



Microscopy in Endodontics: A Bibliometric Survey

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Abstract

Background: Microscopy is a resource used in endodontics as an aid in the study of pulp and periapical pathologies; it has allowed Endodontics to become more accurate, less invasive and has enabled greater chances of success in treatment. We aimed to map the scientific production on “microscopy” and “endodontics” in the databases, the ISI Web of Knowledge/Web of Science™.

Methods: This bibliometric survey was conducted using ISI Web of Knowledge/Web of Science database, in the time frame between the years 1945 and 2016, the first being found in 1981.

Results: Overall, 287 articles were identified. These articles are published in 63 different journals and were written by 1145 authors who have links to 336 institutions, located in 46 countries. To achieve these articles, 5,668 references were used, with an average of approximately 20 references per article. In the national literature the number of studies on the subject is broad compared to the international literature.

Conclusion: The bibliometric review showed the potential of microscopy in clinical practice, the continuity of the investigation, in view of the need to expand knowledge on the topic that remains relevant.

Keywords: Microscopy; Endodontics; Bibliometrics

Introduction

Endodontics is the science that involves the etiology, prevention, diagnosis and treatment of pathological changes in the dental pulp and its repercussions in the periapical region and consequently in the organism (1). The microscope stands out as an important tool for the diagnosis of pathologies, identification of microorganisms, assists in clinical treatment by magnifying the

field of work and helps in the development of research within the field of endodontics, analyzing, for example, the degree of penetration of endodontic cements in lateral root canals (2).

For a long time, endodontic practice depended on tactile sensitivity to perform the procedures, with radiography as an aid in diagnosis and treatment, which is not accurate, as it shows only



two dimensions of a three-dimensional object (3). The use of the Operating Microscope (OM) was first proposed in 1977 by Baumann (4). In dentistry, microscopy was introduced through endodontics in 1986 (5).

OM offers many benefits. High magnification helps in locating calcified root canals, detecting microfractures, identifying isthmus, interpreting the complexities of the root canal system, aiding in the removal of fractured instruments and in coronary access (6).

The equipment allows the procedures to be adjusted according to the increased visual capacity conferred and the coaxial lighting. Its use is essential for the treatment results to be successful and longevity (7).

It is also used for studies of cells and tissues of the pulp and periapical region, biocompatibility study of materials used in endodontics, in addition to diagnosing pathologies that affect the periapical region and pulp stem cells (8,9).

The Scanning Electron Microscope (SEM) allows for magnifications of 300,000 times or more. It is used for analyzing the microstructure of solid materials and visualizing the interface of various materials to dental tissues. The images generated by SEM are easily interpreted (10).

We aimed to map the scientific production of great impact on the use of microscopy in endodontics, the importance of various types of microscopes, their use in clinical practice or in the development of scientific research.

Materials and Methods

Bibliometric research was conducted using one of the main methods of quantitative, exploratory and descriptive analysis for scientific research in which its data measure the contribution of knowledge derived from publications in certain areas and helps in the development of other studies with the same methodology (11-13). An exploratory and descriptive bibliometric research with a quantitative technique was conducted. For data collection, the search period available in the main database, Web of Science[™], for years 1945-

2016 was used in order to allow the replication or update of this study without the need to perform it again from the beginning. Thus, defined search terms were: “microscop *” (it was used to enable the search with the words “microscope” and “microscopy”) and “endodontics”. These two terms represent the association intended to meet the objective of the study. The collection was carried out from the search for these terms in the "topic", which represents the title of the articles, abstracts, author's keywords and created keywords (Keywords plus). The results showed the first publication record in 1981. After the search, 287 papers were identified that were used as a set of articles for the bibliometric analyzes proposed in this research. There was no filter for areas of knowledge, countries or languages of the studies covering all records of publications that had the two terms in association. After the search, articles from events or still being edited (Conference Proceedings) and records from “preceedings papers”, “editorial material” and “letter” were excluded from the results, resulting only in final and complete papers ”article” and “review” (articles and reviews).

After the data collection, the material was analyzed from the export of these data to the HistCite[™] bibliometric analysis software package, in order to organize the information and facilitate the analysis. The trajectory of the annual evolution of publications was analyzed, the journals with the greatest number of records, the authors with the greatest number of publications, the number of articles distributed by the authors' parents of origin, the articles most cited in the Web of Science (global) and those most cited in the set of selected articles (location). These organized data are presented in the results section. In addition to this data generated by the software, general aspects of the texts of the seventeen articles that compose that make up the two most cited work groups were identified in order to identify their main contributions to the theme in analyzes and their interrelationships in citations identified between these texts. The results of these analyzes are presented in the discussion section.

Results

After conducting the bibliometric survey in the main collection of the *Web of Science*[™], 287 articles on pain and dentistry were identified. These articles are published in 63 different journals indexed to the database in question and were written by

1145 authors who have links to 336 institutions, located in 46 countries. To achieve these articles, 5668 references were used, with an average of approximately 20 references per article. These results are presented from Tables 1-4 and according to Figs. 1 and 2.

Table 1: General Results of the Bibliometric Survey on Microscopy/Endodontics (1981-2016)

<i>Bibliometric Data</i>	<i>Amount</i>
Publications (articles)	287
Indexed journals	63
Authors	1145
Institutions (authors' Affiliations)	336
Countries	46
References cited	5.668

Source: Own elaboration based on data from *Web of Science*.

Table 2: Top Journals with more articles published (1981-2016)

<i>Journal</i>	<i>Amount of Articles</i>	<i>Citations</i>
Journal of Endodontics	92	1655
International Endodontic Journal	38	565
Microscopy Research and Technique	20	65
Journal of Applied Oral Science	15	55
Lasers in Medical Science	10	105
Australian Endodontic Journal	6	36
Dental Materials	5	53
Scanning	5	1
Brazilian Oral Research	4	5
British Dental Journal	4	28

Source: Own elaboration based on data from *Web of Science*.

Table 3: Authors with the largest number of publications (1981-2016)

<i>Authors</i>	<i>Amount of Articles</i>	<i>Affiliation</i>	<i>Country</i>
So MVR	17	Federal University of Rio Grande do Sul	Brazil
Kuga MC	14	State University of São Paulo	Brazil
Duarte MAH	10	University of Sao Paulo	Brazil
Faria G	10	State University of São Paulo	Brazil
Bottino MC	9	Indiana University	USA
da Rosa RA	7	Federal University of Rio Grande do Sul	Brazil
Santini MF	7	Federal University of Rio Grande do Sul	France
Silva-Sousa YTC	7	University of Ribeirão Preto	Brazil
de Figueiredo JAP	6	Pontifical Catholic University of Rio Grande do Sul	Brazil
Grecca FS	6	Federal University of Rio Grande do Sul	Brazil

Source: Own elaboration based on data from *Web of Science*.

Table 4: Number of articles by country of origin of the authors' affiliations

<i>Country</i>	<i>Amount</i>
Brazil	94
United States of America	70
United Kingdom	20
Germany	19
China	13
Australia	11
Iran	11
Italy	10
Japan	10
Canada	9

Source: Own elaboration based on data from *Web of Science*.



Fig. 1: Distribution of publications on Microscopy / Endodontics (1981-2016)

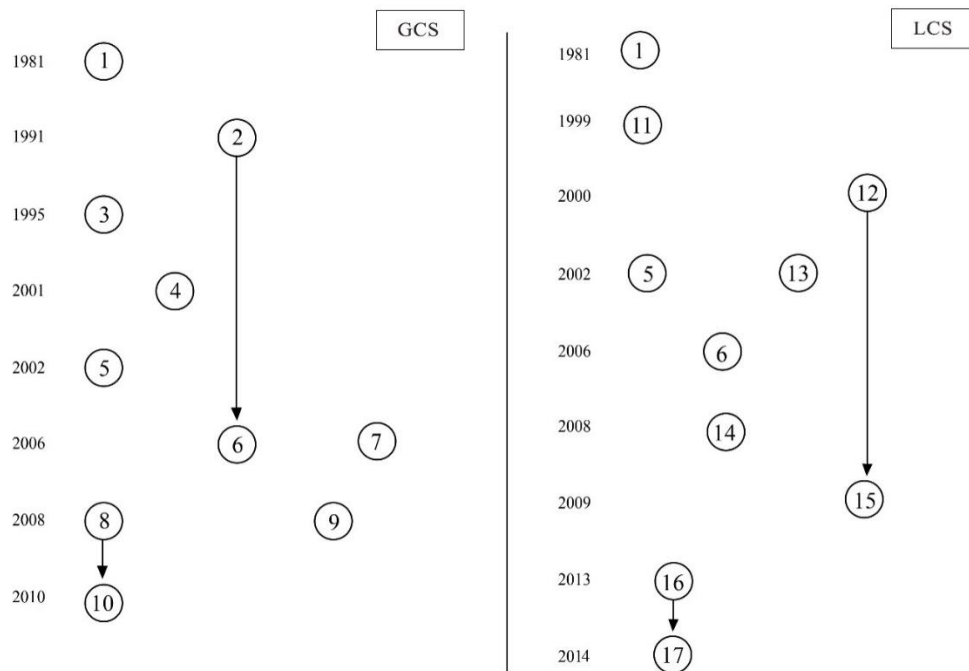


Fig. 2: Legend: GCS – *Global Citation Score* (Top 10 articles on the topic that received the most citations in *Web of Science*)

LCS – *Local Citation Score* (Top 10 articles on the topic that received the most citations from the selected articles)

1 – Godan et al. (1981)

2 – Molven; Olsen & Kerekes (1991)

3 – Moshonov et al. 1995

4 – Kuhn; Tavernier; Jordan, 2001

5 – Guerisoli et al 2002

6 – Clegg et al 2006

7 – Schoop et al 2006

8 – Cordeiro et al 2008

9 – Prescott et al 2008

10 – Sakai et al 2010

11 – Mines et al 1999

12 – Moritz et al 2000

13 - Mayer; Peters; Barbakow, 2002

14 - Chopra; Murray; Namerow, 2008

15 – Schoop et al 2009

16 – Bottino et al 2013

17 – Palasuk et al 2014

Discussion

In terms of global citation, the first article was using scanning electron microscopy, a study (14) in which the authors aimed to compare the efficacy of three irrigants: TEGO, sodium hypochlorite and RDTA, using needles with lateral perforation. The results prove the effectiveness of the system. Needle in intracanal irrigation as it produces a greater distribution of the solution and the effects of any irrigant are probably improved. RDTA showed superior results when compared to TEGO and sodium hypochlorite, however, the three solutions tested did not com-

pletely remove Smear Layer (dentin sludge). The authors suggested studies with new materials or combinations.

Ten years later, Molven et al (15) also used SEM, in order to evaluate the bacterial profile of the apical region of teeth with injury. The authors used six extracted teeth in the study, which had pulp necrosis and radiographically visible periapical lesion. The teeth were fixed in gluteraldehyde and then washed in distilled water, dehydrated in ethanol and the critical point was dried with carbon dioxide as the transition fluid. The dried specimens were spray coated with a 400 Å platinum layer and scanned for SEM evaluation. The

topography of the canal flora was made up of filamentous bacteria, however coccus and spirochetes were also found.

Clegg et al. (16) used the work of Molven et al. (15) as a reference. The authors evaluated the efficacy of different concentrations of sodium hypochlorite (NaOCl) and 2% chlorhexidine (CHX) in specimens grown in apexes with the objective of forming bacterial biofilm. The teeth were immersed in sodium hypochlorite at 6%, 3% and 1% and chlorhexidine at 1% and 2% and observed the interruption of biofilm formation and bacteria elimination. The specimens were observed through SEM. The sodium hypochlorite 6% was the only irrigant capable of rendering the bacteria non-viable and physically removing the biofilm. The OM was used in order to study stem cells from teeth (SHED), the authors observed that stem cells (SHED) differentiated into cells similar to odontoblasts (8). This work was already mentioned in 2010 (17) in an article using confocal microscopy in which stem cells were researched. The work aimed to test the hypothesis that stem cells from exfoliated primary teeth (SHED) differ in functional odontoblasts and endothelial cells. SHED can be induced to differentiate into functional odontoblasts and endothelial cells.

At the level of local citation, the first article had as reference the subject on the Effectiveness of Various Irrigation Solutions for Endodontics: A SEM, in which it aimed to compare the effectiveness of three irrigating substances through needles with perforated tips, concluded that the irrigations with perforated needles were more effective in the result, and that the solutions used produced a free channel, although in the end none was completely sufficient being used alone (14).

About 18 years later, another article (18) on the use of the microscope in endodontics that had only local impact, where he used a questionnaire on the OM, in order to determine how the microscope is used, the specific treatment procedures, formal training, and the most difficult difficulties. Common with its use and in the final result that 52% of the endodontists surveyed

have access and use the OM in their practices. Of those surveyed who use OM, 36% report not using it as often as at the beginning.

In the following year, another study (19) was published with the use of SEM, with the objective of evaluating the specific effect of irradiation through dentin on gram-negative and gram-positive bacteria in relation to their cell structure and the final result shows that Nd laser irradiation: YAG is capable of disinfecting even the deepest layers of the cell wall. This work was mentioned by Schoop (20) where SEM was also used and with the objective of evaluating the effectiveness of the applied irradiation through a fiber tip with a diameter of 200 μm .

In 2013, another work (21) was also published using the SEM, research on morphology, diameter, bacterial structure, which aimed to evaluate the mechanical properties of synthesized materials containing antibiotics, which resulted in the lower concentration being clinically more beneficial and more important to avoid effects on viable stem cells. This work has already been cited by Palasuk et al. (22) in an article using SEM, a research with antimicrobial potential, which aimed to assess the antimicrobial potential of the combination of (MET and CIP), resulting in the antibacterial efficacy of antibiotics released from bimix scaffolding. Against Ef, Pg and Fn growth inhibition was seen.

Conclusion

The bibliometric review identified the growth of research on different types of microscopy and numerically expressing works of greater relevance at national and international level involving dentistry, more specifically endodontics. The stability in scientific production as of 2014 on the subject suggests continuity of research, in view of the need to expand knowledge on the topic that remains relevant.

The mapping made it possible to identify the years in which the publications had a trajectory of greater evolution, the journals which had the greatest number of records, authors with the

greatest number of publications and the number of articles distributed by country, with greater relevance at the global and local level.

According to the applied methodology, the topic has a high potential for study. Microscopy is a comprehensive resource, involving from clinical experience with visual magnification, as well as analysis of structure and tissues, such as stem cells.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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