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Laser therapy for dentin hypersensitivity: a bibliometric analysis of top-cited articles

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Abstract:
Background: *Dentin hypersensitivity (DH) is a prevalent clinical condition that negatively impacts patients' quality of life, and laser therapy has emerged as a promising non-invasive treatment option. Given the growing volume of publications, bibliometric studies are useful tools for synthesizing current knowledge. The aim of this study was to conduct a bibliometric analysis of the 10 most-cited articles on laser therapy for DH indexed in the Web of Science Core Collection.*
Materials and Methods: *This is a descriptive bibliometric study. The search was conducted in July 2026 in the Web of Science Core Collection with no restrictions on publication date or language. The 10 most cited articles were selected, and data were tabulated regarding citation count, year, journal, country, study design, laser type, keywords, and co-authorship. Network maps were constructed using VOSviewer.*
Results: *The 10 articles received a total of 1,074 citations (mean 107.4 per article). The most cited article was Kimura et al. (2000), with 215 citations. The Journal of Clinical Periodontology was the most prominent journal (30%). Italy and Iran were the most represented countries (2 articles each). Systematic reviews predominated (40%). Nd:YAG (7/10 articles) and diode GaAlAs (8/10) were the most studied high-power and low-power lasers, respectively. The keyword map revealed "systematic review" as the central hub (2010–2015), and the co-authorship network showed fragmented groups, with the University of Coimbra cluster as the most recent.*
Conclusions: *The highest-impact research on laser therapy and DH is characterized by a predominance of systematic reviews, the centrality of Nd:YAG and diode GaAlAs lasers, and fragmentation of scientific collaboration networks.*
Key word*: Dentin Hypersensitivity; Laser; Bibliometrics; Laser Therapy.*

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I. Introduction

Dentin hypersensitivity (DH) is defined as a sharp, short-lasting pain of sudden onset that occurs in response to thermal, tactile, osmotic, evaporative, or chemical stimuli and cannot be attributed to any other dental pathology[1]. Its prevalence in the adult population ranges from 10% to 30%, most frequently affecting individuals between 20 and 40 years of age, with a predilection for canines and premolars[2,3]. The condition negatively impacts patients' quality of life, interfering with daily activities such as eating, drinking, oral hygiene, and, in some cases, even speaking.

The most widely accepted etiological mechanism for DH is the hydrodynamic theory proposed by Brännström, according to which external stimuli cause displacement of dentinal fluid within the tubules, activating mechanoreceptors in the pulp and generating the painful sensation. For this phenomenon to occur, dentin must be exposed to the oral environment, usually as a result of gingival recession, cervical abrasion, acid erosion, or a combination of these factors[4]. Thus, DH treatment may be directed at blocking nerve impulse transmission, using desensitizing agents that interfere with nerve fiber depolarization, or occluding exposed dentinal tubules, thereby preventing dentinal fluid displacement.

Accordingly, several therapeutic approaches have been proposed over the years. Topical desensitizing agents include fluoride varnishes, potassium nitrate-based compounds, oxalates, glutaraldehyde, and adhesive resins[5]. Although many of these agents provide satisfactory immediate results, their main limitation is the durability of the effect, as they may be removed by brushing, salivary action, or mechanical wear over time[6].

In this context, laser therapy has emerged as a promising non-invasive alternative for the treatment of DH. High-power lasers, such as Nd:YAG, Er:YAG, CO_2, and Er,Cr:YSGG, promote fusion and recrystallization of superficial dentin, resulting in occlusion of dentinal tubules and reduced dentin permeability[7]. Low-power lasers, such as diode (GaAlAs) and He-Ne lasers, act through biostimulatory effects, inducing tertiary dentin

formation and modulating pulpal inflammatory response, in addition to having a direct analgesic effect on nerve fibers[8,9].

In vitro studies have shown that different lasers are capable of occluding dentinal tubules with variable efficacy, while randomized clinical trials have confirmed significant pain reduction in patients treated with laser, both alone and in combination with desensitizing agents[10-12].

In recent years, the number of publications on laser therapy and DH has grown considerably. Systematic reviews and meta-analyses have been published to synthesize the available evidence. However, given this substantial volume of articles, it has become difficult for clinicians and researchers to identify the most relevant and established publications. Bibliometric studies are valuable tools for filling this gap, as they enable mapping of the highest-impact articles, the most productive researchers and institutions, thematic trends, and scientific collaboration networks, organizing knowledge in an objective manner[13]. To date, no bibliometric study has been identified that specifically focuses on the most-cited articles on laser therapy for DH.

Therefore, the aim of the present study was to conduct a bibliometric review of the 10 most-cited articles on the use of laser therapy for dentin hypersensitivity indexed in the Web of Science Core Collection, analyzing geographic distribution, temporal distribution, collaboration networks, study design, and types of lasers investigated.

II. Material And Methods

This study is classified as a descriptive bibliometric review, conducted through a search using the Web of Science Core Collection (WoS-CC) database. Initially, a structured search strategy was designed and tested: TS=("dentin hypersensitivity" OR "dentine hypersensitivity" OR "dentinal hypersensitivity" OR "cervical dentin sensitivity" OR "tooth sensitivity" OR "sensitive dentin" OR "dental hypersensitivity") AND TS=("low-level laser therapy" OR "low level laser" OR "low-level light therapy" OR LLLT OR "photobiomodulation" OR "photobiomodulation therapy" OR PBM OR "laser phototherapy" OR "laser therapy" OR "laser treatment" OR "laser irradiation" OR "diode laser" OR "GaAlAs laser" OR "InGaAlP laser" OR "HeNe laser" OR "helium-neon laser" OR "low intensity laser" OR "low power laser" OR "soft laser" OR "Nd:YAG laser" OR "Er:YAG laser" OR "Er,Cr:YSGG laser" OR "CO2 laser" OR "carbon dioxide laser" OR "neodymium laser" OR "erbium laser" OR "high-power laser" OR "high power laser" OR "high intensity laser" OR "solid-state laser"). The study selection was performed on July 10, 2026, with no restrictions regarding publication date or language.

The 10 articles with the highest citation counts in the WoS-CC whose main focus was the use of laser therapy for dentin hypersensitivity were included in the study. Titles and abstracts were initially screened; the full text was assessed when necessary to resolve inclusion or exclusion decisions. This review included studies of any methodological design. Conference abstracts, books, and letters to the editor were excluded.

After article selection, the following bibliometric parameters were tabulated for each study: title, year of publication, number of citations, institution, country and continent (based on the corresponding author's affiliation), journal title, study design, type of laser used, keywords, and authors. Data were presented as tables (title, number of citations, year of publication, affiliation, journal, and laser type) and as a map for country and continent data, which was constructed using the MapChart tool. Additionally, network maps for co-authorship and keywords were created using VOSviewer software.

The co-authorship map displays information on each cluster, represented by nodes of distinct sizes and colors. The larger the node, the greater the representativeness of the information. Proximity between nodes on the map also indicates a stronger co-authorship relationship, as do the lines connecting the elements of the analysis. The same principles apply to the keyword analysis. For this analysis, author keywords were considered.

III. Result

The search yielded 381 results using the described search strategy in the Web of Science Core Collection. The 10 most-cited articles together received 1,074 citations, with a mean of 107.4 citations per article.

The most-cited article was Kimura et al. (2000)[7], with 215 citations, a narrative review that addressed the use of Nd:YAG, CO_2, diode (GaAlAs), and He-Ne lasers for the treatment of dentin hypersensitivity. The second was Schwarz et al. (2002)[10], which accumulated 122 citations with a randomized clinical trial evaluating the Er:YAG laser.

Analysis of laser types revealed that the 10 most-cited articles addressed both high-power and low-power lasers. Among high-power lasers, Nd:YAG was the most frequent, present in 7 of the 10 articles, followed by Er:YAG, mentioned in 6 articles. The CO_2 laser appeared in 4 studies, and Er,Cr:YSGG in 3 articles. Among low-power lasers, the diode laser (GaAlAs) was widely predominant, present in 8 of the 10 articles, while He-Ne was cited in 2 articles, both reviews.

This distribution indicates that Nd:YAG and diode (GaAlAs) are the most investigated high-power and low-power lasers, respectively, among the highest-impact articles in the field. Nd:YAG was evaluated in both randomized clinical trials[7] and in vitro tubule occlusion studies[4], whereas the diode laser (GaAlAs) was tested in placebo-controlled clinical trials[5,8]. The Er:YAG and CO_2 lasers also stand out, particularly in comparative studies with other lasers and in systematic reviews.

Among the review articles[1-3,11.14], high-power Nd:YAG, Er:YAG, CO_2, and Er,Cr:YSGG lasers are the most frequently discussed for the treatment of dentin hypersensitivity, whereas the diode laser (GaAlAs) is consolidated as the main low-power alternative, possibly due to its lower cost, portability, and safety profile. Table 1 shows the list of the 10 most-cited articles, ranked by number of citations, and the laser types used.

Figure 1 illustrates the geographic distribution of the articles based on the corresponding author's affiliation. A concentration of studies was observed in Europe (Italy, Germany, Portugal, and Australia), Asia (Iran, Japan, and Taiwan), and South America (Brazil). Italy and Iran were the most represented countries, each with 2 articles (20%). Both Italian articles were from the Università dell'Aquila, both authored by Sgolastra and colleagues. The two Iranian articles were from Isfahan University of Medical Sciences[7] and Shahid Beheshti University of Medical Sciences[4]. The remaining countries, Germany, Brazil, Japan, Portugal, Taiwan, and Australia, contributed 1 article each (10%). The University of São Paulo was the only representative from the Americas among the 10 most-cited articles.

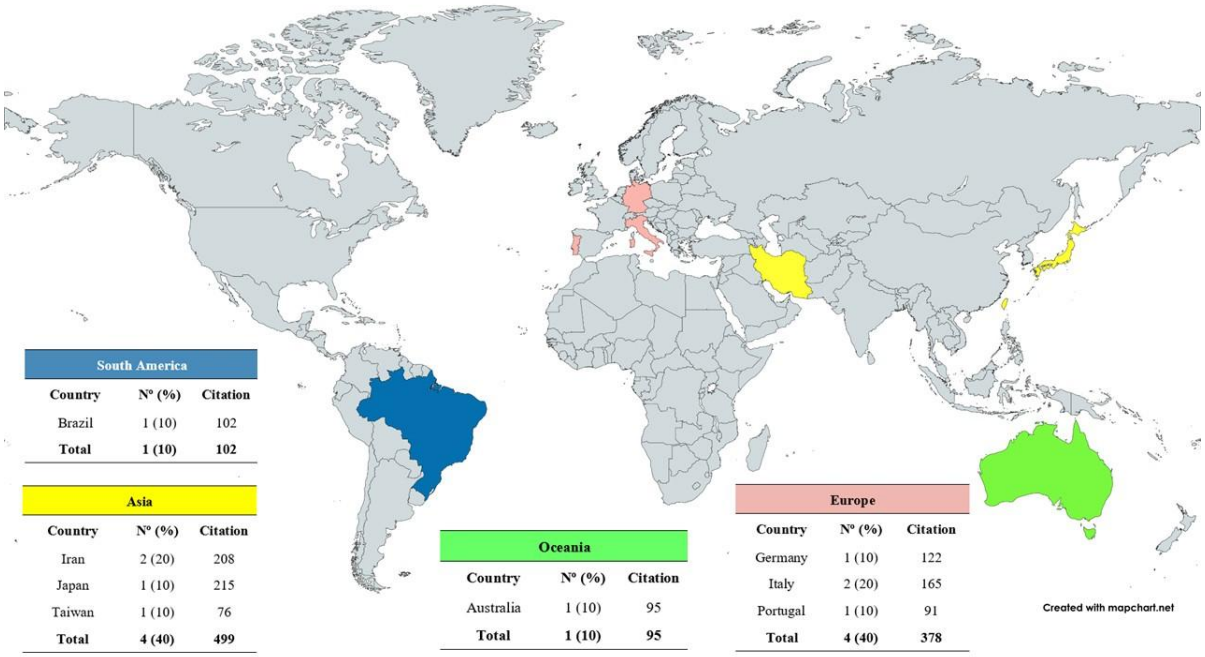
Table 1. The 10 most-cited articles

Rank	Article referece	Citations (WoS-CC)	Laser treatment
1	KIMURA, Y.; WILDER-SMITH, P.; MATSUMOTO, K. Treatment of dentine hypersensitivity by lasers: a review. Journal of Clinical Periodontology, v. 27, n. 10, p. 715–721, 2000.	215	Review article discussing Nd:YAG and CO_2 lasers (high-power) and diode laser (GaAlAs) and He-Ne laser (low-power).
2	SCHWARZ, F.; ARWEILER, N.; GEORGE, T.; REICH, E. Desensitizing effects of an Er:YAG laser on hypersensitive dentine. Journal of Clinical Periodontology, v. 29, n. 3, p. 211–215, 2002.	122	Group 1: Er:YAG laser Group 2: Dentin Protector (Vivadent) Group 3: No intervention
3	BIRANG, R.; POURSAMIMI, J.; GUTKNECHT, N.; LAMPERT, F.; MIR, M. Comparative evaluation of the effects of Nd:YAG and Er:YAG laser in dentin hypersensitivity treatment. Lasers in Medical Science, v. 22, n. 1, p. 21–24, 2007.	119	Group 1: Nd:YAG laser Group 2: Er:YAG laser Group 3: No intervention
4	CORONA, S. A. M.; NASCIMENTO, T. N.; CATIRSE, A. B. E.; LIZARELLI, R. F. Z.; DINELLI, W.; PALMA-DIBB, R. G. Clinical evaluation of low-level laser therapy and fluoride varnish for treating cervical dentinal hypersensitivity. Journal of Oral Rehabilitation, v. 30, n. 12, p. 1183–1189, 2003.	102	Group 1: Diode laser (GaAlAs) Group 2: Sodium fluoride varnish (Duraphat®)
5	GERSCHMAN, J. A.; RUBEN, J.; GEBART-EAGLEMONT, J. Low level laser therapy for dentinal tooth hypersensitivity. Australian Dental Journal, v. 39, n. 6, p. 353–357, 1994.	95	Group 1: Diode laser (GaAlAs) Group 2: Placebo
6	MARTO, C. M.; BAPTISTA PAULA, A.; NUNES, T.; PIMENTA, M.; ABRANTES, A. M.; PIRES, A. S.; LARANJO, M.; COELHO, A.; DONATO, H.; BOTELHO, M. F.; MARQUES FERREIRA, M.; CARRILHO, E. Evaluation of the efficacy of dentin hypersensitivity treatments—a systematic review and follow-up analysis. Journal of Oral Rehabilitation, v. 46, n. 10, p. 952–990, 2019.	91	Review article discussing diode, Nd:YAG, Er:YAG, and Er,Cr:YSGG lasers (high-power) and diode laser (GaAlAs) (low-power).

7	GHOLAMI, G. A.; FEKRAZAD, R.; ESMAIEL-NEJAD, A.; KALHORI, K. A. M. An evaluation of the occluding effects of Er,Cr:YSGG, Nd:YAG, CO_2 and diode lasers on dentinal tubules: a scanning electron microscope in vitro study. Photomedicine and Laser Surgery, v. 29, n. 2, p. 115–121, 2011.	89	Group 1: Er,Cr:YSGG laser Group 2: Nd:YAG laser Group 3: CO_2 laser Group 4: Diode laser Group 5: No intervention
8	SGOLASTRA, F.; PETRUCCI, A.; GATTO, R.; MONACO, A. Effectiveness of laser in dentinal hypersensitivity treatment: a systematic review. Journal of Endodontics, v. 37, n. 3, p. 297–303, 2011.	85	Review article discussing Nd:YAG, Er:YAG, and CO_2 lasers (high-power) and diode laser (GaAlAs) and He-Ne laser (low-power).
9	SGOLASTRA, F.; PETRUCCI, A.; SEVERINO, M.; GATTO, R.; MONACO, A. Lasers for the treatment of dentin hypersensitivity: a meta-analysis. Journal of Dental Research, v. 92, n. 6, p. 492–499, 2013.	80	Review article discussing Er:YAG, Er,Cr:YSGG, and Nd:YAG lasers (high-power) and diode laser (GaAlAs) (low-power).
10	LIN, P.Y.; CHENG, Y.W.; CHU, C.Y.; CHIEN, K.L.; LIN, C.P.; TU, Y.K. In-office treatment for dentin hypersensitivity: a systematic review and network meta-analysis. Journal of Clinical Periodontology, v. 40, n. 1, p. 53–64, 2013.	76	Review article discussing Nd:YAG, CO_2, Er,Cr:YSGG, and Er:YAG lasers (high-power) and diode laser (GaAlAs) (low-power).

WoS-CC = Web of Science Core Collection

Figure 1. Geographic distribution of the included articles showing the number of publications and citations.



Geographic distribution of the included articles showing the number of publications and citations. Italy and Iran were the most represented countries (2 articles each), followed by Germany, Brazil, Japan, Portugal, Taiwan, and Australia (1 article each). The 10 articles together received 1,074 citations.

The publications span a period of 25 years (1994 to 2019). The years 2011 and 2013 had the highest number of publications among the 10 most-cited articles, with 2 articles each (20%). The remaining years (1994, 2000, 2002, 2003, 2007, and 2019) contributed 1 article each (10%). This finding suggests that interest in the topic intensified in the early 2010s, a period when systematic reviews and meta-analyses began to consolidate the available evidence. The 10 articles were published in 7 different journals. The Journal of Clinical Periodontology stood out as the journal with the highest number of publications, with 3 articles (30%), followed

by the Journal of Oral Rehabilitation, with 2 articles (20%). The remaining journals published 1 article each (10%).

Regarding study design, 4 articles (40%) were classified as systematic reviews (including meta-analyses), 3 (30%) as randomized clinical trials, 2 (20%) as in vitro laboratory studies, and 1 (10%) as a narrative review. The predominance of systematic reviews among the most-cited articles indicates that the scientific community values evidence synthesis studies, which provide a consolidated overview of the efficacy of lasers for the treatment of dentin hypersensitivity. Table 2 presents the year and journal of publication, corresponding author affiliation, and study design of the 10 most-cited articles.

Table 2. Year and journal of publication, corresponding author affiliation, and study design of the 10 most-cited articles.

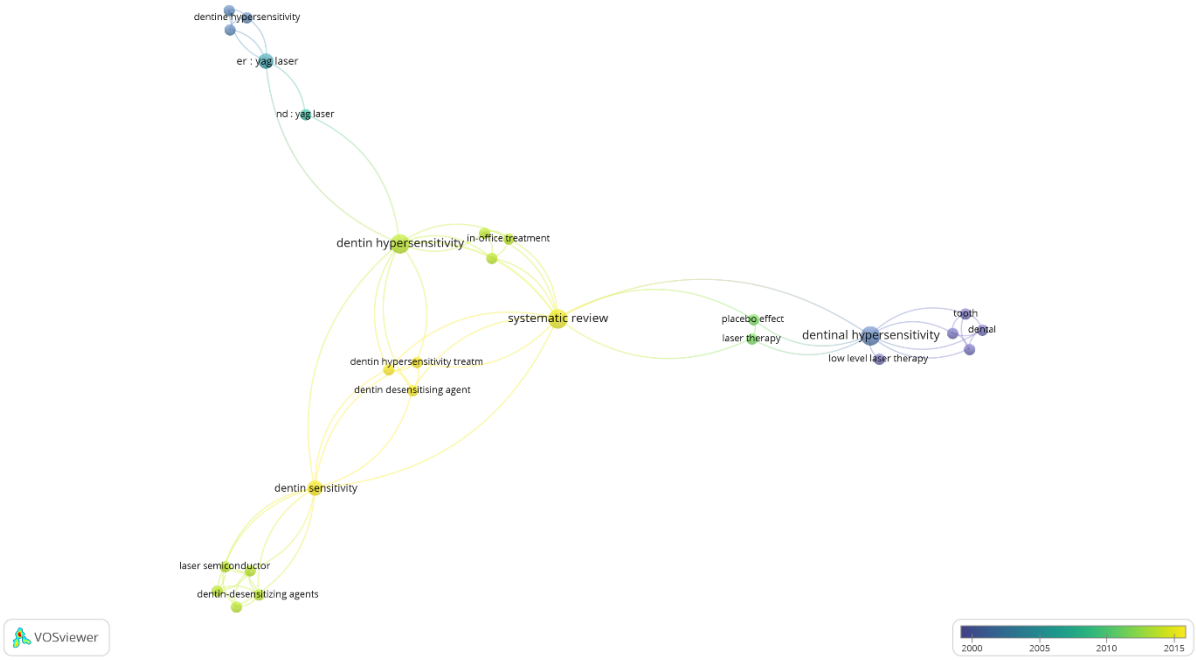
Year of publication	**Nº (%)**
2019	1 (10)
2013	2 (20)
2011	2 (20)
2007	1 (10)
2003	1 (10)
2002	1 (10)
2000	1 (10)
1994	1 (10)
Journal	**Nº (%)**
Journal of Clinical Periodontology	3 (70)
Journal of Oral Rehabilitation	2 (20)
Laser in Medical Science	1 (10)
Australian Dental Journal	1 (10)
Photomedicine and Laser Surgery	1 (10)
Journal of Endodontics	1 (10)
Journal of Dental Research	1 (10)
Corresponding author affiliation	**Nº (%)**
Università dell'Aquila (Italy)	2 (20)
Ludwig Maximilian University (Germany)	1 (20)
Isfahan University of Medical Sciences (Iran)	1 (10)
Universidade de São Paulo (Brazil)	1 (10)
University of Melbourne (Australia)	1 (10)
University of Coimbra (Portugal)	1 (10)
Shahid Beheshti University of Medical Sciences (Iran)	1 (10)
Showa University (Japan)	1 (10)
National Taiwan University (Taiwan)	1 (10)
Study design	**Nº (%)**
Systematic review	4 (40)
Randomized clinical trial	3 (30)
In vitro laboratory study	2 (20)
Narrative review	1 (10)

Figure 2 shows the co-occurrence map of author keywords, constructed using VOSviewer software. The temporal scale (2000–2015) reveals the evolution of research terms over time. Blue nodes (approximately 2000–2005) represent the earliest terms, such as *dentinal hypersensitivity*, *tooth*, *dental*, and *dentine hypersensitivity*, indicating the foundational concepts in the field. Green nodes (approximately 2005–2010) mark a transition phase, with terms such as *nd:yag laser*, *placebo effect*, and *laser therapy* gaining prominence.

Yellow nodes (approximately 2010–2015) concentrate the most recent and most frequently occurring terms, such as *systematic review*, *dentin sensitivity*, *dentin hypersensitivity*, and *in-office treatment*.

Three main subclusters were observed radiating from a central hub represented by the term *systematic review*, suggesting that systematic reviews have become the main method for synthesizing knowledge in the field, based on the included articles. The *dentin hypersensitivity* node also functions as an important connector between different thematic clusters. The thickness of the connecting lines between nodes varies according to co-occurrence strength, and the proximity between terms reflects their conceptual association.

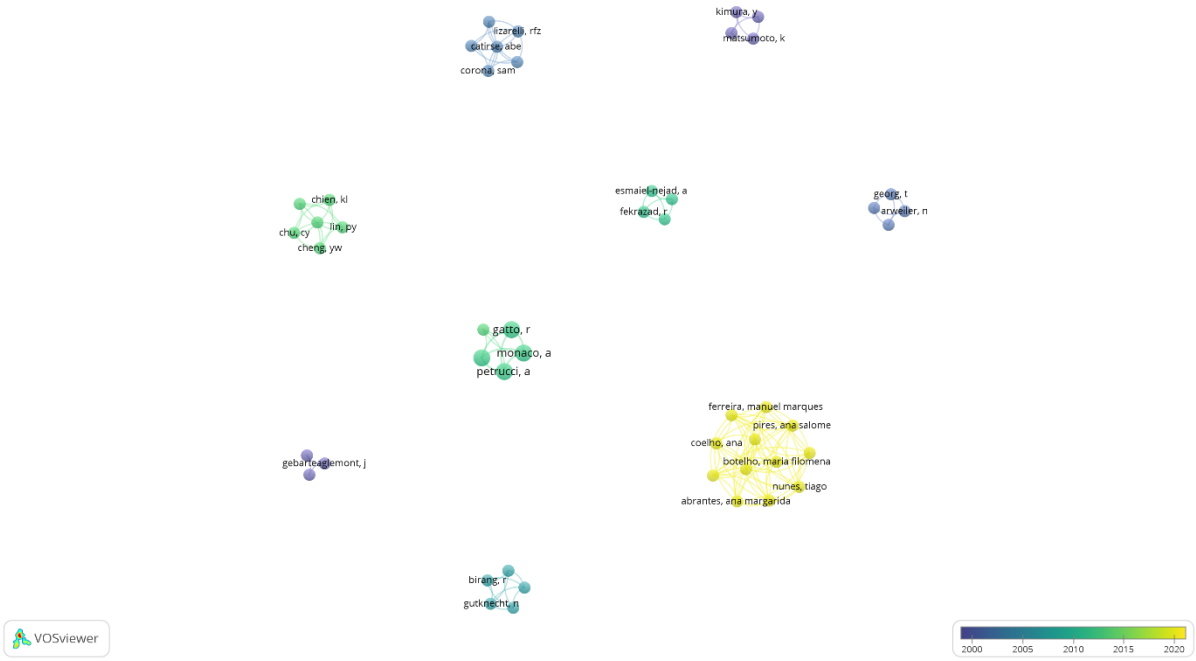
Figure 2. Co-occurrence cluster of keywords used in the studies.



The co-authorship network map reveals the formation of well-defined collaboration clusters, each represented by a color indicating the average activity period. The blue/indigo cluster (approximately 2000) represents the earliest researchers, including Gerschman et al. (1994)[8] and the group of Schwarz, et al. (2002)[10], indicating the initial collaborations in the field. The greenish-blue cluster (approximately 2010) includes researchers such as Birang, Gutknecht, Fekrazad, and Esmaiel-Nejad, who published comparative studies between different laser types in the late 2000s. The green cluster (approximately 2015) brings together the Italian group (Gatto, Monaco, Petrucci, and Sgolastra et al.) and the Taiwanese group (Lin, Chien, Chu, Cheng), responsible for the systematic reviews and meta-analyses published between 2011 and 2013. The yellow cluster (approximately 2020), the largest and densest cluster, represents the Portuguese group from the University of Coimbra (Marto, Botelho, Pires, Coelho, Nunes, Abrantes, Ferreira, Carrilho), authors of the most recent article among the 10 most-cited (2019).

The nodes in the yellow cluster are visibly larger and the connections more numerous, indicating high productivity and strong intra-group collaboration. In contrast, the absence of connecting lines between the different colored clusters highlights the fragmentation of research in the field, with groups working relatively in isolation, without significant inter-institutional collaboration among the most-cited researchers. Figure 3 shows the co-authorship network among the researchers of the 10 most-cited articles, generated in VOSviewer with a temporal scale from 2000 to 2020.

Figure 3. Co-authorship cluster among the studies.



IV. Discussion

Dentin hypersensitivity is a frequent clinical condition that significantly affects patients' quality of life, generating sharp pain in response to everyday stimuli such as eating and oral hygiene. Laser therapy has become established as a promising alternative because it is non-invasive and easy to apply, but the growing volume of publications makes it difficult to identify which evidence actually guides clinical practice. In this scenario, bibliometric studies are useful tools for mapping the highest-impact scientific production, helping researchers and clinicians locate the most relevant references. The present study analyzed the 10 most-cited articles on laser therapy for DH indexed in the Web of Science Core Collection, providing an objective overview of the consolidated knowledge in the field.

The most-cited article was the narrative review by Kimura et al. (2000)[1], with 215 citations. This pioneering study consolidated knowledge on the application of Nd:YAG, CO_2, diode, and He-Ne lasers for the treatment of dentin hypersensitivity, serving as a fundamental reference for subsequent research. Its high citation count reflects its seminal nature, as it systematized the mechanisms of action and the evidence available at the time. Bibliometric studies in dentistry frequently identify narrative and systematic reviews among the most-cited articles, as they provide syntheses that guide clinical practice and further research[13].

The predominance of the GaAlAs diode laser (8 of 10 articles) and Nd:YAG laser (7 of 10 articles) as the most investigated lasers is consistent with the contemporary literature. Recent reviews confirm that the diode laser, due to its low cost, portability, and safety profile, is the most studied low-power option, while Nd:YAG stands out among high-power lasers for its tubule occlusion capacity[14]. A scoping review published in 2024 reinforced that both high- and low-power lasers promote dentinal tubule occlusion, with mechanisms involving dentin fusion and recrystallization for high-power lasers and stimulation of tertiary dentin formation for low-power lasers[14]. Furthermore, an in vitro study compared the efficacy of diode, Nd:YAG, and Er:YAG lasers associated with fluoride in tubule occlusion and demonstrated that all wavelengths were effective, with Nd:YAG presenting the largest occluded area diameters[16].

Regarding study design, systematic reviews accounted for 40% of the most-cited articles, followed by randomized clinical trials (30%). This finding is consistent with the keyword co-occurrence map, which identified *systematic review* as the central hub in the field from 2010 to 2015. An umbrella review published in 2024, which synthesized systematic reviews on the topic, concluded that both low- and high-power laser therapy are effective in reducing dentin hypersensitivity, although the quality of evidence remains limited by protocol heterogeneity[15]. Similar results were found by Pion et al. (2023)[6], whose meta-analysis demonstrated significant pain reduction with laser use compared to placebo but highlighted the need for standardization of irradiation parameters.

The Journal of Clinical Periodontology stood out with 3 articles among the 10 most-cited (30%). This may be explained by the relationship between dentin hypersensitivity and periodontal disease, since gingival recession, common in periodontal patients, exposes root dentin, making hypersensitivity treatment a topic of direct interest to periodontists[3,10].

Geographic distribution revealed leadership from Italy and Iran, each with 2 articles. The Italian group from Università dell'Aquila[11,14] produced the first systematic review and the first meta-analysis on the topic, granting them prominence. Iran, in turn, contributed highly relevant clinical trials and in vitro studies[4,7]. Brazil, represented by the University of São Paulo[5], had only one article among the 10 most-cited, highlighting the need for greater Brazilian high-impact scientific production in the field. A recent bibliometric analysis on photobiomodulation in dentistry pointed to Brazil as one of the most productive countries in absolute number of publications, but with citations concentrated among articles from established groups[13].

The keyword co-occurrence map revealed a clear temporal evolution of terms. The transition from *dentinal hypersensitivity* and *tooth* (2000–2005) to *systematic review* and *in-office treatment* (2010–2015) reflects the maturation of the field: early studies established the field, while more recent research sought to synthesize evidence and define clinical protocols. This trend is corroborated by a 2023 systematic review that compared lasers and desensitizing agents, concluding that the combination of laser with topical agents appears to offer the best clinical outcomes[6].

The co-authorship network revealed fragmented research clusters, without significant inter-institutional collaboration among the most-cited groups. The Portuguese group from the University of Coimbra[2] formed the most recent and densest cluster, indicating an active and productive line of research. The observed fragmentation is a common phenomenon in fields with multiple independent research centers and may represent an opportunity for the establishment of multicenter collaborative networks that produce robust clinical trials and standardized protocols.

As limitations of this study, the restriction to a single database (Web of Science Core Collection) and the analysis focused only on the 10 most-cited articles should be noted, which may not reflect the entirety of scientific production on the topic. Furthermore, citation counts may be influenced by time since publication, older articles have a longer window to accumulate citations. Future studies may expand the sample, include databases such as Scopus and PubMed, and conduct bibliographic coupling and co-citation analyses to deepen the mapping of the field.

V. Conclusion

It is concluded that the highest-impact research on laser therapy and dentin hypersensitivity is characterized by a predominance of systematic reviews and the centrality of Nd:YAG and diode GaAlAs lasers as the most studied. The Journal of Clinical Periodontology was the most prominent journal, and regarding geographic distribution, Italy and Iran led.

The keyword co-occurrence map showed temporal evolution of terms, with *systematic review* established as the central hub of the field (2010–2015), and the co-authorship network revealed fragmented groups without significant inter-institutional collaboration, with emphasis on the Portuguese group from the University of Coimbra as the most recent cluster.

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