

# DECISION-MAKING PROCESS IN ENDODONTIC PRACTICE

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Clinical decision-making regarding retention and treatment or extraction can be a significant challenge that is a complex process influenced by clinical and non-clinical factors (Abdulrahman et al., 2020). Clinicians commonly face the dilemma for decide on endodontically treating for retaining a tooth or extracting based on multiple risk factors including endodontic and periodontal criteria, remaining tooth structure, the extent of previous restorations as well as the strategic value of the tooth (El-Swiah & Walker, 1996; Mohammed Edrees Sayed, Carlos Alberto Jurado, Akimasa Tsujimoto, & Jose Obed Garcia-Cortes, n.d.; N. U. Zitzmann, Krastl, Hecker, Walter, & Weiger, 2009; Nicola U Zitzmann et al., 2010).

Treatment selection and choice may be based more on prior experiences and inherent biases than objective probabilities. The evidence of science proved that patient-related factors influence the treatment plan, however according to a study by Re et al. (2017), when the patient is a dentist, more conservative treatment options are preferred. Although different reasons are debatable; the answer that the dentists gave to the question "If this was your tooth?" is one of the proofs of this situation. Spangberg highlighted that there is a clinical practice in endodontics for which solutions are given based on opinion (Spångberg, 2001). While the decision mechanism is very crucial even in teeth with clear indications

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based on evidence, the situation becomes very complicated in teeth with suspicious prognoses. Evidence-based practice has become the new paradigm in all fields of medicine, as well as in the field of dentistry, and endodontics. The American Dental Association (ADA) suggested a definition of the term evidence-based dentistry in 1999, "... evidence-based dentistry is an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences."(Chiappelli, 2019). Therefore, when making a decision, the current situation and the prognosis probabilities should be discussed concerning evidence-based data and the patient. In this regard, engaging patients in shared decision-making is an indispensable requirement (Azarpazhooh et al., 2016; Rajagopal & Kelly, 2020).

Meta-analysis and systematic reviews, essential tools to summarize specific topics and at the top of the evidence pyramid, can be used to reach clear evidence on target subject synthesis (Muka et al., 2020). In addition, the visualization analysis of the published articles using bibliometrics provides a historical and scientometric overview of progress (Yılmaz et al., 2019). Bibliometrics uses quantitative measures to assess the trends in the target topic and recent conclusions and are growing rapidly with the production of new parameters, assessment tools, and normative data (Roldan-Valadez, Yoselin Salazar-Ruiz, Ibarra-Contreras, & Rios, 1936).

On behalf of the evidence for guiding the treatment selection for improving prognosis outcomes, there is a need to determine the factors that affect the decision-making process in endodontic practice. To the best of our knowledge, there is no publication concerning the round-up evaluation of the research studies on factors affecting clinical treatment choices. Therefore, this study aimed to evaluate clinical decision-making for endodontic treatment using bibliometrics.

### **Search Strategy**

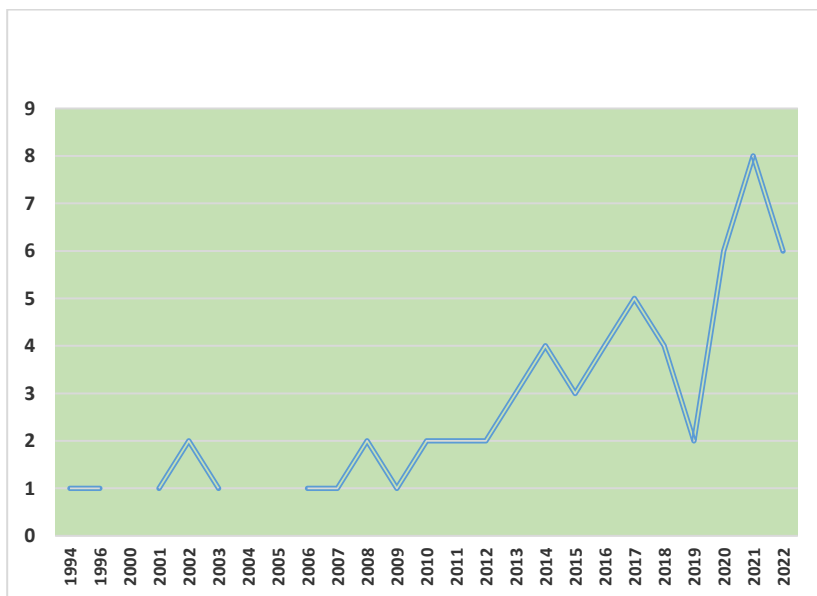
A systematic search limited to English language publications and original articles about any of the decision-making processes concerning the endodontic practice was conducted through online databases, including Thomson Reuters Web of Science by using the Clarivate, PubMed, Google Scholar, and Scopus search engines through 2023. The search strategy was conducted as follows in all fields including the database: "treatment" and "decision" or "planning" and the data were filtered under the limitation using "endodontics" or "root canal" and their combinations with other keywords were used as to refine the search results on a more granular level in the field. The articles listed after the search criteria were manually screened. Review articles, case reports, proceeding papers,

conference papers, editorial materials or letters, corrections, notes, early access papers, and off-topic studies were excluded from the study.

The final data including the full record and cited references were exported using the ‘tab-delimited file’ tool. The first author, title, journal name, institute/country, number of authors, year, citation, keywords, abstracts, aim, and conclusion were recorded. VOSviewer version 1.6.10 software (Centre for Science and Technology Studies, Leiden University, Netherlands) was used to map the bibliometric network of the exported data that has an automatic term identification algorithm (downloadable at [www.vosviewer.com](http://www.vosviewer.com)). Bibliographic networks were built based on the co-authorship network, the co-authorship network of countries, and keywords co-occurrence. To visualize all clarity of mapping, the minimum number of published articles by authors, and the minimum number of published articles by the countries has been set to one. Additional data and visual graphics were created by Microsoft Excel (Microsoft 365, 2023, Excel® for Mac).

### Research Outputs

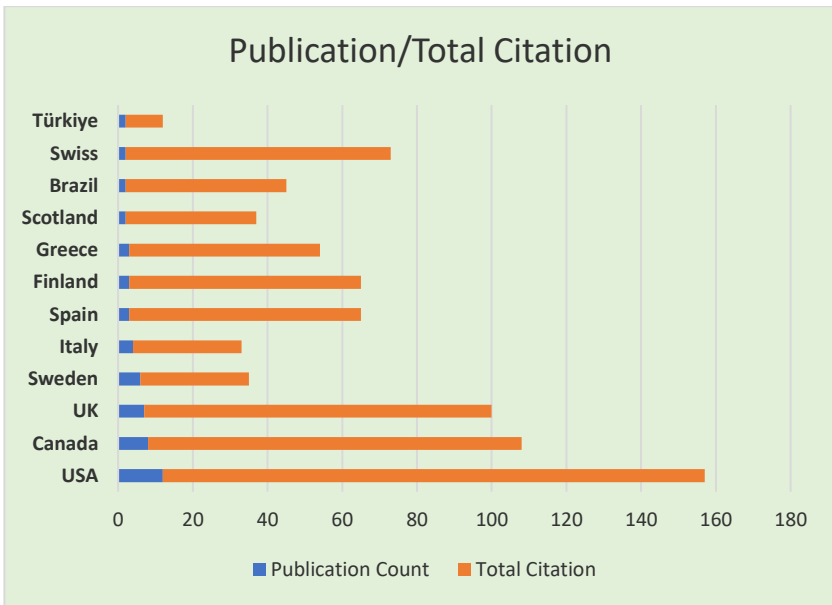
After the inclusion criteria were applied and duplicates were excluded, a total of 56 from possible 201 original research articles from all databases between 1994-2023 were included in the study as a result of the search with the keywords (**Figure 1**).



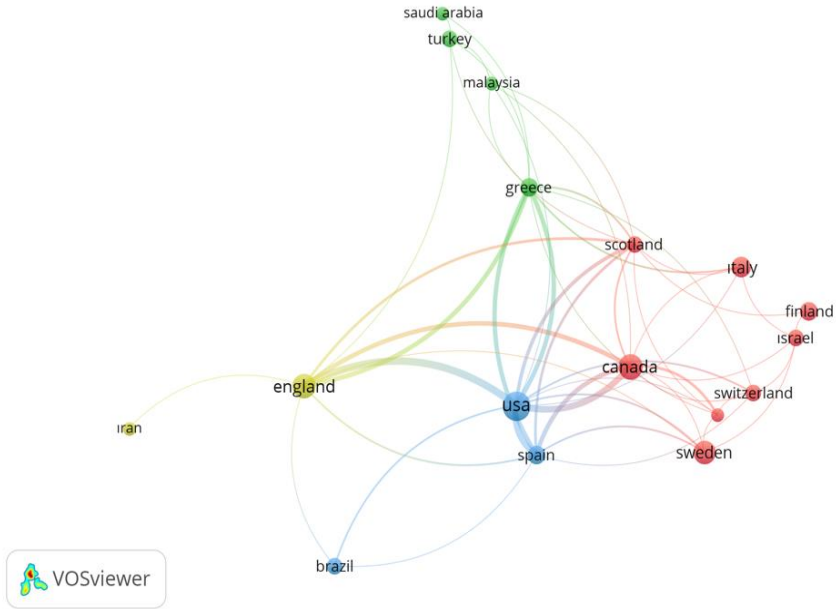
**Figure 1.** Distribution of document count by year of published articles concerning clinical decision-making in the field of endodontics

214 researchers in total had publication on the subject. The highest contribution was conducted by the United States of America from 21 countries with 12 original articles, followed by Canada with 7 articles, and England with 5 articles (**Figures 2, 3**).

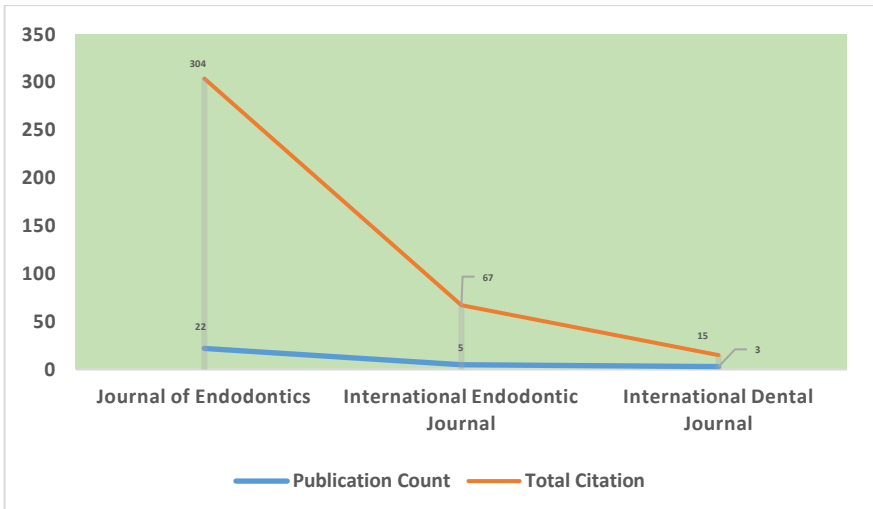
The journal that accepted the largest number of articles on the sub-ject was the Journal of Endodontics with 22 articles, followed by the International Endodontic Journal and International Dental Journal (**Figure 4**).



**Figure 2.** Distribution of total citations by published articles concerning clinical decision-making in the field of endodontics



**Figure 3.** The visualization citation map of the country of origin for 21 collaborating countries.



**Figure 4.** Journal /publication /citation of published articles concerning clinical decision-making in the field of endodontics

It was observed that the hypotheses of the included 56 articles evaluated different factors that may be influential in clinical decision-making. Of these studies, 43 articles examined treatment preferences in current conditions, 2 examined the technique to be applied in the treatment, and 3 examined the situations in which patients were referred. When evaluated from another point of

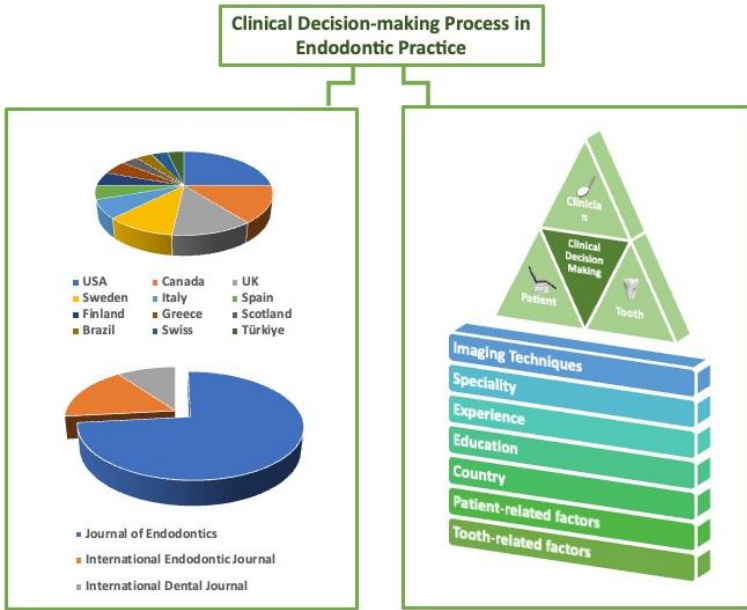
view, 43 articles referred to clinician preferences, 5 were patient preferences, and 1 was preferences if the patient was a dentist. Other articles could not be classified. Of the included studies, a total of 152 unique keywords were identified. The most frequent keywords and the number of times they appear in the articles were provided in **Table 1**.

**Table 1.** The most frequent keywords of the included articles

Rank	Keywords	Frequency
1	endodontics	28
2	decision making	14
3	decision-making	7
4	treatment planning	7
5	cone-beam computed tomography	7
6	apical periodontitis	6
7	patient preference	5
8	dentists	4
9	dental education	4

The majority of the articles included in this study focused on methodologies that question treatment preferences on the basis of dentists and depending on dental factors.

These studies have shown that not only dental factors but also education level, different specialties, similar physician groups, countries, patient-related factors, and as well as imaging techniques are effective in clinical decision-making (**Figure 5**).



**Figure 5.** The summary of factors that affect the decision-making process in endodontic practice

### Discussion

This study aimed to evaluate clinical decision-making in the fields of endodontics using bibliometrics. Bibliometric analysis can give an idea about the impact of the researched topic by using citation rates. The results obtained from this study reveal that clinical decision-making is an issue that has a significant impact on endodontic practice and is widely considered. Why, all included articles, even the most recent ones, have high citation rates. To the best of our knowledge, when the literature is evaluated, a comprehensive and roundup analysis on this subject has not been identified, which reveals the necessity and novelty of this work.

The title, keywords, and abstracts have a very crucial role in the articles which should emphasize the most striking results of the study and highlight the message that is intended to be conveyed to the readers. Although there is a strategy to reach the right information evidence-based, there is also a title, keyword, and abstract strategy for not only getting published but as well as the dissemination of the article. These points should be constructed in a way that provides the readers with a general overview of the article and enables them to have a general idea about the article. Besides these structures should be created with the right choices for the articles to spread to large masses and to be used as evidence and cited in future studies. There may be articles about the topic that are overlooked in the applied search strategy, although many databases are searched using general keywords,

and additional manual screening. It may be explained as the articles not appearing in the search criteria from the keyword, title, or abstract trio. This situation is the main limitation of the study.

### ***Countries and Journals***

The bibliometric data presented that the American continent which includes the United States of America and Canada were the most prolific countries for this subject. Besides Journal of Endodontics which is the official journal of the American Association of Endodontists was the publisher that accepted the highest number of articles on this subject, followed by England and International Endodontic Journal which is the official journal of the European Society of Endodontology, and British Endodontic Society. This is not surprising since they are among the countries and associations that lead endodontists with their scientific contributions and as well as guidance.

### ***The Impact of Imaging Technology***

Considering the years, the increase in the distribution of publications in recent years can be explained as the innovation in treatment procedures with the change in technology and material science. In particular, the importance of imaging techniques in treatment planning cannot be ignored (Bhatt et al., 2021). Kakavetsos et al. (2020) evaluated the CBCT referral rate for endodontic treatment and highlighted that a small percentage of patients referred for primary or secondary root canal treatment are further referred by the clinician for CBCT imaging and the initial diagnosis after CBCT evaluation may be changed to a significant extent. Besides, Ptak et al. and de Almeida et al. (Fernando José Mota de Almeida, Hassan, Nasir Abdulrahman, Brundin, & Romani Vestman, 2021; Ptak, Finkelman, & Amato, 2021) reported and suggested consistent results for various clinical scenarios in endodontology. The spread of advanced imaging techniques such as CBCT has also affected clinical decision-making; for example, the decision to surgical root canal treatment for tooth preservation, or on the contrary, convert the suspicious diagnosis into a hopeless (Abramovitz, Better, Shacham, Shlomi, & Metzger, 2002; Curtis, VanderWeele, Ray, & Wealleans, 2018; Ee, Fayad, & Johnson, 2014; Haxhia, Ibrahim, & Bhagavatula, 2021a; Fernando J Mota de Almeida, Huuonen, Molander, & Kvist, 2016; Rodríguez, Abella, Durán-Sindreu, Patel, & Roig, 2017; Rodríguez, Patel, Durán-Sindreu, Roig, & Abella, 2017; Viana Wanzeler et al., 2020; von Arx, Roux, & Bürgin, 2014). Matny et al. (Matny, Ruparel, Levin, Noujeim, & Diogenes, 2020) highlighted that the treatment choice and the related prognosis of external cervical root resorptions depend on the volumetric quantification of resorptive defects and provide important information to help clinicians decide on clinical decision-making and inform the patients of the expected outcome. Additionally,



they recommended focusing on automating volumetric assessments of root resorptions to aid in unbiased chairside treatment planning choices.

### ***The Impact of Patients***

Various factors may well affect the clinical decision-making for endodontics. Patient preferences are also one of the influencing factors. In addition to evidence-based scientific preferences; unfortunately, dental treatments are costly in most cases all over the world, and this may affect treatment choices. A patient preference-based study by Chatzopoulos & Wolff (2017) evaluated the socioeconomic levels of the patients and concluded that the patients who prefer tooth retention by endodontic treatment have higher socioeconomic conditions than the patients who prefer extraction followed by implants. However, Walker et al. (2015) questioned this situation and reported that the patient's funding status did not influence the clinician's decision-making when considering root canal treatment as an option. Inconsistency, Azarpazhooh et al. (2015) reported that even with a low budget, the majority of patients value preserving their natural teeth instead of tooth extraction. Besides, Aminoshariae et al. (2014) found that while health insurance did not play a role in deciding the treatment plan, there could be differences in the procedures applied according to the treatment type.

One of the factors affecting clinical decision-making preferences from the patient's point of view is the number of visits for root canal treatment. Vela et al. (2012) reported that most of the patients would prefer single-visit root canal treatment regardless of prognosis success, however, many would prefer two-visit root canal treatment if outcome success is greater than that of a single visit. This result confirms that it is important to discuss treatment outcomes and consider the patients' preferences when treatment planning. Survey-based research conducted by Azarpazhooh (2013) evaluated the patient's preference for painful apical periodontitis when considering its preservation with root canal treatment or its extraction followed by various clinical treatment scenarios. In conclusion, higher annual income, previous root canal treatment history, good/excellent self-rated oral health functional dentition, and regular appointments were associated with high preferences for preservation in response to different questions. In addition, patients invariably participate in collaborative decision-making to treat the tooth with apical periodontitis, and a majority of them prefer tooth retention (Azarpazhooh et al., 2014).

### ***The Impact of Clinicians***

With the development of technology and material science, international access to information is also developing in direct proportion. This situation is reflected in undergraduate education and the awareness of preventive dentistry is increasing. Undergraduate dentistry education can play an efficient role in

evidence-based treatment strategies in clinical practice. The process of critical clinical decision-making is indoctrinated in dental schools through preclinical education and pre-graduation clinical training (Booth DDS, Eckert MS, & Fontana DDS, 2021). It was reported that academic training affects undergraduate decision-making (Alim-Uysal, Dincer, Yurtgezen, & Guneser, 2021; Weber, Alves, & Maltz, 2011). This situation explains the fact that undergraduate students and dentists with closer graduation dates prefer more conservative treatment than more experienced general dentists. However, Pesonen et al. (2021) evaluated the case difficulty criteria of the educators who were responsible for endodontic training in dental schools and corresponding assessments by dental students and concluded that the students evaluated most cases to be easier than the supervisors. They explained this situation that undergraduate students may not be able to fully consider all factors and also may consequently miss possible hazardous factors. The reason why dentists who graduate closer prefer to treat more cases may be that they lack sufficient clinical experience. The other factor that affects the decision-making process is postgraduate experience and education (Liew, Zainal Abidin, Cook, & Kanagasingam, 2021). Many cases or treatment choices related to different endodontic management were subjected to dentists who have different levels of experience and postgraduation status, as well as various specialties (AbuMostafa, Alharbi, Al Shawaf, Almikhem, & Aljuhayyim, 2021; Bigras, Johnson, BeGole, & Wenckus, 2008; Dawson, Fransson, & Wolf, 2021; Dechouniotis, Petridis, & Georgopoulou, 2010; Haxhia, Ibrahim, & Bhagavatula, 2021b; Koopaeei, Inglehart, McDonald, & Fontana, 2017; Stangvaltaite et al., 2023; Zadik & Levin, 2008). Dechouniotis et al. (2010) reported that endodontists present the most consistent agreement among the other groups with more conservative treatment options. Additionally, various researchers presented similar results (Çiçek, Özsezer-Demiryürek, Özerol-Keskin, & Murat, 2016; McCaul, McHugh, & Saunders, 2001; Fernando J Mota de Almeida et al., 2016; Rawski et al., 2003). However, Burns et al. (2018) concluded that clinicians may lack consistency in their decision-making over time in some cases.

Most of the studies mentioned above include case-by-case evaluations of survey-based studies. However, the treatment preferences that respond to the questionnaires and the treatments applied in the clinic by dentists are not always clinical scenarios in real life (Heinikainen, Vehkalahti, & Helsinki, 2002). At this point, referral case preferences are important that may aid in tooth survival in some cases (Tzimpoulas, Alisafis, Tzanetakos, & Kontakiotis, 2012). Barnes et al. and Tavakolinejad et al. (Barnes, Patel, & Mannocci, 2011; Tavakolinejad et al., 2015) reported that the most referred cases to specialists by general dentists are, in order, secondary endodontic treatment cases, surgical root canal

treatments, narrow or obstruct root canals, complicated trauma cases, and iatrogenic errors during root canal treatment.

For treatment approaches, clinician preferences in different countries also differ (Bestall, Flynn, Charleson, & Abbott, 2020; Burns et al., 2018; Stangvaltaite et al., 2023; Zadik & Levin, 2008). Besides, Patel et al. (2019) reported that unconscious racial bias also may have an impact on treatment planning decisions.

### ***The Possible Role of Artificial Intelligence***

Individualized strategies for diagnostics and case selection are crucial for clinical decision making. However, alternative methods may be considered to improve technical selection and prognosis outcomes as well as a guide for clinical decisions (Signor et al., 2021). Simulation of virtual reality has had a significant impact on the training of psychomotor skills, however, there is still a lack of evidence on its use for teaching decision-making. This is particularly notable, considering the known importance of decision-making in achieving favorable treatment outcomes (Vannaprathip, Haddawy, Schultheis, & Suebnukarn, 2022). Besides, machine learning models may be used to assist tool selection, especially for a field that has a lot of technical tools and equipment such as endodontics (Thakur, Kankar, Parey, Jain, & Jain, 2022).

### **Conclusions**

In conclusion, the distribution of publications in the field of clinical decision-making shows exponential growth in the past years. The present study showed that the training and specialization of the clinician, experience over years, imaging techniques, patient-related factors, and regional differences may have an impact on management preferences, in addition to the condition of the related tooth. Artificial intelligence and deep learning are expected to play a greater role in clinical decision making in terms of endodontics in the future.

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