate
Healozone	75	65	4.2	Ambient air	650 mL/min
Ozonytron	18	14.5	Unclear	Air/Pure O <sub>2</sub>	Unclear
Prozone	12	10.5	0.2	Ambient air	2 L/min
Others	13	11	Not specified		

Table 5. Frequency and relative frequency distribution of articles by field of research and results.

Field	N	Results (%) *		
		G/S	G/NS	NS
Caries	46	71	29	
Materials	36	86	14	
Endodontic	34	77	23	
Surgery	29	89	11	
Periodontics	17	75	25	
Soft tissue lesions (STL)	8	88	12	
Temporomandibular Joint (TMJ)	6	100	-	
Dental unit water lines (DUWL)	4	100	-	
Whitening	4	50	50	
Orthodontics	3	67	33	
General	38			
<b>Total</b>	<b>225</b>	<b>77</b>	<b>23</b>	

Legend: N, total number of manuscripts. \* Percent of Results: G/S Good/Significant, G/NS Good/non-significant, NS non-significant.

### **Clinical Expertise:** Dental professionals' Ozone Clinical protocols – Parameters

Due to logistical and time constraints, the collection of clinical protocols and fields of application of ozone therapy applied by the majority of worldwide dental professionals was limited to direct contacts with individual dentists, associations, educators and trainers. Information pertaining to ozone concentration, oxygen source and modes of application were gathered in order to draw a general guideline that is mostly followed by the dental professionals.

The majority of dentists use ozone gas and water (mostly combined), few others use ozonated water only. The following are the reported concentrations used:

- i. Ozone gas: Concentration 10-100 µg/mL. Flow rate: 30-1 000 mL/min. Application time: 30 s to 5 min.
- ii. Ozonated water: Concentration 4-20 µg/mL; Volume: Unclear.
- iii. Ozonated oils peroxide value (PV): Unclear.

### 3. Results

#### 3.1. Group Gas only

Table 6. Frequency and relative frequency distribution of articles by country, year of publication, results and type of ozone gas generator

Country	1999 2004	2005 2010	2011 2015	2016 2017	N 118	%	Results (%) <sup>1</sup>			Generator <sup>2</sup>		
							G/S	G/N S	N S	H	Oz	P
1. Turkey	-	4	20	8	32	26.5	69	31		9	13	4
2. U.K.	20	2	3	1	26	22.5	92.5	7.5		26		
3. Germany	1	4	1	3	9	7.5	44.5	55.5		8		
4. Italy	-	4	1	2	7	6	71.5	28.5		3	1	
5. Sweden	1	2	2	1	6	5	66.5	33.5		4		1
6. Switzerland	-	5	1	-	6	5	20	80		5		1
7. Brazil	-	-	1	3	4	3.5	25	75			1	
8. Egypt	1	-	2	-	3	2.5	66.5	33.5		2	1	
9. Australia	-	2	1	-	3	2.5	33.5	66.5		2		1
10. Croatia	-	2	1	-	3	2.5	100	-		3		
11. Portugal	-	-	3	-	3	2.5	100	-		1		2
12. U.A.E.	-	2	-	-	2	1.5	100	-		2		
<b>Total</b>	<b>23</b>	<b>27</b>	<b>36</b>	<b>18</b>	<b>104</b>		<b>67%</b>	<b>33%</b>		<b>74*</b>	<b>17*</b>	<b>12*</b>
<i>Not listed: countries with 1 article only (14 manuscript)</i>							-	-		65%	15%	10%

Legend: N, total number of manuscripts 118 (include 14 manuscripts of the non-listed countries) 1) G/S Good/Significant, G/NS Good/non-significant, -NS non-significant. 2) Type of generator: **H**: Healozone; **Oz**: Ozonytron; **P**: Prozone. U.K., United Kingdom; U.A.E., United Arab Emirates, \* Including the not listed article.

##### 3.1.1 Generators used in group Gas only

1. The Healozone<sup>6</sup> generator was used in 65% of the ozone gas only studies - Table 6. For safety reasons, this system generates ozone gas only when a hermetic seal of the treatment area is achieved by using a silicone cap on the delivery handpiece. It generates ozone gas from dry ambient air at a fixed concentration of ~4.2 µg/mL and ~650 mL/min flow rate. The application time varied from 10 s to 180 s yielding a total dose of (0.06 – 8.20) mg ozone gas. In 57/74 studies (77%) good/significant results were noted, whereas the remaining 23% revealed a combined good/non-significant and non-significant results.

Only one *in vivo* study, which showed good/significant results, used a second version of the Healozone which generates ozone gas from dry ambient air as the first version) or from pure oxygen at a fixed concentration of 32 µg/mL. Application time was 120 s yielding a total ozone dose of ~128 mg.



2. *The Ozonytron*<sup>7</sup> was used in 15% of the ozone gas only studies – Table 6. This system generates a plasma phase, including ozone, from the air surrounding the treatment area via an electro-magnetic field. Other models generate ozone from pure oxygen. According to the technical specifications from the manufacturer’s website, as well as the ozone concentration values and measurement units, it is difficult to specify with accuracy the ozone concentration that can be achieved with these units. The claimed ozone gas concentration values, in our opinion, are either exaggerated or misrepresented, a fact confirmed by the following concentration values as indicated in the manufacturer’s website:

“Ozone concentration when using the ozone injector:

- *Flowing in with 1 L/min*
- *Using atmospheric oxygen: 800 ppm to 22 000 ppm*
- *Using 99.5 % medically pure oxygen from the gas bottle: 3 000 bis 100 000 ppm – (6 – 200) g/L*

Converting ppm into µg/mL (refer to sidebar 2), it is clear that there is a misrepresentation of the ozone concentration and the measurement units used.

#### Sidebar II

Converting ppm into µg/mL

800 ppm to 22 000 ppm is equal to about 1.6 µg/mL – 44 µg/mL.

3 000 ppm to 100 000 ppm is about 6 µg/mL – 200 µg/mL.

6 – 200 g/L is equal to 6 000 – 200 000 µg/mL.

The majority of the articles citing the use of the ozone injector, the Ozonytron, the ozone concentration could not be easily interpreted as the authors reported it in general terms such as “According to the manufacturer’s instructions”, “The system was operated at 5N intensity in accordance with the manufacturer’s instructions”, “O<sub>3</sub> was delivered at 100 % for 40 s with peristaltic motions, as recommended by the manufacturer”, “Gas Topical application. Activated oxygen ozone) concentration of 30 %”, or “In accordance with the manufacturer’s instructions, at 100% volume for 40 s”.

Of the 17 studies, 65% showed good/significant results and 35% combined good/non-significant and non-significant results.

3. *The Prozone*<sup>8</sup> was used in 10% of the ozone gas only studies – Table 6. This system generates ozone from ambient air at a fixed ozone concentration of ~0.25 µg/mL and 2 L/min flow rate. Time of application varied between 6 s and 240 s yielding a total applied ozone dose of 0.08 mg – 2 mg. Of the 12 studies, 50% showed good/significant results and 50% combined good/non-significant and non-significant results.

By comparison to medical ozone generators where only pure oxygen is used to generate ozone gas, these dental systems operate on ambient air and produce low ozone concentrations. A reason why most of the research authors used these models is that they are CE medical device certified, which is a prerequisite in the European Union where the vast majority of research was conducted.

This discrepancy between medical and dental ozone systems is unclear. It’s highly recommended that dental ozone manufacturers follow the technical specifications commonly used in medical ozone systems which reference pure oxygen sources and a large spectrum of ozone gas concentrations.

**Summary of ozone parameters used in group gas only between research and clinicians:**

Group O <sub>3</sub> gas only	Research	Dentists	Results %		
			G/S	G/NS	NS
Concentration (µg/mL)	0.2 – 4.2	10 - 100	67	33	
Oxygen source	Ambient air	Pure oxygen	-	-	-
Dose (mg)	0.06 – 8.2	3 - 120	-	-	-

Legend: Results: G/S, Good/Significant; G/NS, Good/non-significant; NS, non-significant.

A clear divergence is evident between “ozone gas only” research studies and clinicians reference oxygen source and ozone concentrations. It is noteworthy to mention that dentists follow the same specifications and parameters as used by medical doctors in topical applications, which is also well reflected in medical research covering this particular field of application. Whereas the dental research in “ozone gas only” is somehow following a different path.

It is with hope that future dental ozone studies take into consideration this finding. We would also hope that authors consider following the same guidelines, specifications and parameters as used in medical topical applications. We suspect that the negative results (33%) would be vastly improved. It is also anticipated that dental ozone manufactures provide reliable and improved systems specifically designed for dental applications and be CE certified in order to be safely and legally used in dental ozone studies.

**3.2. Group ozonated water only**

Table 7. Summary of articles by country, Field, and Results.

Country	N	Country	N	Field	N	Field	N	Results %		
								G/S	G/NS	NS
Japan	10	Switzerland	4	Periodontics	13	DUWL	4	85	15	
India	8	Egypt	3	Surgery	9	Caries	3			
Germany	7	China	3	Endodontic	7	Soft tissue lesions	2			
Brazil	6	U.K.	2	Materials	6	TMJ	1			
Turkey	5	<b>53 articles*</b>		General	6	Cytotoxicity	1			

Legend: N, total number of manuscripts. \* Including the not listed article (countries with 1 article only). DUWL, Dental unit water lines; TMJ, Temporomandibular Joint; UK, United Kingdom. Results: G/S, Good/Significant; G/NS, Good/non-significant; NS, non-significant.

Lower negative results were noted in group “ozonated water only” (15%) – Table 7 - compared to group “ozone gas only” (33%) – Table 6.

Table 8. Ozonated water concentration used in the studies and results.

Low concentrations $\mu\text{g/mL}$	N	%	High concentrations $\mu\text{g/mL}$	N	%
< 0.1	10	19	4-6	12	23
< 2	6	12	8-15	8	15
			16-25	17	32
Total	16	31		37	69
Results %	G/S: 50 G/NS-NS: 50		Results %	G/S: 89 G/NS-NS: 11	

Legend: N, total number of manuscripts. %, percent of the total number of manuscripts analyzed (53). Results: G/S, Good/Significant; G/NS, Good/non-significant; NS, non-significant.

It was further observed that 19% of the total number of studies used less than 0.1  $\mu\text{g/mL}$  concentration, and 12% used less than 2  $\mu\text{g/mL}$ , yielding 50% combined negative results in comparison to 11% in other studies where a higher concentration of (4-25)  $\mu\text{g/mL}$  was used.

Unlike the observed discrepancy in ozone parameters between clinicians and research in the group "ozone gas only", there is a concordance between clinical applications and research findings in the group "ozonated water only".

It is thus recommended that future research studies use medium to high ozonated water concentrations of (4-25)  $\mu\text{g/mL}$  which are commonly used in medical topical applications and by dental clinicians.

### 3.3 Group ozonated oils

Table 9. Summary of articles by Country and Field.

Country	N	Field	N
Italy	7	Surgery	10
India	6	Antibacterial	6
Egypt	5	Periodontics	4
Cuba	4	Endodontic	3
Brazil	3	Soft tissue lesions	2
Countries 1 article each	5	Cytotoxicity	2
		Caries	1
		Materials	1
		Hyper-sensitivity	1

Legend: N, total number of manuscripts. Total number of manuscript analyses was 30.

Table 10. Concentrations and Results.

Concentration $\text{mEq O}_2/\text{kg}$	N	Results % [G/S]
~ 1 300	4	100
590	1	
0.025-0.5%	1	
Not specified	24	

Legend: N, total number of manuscripts. G/S, Good significant. Total number of manuscript analyses was 30.

The major positive result noted in ozonated oils studies is strongly suggestive of their usefulness in dental applications, as was also observed in topical medical applications. In the majority of the dental studies, the lack of ozonated oils concentration specification was observed. The role and responsibility of ozonated oils producers to label their products with the peroxide value<sup>9</sup> (in mEq O<sub>2</sub>/kg or in mmol O<sub>2</sub>/kg) is vital in order to compare different ozonated vegetable oils and the concentrations best suited for dental applications.

### 3.4 Group ozone gas and ozonated water

A striking observation is the very low number of studies where both ozone gas and ozonated water were used. In medical topical applications studies, it's only normal to use both gas and water, and the positive results observed in the 14 dental studies is proof that both gas and water should be used instead of only gas or only water.

In our opinion, the common practice in clinical applications of the combined use of gas and water when applicable should be the norm in future dental research studies, as well as the use of medium to high ozone concentrations.

Table 11. Summary of articles by Country or Field.

Country	N	C/S <sup>1</sup>	Field	N
Egypt	3	C	Endodontic	5
Brazil	3	S	Materials	2
Turkey	3	S	Cytotoxicity	2
Germany	2	S	TMJ	1
Cuba	1	C	Caries	1
USA	1	C	Soft tissue lesions	1
Poland	1	S	Periodontics	1
			Surgery	1
<b>Total</b>	<b>14</b>		<b>Total</b>	<b>14</b>

Legend: N, total number of manuscripts. <sup>1</sup>C/S: *Combined or Separate use of ozone gas and/or water.* TMJ, Temporomandibular Joint.

Table 12. Concentrations and Results.

Concentration µg/mL		N	Results %	
Ozone gas	Ozonated water		GS	G/NS
4.2	4	5	93	7
0.2-53	1-20	2		
6-20	20	2		
60	25	1		
40	8	1		
Not specified		3		

Legend: N, total number of manuscripts. Results: G/S, Good/Significant; G/NS, Good/non-significant. Total number of manuscript analyses was 14.

### 3.5. Group Topical – Systemic ozone application

Table 13. Summary of articles by Country, Field, Application Mode and Results.

Country	Field	N	Application Mode	Results %
				[GS]
Ukraine	Surgery	2	O <sub>3</sub> water + IV O <sub>3</sub> saline	100
Egypt	Surgery	1	Not specified	
Russia	Surgery	1	O <sub>3</sub> water + IV O <sub>3</sub> saline	
Cuba	TMJ	1	IA vs. Rectal + IA	
Turkey	Surgery	1	Intraperitoneal + O <sub>3</sub> gas	

Legend: N, total number of manuscripts. TMJ, Temporomandibular Joint. IV, Intra Venous; IA, Intra articular. Results: GS Good/Significant. Total number of manuscript analyses was 6.

In light of the increasing evidence and research into oral-systemic health links, it is essential that medical and dental health professionals along with researchers, join efforts and conduct more studies in order to elucidate the usefulness of ozone therapy in both oral and systemic chronic inflammatory diseases.

This holistic health approach would greatly benefit patients suffering from chronic oxidative stress where ozone therapy is highly indicated.

In our opinion, there is an urgent need to conduct more studies on ozone therapies. This should propel ozone therapy as a whole to a totally new level of prominence. Especially when we consider that adult chronic periodontitis is one of the most common chronic inflammatory diseases contributing to systemic conditions and disease.

### 3.6. Group ozone injections

There have been a very large number of published articles in medical ozone therapy with the highest grade of evidence-based medicine to support vertebral-paravertebral ozone injections. The promising positive results seen in these dental studies and considering the comparison to this medical research, should warrant more research into ozone gas injections in temporomandibular joint (TMJ) and related muscles.

As in the case of chronic periodontitis which affects a large number of the population, temporomandibular joint disorders are also considered some of the most common skeletal inflammatory and degenerative conditions.

Future research in this field would help dental clinicians to distinguish between the beneficial effects of the TMJ intra-articular and the para-articular ozone injections, as well as the topical applications as seen in some studies where ozone gas was topically applied over the affected TMJ area (Table 14).

Table 14. Summary of articles by Country, Field, Application Mode and Results.

Country	Field	N	Application Mode	Results %
Egypt	TMJ	3	O <sub>3</sub> gas and/or O <sub>3</sub> water	[G/S] 100
Turkey	Ortho	1	O <sub>3</sub> gas	

Legend: N, total number of manuscripts. TMJ, Temporomandibular joint. Ortho., Orthodontics. Results: G/S Good/Significant. Total number of manuscript analyses was 4.

## 4. Discussion

It is indisputable that ozone therapy in dentistry is growing and is being used by an increasing number of dentists worldwide. The clinical experiences and treatment outcomes are adding significant amounts of knowledge. Dental research should follow and support dental professionals in their daily practice of ozone therapy. As well, dental professionals will benefit from the experiences of our medical colleagues.

Most importantly, the discrepancy noted between research and clinicians in ozone gas specifications and oxygen feed sources is significant. A major contributing factor to this discrepancy is the available dental ozone gas systems offered to researchers, most of which operate on ambient air and generate low ozone gas concentrations.

In addition, it is fundamental that ozone dental units be designed with a larger spectrum of gas concentration and be certified for use in research. There is a large choice of commercially available medical units. However the average cost of these systems might be prohibitive for dental use.

In 15% of the ozone gas articles, the concentration and flow rate were not clearly specified, thus of little or no value for clinicians. It is paramount that authors measure the concentrations of the generated gas, and not solely rely on manufacturers' recommendations.

Similarly, the peroxide value (PV) of the ozonated oil products should be tested by researchers in all instances. The majority of ozonated oils articles did not specify the PV, which is essential for clinicians to choose the appropriate concentration according to the clinical case.

We cannot stress enough about the need and importance of future dental research studies incorporating both ozone gas and water, as well as ozonated oils when applicable. These therapies are what the majority of dentists apply in their practice and it might very well improve the overall positive and significant results in research.

Dental ozone research ought to change its course to meet the expectations of clinicians. Research needs to explore new and different studies than the conventional and well-studied antimicrobial potential of ozone. Most importantly the direct ozone application on pulp exposures, whether due to caries, trauma or iatrogenic, and to evaluate the potential of dentin generation and pulp tissue cytotoxicity according to the ozone form and applied dose.

The assistance and cooperation of our medical colleagues is well appreciated, especially in conducting more studies in the field of oral-systemic links.

Lastly, ozone equipment manufacturers have a major role to play in the evolution of dental ozone research and clinical ozone practices.

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## Appendix: Articles Consulted

Some selected unpublished articles without formal citation (**highlighted in yellow**) were collected from scientific ozone meetings.

### Ozone Gas

1. **Influence of Ozone on Oxidation of Dental Alloys.** Suzuki/Oizumi/Furuya/Okamoto/Rosenstiel. International Journal of Prosthodontics Year 1999 Volume 12, Issue 2.
2. **Chemical treatment of machined titanium surfaces. An in vitro study.** [Krozer A, Hall J, Ericsson I. Clin Oral Implants Res.](#) 1999 Jun;103):204-11.
3. **Antimicrobial effect of a novel ozone- generating device on micro-organisms associated with primary root carious lesions** Caries Res. 2000 Nov-Dec;346):498-501. Baysan A, Whiley RA, Lynch E.
4. Patients attitudes to managing caries with Ozone. Domingo H, Smith C, Freeman R, Lynch E. J Dent Res, 81: A-183; 2002 2002 99 n/an/a
5. Clinical reversal of root caries using Ozone: 6-month results. Baysan A, Lynch E. J Dent Res, 81: A-343; 2002. 2002 80 214
6. Clinical Reversal of Occlusal Pit & Fissure Caries Using Ozone. Holmes J. The First Pan European Festival of Oral Sciences, Cardiff, UK. Abstract no. 431; 2002 and J Dent Res, 82: C-535;
7. **Ozone, an effective treatment for DUWL.**
8. Bond strengths of composite to enamel /dentine treated with ozone. Hussey D, Armstrong C, Lynch E. The First Pan European Festival of Oral Sciences, Cardiff, UK. Abstract no. 697; 2002
9. **Clinical reversal of root caries using ozone, double-blind, randomized, controlled 18-month trial.** Gerodontology. 2003 Dec;202):106-14. Holmes J.
10. Clinical Reversal of Pit & Fissure Caries after Using Ozone. Reaney D, Lynch E. AADR Abstract no. 674; 2003. 2003 22 78 30 Seconds Primary Pit & Fissure Carious Lesion
11. Treatment of Primary Occlusal Pit and Fissure Caries with Ozone. Cronshaw MA Six-month Results IADR Abstract no. 2750;2003.
12. Ozone Efficacy in Treatment of Occlusal Caries in Primary Teeth. Abu-Salem OT, Marashdeh MM, Lynch E. J Dent Res, 82: B-136; 2003 2003 16 42
13. Successful Use of Airabrasion in Conjunction with Ozone Treatment. Clifford C. J Dent Res, 82: B-2747; 2003. 2003 37 48
14. Ozone Efficacy in Treatment of Occlusal Caries in Primary Teeth. Abu-Salem OT, Marashdeh MM, Lynch E.. AADR Abstract no. 685; 2003. 2003 17 50
15. Primary Colonization of DUWL by *P. aeruginosa* & its Eradication by Ozone. Al Shorman, Abu-Naba'a, Coulter W, Lynch E. J Dent Res, 82: B-284; 2003.
16. Bond strength of glass-ionomer's to dentine after Heal Ozone treatment. Czarnecka B, Continental NOF Divisions of the IADR Abstract no. 63; 2004. 2004
17. Ozone Treatment of Root Caries after 21-Months. Holmes J. IADR Abstract no. 117; 2004.
18. The Effect of Ozone on Fissure Caries in Permanent Molars. Huth KC, Paschos E, & Hickel R. IADR Abstract no. 2466; 2004 2004 41 114
19. Clinical Reversal of Occlusal Pit & Fissure Caries Using Ozone. Hamid A. IADR Abstract no. 3470 2004. 2004 184 184
20. Reversal of Caries Using Airabrasion & Ozone- Nine Month Results. Clifford C. IADR Abstract no. 2467; 2004.
21. Restoration of ART & Ozone treated primary root carious lesions. Holmes J. J Dent Res, IADR Abstract 2004.
22. Reduction in treatment time with combined air abrasion & Ozone compared to traditional 'Drill & Fill'. Domingo H, Holmes J. J Dent Res, IADR abstract 2004.

23. Influence of ozone treatment on marginal adaptation of fissure sealing. Hiller Ka, Continental NOF Divisions of the IADR Abstract no. 62; 2004. 2004.
24. Ozone air levels adjacent to a dental ozone gas delivery system. [Johansson E](#), Dental Hygienist Education, Department of Odontology, Umeå University, Umeå, Sweden. *Acta Odontologica Scandinavica*, 2007; 65: 324-330
25. Treating open carious lesions in anxious children with ozone. A prospective controlled clinical study. [Dähnhardt JE](#), [Jaeggi T](#), Lussi A. University of Bern, Switzerland. *Am J Dent*. 2006 Oct;19(5):267-70.
26. High-resolution <sup>1</sup>H NMR investigations of the oxidative consumption of salivary biomolecules by oral rinse peroxides. *Acta Odontol Scand*. 2013 Jan;71(1):223-35. doi: 10.3109/00016357.2012.658082. Epub 2012 Apr 23
27. Determination of the Performance of Various Root Canal Disinfection Methods after In Situ Carriage. Anca Virtej, Dr. med. dent. 2007 by the American Association of Endodontists. doi:10.1016/j.joen.2006.11.025
28. Antibacterial effect of an ozone device and its comparison with two dentin-bonding systems. Olga Polydorou, Germany, *Eur J Oral Sci* 2006; 114: 349–353.
29. Assessment of enamel changes during fixed orthodontic treatment with and without ozone– Amna AL-Shamsi. School of Medicine and Dentistry Queen’s University of Belfast (QUB) - PhD thesis 2007
30. Efficacy of gasiform ozone and photodynamic therapy on a multispecies oral biofilm in vitro. Müller P, Guggenheim B, Schmidlin PR. *Eur J Oral Sci* 2007; 115: 77–80. \_ 2007 *Eur J Oral Sci*
31. Effect of ozone treatment on the molecular composition of dentin. [ANTIPA, L.](#) [PAPAGIANNOULIS](#), and [G. ELIADES](#), University of Athens EKPA), Greece, 2007.
32. Primary Fissure Carious Lesion Reversal Using Ozone. Alena Knežević, Croatia/ *Acta Stomatol Croat*. 2007;41(1):31-8.
33. Assessment of ozone in root canal therapy – PhD theses
34. Assessment of the Ozone-Mediated Killing of Bacteria in Infected Dentine Associated with Non-Cavitated Occlusal Carious LesionsA. Baysan D. *Beighton Caries Res* 2007;41:337–341 DOI: 10.1159/000104790
35. Effect of ozone on the remineralization of enamel in vitro. [Nie L](#), [Li X](#), [Hu DY](#). *Zhonghua Kou Qiang Yi Xue Za Zhi*. 2007 Feb;42(2):102-5.
36. Effects of ozone and sodium hypochlorite on caries-like lesions in dentin. [Zaura E](#), [Buijs MJ](#), [ten Cate JM](#). *Caries Res*. 2007;41(6):489-92. Epub. 2007 Oct 1.
37. **The inability of *Streptococcus mutans* and *Lactobacillus acidophilus* to form a biofilm in vitro on dentine pretreated with ozone.** *Aust Dent J*. 2008 Dec;53(4):349-53. Knight GM, McIntyre JM, Craig GG, Mulyani, Zilm PS.
38. Comparison of the immediate effects of gaseous ozone and chlorhexidine gel on bacteria in cavitated carious lesions in children in vivo. Hauser-Gerspach I, Lussi A. *Clin Oral Investig*. 2008 Nov 26.
39. Effect of ozone gas application on the mechanical properties of dental adhesives bonded to dentin. Magni E, Ferrari M, Hickel R, Huth KC *Dent Mater*. 2008 Oct;24(10):1428-34. Epub 2008 Jul 22
40. Treating sensitive cervical areas with ozone. A prospective controlled clinical trial. [Dähnhardt JE](#), [Gygax M](#), [Martignoni B](#), [Suter P](#), [Lussi A](#). *Am J Dent*. 2008 Apr;21(2):74-6
41. The disinfecting effect of ozonized oxygen in an infected root canal: an in vitro study. Stoll R, Venne L, Jablonski-Momeni A, [Mutters R](#), [Stachniss V](#). *Quintessence Int*. 2008 Mar;39(3):231-6.
42. Bond strength of fiber posts after the application of erbium:yttrium-aluminum-garnet laser treatment and gaseous ozone to the root canal. [Bitter K](#), [Noetzel J](#), [Volk C](#), [Neumann K](#), [Kielbassa AM](#). *J Endod*. 2008 Mar;34(3):306-9.
43. Effect of ozone and Tooth Mousse on the efficacy of peroxide bleaching. [Manton DJ](#), [Bhide R](#), [Hopcraft MS](#), [Reynolds EC](#). *Aust Dent J*. 2008 Jun;53(2):128-32.



44. **Efficacy of calcium hydroxide, Er:YAG laser or gaseous ozone against *Enterococcus faecalis* in root canals.** Noetzel J, Nonhoff J, Bitter K, Wagner J, Neumann K, Kielbassa AM. *Am J Dent.* 2009 Feb;221):14-8
45. Ultraviolet-ozone treatment reduces levels of disease-associated prion protein and prion infectivity. Christopher J *BMC Research Notes* 2009, 2:121doi:10.1186/1756-0500-2-121
46. Antibacterial effect of ozone on cariogenic bacterial species. Johansson E, [Claesson R](#), [van Dijken JW](#). *J Dent.* 2009 Jun;376):449-53. doi: 10.1016/j.jdent.2009.02.004. Epub 2009 Apr 1.
47. Comparison of the immediate effects of gaseous ozone and chlorhexidine gel on bacteria in cavitated carious lesions in children in vivo. [Hauser-Gerspach I](#) [Lussi A](#). *Clin Oral Investig.* 2009 Sep;133):287-91. doi: 10.1007/s00784-008-0234-4. Epub 2008 Nov 26.
48. Preventive effect of ozone on the development of white spot lesions during multibracket appliance therapy. [Kronenberg O](#), [Lussi A](#), [Ruf S](#). *Angle Orthod.* 2009 Jan;791):64-9. doi: 10.2319/100107-468.1.
49. The influence of Healozone on microleakage and fissure penetration of different sealing materials. [Dukić W](#), [Dukić OL](#), [Milardović S](#). *Coll Antropol.* 2009 Mar;331):157-62.
50. Bactericidal effect of KTP laser irradiation against *Enterococcus faecalis* compared with gaseous ozone: an ex vivo study. [Kuštarczy A](#). *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2009 May;1075):e73-9
51. Enamel and dentin bond strength following gaseous ozone application. [Cadenaro MJ](#) *Adhes Dent.* 2009 Aug;114):287-92.
52. **Shear bond strength of epoxy resin-based endodontic sealers to bovine dentin after ozone application.** [Bojar W](#)<sup>1</sup>, [Czarnecka B](#), [Pryliński M](#), [Walory J](#). *Acta Bioeng Biomech.* Poland, 2009;113):41-5.
53. Influence of ozone application on the repair strength of silorane-based and ormocer-based composites. [Magni E](#) *Am J Dent.* 2010 Oct;235):260-4. University of Siena, School of Dental Medicine.
54. Effect of ozone pretreatment on the microleakage of pit and fissure sealants. [Cehreli SB](#), [Yalcinkaya Z](#), [Güven-Polat G](#), [Cehreli ZC](#). *J Clin Pediatr Dent.* 2010 Winter;352):187-90.
55. Effects of ozone and ND:YAG laser pretreatment on bond strength of self-etch adhesives to coronal and root dentin. [Gurgan S](#) 2010 Oct;28 Suppl 2:S3-9. doi: 10.1089/pho.2009.2608. Epub 2010 Oct 9.
56. The use of ozone to lighten teeth. An experimental study. [Tessier J](#), [Rodriguez PN](#), [Lifshitz F](#), [Friedman SM](#), [Lanata EJ](#). *Acta Odontol Latinoam.* 2010;232):84-9.
57. Shear bond strength to enamel after power bleaching activated by different sources. [Can-Karabulut DC](#)<sup>1</sup>, [Karabulut B](#). *Eur J Esthet Dent.* 2010 Winter;54):382-96.
58. Influence of ozone application on the repair strength of silorane-based and ormocer-based composites. [Magni E](#)<sup>1</sup>, [Ferrari M](#), [Papacchini F](#), [Hickel R](#), [Ilie N](#). *Am J Dent.* 2010 Oct;235):260-4.
59. Tubular occlusion of simulated hypersensitive dentin by the combined use of ozone and desensitizing agents. RASHA RAAFAT ISSN 0001-6357 *Odontologica Scandinavica*, 2011.
60. Effect of ozone application on the resin-dentin microtensile bond strength. [Rodrigues PC](#), [Souza JB](#), [Soares CJ](#), [Lopes LG](#), [Estrela C](#). *J Contemp Dent Pract.* 2011 Jul 1;124):279-86.
61. Influence of ozone on the composite-to-composite bond. [Magni E](#)<sup>1</sup>, [Ferrari M](#), [Papacchini F](#), [Hickel R](#), [Ilie N](#). *Clin Oral Investig.* 2011 Apr;152):249-56. doi: 10.1007/s00784-009-0370-5. Epub 2010 Jan 7.
62. Microbiological effects of gas action depending on the method and the time of application using the ozonytron device. Experimental study. [Wilczyńska-Borawska M](#) *Ann*

- [Acad Med Stetin](#). 2011;572):99-103.
63. The effect of dentin hypersensitivity treatments on the shear bond strength to dentin of a composite material. [Can-Karabulut DC](#), [Karabulut B](#). [Gen Dent](#). 2011 Jan-Feb;591:e12-7.
  64. Effects of different cavity disinfectants on shear bond strength of a silorane-based resin composite. [Arslan SJ Contemp Dent Pract](#). 2011 Jul 1;124):279-86.
  65. Molar incisor hypomineralization. Morphological and chemical aspects, onset and possible etiological factors. [Fagrell T](#)<sup>1</sup>. [Swed Dent J Suppl](#). 2011;216):5, 11-83.
  66. Treatment of root canal biofilms of *Enterococcus faecalis* with ozone gas and passive ultrasound activation. [Walsh LJ](#). [J Endod](#). 2012 Apr;384):523-6. doi: 10.1016/j.joen.2011.12.020. Epub 2012 Feb 2.
  67. The antibacterial effect of gas ozone after 2 months of in vitro evaluation. [Polydorou OClin Oral Investig](#). 2012 Apr;162):545-50. doi: 10.1007/s00784-011-0524-0. Epub 2011 Feb 18.
  68. Influence of gaseous ozone in peri-implantitis: bactericidal efficacy and cellular response. An in vitro study using titanium and zirconia. [Hauser-Gerspach](#);164):1049-59. doi: 10.1007/s00784-011-0603-2. Epub 2011 Aug 13.
  69. Comparison of the effects of Er,Cr:YSGG laser and different cavity disinfection agents on microleakage of current adhesives. [Arslan SLasers Med Sci](#). 2012 Jul;274):805-11. doi: 10.1007/s10103-011-0980-4. Epub 2011 Aug 19.
  70. Effect of different disinfectant methods on the initial microtensile bond strength of a self-etch adhesive to dentin. [Dalkilic EELasers Med Sci](#). 2012 Jul;274):819-25. doi: 10.1007/s10103-011-0987-x. Epub 2011 Sep 14.
  71. The additional effect of ozone in combination with adjunct remineralisation products on inhibition of demineralisation of the dental hard tissues in situ. [Duggal MS](#) 2012 Nov;4011):934-40. doi: 10.1016/j.jdent.2012.07.012.
  72. The effect of the application of gaseous ozone and ND: YAG laser on glass-fibre post bond strength. [Kivanç BHAust Endod J](#). 2012 Dec;383):118-23. doi: 10.1111/j.1747-4477.2010.00265.x. Epub 2010 Oct 24.
  73. The effect of subgingival ozone and/or hydrogen peroxide on the development of peri-implant mucositis: a double-blind randomized controlled trial. McKenna DF, Borzabadi-Farahani A, Lynch E. *Int J Oral Maxillofac Implants*. 2013 Nov-Dec;28(6):1483-9. doi: 10.11607/jomi.3168
  74. Antimicrobial Effect of Ozone on Cariogenic Microorganisms in vitro. [Duygu Tuncer](#)DOI: 10.1080/01919512.2013.796862; 2013
  75. Efficacy of ozone on microorganisms in the tooth root canal. [Halbauer K](#)<sup>1</sup>, [Prskalo K](#), [Janković B](#), [Tarle Z](#), [Pandurić V](#), [Kalenić S](#). [Coll Antropol](#). 2013 Mar;371):101-7.
  76. Comparing the antibacterial activity of gaseous ozone and chlorhexidine solution on a tooth cavity model. Arife Kapdan 1, Nurhan Öztaş 2, Zeynep Sümer 3 *Turkey J Clin Exp Dent*. 2013;53):e133-7.
  77. Antibacterial efficacy of prophylactic ozone treatment on patients with fixed orthodontic appliances. [Aykut-Yetkiner AActa Odontol Scand](#). 2013 Nov;716):1620-4. doi: 10.3109/00016357.2013.786838. Epub 2013 Apr 16.
  78. Effect of ozone gas on the shear bond strength to enamel. [Pires PTJ Appl Oral Sci](#). 2013 Mar-Apr;212):177-82. doi: 10.1590/1678-7757201302362.
  79. Evaluation of the clinical and antimicrobial effects of the Er:YAG laser or topical gaseous ozone as adjuncts to initial periodontal therapy. [Yılmaz SPhotomed Laser Surg](#). 2013 Jun;316):293-8. doi: 10.1089/pho.2012.3379.
  80. Synergistic Antimicrobial Action of Chlorhexidine and Ozone in Endodontic Treatment. Rita Noites, *BioMed Research International* Volume 2014 2014), Article ID 592423.
  81. In Vitro Inactivation of Herpes Virus by Ozone. Greici Petrya, Luciana Grazziotin Rossatob, Jaqueline Nespoloc, Luiz Carlos Kreutzc & Charise. *Ozone: Science & Engineering*, 36: 249–252 ISSN: 0191-9512 print / 1547-6545 online DOI: 10.1080/01919512.2013.862165

82. Comparative Evaluation of the Effects of Ozone, Diode Laser, and Traditional Cavity Disinfectants on Microleakage. Şifa Güneş, *Ozone Science & Engineering*, 36: 206–211 ISSN: 0191-9512 print / 1547-6545.
83. Effects of ozone therapy on pain, swelling, and trismus following third molar surgery. [Kazancıoğlu HO<sup>1</sup>](#), [Kurklu E](#), [Ezirganlı S](#). *Int J Oral Maxillofac Surg*. 2014 May;435):644-8. doi: 10.1016/j.ijom.2013.11.006.
84. Comparison of the influence of ozone and laser therapies on pain, swelling, and trismus following impacted third-molar surgery. Kazancıoğlu [Lasers Med Sci](#). 2014 Jul;294):1313-9. doi: 10.1007/s10103-013-1300-y
85. Efficacy of endodontic applications of ozone and low-temperature atmospheric pressure plasma on root canals infected with *Enterococcus faecalis*. [Üreyen Kaya B](#) *Lett Appl Microbiol*. 2014 Jan;581):8-15. doi: 10.1111/lam.12148.
86. The effect of ozone on progression or regression of artificial caries-like enamel lesions in vitro. [Tahmassebi JF](#), [Chrysafi N](#), [Duggal MS](#). *J Dent*. 2014 Feb;422):167-74. doi: 10.1016/j.jdent.2013.11.011
87. Immobilization of naringin onto chitosan substrates by using ozone activation. [Li CH](#), [Colloids Surf B Biointerfaces](#). 2014 Mar 1;115:1-7. doi: 10.1016/j.colsurfb.2013.11.006.
88. The investigation of non-invasive techniques for treating early approximal carious lesions: an in vivo study. [Yazıcıoğlu O](#), [Ulukapı H](#). *Int Dent J*. 2014 Feb;641):1-11. doi: 10.1111/idj.12056.
89. In vitro assessment of the recurrent doses of topical gaseous ozone in the removal of *Enterococcus faecalis* biofilms in root canals. [Kaptan F](#), *Niger J Clin Pract*. 2014 Sep-Oct;175):573-8. doi: 10.4103/1119-3077.141421.
90. Synergistic Antimicrobial Action of Chlorhexidine and Ozone in Endodontic Treatment. Rita Noites, Hindawi Publishing Corporation BioMed Research International Volume 2014, 10.1155/2014/592423
91. Ozone treatment of recurrent aphthous stomatitis: a double blinded study. Mahmoud K. AL-Omiri, Mohannad Alhijawi, Bader K. AlZarea, Ra'ed S. Abul Hassan & Edward Lynch Scientific Reports 6, Article number: 27772 (2016)doi:10.1038/srep27772.
92. Bleaching effect of ozone on pigmented teeth. [Zanjani VA<sup>1</sup>](#), [Dent Res J Isfahan](#). 2015 Jan-Feb;121):20-4.
93. Can Dentin Surfaces Be Bonded Safely with Ozone and Boric Acid? Ertuğrul Ercana Turkey 2015 Journal of the International Ozone Association, DOI: 10.1080/01919512.2015.1045059
94. Effects of ozone and photo-activated disinfection against *Enterococcus faecalis* biofilms in vitro. [Tuncay Ö<sup>1</sup>](#), *Niger J Clin Pract*. 2015 Nov-Dec;186):814-8. doi: 10.4103/1119-3077.163289.
95. Remineralization Capacity of Three Fissure Sealants with and without Gaseous Ozone on Non-Cavitated Incipient Pit and Fissure Caries Murat UNAL DDS, Journal of Clinical Pediatric Dentistry: Summer 2015, Vol. 39, No. 4
96. Which is the most effective disinfection method in primary root canals: Conventional or newly developed ones? [Kapdan A](#) *Niger J Clin Pract*. 2015 Jul-Aug;184):538-43. doi: 10.4103/1119-3077.154207.
97. The treatment of periodontal disease using local oxygen-ozone. Gianluca Sacco, Guglielmo Campus. *Ozone Therapy* 2016; 1:6498 doi:10.4081/ozone.2016.6498
98. Comparison of ozone gas and sodium hypochlorite/chlorhexidine two-visit disinfection protocols in treating apical periodontitis a RCT. Stefan Kist1 & Karin Christine Huth *Clin Oral Invest* DOI 10.1007/s00784-016-1849-5
99. Effects of photodynamic therapy, 2 % chlorhexidine, triantibiotic mixture, propolis and ozone on root canals experimentally infected with *Enterococcus faecalis*: an in vitro study. [Camacho-Alonso F](#), [Salmerón-Lozano P](#), [Martínez-Beneyto Y](#). *Odontology*. 2016 Oct 22.

100. **Prevention of occlusal caries using a ozone, sealant and fluoride varnish in children.** [Kalnina J](#), [Care R](#). [Stomatologija](#). 2016;181):26-31.
101. Effects of combining ozone and hydrogen peroxide on tooth bleaching: A clinical study. [Al-Omiri MK](#), [Hassan RS](#), [AlZarea BK](#), [Lynch E](#). [J Dent](#). 2016 Oct;53:88-93. doi: 10.1016/j.jdent.2016.08.002.
102. Efficiency of gaseous ozone in reducing the development of dry socket following surgical third molar extraction. [Ahmedi J<sup>1</sup>](#), [Ahmedi E](#), [Seifija O](#), [Agani Z](#), [Hamiti V](#). 2016 Jul-Sep;103):381-5. doi: 10.4103/1305-7456.184168.
103. Ozone Therapy Enhances Osseous Healing in Rats with Diabetic With Calvarial Defects: A Morphometric and Immunohistochemical Study. [Alpan AL](#), [Toker H](#), [Ozer H](#). [J Periodontol](#). 2016 Aug;87(8):982-9. doi: 10.1902/jop.2016.160009.
104. LPS levels in root canals after the use of ozone gas and high frequency electrical pulses. [Melo TABraz Oral Res](#). 2016;30.
105. Effect of gaseous ozone on Enterococcus faecalis biofilm-an in vitro study. [Boch TClin Oral Investig](#). 2016 Sep;207):1733-9. doi: 10.1007/s00784-015-1667-1.
106. The effect of different concentrations of topical ozone administration on bone formation in orthopedically expanded suture in rats.[Buyuk SK](#), [Ramoglu SI](#), [Sonmez MF](#). [Eur J Orthod](#). 2016 Jun;38(3):281-5. doi: 10.1093/ejo/cjv045.
107. Effect of gaseous ozone and light-activated disinfection on the surface hardness of resin-based root canal sealers. [Tuncay Ö](#), [Er Ö](#), [Demirbuga S](#), [Zorba YO](#), [Topçuoğlu HS](#). [Scanning](#). 2016 Mar-Apr;38(2):141-7. doi: 10.1002/sca.21222.
108. Effects of Diode Laser, Gaseous Ozone, and Medical Dressings on Enterococcus faecalis Biofilms in the Root Canal. Kerstin Bitter, Germany BioMed Research International Volume 2017, Article ID 6321850,
109. Comparison of Ozone and Photo-Biomodulation Therapies on Mental Nerve Injury in Rats.[Yucesoy TJ Oral Maxillofac Surg](#). 2017 Apr 26. pii: S0278-2391(17)30472-X. doi: 10.1016/j.joms.2017.04.016.
110. Ozone Gas Effect on Mineral Content of Dentin exposed to Streptococcus mutans Biofilm: An Energy-dispersive X-ray Evaluation. [Chaves RMJ Contemp Dent Pract](#). 2017 Apr 1;18(4):265-269.
111. Comparison of laser and ozone treatments on oral mucositis in an experimental model. [Bayer S<sup>1</sup>](#), [Kazancioglu HO<sup>2</sup>](#), [Acar AH<sup>1</sup>](#), [Demirtas N](#), [Kandas NO](#). [Lasers Med Sci](#). 2017 Apr;32(3):673-677.
112. Antimicrobial activity of ozone and NaF-chlorhexidine on early childhood caries. [Ximenes MBraz Oral Res](#). 2017 Jan 5;31:e2. doi: 10.1590/1807-3107BOR-2017.vol31.0002.
113. Ozone Treatment on Dentin Hypersensitivity Surfaces – A Pilot Study. Karlsson Lena and Kjaeldgaard Institutet, Sweden The Open Dentistry Journal, 2017, 11, 65-70
114. The biostimulatory effect of ozone application on bone healing in the midpalatal suture after rapid maxillary expansion of rats. A comparative study. Mohamed A Ahmed, Sherif S Marcos, Mohamed N Mawsouf and Abadi M El Kadi.
115. Local oxygen therapy for treating acute necrotizing periodontal disease in smokers. [Gaggl AJ](#), [Rainer H](#), [Grund E](#), [Chiari FM](#). [J Periodontol](#). 2006 Jan; 77(1):31-8.
116. Effect of ozone therapy on autogenous bone graft healing in calvarial defects: a histologic and histometric study in rats. H. Ozdemir, H. Toker, H. Balci, H. Ozer. [J Periodont Res](#) 2013; 48: 722–726
117. Effects of laser and ozone therapies on bone healing in the calvarial defects. [Kazancioglu HO](#), [Ezircanli S](#), [Aydin MS](#). [J Craniofac Surg](#). 2013 Nov;24(6):2141-6. doi: 10.1097/SCS.0b013e3182a244ae.
118. Evaluating the effect of an ozone delivery system on the reversal of dentin hypersensitivity: a randomized, double-blinded clinical trial. [Azarpazhooh A](#), [Limeback H](#), [Lawrence HP](#), [Fillery ED](#). [J Endod](#). 2009 Jan;35(1):1-9. doi: 10.1016/j.joen.2008.10.001.
119. Assessment of antibacterial efficacy of ozone therapy in treatment of caries at

- the white spot stage. Makeeva IM doi: 10.17116/stomat20179647-10.
120. The effects of ozone application on genotoxic damage and wound healing in bisphosphonate-applied human gingival fibroblast cells. Akdeniz SS Clin Oral Investig. 2017 Jul 11. doi: 10.1007/s00784-017-2163-6
  121. Effect of ozone therapy on autogenous bone graft healing in calvarial defects: a histologic and histometric study in ratsH. Ozdemir, H. Toker, H. Balci, H. Ozer 3 March 2013
  122. Effects of laser and ozone therapies on bone healing in the calvarial defects. [Kazancioglu HO](#), [Ezirganli S](#), [Aydin MS](#). [J Craniofac Surg](#). 2013 Nov;246):2141-6. doi: 10.1097/SCS.0b013e3182a244ae.
  123. Evaluating the effect of an ozone delivery system on the reversal of dentin hypersensitivity: a randomized, double-blinded clinical trial. [Azarpazhooh A](#), [Limeback H](#), [Lawrence HP](#), [Fillery ED](#). [J Endod](#). 2009 Jan;35(1):1-9. doi: 10.1016/j.joen.2008.10.001.

## Ozone Water

1. **Ralph Turk ozone in dentistry 1985.**
2. Antimicrobial activity of ozonized water in determined experimental conditions. Minguez F, Gomez-Lus ML, Andre J, Cabronero MJ, Prieto J.Rev Sanid Hig Publica Madr ), 64:415-423; 1990.
3. **Periodontology – New methods. A Brauner 1991**
4. Ozone in Oral Surgery - Current Status and Prospects. A. Filippi. *Ozone Science & Engineering* 19, pp. 387-393; 1997
5. **The Influence of Ozonised Water On The Epithelial Wound Healing Process In The Oral Cavity. Andreas FilippiClinic of Oral Surgery, -Radiology and Oral MedicineUniversity of Basel, Hebelstrasse 3, Basel, Switzerland**
6. **Influence of Ozone on Oxidation of Dental Alloy.** Suzuki/Oizumi/Furuya/Okamoto/Rosenstiel. Int J Prosthodont. 1999 Mar-Apr;12(2):179-83
7. Effects of Ozone Solution on the Healing and Anti-infection of Traumatic Wound. Zhou, You-sheng / Peng, Wan-yong Herald of Medicine, issue 4, 2001, ISSN: 1004-0781 CNKI:SUN:YYDB.0.2001-04-002
8. The effectiveness of ozonated water for hand washing before surgery. [Isosu T](#), [Kan K](#), [Hayashi T](#), [Fujii M](#), [Masui](#). 2001 Jun;506):672-5.
9. **Safety of Ozonated Solution as an Antiseptic of the Ocular Surface prior to Ophthalmic Surgery.** Kashiwagi K. Ophthalmologica 2001;215:351–356 DOI: 10.1159/000050884)
10. Ozonated saline shows activity against planktonic and biofilm growing Staphylococcus aureus in vitro: A potential irrigant
11. for infected wounds. Hayder Al-Saadi', Inga Potapova, Edward TJ Rochford, Thomas F Moriarty PhD, & Peter Messmer
12. Research Institute Davos, A0 Foundation, Davos Platz. Switzerland International Wound Journal ISSN 1742-4801
13. PCNA-expression of cementoblasts& fibroblasts on the root surface after extraoral rinsing for decontamination. Ebensberger U, Pohl Y, Filippi A.Dent Traumatol,18:262-266;2002.
14. Effect of denture cleaner using ozone against methicillin-resistant Staphylococcus aureus and E. coli T1 phage. Murakami H, Mizuguchi M, Hattori M, Ito Y, Kawai T, Hasegawa J. Dent Mater J, 21:53-60; 2002. 2002
15. Antimicrobial effect of ozonated water on bacteria invading dentinal tubules. Nagayoshi M, Kitamura C, Fukuizumi T, Nishihara T, Terashita M. J Endod. 2004 Nov;30(11):778-8.
16. Efficacy of ozone on survival and permeability of oral microorganisms. Nagayoshi M, Fukuizumi T, Oral Microbiol Immunol 2004; 19: 240–246. \_ Blackwell Munksgaard, 2004.

17. Pasteurization effect of ozone water for pressure ulcers. [KONDO CHIZUKO](#) Keiseigeka) Japanese Journal of Pressure Ulcers ISSN:1345-0417 VOL.7;NO.1;PAGE.53-56(2005)
18. Management of Aggressive Periodontitis Using Ozonized Water. Ramzy M. I., Gomaa H. E, Mostafa M. I. and Zaki B. MMed. J. N R C, Vol. 6, No. 1, pp. 229-245 2005)
19. Application of ozonated water in local augmentation in dental implantology A. Filippi 2005
20. Influence of ozonated oils and water in oral surgery
21. Microbicidal efficacy of ozonated water against *Candida albicans* adhering to acrylic denture plates. M. Arita, M. Nagayoshi, Oral Microbiology and Immunology Volume 20 Page 206 - August 2005 doi:10.1111/j.1399-
22. An in vitro evaluation of the ability of ozone to kill a strain of *Enterococcus faecalis*. R. S. Hems International Endodontic Journal, 38, 22–29, 2005
23. Disinfection of dental unit water with ozone. LAURENCE J. WALSH 2006
24. Effect of aqueous ozone on the NF-kappaB system. J. Huth KC, Saugel B, Jakob FM, [Cappello C](#), [Quirling M](#), [Paschos E](#), [Ern K](#), [Hickel R](#), [Brand K](#) Dent. Res. 2007 May;86(5):451-6.
25. Effectiveness of ozonated water on *Candida albicans*, *Enterococcus faecalis*, and endotoxins in root canals. [Cardoso MG](#)<sup>1</sup>, [de Oliveira LD](#), [Koga-Ito CY](#), [Jorge AO](#). [Oral Surg Oral Med Oral Pathol Oral Radiol Endod](#). 2008 Mar;105(3):e85-91. doi: 10.1016/j.tripleo.2007.10.006.
26. A quantitative approach to the effectiveness of ozone against microbiota organisms colonizing toothbrushes. [Bezirtzoglou E](#), [J Dent](#). 2008 Aug;36(8):600-5.
27. Ozonated Water Improves Lipopolysaccharide-Induced Responses of an Odontoblast-like Cell Line. Fumiko Noguchi, DDS, American Association of Endodontists. doi:10.1016/j.joen.2009.01.01
28. Antimicrobial activity of ozonated water. [Białoszewski D](#), [Med Sci Monit](#). 2010 Sep;16(9):MT71-5.
29. The use of ozonated water and 0.2% chlorhexidine in the treatment of periodontitis patients: a clinical and microbiologic study. Kshitish D, Laxman VK. Indian J Dent Res. 2010 Jul-Sep;21(3):341-8. doi: 10.4103/0970-9290.70796.
30. Effect of ozone water on the inflammation and repair in infected wounds. HUANG Hua-jun, Hospital, Southern Medical University, Guangzhou 510515, China [2010-03](#)
31. Antimicrobial activity of super-oxidised water against oral microorganisms. Kiyotaka Yamada Archives of oral biology 55 (2010) 397 – 400
32. Does ozone water affect the bond strengths of orthodontic brackets? [Pithon MM](#), [dos Santos RL](#). [Aust Orthod J](#). 2010 May;26(1):73-7.
33. Management of gingival inflammation in orthodontic patients with ozonated water irrigation--a pilot study. [Dhingra K](#)<sup>1</sup>, [Vandana KL](#). [Int J Dent Hyg](#). 2011 Nov;9(4):296-302. doi: 10.1111/j.1601-5037.2011.00506.x
34. Antimicrobial effects of ozonated water on the sanitization of dental instruments contaminated with *E. coli*, *S. aureus*, *C. albicans*, or the spores of *B. atrophaeus* Julio César et al; SP, Brazil 2010
35. Ozonized Water in Dental Traumatology – A Preliminary Study on the Treatment of Avulsed Teeth, *in Vitro*. [D. Zimmermann](#), [T. Waltimo](#) & [A. Filippi](#) 2012
36. Study on Effects of Different Concentrations of Ozone Solution on the HBV Virus in Dental Unit Waterlines. YANG Xin, The First Central Hospital, Clinical College of Tianjin Medical University, Tianjin 300100, China
37. Evaluation of the Effect of Ozonized Water on Periodontium of Diabetic Rats. M. Zaki Der Pharmacia Sinica, 2012, 31(1):31-40
38. The antimicrobial effect of 0.1 ppm ozonated water on 24-hour plaque microorganisms *in situ*. Syed Sadatullah Braz Oral Res. 2012 Mar-Apr;26(2):126-31
39. Effect of Ozonised water on Chronic Periodontitis - A Clinical Study. Katti SS, Chava VK. Effect of Ozonised water on Chronic Periodontitis - A Clinical Study. J Int Oral Health 2013;55(1):79-84.

40. Aqueous-ozone irrigation of bone monocortical wounds in hyperglycemic rats. Alexandre Viana Acta Cirúrgica Brasileira - Vol. 28 5) 2013 – 327
41. 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. [Hayakumo SCLin Oral Investiq.](#) 2013 Mar;172):379-88. doi: 10.1007/s00784-012-0711-7
42. Effects of ozone nano-bubble water on periodontopathic bacteria and oral cells -in vitro studies. Sae HayakumoSci. Technol. Adv. Mater. 15 (2014) 055003
43. Ozone as an adjunct to conventional nonsurgical therapy in chronic periodontitis: a randomized controlled clinical trial. Al Habashneh R, Alsalman W, Khader Y. J Periodontal Res. 2015 Feb;501):37-43. doi: 10.1111/jre.12177.
44. Comparison of the antimicrobial activity of three different concentrations of aqueous ozone on *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Enterococcus faecalis* – in vitro study Nogales, CG. Revista Española de Ozonoterapia vol. 4, nº 1. pp. 9-15, 2014
45. Antibacterial Efficacy of Aqueous Ozone in Root Canals Infected by *Enterococcus faecalis* Ihsan Hubbezoglu Jundishapur J Microbiol. 2014 July; 77): e11411.
46. Antimicrobial effect of ozonated water, sodium hypochlorite and chlorhexidine gluconate in primary molar root canals Zeynep Goztas Eur J Dent 2014;8:469-74.
47. Ozone and Its Role in Periodontal Therapy-A Review. Dr. Vinutha R.S , BDS 1, Dr. Reema Lakshmanan, MDS 2 Journal of Dental and Medical Sciences IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861. Volume 13, Issue 1 Ver. IX.
48. Disinfection of Dental Instruments Contaminated with *Streptococcus mutans* Using Ozonated Water Alone or Combined with Ultrasound Pâmela Maria Moreira Fonseca. International Ozone Association ISSN: 0191-9512 print / 1547-6545 online DOI: 10.1080/01919512.2014.904740
49. Evaluation of effect of topical ozone therapy on salivary Candidal carriage in oral candidiasis. [Khatri I](#), [Moger G](#), [Kumar NA](#). [Indian J Dent Res](#). 2015 Mar-Apr;262:158-62. doi: 10.4103/0970-9290.159146.
50. Microorganisms Inactivation by Ozone Dissolved in Aqueous Solution: A Kinetic Study Based on Bacterial Culture Lipids Unsaturation. Arizbeth Pérez, Tatiana Poznyak & Isaac Chairez. Accepted author version posted online: 14 Jan 2015. Ozone: Science & Engineering: 10.1080/01919512.2014.917947 / 14 Jan 2015
51. Effect of Instrumentation Techniques, Irrigant Solutions and Artificial accelerated Aging on Fiberglass Post Bond Strength to Intraradicular Dentin. [Santana FR](#), [Soares CJ](#), [Silva JA](#), [Alencar AH](#)<sup>1</sup>, [Renovato SR](#), [Lopes LG](#), [Estrela C](#) . [J Contemp Dent Pract](#). 2015 Jul 1;167):523-30.
52. A Comparative Analysis of Antimicrobial Property of Wine and Ozone with Calcium Hydroxide and Chlorhexidine. [Anand SK](#), [Ebenezar AV](#), [Anand N](#), [Mary AV](#), [Mony B](#). [J Clin Diagn Res](#). 2015 Jun;96 :ZC04-6. doi: 10.7860/JCDR/2015/11355.6030.
53. Effects of Ozone Therapy on the Early Healing Period of Deepithelialized Gingival Grafts: A Randomized Placebo-controlled Clinical Trial. [J Periodontol](#). 2016 Jun;876):663-71. doi: 10.1902/jop.2016.150217.
54. Influence of ozone and paracetic acid disinfection on adhesion of resilient liners to acrylic resin. [Ekren O](#)<sup>1</sup>, [Ozkumur A](#)<sup>1</sup>. [J Adv Prosthodont](#). 2016 Aug;84):290-5. doi: 10.4047/jap.2016.8.4.290. Epub 2016 Aug 18.
55. Effect of ozone to remineralize initial enamel caries: in situ study. [Samuel SR](#), [Dorai S](#), [Khatri SG](#)<sup>3</sup>, [Patil ST](#)<sup>4</sup>. [Clin Oral Investiq](#). 2016 Jun;205):1109-13. doi: 10.1007/s00784-016-1710-x.
56. Antibacterial effects of two different types of laser and aqueous ozone against *Enterococcus faecalis* in root canals. [Zan R](#)<sup>1</sup>, [Hubbezoglu I](#), [Sümer Z](#), [Tunç T](#), [Tanalp J](#). [Photomed Laser Surg](#). 2013

## Ozonated Oil

1. Mandible-Ozone Therapy for Osteomyelitis: Literature Review and Case Report. S. BRUZADELLI-MACEDO - C.C. CARDOSO - A.S. MAYRINK G. DEMARTINI - F. FRASCHINI. *International journal on drugs and therapy* Vol. XIX - n. 1/2 77-81) – 2002
2. **Suppressive effects on immune cells and oxidative cytotoxicity of ozonated olive oil. Japan 2005**
3. Periradicular Repair after Two-Visit Endodontic Treatment Using Two Different Intracanal Medications Compared to Single-Visit Endodontic Treatment. Adriana M. Vieira SILVEIRA Hélio P. LOPES José F. SIQUEIRA Jr Sérgio B. MACEDO Alberto CONSOLARO. *Braz Dent J* 2007) 184): 299-304
4. Ozone therapy in extractive surgery on patients treated with bisphosphonates. [Agrillo A](#), [Sassano P](#), [Rinna C](#), [Priore P](#), [Iannetti G](#). *J Craniofac Surg*. 2007 Sep;185):1068-70.
5. Ozone Therapy in the Treatment of Avascular Bisphosphonate-Related Jaw Osteonecrosis. AllesandroAgrillo, MD, PhD, Claudio Ungari, MD, Fabio Filiaci, MD, Paolo Priore, MD, Giorgio Iannetti, MD, PhD, Rome, Italy *The Journal of Craniofacial Surgery*, 18 (5) September 2007
6. Role of ozone therapy in the treatment of osteonecrosis of the jaws in multiple myeloma patients. Maria Teresa Petrucci, Cristiano Gallucci, Alessandro Agrillo, Maria Cristina Mustazza, Robin Foà. Hematology, Department of Cellular Biotechnologies and Hematology; Clinica Maxillo-Facial University “La Sapienza” of Rome, Italy *Haematologica* 2007; 92:1289-1290. DOI: 10.3324/haematol.11096
7. Effect of bleaching versus repolishing on colour and surface topography of stained resin composite. [Abd Elhamid M<sup>1</sup>](#), [Mosallam R](#). *Aust Dent J*. 2010 Dec;55(4):390-8. doi: 10.1111/j.1834-7819.2010.01259.x. El Seka El Haded Hospital, Cairo, Egypt.
8. Efficacy and safety of medical ozone O<sub>3</sub>) 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 q. Carla Ida Ripamonti, Enrico Cislighi b, Luigi Mariani c, Massimo Maniezzo *Oral Oncology* 47 2011)
9. Evaluation of the Effect of Ozonated Plant Oils on the Quality of Osseointegration of Dental Implants under the Influence of Cyclosporine A: An *In Vivo* Study Amany A. El Hadary *Egypt 2011*
10. Effect of Oleozon on Healing of Exposed Pulp Tissues. Rania Sayed Mosallam; Amany Nemat; Ahmed El-Hoshy and Shiro Suzuki. *Journal of American Science*, 2011;75)
11. **Ozonized oils: a qualitative and quantitative analysis.**
12. Therapeutic effect of topical ozonated oil on the epithelial healing of palatal wound sites: a planimetric and cytological study. [Patel PV<sup>1</sup>](#), [Kumar V](#), [Kumar S](#), [Gd V](#), [Patel A](#). *J Invest Clin Dent*. 2011 Nov;24):248-58. doi: 10.1111/j.2041-1626.2011.00072.x.
13. Effect of subgingival application of ozonated olive oil in chronic periodontitis: a controlled, randomized double blind clinical study PV Patel – J Holmes 2012. [Guinesi AS<sup>1</sup>](#), [Andolfatto C](#), [Bonetti Filho I](#), [Cardoso AA](#), [Passaretti Filho J](#), [Farc RV](#). *Braz Dent J*. 2011;22(1):37-40.
14. Evaluation of ozonated olive oil on post-surgical root dentin hypersensitivity: a randomized, double-blinded, controlled, clinical trial MINERVA STOMATOL 2013;62:147-161
15. Ex-vivo effect of intracanal medications based on ozone and calcium hydroxide in root canals contaminated with *Enterococcus faecalis*. [Farc RV<sup>1</sup>](#), [Pizzolitto AC](#), [Tanomaru JM](#), [Morgental RD](#), [Lima RK](#), [Bonetti-Filho I](#). *Braz Dent J*. 2013;24(2):103-6. doi: 10.1590/0103-6440201301992.
16. The effects of subgingival application of ozonated olive oil gel in patient with localized aggressive periodontitis. A clinical and bacteriological study M.Y.M. Shoukheba, Sh.A. Ali. *Tanta Dental Journal* 11 (2014) 63e73
17. Success of root fillings with zinc oxide-ozonated oil in primary molars: preliminary results. [Chandra SP<sup>1</sup>](#), [Chandrasekhar R](#), [Uloopi KS](#), [Vinay C](#), [Kumar NM](#). *Eur Arch*



- [Paediatr Dent](#). 2014 Jun;153):191-5. doi: 10.1007/s40368-013-0094-8
18. Impact of experimental conditions on the composition and the antibacterial activity of ozonized oils. Moureu S, Violleau F, Ali Haimoud-Lekhal D, Calmon A1. *Chem Phys Lipids*. 2015 Jan 23. pii: S0009-3084(15)00005-5. doi: 10.1016/j.chemphyslip.2015.01.004.
  19. Efficacy of OLEOZON® compared to Alvogil in the treatment of alveolitis. Judit Martínez Abreu1 *Journal of Ozone Therapy*, Vol 1, Nº 1, December 2015
  20. Efficacy of ozonized olive oil in the management of oral lesions and conditions: A clinical trial. [Tarun Kumar](#), [Neha Arora](#), [Gagan Puri](#), [Konidena Aravinda](#), [Avani Dixit](#), and [Deepa Jatti](#) [Contemp Clin Dent](#). 2016 Jan-Mar; 71): 51–54.
  21. Does Topical Ozone Therapy Improve Patient Comfort After Surgical Removal of Impacted Mandibular Third Molar? A Randomized Controlled Trial. [Sivalingam VP](#), [Panneerselvam E](#), [Raja KV](#), [Gopi G](#)<sup>4</sup>. [J Oral Maxillofac Surg](#). 2017 Jan;75(1):51.e1-51.e9. doi: 10.1016/j.joms.2016.09.014. Epub 2016 Sep 16.
  22. **Application of Oleozon in the Treatment of Subprosthesis Stomatitis.** L. Lemus, E. Ordaz, E. Rodríguez. *Briones Montoto Dental Clinic, Pinar del Rio, Cuba.*
  23. Ozonated Olive Oil with a High Peroxide Value for Topical Applications: In-Vitro Cytotoxicity Analysis with L929 Cells [Yasemin Günaydın](#), [Handan Sevim](#), [Deniz Tanyolac](#) & [Özer A. Gürpınar](#) *Ozone: Science & Engineering*, DOI: 10.1080/01919512.2017.1341832
  24. Therapeutic Effects of Topical Application of Ozone on Acute Cutaneous Wound Healing. Hee Su Kim; *J Korean Med Sci* 2009; 24: 368-74 ISSN 1011-8934 DOI: 10.3346/jkms.2009.24.3.368
  25. Antibacterial activity of ozonized sunflower oil (Oleozone). [Sechi LA](#), [Lezcano I](#), [Nunez N](#), [Espim M](#), [Duprè I](#), [Pinna A](#), [Molicotti P](#), [Fadda G](#), [Zanetti S](#). [J Appl Microbiol](#). 2001 Feb;90(2):279-84.
  26. Comparison of the antibacterial activity of an ozonated oil with CHX and povidone-iodine. Marco Montevecchi<sup>1</sup>, Antonio Dorigo<sup>1</sup>, Monica Cricca<sup>2</sup>, Luigi Checchi<sup>1</sup>. *New microbiologica*, 36, 289-302, 2013
  27. Effect of ozone on osseointegration of endosseous implants in osteoporotic bone. Yusr O. Mady and Amal Hassan Source: *Egyptian Dental Journal*, 2006, 52 , 1.2, 307

### Ozone Gas-Water

1. In vitro testing of a denture cleaning method using ozone. [Oizumi M](#), [Suzuki T](#), [Uchida M](#), [Furuya J](#), [Okamoto Y](#). [J Med Dent Sci](#). 1998 Jun;45(2):135-9.
2. Effect of ozone on oral cells compared with established antimicrobials. Huth KC, Jakob FM, Saugel B, Cappello C, Paschos E, Hollweck R, Hickel R, Brand K. Effect of ozone on oral cells compared with established antimicrobials. *Eur J Oral Sci* 2006; 114: 435–440.
3. Antimicrobial efficacy of ozonated water, gaseous ozone, sodium hypochlorite and chlorhexidine in infected human root canals. C. Estrela, C. R. A. Estrela, D. A. Decurcio, A. C. B. Hollanda & J. A. Silva. *International Endodontic Journal* *International Endodontic Journal*, 40, 85–93, 2007.
4. Effectiveness of ozone against endodonto-pathogenic microorganisms in a root canal biofilm model. K. C. Huth<sup>1</sup>, M. Quirling<sup>1,2</sup>, S. Maier, K. Kamereck, M. AlKhayer, E. Paschos, U. Welsch, T. Miethke, K. Brand & R. Hickel<sup>1</sup> *International Endodontic Journal* 42, 3–13, 2009
5. Activity of ozonated water and ozone against *Staphylococcus aureus* and *Pseudomonas aeruginosa* biofilms. Dariusz Bialoszewski *Med Sci Monit*, 2011; 17(11): BR339-344
6. Gaseous and Aqueous Ozone Therapy for Treatment of Mucositis Secondary to Chemotherapy Radiotherapy. James E. Shenberg, and Charles Blumthe / *Pain Practitioner*. Fall 2011

7. Influence of Ozone Gas and Ozonated Water Application to Dentin and Bonded Interfaces on Resin-Dentin Bond Strength. [Garcia EJ](#), Brazil [J Adhes Dent](#). 2012 Jan 11. doi: 10.3290/j.jad.a22707.
8. Antibacterial Effect of Gaseous and Aqueous Ozone in Root Canals Infected by *Enterococcus Faecalis*. Recai Zan, Ihsan Hubbezoglu, Zeynep Sumer & Tutku Tunc
9. *Ozone: Science & Engineering*, 36: 264–268 Copyright © 2014 International Ozone Association ISSN: 0191-9512 print / 1547-
10. Therapeutic effects of Ozone therapy in adult periodontitis treatment, subtypes I and II. MSc. Dra. Judit Martínez Abreu 1, Dr. Mark T. Weisser, DC Silvia Menéndez Cerero. *Journal of Ozone Therapy*, Vol 1, N° 1 December 1), 2015
11. Effects of different cavity-disinfectants and potassium titanyl phosphate laser on microtensile bond strength to primary dentin. [Oznurhan F<sup>1</sup>](#), [Ozturk C](#), [Ekci ES](#). [Niger J Clin Pract](#). 2015 May-Jun;183):400-4. doi: 10.4103/1119-3077.151774.
12. Ozone therapy as an adjuvant for endodontic protocols: microbiological – *ex vivo* study and cytotoxicity analyses. Carlos Goes NOGALES<sup>1</sup>, Marina Beloti FERREIRA<sup>1</sup> *Appl Oral Sci*. 2016;246):607-13
13. Clinical and radiographic evaluation the effect of ozone therapy on tissue surrounding implant retained mandibular overdentures. Iman M.S. Matar Department of Prosthodontics, Faculty of Dentistry, Pharos University, Alexandria, Egypt. *Revista Española de Ozonoterapia* vol. 6, n° 1. pp. 51-62, 2016
14. Effect of Ozone and CO<sub>2</sub> Laser on Dental Caries Progression. [K.A. ALI<sup>1</sup>](#), R. SEGHI, M. MOHSEN, M. SALAH EL DIN, M. HASAN, and H. ABD EL MAGUID, College of Dentistry, Suez Canal University, Egypt, Columbus, OH, USA, Ohio State University, Columbus, USA, Faculty of Oral and Dental Medicine, Cairo University, Egypt, College of Dentistry, Suez Canal University, Ismailia
15. Antifungal Efficacy of Aqueous and Gaseous Ozone in Root Canals Infected by *Candida albicans*. Ihsan Hubbezoglu, Recai Zan 2, Tutku Tunç, Zeynep Sumer, Feridun Hurmuzlu Cumhuriyet. *Jundishapur Journal of Microbiology*. 2013 July; 65): e8150. DOI: 10.5812/jjm.8150

### Topical - Systemic

1. Ozone-oxygen therapy in maxillo-facial bone surgery. Malanchuk V.A., Kopchak A.V. Department of Oral and Maxillo-Facial Surgery, National Medical University Zoologichna, Kiev, Ukraine
2. Ozone influence on the mandible regeneration in rats. V.A. Malanchuk, A.V. Kopchak, V.V. Grigorovsky. Department for Oral and Maxillo-facial Surgery National Medical University, Kiev, Ukraine
3. A comparison of the biostimulatory effect of local and systemic ozone application on bone healing in the midpalatal suture after rapid maxillary expansion of rats. Sherif S Marcos, Mohamed A Ahmed, Mohamed N Mawsouf and Abadi M El Kadi.
4. The Effect of Ozone on the Lipid Peroxidation Processes in Case of Mandible Fractures. N.E. Homutinnikova<sup>1</sup>, E.A. Durnovo, Nizhny Novgorod State Medical Academy, Department of Surgical Dentistry and Maxillofacial Surgery, Minin sg. 10/1, 603005, Nizhny Novgorod, RUSSIA.
5. Histomorphometric evaluation of the effect of systemic and topical ozone on alveolar bone healing following tooth extraction in rats F. Erdemci, Y. Gunaydin, *Int. J. Oral Maxillofac. Surg*. 2014; 43: 777–783
6. Systemic and intra-articular ozone therapy in temporomandibular joint arthritis with rheumatoid arthritis. Méndez-Pérez, Ivonne; Menéndez-Cepero, Silvia

## References

1. Schwartz-Tapia A, Martínez-Sánchez G, Sabah F, et al. Madrid Declaration on Ozone Therapy. . *ISCO3*. 2015:50.
2. Renate VH, Sonia LFO, Fahmy Z. Ozone in Medicine: Clinical Evaluation and Evidence Classification of the Systemic Ozone Applications, Major Autohemotherapy and Rectal Insufflation, According to the Requirements for Evidence-Based Medicine. *Ozone: Science & Engineering*. 2016:25.
3. José Oswaldo dOJ, Gustavo VL. Ozone therapy for lumbosciatic pain. *Rev Dor. São Paulo*. 2012;13(3):261-270.
4. De Oliveira Magalhaes FN, Dotta L, Sasse A, Teixera MJ, Fonoff ET. Ozone Therapy as a Treatment for Low Back Pain Secondary to Herniated Disc: A Systematic Review and Meta-analysis of Randomized Controlled Trials. *Pain Physician*. Mar 2012;15(2):E115-129.
5. Steppan J, Meaders T, Muto M, Murphy KJ. A metaanalysis of the effectiveness and safety of ozone treatments for herniated lumbar discs. *J Vasc Interv Radiol*. Apr 2010;21(4):534-548.
6. TECHNOLOGY H. 2011; <http://www.healozone.de/en>. Accessed 14/02, 2018.
7. Ozonytron. Germany. <https://www.ozonytron.com/en>. Accessed 14/02, 2018.
8. W&H. Austria. [www.wh.com/en\\_global](http://www.wh.com/en_global). Accessed 14/02, 2018.
9. ISCO3, Martínez-Sánchez G, Lozano ÓL. Physico-chemical characterization of ozonized oil. Peroxide Value. <http://isco3.org/officialdocs/#4>. 2016;ISCO3/LAB/00/04