

Research Article



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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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The top 10 most-cited articles on the management of fractured instruments: a bibliometric analysis

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ABSTRACT

Objectives: The purpose of this research was to identify the top 10 most-cited articles on the management of fractured or broken instruments and to perform a bibliometric analysis thereof.

Materials and Methods: Published articles related to fractured instruments were screened from online databases, such as Web of Science, Scopus, PubMed, and ScienceDirect, and highly cited papers, with at least 50 citations since publication, were identified. The most-cited articles were selected and analysed with regard to publication title, authorship, the journal of publication, year, institution, country of origin, article type, and number of citations.

Results: The top 10 most-cited articles were from various journals. Most were published in the *Journal of Endodontics*, followed by the *International Endodontic Journal*, and *Dental Traumatology*. The leading countries were Australia, Israel, Switzerland, the USA, and Germany, and the leading institution was the University of Melbourne. The majority of articles among the top 10 articles were clinical research studies ($n = 8$), followed by a basic research article and a non-systematic review article.

Conclusions: This bibliometric analysis revealed interesting information about scientific progress in endodontics regarding fractured instruments. Overall, clinical research studies and basic research articles published in high-impact endodontic journals had the highest citation rates.

Keywords: File fracture; Instrumentation; Nickel-titanium files; Root canal preparations; Root canal treatment

INTRODUCTION

With technological advancements, it has become important for clinicians and researchers to keep up to date with emerging trends, for which they consult research articles to make evidence-based clinical decisions. As practitioners are shifting towards rotary endodontic instruments, they are taking up the challenge to access narrow and curved canals for root canal treatment, as a result of which they encounter a variety of procedural accidents and obstacles to routine therapy [1]. One such obstacle is intracanal instrument fracture, which not only includes endodontic files, but can also include Gates Glidden burs, lentulo spirals,

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and finger spreaders. Fracture often results from improper use of an endodontic instrument [2], and it occurs most commonly in the apical third of a root canal due to its curvature [3-5]. An apt saying in this context is, 'the more we explore, the more we experience.' The increasing frequency of such events calls attention to research on fractured or broken instruments and their management.

Bibliometrics is the statistical analysis of written publications, such as books or articles. Bibliometric methods are frequently used in the field of library and information science, including scientometrics [6]. Bibliometric analysis is an assessment in which the quantitative and qualitative aspects of scientific articles are inspected, generating data that can help design policies to promote scientific output. These type of studies take in account expert opinions and judgments within a given discipline and provide useful, objective tools for studying the developmental processes at work in scientific activity [7].

As stated by Bellini [8], "There is no way for authors to obtain information about downloading of their articles unlike what is the possibility for citations." With 7 articles related to endodontics making it into the top 100 most cited articles in dentistry [9], so far only a single analysis, entitled 'Top-cited articles in endodontic journals,' was published in 2011 [10]. This article collects and analyses the top 10 most-cited articles on the management of broken/fractured instruments, which brought about a boost in the research field of endodontics and were of the utmost value to practitioners.

The following bibliometric analysis presents a comparison of these articles in terms of the journals where they were published, along with the type of study. The purpose of this citation analysis was to raise the awareness of fellow endodontists and practitioners about the significance of these findings regarding the management of broken/fractured instruments, which might be useful in the long-term.

MATERIALS AND METHODS

The top 10 most-cited articles about the management of fractured instruments were gathered from well-recognized journals, such as *Journal of Endodontics*, *International Endodontic Journal*, *Journal of the American Dental Association*, and *Dental Traumatology*, formerly known as *Endodontics & Dental Traumatology*. The number of citations was recorded with the assistance of the ISI Web of Science, Scopus, ScienceDirect, and Google Scholar databases, as of August 2017. The documentation of such articles started from 1970 and extended to 2016.

The following information was gathered for each report: the total number of citations, the name of the authors, the name of the institution, and the journal in which the article was published. Furthermore, the articles were classified by the type of study as basic research, clinical research, or review articles, and by methodological design as cohort studies, case-control studies, case reports, or randomized controlled trials.

We searched these databases using a series of related keywords that yielded a total of 106,097 results (Table 1). Duplicates were removed, and the records were screened. The articles were further sorted by the level of evidence relevant to endodontics, and ranged from randomized controlled trials to case reports and series [11].

Table 1. Search results for the keywords entered in various databases (results through August 2017)

No.	Keywords	Search results			
		Scopus	Web of Science	ScienceDirect	Google Scholar
1	Fractured endodontic instruments	209	502	3,528	18,400
2	Management of fractured endodontic instruments	25	21	984	18,300
3	Broken endodontic instruments in the root canal	61	51	1,496	12,400
4	Retrieval of broken endodontic instruments from the root canal	10	6	144	4,670
5	Separated endodontic instruments	72	83	2,527	16,100
6	Removal of fractured endodontic instruments from the root canal	55	53	1,700	24,700
Total		432	716	10,379	94,570

Table 2. Top 10 most-cited articles on fractured instruments and their management

No.	Study	Authors
1	Rotary NiTi instrument fracture and its consequences	Parashos P, Messer HH
2	The impact of instrument fracture on outcome of endodontic treatment	Spili P, Parashos P, Messer HH
3	Probability of removing fractured instruments from root canals	Suter B, Lussi A, Sequeira P
4	Influence of several factors on the success or failure of removal of fractured instruments from the root canal	Hülsmann M, Schinkel I
5	Evaluation of an ultrasonic technique to remove fractured rotary nickel-titanium endodontic instruments from root canals: an experimental study	Ward JR, Parashos P, Messer HH
6	Ultrasonic removal of broken instruments in root canals	Nagai O, Tani N, Kayaba Y, Kodama S, Osada T
7	Methods for removing metal obstructions from the root canal	Hülsmann M
8	Evaluation of an ultrasonic technique to remove fractured rotary nickel-titanium endodontic instruments from root canals: clinical cases	Ward JR, Parashos P, Messer HH
9	A method for the removal of broken endodontic instruments from root canals	Fors UG, Berg JO
10	The outcome of retained instrument removal in a specialist practice	Cujé J, Bargholz C, Hülsmann M

RESULTS

The top 10 most-cited articles were sorted by the number of citations from different databases. **Table 2** depicts the top 10 most-cited articles along with their authors, ranked in descending order. The data were compiled using various databases to minimize bias. **Table 3** comprises of the summary of top 10 most-cited articles on the management of fractured endodontic instruments, their contributing authors, the type of study, the publishing journal, the year of publication, and the number of citations from each database.

The top 10 most-articles were published in 3 different journals: *Journal of Endodontics*, *International Endodontic Journal*, and *Dental Traumatology*. Overall, 50% of the top 10 articles were from the *Journal of Endodontics*, with publication years ranging from 1983 to 2006. The leading countries were Australia, Israel, Switzerland, the USA, and Germany, and the leading institution was the University of Melbourne. The majority of articles among the top 10 articles were clinical research studies ($n = 8$), followed by a basic research article and a non-systematic review article.

DISCUSSION

The objective of this analysis was to identify the most influential articles that are referred to by various researchers and practitioners for managing complications during root canal treatment, because citations reflect the acknowledgment of the research presented in these articles in both research and practice [10]. The number of citations of the top 10 articles on Google Scholar ranged from 65 to 364, and the majority were clinical research.

Table 3. Top 10 most-cited articles on the management of fractured endodontic instruments with the total number of citations from various databases, with information including the authors, type of study, publishing journal, year of publication, and number of citations from respective databases

Article	Authors	Type of study	Journal	Year	Citations			
					Scopus	Web of Science	ScienceDirect	Google Scholar
Rotary NiTi instrument fracture and its consequences	Parashos P, Messer HH	RA	JOE	2006	199	149	199	364
The impact of instrument fracture on outcome of endodontic treatment	Spili P, Parashos P, Messer HH	CR	JOE	2005	95	78	95	219
Probability of removing fractured instruments from root canals	Suter B, Lussi A, Sequeira P	CR	IEJ	2005	60	52	NA	175
Influence of several factors on the success or failure of removal of fractured instruments from the root canal	Hülsmann M, Schinkel I	CR	DT	1999	55	NA	NA	160
Evaluation of an ultrasonic technique to remove fractured rotary nickel-titanium endodontic instruments from root canals: an experimental study	Ward JR, Parashos P, Messer HH	BR	JOE	2003	48	46	48	140
Ultrasonic removal of broken instruments in root canals	Nagai O, Tani N, Kayaba Y, Kodama S, Osada T	CR	JOE	1986	52	42	NA	124
Methods for removing metal obstructions from the root canal	Hülsmann M	CR	JOE	1993	51	38	NA	110
Evaluation of an ultrasonic technique to remove fractured rotary nickel-titanium endodontic instruments from root canals: clinical cases	Ward JR, Parashos P, Messer HH	CR	JOE	2003	45	34	45	99
A method for the removal of broken endodontic instruments from root canals	Fors UG, Berg JO	CR	JOE	1983	36	27	36	78
The outcome of retained instrument removal in a specialist practice	Cujé J, Bargholz C, Hülsmann M	CR	IEJ	2010	25	21	NA	65

JOE, *Journal of Endodontics*; IEJ, *International Endodontic Journal*; DT, *Dental Traumatology*; RA, review article; CR, clinical research; BR, basic research; NA, not available.

The highest-ranking article was a review entitled “Rotary NiTi instrument fracture and its consequences” [12], which had 199 citations in both Scopus and ScienceDirect; this article described the ramifications of fractured instruments, predisposing factors, different techniques for the removal of metals, and its prognosis (Table 3) [12]. The review article presents a summary of fractured instruments and their consequences, based on a thorough analysis of studies of various authors; possible predisposing factors for breakage; its prognosis; and different techniques of retrieval. The broad scope and importance of these topics justify the article's position at the top of our list of most-cited articles. This article was followed by “The impact of instrument fracture on outcome of endodontic treatment” [13], which was cited 95 times and falls into the category of clinical research. Both of those studies were conducted at the University of Melbourne, Australia, and were authored by Parashos and Messer [12] and Spili *et al.* [13]. Parashos and Spili contributed to 4 articles in the *Journal of Endodontics* that were included in the list of the top 10 most-cited articles on this topic.

Our search for the top 10 most-cited articles extended back to 1970. However, the oldest article on our list was by the authors Fors and Berg [14], and was published in the *Journal of Endodontics* in 1983. This article presented the methods used for removal of instruments from straight and tapered canals. The next article on our list was published in 1986 by Nagai *et al.* [15] in the *International Endodontic Journal*; this article contained a discussion of the removal of instruments through ultrasonic techniques. Over time, advances were made in removal techniques, and the most recent article on our list was a study on the micro-endodontic technique by Cujé *et al.* [16], published in the *International Endodontic Journal* in 2010 (Table 3).

With an impact factor of 2.886, the *Journal of Endodontics* is a highly influential journal that many endodontists rely upon, and this fact helps explain why 5 of its articles were included in the top 10 list. *International Endodontic Journal* has an impact factor of 3.015, and 3 of its articles made onto our list, followed by 2 articles from *Dental Traumatology*, with an impact factor of 1.414.

A fractured root canal instrument can be an endodontic file, a sectioned silverpoint, a segment of a lentulo spiral, a Gates Glidden drill, a portion of a carrier-based obturator, a finger spreader, or a paste filler [17]. As dentists' progress in the use of NiTi instruments for curved canal treatment instead of stainless steel instruments, clinicians have the burdensome task of removing them when they fracture. NiTi rotary instruments can be fractured during treatment due to many predisposing factors, including the operator's skill, the instrumentation technique, the anatomy of the root canal system, the number of times the instrument has been used, the instrument design, the manufacturing process, and cleaning and sterilization [18].

The most-cited study focused on the Masserann technique, the Endo-Extractor, the Canal Finder System, and the wire loop technique, as well as ultrasonic techniques using ProFile insertion and Gates Glidden platforming, for the removal of the fractured metallic instruments from the root canal [12]. The conventional method includes obtaining access using a Gates Glidden drill, followed by the introduction of a K-file either to loosen up the fractured instrument or to bypass it, and its overall success rate is 66.6%. The ultrasonic method yielded a success rate of 93.3% for the retrieval of broken instruments through the use of ultrasonic tips in the curved canal. The Masserann kit (Micro-Méga, Besançon, France) has been used for over 30 years as a device for removing broken intracanal instruments. However, the conventional and ultrasonic techniques were found to be more effective in the removal of instruments than the Masserann technique in straight canals. Care must be taken to avoid perforations during instrument retrieval using any of the above procedures [19].

The results obtained in this bibliometric study from a search for the top 10 most-cited articles on the management of fractured instruments contained no systematic reviews, meta-analyses, or randomized controlled trials, which are considered to correspond to the highest level of evidence. Hence, future research in these categories would be beneficial to find the most suitable method for the retrieval of fractured instruments in the canal.

CONCLUSIONS

This bibliometric analysis revealed interesting information about scientific progress in endodontics regarding fractured instruments. Overall, clinical research studies and basic research articles published in high-impact endodontic journals had the highest citation rates.

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