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FACULTAD DE POSGRADO DE CIENCIAS DE LA SALUD

"PATRONES EMERGENTES, COLABORACIÓN E IMPACTO DE LA PRODUCCIÓN CIENTÍFICA SOBRE ÁCIDO HIALURÓNICO EN ODONTOLOGÍA: ANÁLISIS BIBLIOMÉTRICO"

Tesis para optar el Título de:

SEGUNDA ESPECIALIDAD EN ENDODONCIA

Presentado por:

Fiorella Amalia Jimenez Obregon (0009-0004-2546-4538)

Carla Olga Mariana Quinteros Quispe (0009-0000-5825-4036)

Asesor:

Frank Roger Mayta Tovalino (0000-0002-3280-0024)

Lima – Perú

2025

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Los integrantes del Jurado de tesis:

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Miembro 1: Mg. Esp. CESAR ANTONIO GALLARDO GUTIERREZ
Miembro 2: Mg. Esp. GISELLA CALERO HINOSTROZA

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Presentada por las egresadas:

- FIORELLA AMALIA JIMENEZ OBREGON
- CARLA OLGA MARIANA QUINTEROS QUISPE

Para optar el Título Profesional de Segunda Especialidad en Endodoncia

Asesorada por: Dr. Esp. FRANK ROGER MAYTA TOVALINO

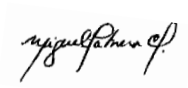
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Señor:

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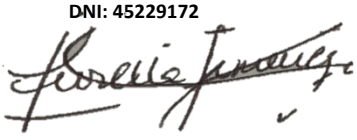
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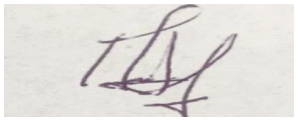
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INFORME DE REVISIÓN DE ORIGINALIDAD

Título del documento evaluado. Patrones emergentes, colaboración e impacto de la producción científica sobre ácido hialurónico en odontología: análisis bibliométrico

Autores. Fiorella Amalia Jimenez Obregon; Carla Olga Mariana Quinteros Quispe

Mecanismo de revisión de originalidad. Evaluación con Turnitin (ID 2861542231)

Código de registro. POS-78-2024-00626

Resultado de la evaluación. 9%

Revisado por. Magaly Kelly Guerrero Huaracallo.

Comentarios sobre la revisión. Filtros usados: excluir fuentes de menos de 12 palabras.



Patrones emergentes

INFORME DE ORIGINALIDAD

9%	3%	7%	3%
INDICE DE SIMILITUD	FUENTES DE INTERNET	PUBLICACIONES	TRABAJOS DEL ESTUDIANTE

FUENTES PRIMARIAS

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2	John Barja-Ore, Jhonny Jesús Chafloque Chavesta, Zaida Zagaceta-Guevara, Brandon E. Guillen-Calle. "Tendencia, colaboración e impacto en la producción científica sobre el aprendizaje basado en simulación durante la formación médica", Educación Médica, 2025 Publicación	2%
3	Submitted to Instituto Tecnologico de Costa Rica Trabajo del estudiante	1%

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DEDICATORIA

A nuestros padres, por ser los pioneros en nuestra formación profesional, quienes con amor nos enseñaron que con educación se nutre nuestra forma de ver el mundo y potencia nuestro aporte a la sociedad, y a ello sumados los valores de perseverancia y disciplina se logran metas y objetivos pudiendo conquistar cualquier obstáculo que se pueda presentar.

A cada uno de nuestros esposos, por creer en nosotras durante este camino, que junto a nuestras hijas son el motivo de siempre mejorar y juntos los pilares más importantes de nuestras vidas, la fuerza de empuje constante del día a día y el refugio necesario donde recargarnos emocional y físicamente.

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AGRADECIMIENTOS

Agradecemos a Dios por darnos la vida para continuar nuestros proyectos, a nuestras familias, por su constante apoyo y ánimos para poder seguir adelante. A nuestro Asesor PhD. Frank Mayta por darnos el soporte necesario durante varias sesiones y guiar nuestras ideas durante la elaboración de nuestro estudio bibliométrico, de igual forma a nuestro Mg. Pedro Tinedo, ya que sin sus coordinaciones el trabajo hubiese representado un reto mucho más difícil de conseguir y al grupo de estudios bibliométricos por darnos la facilidad del sistema bibliometrix.

Nuestro agradecimiento se extiende a la Universidad Científica del Sur, por brindarnos los conocimientos, recursos y facultades de poder elaborar nuestro estudio bibliométrico para obtener el grado de segunda especialidad de Endodoncia.

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"EMERGING PATTERNS, COLLABORATION AND IMPACT OF SCIENTIFIC PRODUCTION ON HYALURONIC ACID IN DENTISTRY: A BIBLIOMETRIC ANALYSIS"

Carla Quinteros-Quispe[1], Fiorella Jimenez-Obregón[1], Pedro Luis Tinedo-López[1], Fran Espinoza-Carhuancho[2], Josmel Pacheco-Mendoza[2], Frank Mayta-Tovalino[2]

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RESUMEN

Objetivo: La biocompatilidad y propiedades regenerativas del ácido hialurónico han destacado en el campo de la medicina, generando gran interés también en el área bucal. El objetivo del estudio fue analizar los patrones emergentes, colaboración e impacto de la producción científica sobre el ácido hialurónico en odontología. **Materiales y Métodos:** Se examinaron artículos indexados en la base de datos Scopus entre enero 2018- mayo 2024, utilizando los términos MESH y operadores lógicos para la búsqueda de información. Diferentes indicadores bibliométricos fueron analizados y los metadatos, exportados con el programa SciVal y con el módulo Bibliometrix del software RStudio versión 4.2.3. **Resultados**: De los 767 documentos analizados, se destacó que la universidad de mayor producción científica fue University of Bern, donde el autor Sculean Anton encabezó el top 10 de autores con más cantidad de artículos escritos y que la revista con mayor número de publicaciones fue Clinical Oral Investigation. **Conclusiones:** Existió un aumento gradual de publicaciones, donde las revistas de mayor producción científica se encuentran en Q1, Estados Unidos fue el país con mayor colaboración científica con otros países, pero destacó que el autor Sculean Anton, de Suiza, fue el que presentó mayor cantidad de investigaciones. Por lo tanto, con estas revelaciones se pretende que continúen y amplíen más conocimientos referentes a nuevas aplicaciones del ácido hialurónico en las diferentes ramas de la odontología.

Keywords: Bibliometrics, Dentistry, Hyaluronic Acid

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ABSTRACT

Aim: This observational, descriptive, retrospective presentation aimed to analyze the emerging patterns, collaboration, and impact of scientific production on hyaluronic acid (HA) in dentistry. Materials and Methods: A bibliometric analysis of research indexed in Scopus from January 2018 to May 2024 was performed. Emerging patterns, collaboration, impact, Bradford's law, and Lotka's law were applied. In addition, thematic maps were designed to visualize the connections between authors and countries. Results: A total of 767 documents from 176 diverse sources were analyzed, identifying 3 437 authors. Articles were the most common type of document. The author of the highest scientific output was Sculean Anton of the University of Bern, Switzerland. Most of the articles were published in first-quartile journals, with Clinical Oral Investigation and Journal of Thermal Analysis and Calorimetry having the highest number of publications. The University of Bern in Switzerland was the institution with the highest research output. Conclusion: This study provides a comprehensive overview of the academic production of HA in dentistry. The results highlight the importance of international collaboration and the concentration of scientific production in certain institutions and journals. These findings may be useful to researchers and institutions seeking to understand and navigate the field of HA in dentistry.

Keywords: Bibliometrics, Dentistry, Hyaluronic Acid

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I. INTRODUCTION

Hyaluronic acid (HA), a biopolymer, is naturally present in various human tissues, including skin, joints, and eyes.[1] This substance can be processed, altered, and combined with other materials, broadening its potential for various biomedical applications.[2,3]

Hyaluronan, often referred to in scientific literature, is a key glycosaminoglycan found in the extracellular matrix, where it plays an essential role in maintaining tissue hydration.[4-6] This component is present in a variety of vertebrate tissues and performs a range of biological functions that are influenced by its molecular weight. Hyaluronan with high molecular weight exhibits anti-inflammatory, anti-proliferative, anti-angiogenic, and immunosuppressive properties. It can bind to fibrinogen, thereby regulating the levels of inflammatory cytokines and the migration of stem cells. Conversely, low molecular weight hyaluronan exhibits immunostimulatory and angiogenic properties. It triggers the production of pro-inflammatory cytokines, chemokine, and growth factors, and promotes the remodeling of the extracellular matrix.[7]

The biocompatibility and regenerative properties of HA have garnered significant attention in the field of dentistry.[1] For instance, current studies in endodontics suggest that HA, in the form of hydrogels, provides biocompatible and minimally immunogenic structures that support stem cell therapy in the regeneration of the dentin–pulp complex.[8,9]

In addition, injections of HA have been found to encourage synovial cells to produce endogenous acid, which in turn aids in the repair of cartilage tissue. This method could provide an alternative treatment strategy for patients with temporomandibular disorders

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who experience chronic pain and/or who have not responded to traditional treatment. The procedure for injecting the temporomandibular joint is minimally invasive and associated with a low incidence of complications. Application in conjunction with techniques such as arthroscopy or arthrocentesis can synergize and enhance both short- and long-term effects, whereas its adverse effects are minor and transient.[10-12]

In periodontics, HA has been shown to provide symptomatic relief for both the marginal gingiva and deeper periodontal tissues. These treatments result in clinical improvements for patients with gingivitis, periodontitis, and periodontal defects, accelerating wound healing.[13] Furthermore, when used as a coating on titanium implants, HA gel enhances the implant–bone connection.[14] The material effectively reduces discomfort following implant placement, suggesting that it serves as a complementary method for managing post-surgical pain.[15]

Consequently, this bibliometric study aimed to analyze the emerging patterns, collaboration, and impact of scientific production on HA in dentistry.

II. MATERIALS AND METHODS

1. Study design

An observational, descriptive, and retrospective study was conducted using a bibliometric approach to analyze research related to the topic indexed in the Scopus database. The search was conducted from January 2018 to May 2024.

2. Information search

Initially, an appropriate selection of keywords was made. Subsequently, terms available in the Medical Subject Heading thesaurus were included, and the logical operators, such

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as AND and OR, were used to define a search strategy. This strategy was designed to ensure a comprehensive and accurate retrieval of relevant studies on the topic: TITLE-ABS ("hyaluronic acid" OR "hyaluronan" OR "HA" OR "sodium hyaluronate" OR "hyaluronate" OR "hyaluronic acid filler" OR "hyaluronic acid gel" OR "hyaluronic acid injection") AND SUBJAREA ("DENT"). The search was conducted on May 15, 2024, and 767 documents were found for the period from January 2018 to May 2024. These documents included 687 articles, 57 reviews, 8 short surveys, 5 book chapters, 4 errata, 3 notes, 1 letter, 1 conference paper, and 1 book. The diverse range of documents provides a comprehensive overview of the research landscape on the topic.

3. Bibliometric indicators

Several production, networking, and impact indicators were measured, including annual growth, *h*-index, journal quartile, Source-Normalized Impact per Paper (SNIP), CiteScore 2022, the number of citations and publications, citations per publication, authorship, country, institution, and type of collaboration. Additionally, Bradford's law, Lotka's law, and thematic evolution diagrams were applied. Thematic maps were also used to identify the relationships between authors and countries, and collaborations.

4. Bibliometric procedure

The bibliometric information of the scientific publications was exported as.xls files for metadata evaluation using the SciVal program (Elsevier). Additionally, Microsoft Excel 2019 was used to create a trend graph, and frequencies and percentages were calculated for categorical variables. The metadata exported in Comma-Separated Values format were analyzed with the bibliometrix tool of R Studio software version 4.2.3 (Bibliometrix, Boston, Massachusetts, USA). Furthermore, citation visualization

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networks by country were designed using the VOSviewer software version 1.6.19. This comprehensive approach allowed for a detailed and nuanced analysis of the scholarly literature on HA in dentistry.

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III. RESULTS

The bibliometric analysis spanned the years 2018–2024, during which it examined 767 documents sourced from 176 distinct outlets. The study noted an annual growth rate of −3.65%. The research identified 3 437 authors, with an average of 5.2 co-authors per document and international co-authorships making up 27.12% of the total. The most prevalent type of document was articles, with 687 instances noted (Table 1).

Table 1: Scholarly Output

Description	**Results**
Timespan	2018:2024
Sources (Journals, Books, etc)	176
Documents	767
Annual Growth Rate %	-3.65
Document Average Age	2.98
Average citations per doc	7.412
References	26 811
Document contents	
Keywords Plus (ID)	3 466
Author's Keywords (DE)	1 974
Authors	
Authors	3 437
Authors of single-authored docs	25
Authors collaboration	
Single-authored docs	27
Co-Authors per Doc	5.2
International co-authorships %	27.12
Document types	
article	687
book	1
book chapter	5
conference paper	1
erratum	4
letter	1
note	3
review	57
short survey	8

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The top 10 authors with the highest production were Sculean Anton from the University of Bern, Switzerland, with 19 articles and an *h*-index of 72. Meanwhile, Eliezer Meyzi from Tel Aviv University in Israel had the highest impact, with 31 citations per publication and having only published five articles. Finally, South Korea stood out with four researchers among the authors who had the highest research activity in this field of knowledge (Table 2).

Table 2. Top 10 authors

Author	Affiliation	Country/Region	Scholarly Output	h-index	Citations per Publication
Sculean, Anton	University of Bern	Switzerland	19	72	18
Koo, Ki-tae	Seoul National University	South Korea	7	29	7.4
Widiyanti, Prihartini	Universitas Airlangga	Indonesia	7	9	2.4
Kannan, Thirumulu Ponnuraj	Universiti Sains Malaysia	Malaysia	6	15	7.5
Kim, Sungtae	Seoul National University	South Korea	6	17	5.8
Pilloni, Andrea	University of Rome La Sapienza	Italy	6	26	18.8
Shirakata, Yoshinori	Kagoshima University	Japan	6	18	15.8
Eliezer, Meizi	Tel Aviv University	Israel	5	8	31
Lee, Jungwon	Seoul National University	South Korea	5	10	5.6
Lee, Yongmoo	Seoul National University	South Korea	5	34	7.2

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(Table 3) shows the number of articles on HA in dentistry according to the quartile of the journal where they were published. Most articles were in Q1 with 307, Q2 with 232, and Q3 and Q4 with 106 and 53, respectively, with 2023 being the year of highest production.

Table 3. Publications by journal quartile by CiteScore percentile

CiteScore quartile	Overall	2018	2019	2020	2021	2022	2023	2024
Q1	307	33	36	45	47	41	65	40
Q2	232	27	34	35	35	40	43	18
Q3	106	20	15	22	8	23	12	6
Q4	53	8	9	7	10	6	11	2
Total	698	88	94	109	100	110	131	66

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Two of the most important journals with the highest number of publications were *Clinical Oral Investigation* and the *Journal of Thermal Analysis and Calorimetry*. The *Dental Materials* journal presented a CiteScore of 9.2, which was the most valued, and an SNIP of 1.88, representing the highest probability of being cited per article in the field of HA in dentistry. However, the journal with the highest impact was the *Journal of Cranio-Maxillofacial Surgery*, with 18.5 citations per publication (Table 4).

Table 4. Top 10 Scopus sources

Scopus Source	Scholarly Output	CiteScore 2022	SNIP 2022	Citations per Publication
Clinical Oral Investigations	46	6.3	1.52	9
Journal of Thermal Analysis and Calorimetry	39	9.1	1.21	16
Journal of Cranio-Maxillofacial Surgery	20	5.6	1.75	18.5
Journal of International Dental and Medical Research	20	1.2	0.41	2.3
Dental Materials	17	9.2	1.88	10.4
Dental Materials Journal	17	4.2	1.02	12.1
BMC Oral Health	16	4.1	1.37	8.6
Journal of Periodontology	15	8	1.61	10.5
Journal of Stomatology, Oral and Maxillofacial Surgery	15	2.2	0.96	4.8
Clinical Implant Dentistry and Related Research	14	7.7	1.74	8.9

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The data in Table 5 show that the University of Bern in Switzerland ranks first as the institution with the most research work, with 13.3 citations per publication, and in second place was China, with Sichuan University, with 12.6 and 25.4 views per publication.

Tabla 5. Top 10 Institutions by scholarly output

Institution	Country/Region	Scholarly Output	Citations per Publication	Field Weighted Citation Impact	Views per Publication
University of Bern	Switzerland	33	13.3	2.25	26.3
Universidade Estadual Paulista Júlio de Mesquita Filho	Brazil	23	5.7	0.65	19.1
Universitas Airlangga	Indonesia	19	2.9	0.82	23.8
Sichuan University	China	15	12.6	1.11	25.4
Seoul National University	South Korea	14	9.1	1.07	19.8
Universidade de São Paulo	Brazil	14	4.4	1.08	20.4
Cairo University	Egypt	12	6.2	0.73	22.7
University of Rome La Sapienza	Italy	11	13	3.24	35.6
Mansoura University	Egypt	10	4.4	2.09	18
Chulalongkorn University	Thailand	9	3.4	1.03	28.7

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Figure 1 presents the main journals according to Bradford's law, indicating that in zone 1, the journals with the highest number of published articles were found. The *Clinical Oral Investigation* journal had the best impact indices, ranking first, followed by the *Journal of Thermal Analysis* and the *Journal of Cranio-Maxillofacial Surgery*. In total, 13 journals were considered most relevant for the dissemination of information on the subject.

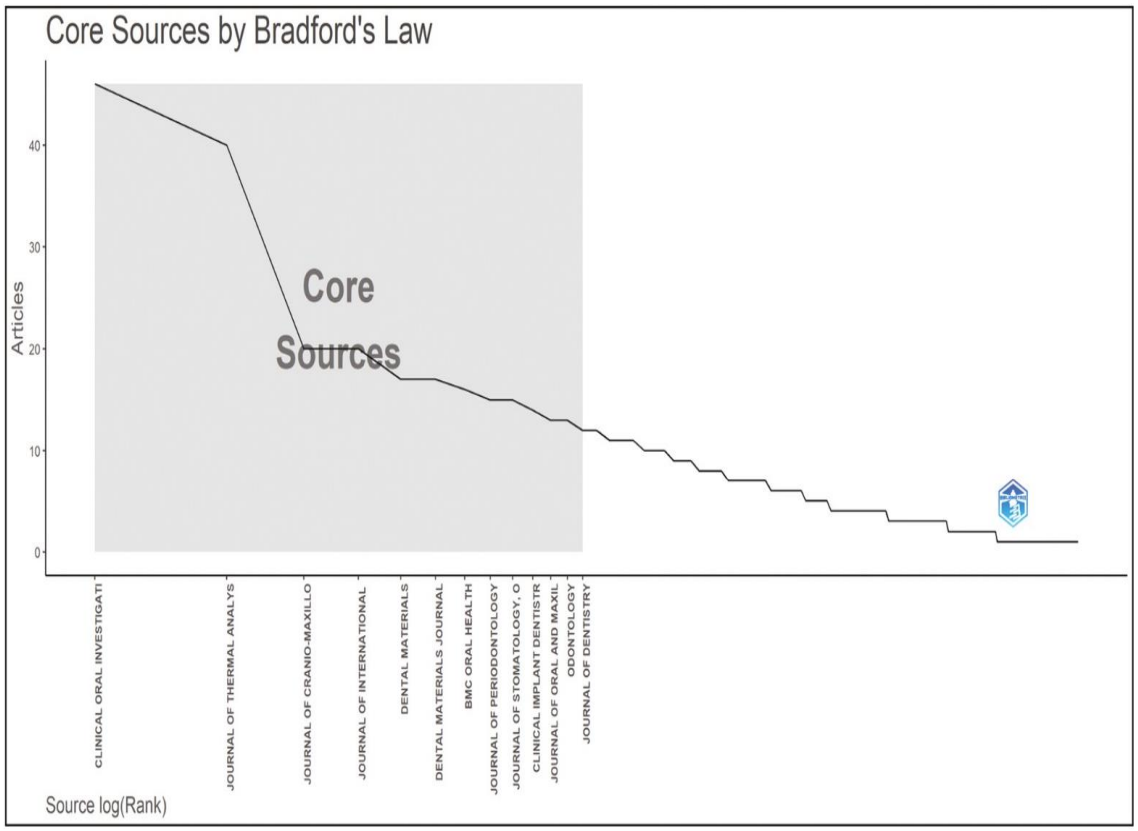


Fig. 1 Bradford´s Law

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The world collaboration map showed different international participation, such as China's participation with the United States up to 10 times; and in the same way, Italy's participation with Switzerland. It is noteworthy that the United States had more cooperation with various countries; followed by China, Brazil, Egypt, and Japan (Figure 2).

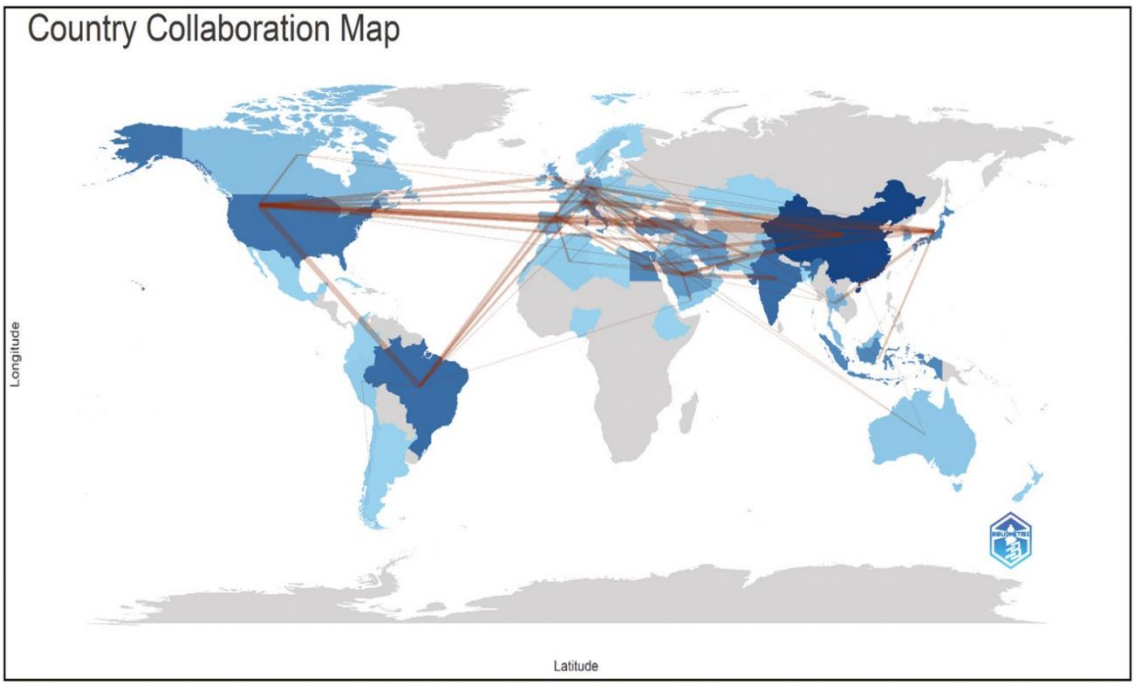


Fig. 2 Country Collaboration Map

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In Figure 3, the evaluation of Lotka's law shows that 90% of the articles were written by authors with only one published document. A single author has 19 documents indexed in Scopus. This analysis revealed that most authors had low scientific production in the field, with the smallest percentage of authors being the highest producers.

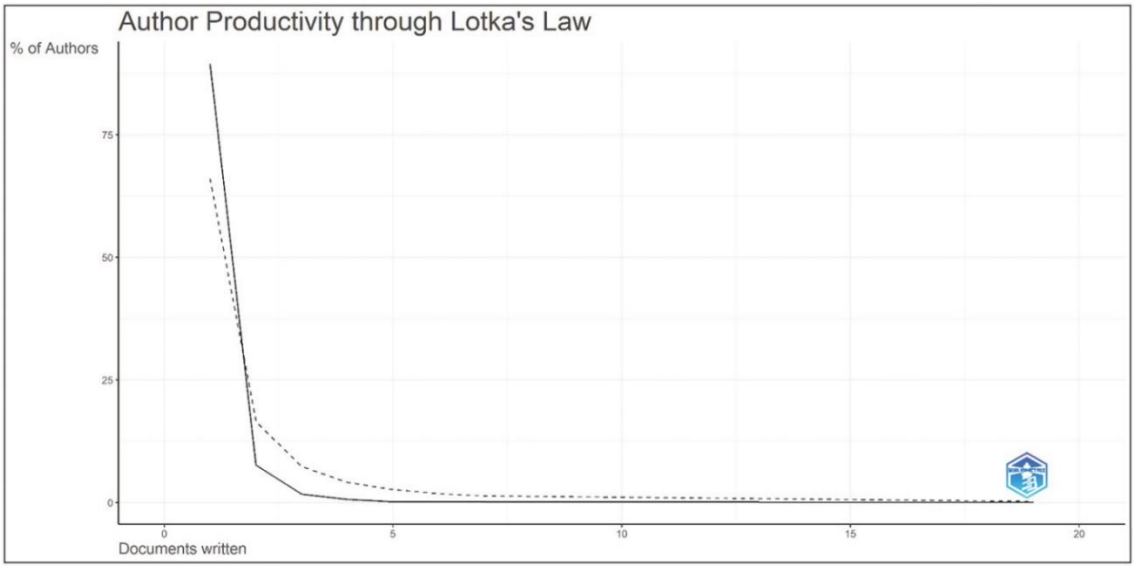
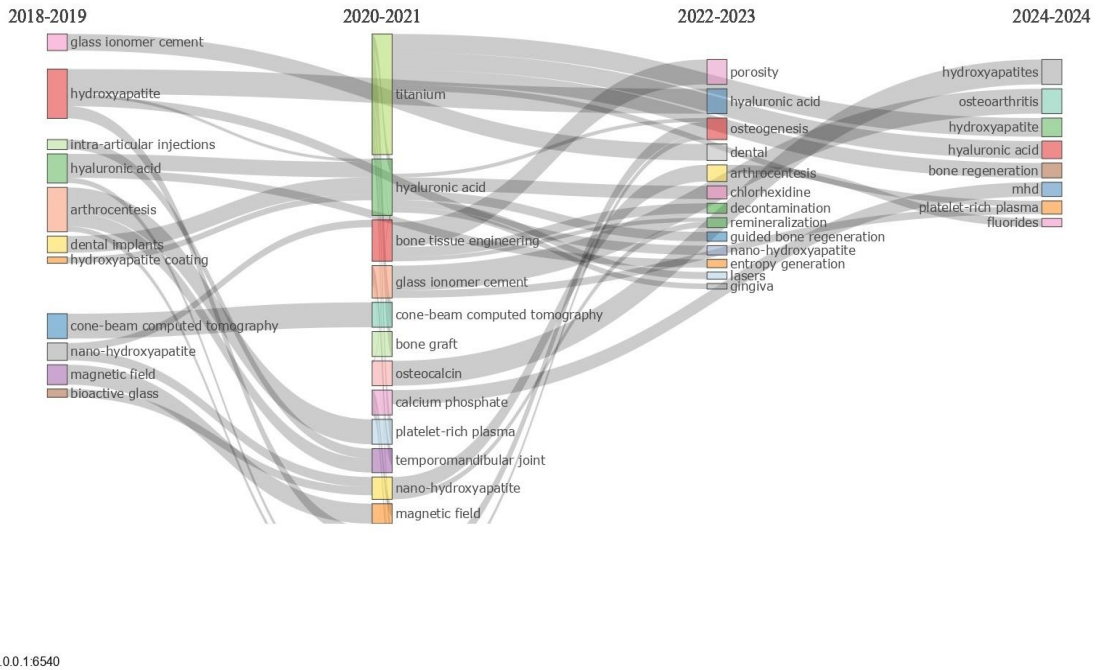


Fig. 3 Lotka´s Law

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When analyzing the graph of thematic evolution on the most important thesauri of the four periods, it was reported that from 2018 to 2019, the predominant words were hydroxyapatite, arthrocentesis, and HA. The first mention was related in 2020–2021 with the thesauri titanium and HA, the most predominant of that period; then, the term titanium evolved to other topics, such as porosity, HA, and osteogenesis. These findings, in turn, broadened their focus to hydroxyapatite, HA, and bone regeneration in the year 2022–2023. As observed, the field of study on HA maintained its relevance in the 4 periods of time (Figure 4).

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Fig. 4 Thematic evolution

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IV. DISCUSSION

The main functions of the HA biomolecule are to serve as a gel scaffold, initiate responses, and store and release chemical signals like hormones and growth factors. Therefore, it is a valuable supplement for the processes of wound healing and regeneration.[16] With the advent of new biomaterials in dentistry, the application of HA in dentistry has become relatively novel and has attracted considerable attention in scientific research.

This bibliometric study resulted in an analysis of 767 documents, revealing that the author with the highest scientific production was Anton Sculean (Switzerland), while Meizi Eleizer (Israel) had the highest impact. One of their joint studies found that topical application of HA can provide additional clinical benefits when used alongside both surgical and nonsurgical periodontal therapies.[17]

In a similar vein, there was a consistent rise in the number of publications, with 2023 marking the year with the highest scientific output in high-demand journals (Q1). The journal titled "*Clinical Oral Investigation*" had the most publications and was also the most impactful. The University of Bern was highlighted as making the most significant contribution. The United States produced a substantial number of articles on HA in dentistry and actively collaborated with other countries, such as China, Brazil, Egypt, and Japan. Correspondingly, Zhang *et al.*[18] described the U.S. as the country with the highest productivity and the highest number of citations for HA in osteoarthritis, indicating its leading position in scientific research. Therefore, it is essential to highlight the global relationships and collaborations among different authors and institutions to achieve better results, thereby generating beneficial impacts on oral health and professional practice.

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Throughout the years, the research term "HA" has consistently maintained its relevance and focus, extending its reach to various fields.[19] As described in the literature,[20] regenerative medicine for dental, oral, and craniofacial applications repairs or regenerates tissues. This area encompasses teeth, dental pulp, periodontal tissues, salivary glands, temporomandibular joints, bones, cartilage, muscles, nerves, and skin.

Noohi *et al.*[21] mentioned in their article that the technique of revascularization is promising, but there are certain restrictions. This led to the development of new protocols for the design and manufacture of appropriate HA scaffolds that meet the necessary criteria. However, additional studies are required to establish an optimal framework for clinical application.

In the field of periodontics, Karakostas *et al.* [22] evaluated the supplementary use of HA to enhance the clinical progression of gingivitis therapy, as well as surgical and non-surgical periodontal treatment. Their findings suggested that topical application of HA was safe, as no adverse effects were reported in any study. However, the authors concluded that further trials with a suitable design are required to determine the optimal regimen for HA-based treatment.

Temporomandibular joint disorders are extensively studied in the medical literature. These disorders are associated with numerous symptoms, including pain, restricted mouth opening, and joint noises, all of which can lead to a decline in quality of life. Both HA and platelet-rich plasma (PRP) injections have demonstrated significant effectiveness in treating these disorders. A study conducted by Nizar *et al.*[23] suggested that the combined injection of HA and PRP offers a greater improvement in patients than the injection of HA alone. This enhanced effectiveness may be attributed to the combined properties of both HA and PRP. Consequently, Abdulah *et al.*[24] indicated that the use of HA in

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implant treatment is safe, as their study obtained significant results, such as reductions in bleeding, edema, bacterial load, healing time, probing depth, and increase in bone formation. These findings highlight the potential of HA in various dental treatments and its impact on improving patient outcomes.

This study emphasized current research on the benefits of HA in dental treatments and aimed to provide physicians with up-to-date clinical evidence. It serves as a starting point for the search for future scopes and to be at the forefront of information. However, it also has certain limitations. For instance, only the Scopus database was analyzed, suggesting that further research should include other databases, such as Web of Science and PubMed. Second, a possible bias could have occurred because all data were extracted using software tools. Third, the search was particularly focused on English articles, which could have led to the exclusion of important studies published in other languages. In addition, the selection of search terms could have affected the results by likely omitting some words related to the topic. In addition, some articles were not freely accessible and thus could not be considered. It is also likely that the lack of self-citation correction by a journal or author could lead to an increase in this number, which could trigger errors in the analysis. Finally, studies similar to this bibliometric analysis were not found in our search, suggesting the need for more information about this field. This study underscores the importance of comprehensive and inclusive research practices[25] in dentistry, particularly when investigating the potential of innovative treatments, such as HA.

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V. CONCLUSIONS

According to the manuscripts analyzed, there was a gradual increase in publications, with the journals with the highest scientific production being those in Q1. This demonstrates that the use of HA has been of great interest in recent years for researchers in the oral cavity. It was also shown that the United States was the country with the most scientific collaborations with other countries, but it was highlighted that Sculean Anton, from Switzerland, was the one who presented the most research. Therefore, with these revelations, this study is intended to continue and expand the knowledge regarding new applications of HA in different dental branches. This study underscores the importance of ongoing and expanded research into the diverse applications of HA in dentistry.

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Versión en español aprobada para publicar (Journal of International Oral Health)

I. INTRODUCCIÓN

El cuerpo humano contiene ácido hialurónico (HA), un biopolímero que se encuentra de forma natural en diversos tejidos como la piel, articulaciones, ojos;[1] y que puede tratarse, modificarse y mezclarse con otras sustancias para su uso en diferentes aplicaciones biomédicas.[2,3]

Este componente usualmente llamado hialuronano, es uno de los glucosaminoglicanos que prevalece en la matriz extracelular manteniendo los tejidos hidratados;[4] presente en muchos tejidos de los vertebrados y ejerciendo varias funciones biológicas que dependen de su masa molecular.[5,6] El de alta masa molecular posee propiedades antiinflamatorias, anti proliferativas, anti angiogénicas e inmunosupresoras, en donde se une al fibrinógeno y controla los niveles de citocinas inflamatorias y la migración de células madre; y por el contrario, el de baja masa molecular tiene propiedades inmunoestimulantes y angiogénicas, por lo que induce citocinas, quimiocinas y factores de crecimiento proinflamatorios y estimula la remodelación de la matriz extracelular.[7]

Su biocompatibilidad y propiedades regenerativas lo han convertido en un tema de gran atención de interés en el campo de la odontología.[1] Por ejemplo, según los estudios actuales[8,9] en endodoncia, el HA en presentación de hidrogeles, proporcionan estructuras biocompatibles y poco inmunogénicas que respaldan la terapia de células madre en la regeneración del complejo dentinopulpar.[9]

Asimismo, las inyecciones de HA inducen a las células sinoviales a sintetizar ácido endógeno y promover la reparación del tejido del cartílago que pueden representar una posible alternativa en el manejo complejo de pacientes con trastornos temporomandibulares que padecen dolor crónico y/o que no responden a abordajes

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conservadores, considerando que el procedimiento de inyección de la articulación temporomandibular es mínimamente invasivo y con un bajo número de complicaciones. Su aplicación con técnicas como artroscopia o artrocentesis, son sinérgicos y potencializa los efectos a corto y largo plazo; mientras que, sus efectos adversos son menores y transitorios.[10-12]

Por otro lado, en periodoncia indicaron que el HA promueve el alivio sintomático tanto en la encía marginal como en los tejidos periodontales más profundos, conduciendo a una mejoría clínica en pacientes con gingivitis, periodontitis, y defectos periodontales, acelerando la cicatrización de heridas.[13]

Además, el gel de ácido hialurónico utilizado como recubrimiento sobre el implante de titanio, mejora la conexión implante-hueso.[14] Y reduce eficazmente el malestar después de la colocación de implantes, sugiriendo así que este material es un método complementario para controlar el dolor post quirurgico.[15]

Por consiguiente, el objetivo de este estudio bibliométrico fue analizar los patrones emergentes, colaboración e impacto de la producción científica sobre HA en la odontología.

II. MATERIALES Y MÉTODOS

1. Diseño de estudio

Se realizó un estudio observacional, descriptivo y retrospectivo, mediante un enfoque bibliométrico para analizar investigaciones relacionadas con el tema, indexadas en la base de datos de Scopus. La busqueda abarcó el periodo de enero 2018- mayo 2024.

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2. Búsqueda de información

En primer lugar, se realizó la selección de palabras clave apropiadas; luego, se incluyeron términos disponibles en el tesauro Medical Subject Heading (MESH), y los operadores lógicos AND y OR, permitiendo definir una estrategia de búsqueda: TITLE-ABS ("hyaluronic acid" OR hyaluronan OR HA OR "sodium hyaluronate" OR hyaluronate OR "hyaluronic acid filler" OR "hyaluronic acid gel" OR "hyaluronic acid injection") AND SUBJAREA(DENT). La búsqueda se realizó el 15 de mayo de 2024 y se encontraron durante el periodo enero 2018 mayo 2024 un total de 767 documentos de los cuales habían 687 artículos, 57 revisiones, 8 encuestas breves, 5 capítulos de libros, 4 erratas, 3 notas, 1 carta, 1 documento de conferencia y 1 libro. La diversa documentación ofrece una visión general del panorama de la investigación sobre el tema.

3. Indicadores bibliométricos

Se utilizaron diferentes indicadores de producción, colaboración e impacto, incluido el crecimiento anual, índice H, el cuartil de la revista cientifica, Source-Normalized Impact per Paper (SNIP), CiteScore 2022, el número de citas y de publicaciones, las citas por publicación, la autoría, país, la institución y el tipo de colaboración; asimismo, la ley de Bradford, la ley de Lotka, y el diagrama de evolución temática. Además, se utilizaron mapas temáticos para visualizar las relaciones entre autores y países, así como las colaboraciones.

4. Procedimiento bibliométrico

La información bibliométrica de las publicaciones científicas se exportó en archivos con extensión .xls. para la evaluación de los metadatos, empleando el programa SciVal (Elsevier). Adicionalmente, se aplicó el programa Microsoft Excel 2019 con el fin de elaborar un gráfico de tenencia y se calcularon las frecuencias y los porcentajes para el estudio de las variables categóricas. Los metadatos exportados en formato de valores

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separados por comas (CSV) fueron analizados con el módulo bibliométrix del software RStudio versión 4.2.3. Además, se diseñaron redes de visualización de citas por país con el programa VOSviewer versión 1.6.19.

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III. RESULTADOS

El estudio bibliométrico abarcó el periodo de tiempo de 2018 al 2024 y analizó 767 documentos de 176 fuentes diferentes con una tasa de crecimiento anual de -3.65%. Se identificaron un total de 3 437 autores, con un promedio de 5.2 coautores por documento y un 27.12% de coautorías internacionales; siendo los artículos (687) los tipos de documentos más comunes (Tabla 1).

Table 1: Producción Académica

Descripción	**Resultados**
Intérvalo de tiempo	2018:2024
Fuentes (Revistas, Libros, etc)	176
Documentos	767
Tasa de crecimiento anual %	-3.65
Edad promedio del documento	2.98
Citas promedio por documento	7.412
Referencias	26 811
Contenidos del Documento	
Palabras claves plus (ID)	3 466
Palabras claves del autor (DE)	1 974
Autores	
Autores	3 437
Autores de documento de un solo autor	25
Colaboración de Autores	
Documentos de un solo autor	27
Co- autores por documento	5.2
Porcentaje de coautorías internacionales %	27.12
Tipos de Documentos	
Artículo	687
Libro	1
Capítulo de libro	5
Documento de conferencia	1
Errata	4
Carta	1
Nota	3
Revisión	57
Encuesta corta	8

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La lista del top 10 de autores con mayor producción científica estuvo encabezada por Sculean Anton, de University of Bern en Suiza, con 19 artículos y un indice h de 72; mientras que, Eliezer Meyzi de Tel Aviv University en Israel fue el autor de mayor impacto con 31 citas por publicación contando sólo con 5 artículos publicados. Finalmente, Corea del Sur fue el país que resaltó con 4 investigadores dentro de los autores con mayor actividad investigadora en este campo del conocimiento (Tabla 2).

Table 2. Los 10 principales autores

Autores	Afiliación	País/ Región	Producción Académica	H-Index	Citaciones por Publi-cación
Sculean, Anton	University of Bern	Switzerland	19	72	18
Koo, Ki-tae	Seoul National University	South Korea	7	29	7.4
Widiyanti, Prihartini	Universitas Airlangga	Indonesia	7	9	2.4
Kannan, Thirumulu Ponnuraj	Universiti Sains Malaysia	Malaysia	6	15	7.5
Kim, Sungtae	Seoul National University	South Korea	6	17	5.8
Pilloni, Andrea	University of Rome La Sapienza	Italy	6	26	18.8
Shirakata, Yoshinori	Kagoshima University	Japan	6	18	15.8
Eliezer, Meizi	Tel Aviv University	Israel	5	8	31
Lee, Jungwon	Seoul National University	South Korea	5	10	5.6
Lee, Yongmoo	Seoul National University	South Korea	5	34	7.2

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En la tabla 3 se mostró el número de artículos realizados sobre ácido hialurónico en odontología, según el cuartil de la revista donde fueron publicados. La mayoría de artículos se ubicaron en Q1 con 307 documentos, Q2 con 232 documentos y, Q3 y Q4, con 106 y 53 documentos respectivamente; siendo el año 2023 el de mayor producción.

Table 3. Publicaciones por cuartil de revista por percentil CiteScore

Cuartil CiteScore	Total	2018	2019	2020	2021	2022	2023	2024
Q1	307	33	36	45	47	41	65	40
Q2	232	27	34	35	35	40	43	18
Q3	106	20	15	22	8	23	12	6
Q4	53	8	9	7	10	6	11	2
Total	698	88	94	109	100	110	131	66

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Dos de las revistas más importantes con mayor número de publicaciones fueron Clinical Oral Investigation y Journal of Thermal Analysis and Calorimetry. La revista Dental Materials presentó un CiteScore de 9.2 siendo la más valorada y un SNIP de 1.88 representando la mayor probabilidad de ser citado por artículo en el campo del ácido hialurónico en odontología. Sin embargo, la revista de mayor impacto fue Journal of Cranio-Maxillofacial Surgery con 18.5 citas por publicación (Tabla 4).

Table 4. Las 10 principales fuentes de Scopus

Fuente de Scopus	Producción Académica	CiteScore 2022	SNIP 2022	Citaciones por Publicación
Clinical Oral Investigations	46	6.3	1.52	9
Journal of Thermal Analysis and Calorimetry	39	9.1	1.21	16
Journal of Cranio-Maxillofacial Surgery	20	5.6	1.75	18.5
Journal of International Dental and Medical Research	20	1.2	0.41	2.3
Dental Materials	17	9.2	1.88	10.4
Dental Materials Journal	17	4.2	1.02	12.1
BMC Oral Health	16	4.1	1.37	8.6
Journal of Periodontology	15	8	1.61	10.5
Journal of Stomatology, Oral and Maxillofacial Surgery	15	2.2	0.96	4.8
Clinical Implant Dentistry and Related Research	14	7.7	1.74	8.9

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Los datos de la tabla 5 evidenciaron que University of Bern de Suiza se posiciona en primer lugar como institución de mayor trabajo investigador, con 13.3 citas por publicación y en segundo lugar se encontró China con Sichuan University con 12.6 y 25.4 vistas por publicación.

Tabla 5. Las 10 principales instituciones por producción académica

Institución	País/ Region	Producción Académica	Citaciones por Publicación	FWCI	Vistas por Publicación
University of Bern	Switzerland	33	13.3	2.25	26.3
Universidade Estadual Paulista Júlio de Mesquita Filho	Brazil	23	5.7	0.65	19.1
Universitas Airlangga	Indonesia	19	2.9	0.82	23.8
Sichuan University	China	15	12.6	1.11	25.4
Seoul National University	South Korea	14	9.1	1.07	19.8
Universidade de São Paulo	Brazil	14	4.4	1.08	20.4
Cairo University	Egypt	12	6.2	0.73	22.7
University of Rome La Sapienza	Italy	11	13	3.24	35.6
Mansoura University	Egypt	10	4.4	2.09	18
Chulalongkorn University	Thailand	9	3.4	1.03	28.7

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La figura 1 presentó las fuentes principales de acuerdo a la ley de Bradford indicando que en la zona 1 se encontraron las revistas con mayor cantidad de articulos publicados. La revista Clinical Oral Investigation tuvo los mejores índices de impacto, ubicándose en la primera posición y seguido por Journal of Thermal Analysis y Journal of Cranio-Maxillofacial Surgery. En total se consideraron 13 revistas las más relevantes para la difusión de la información sobre el tema.

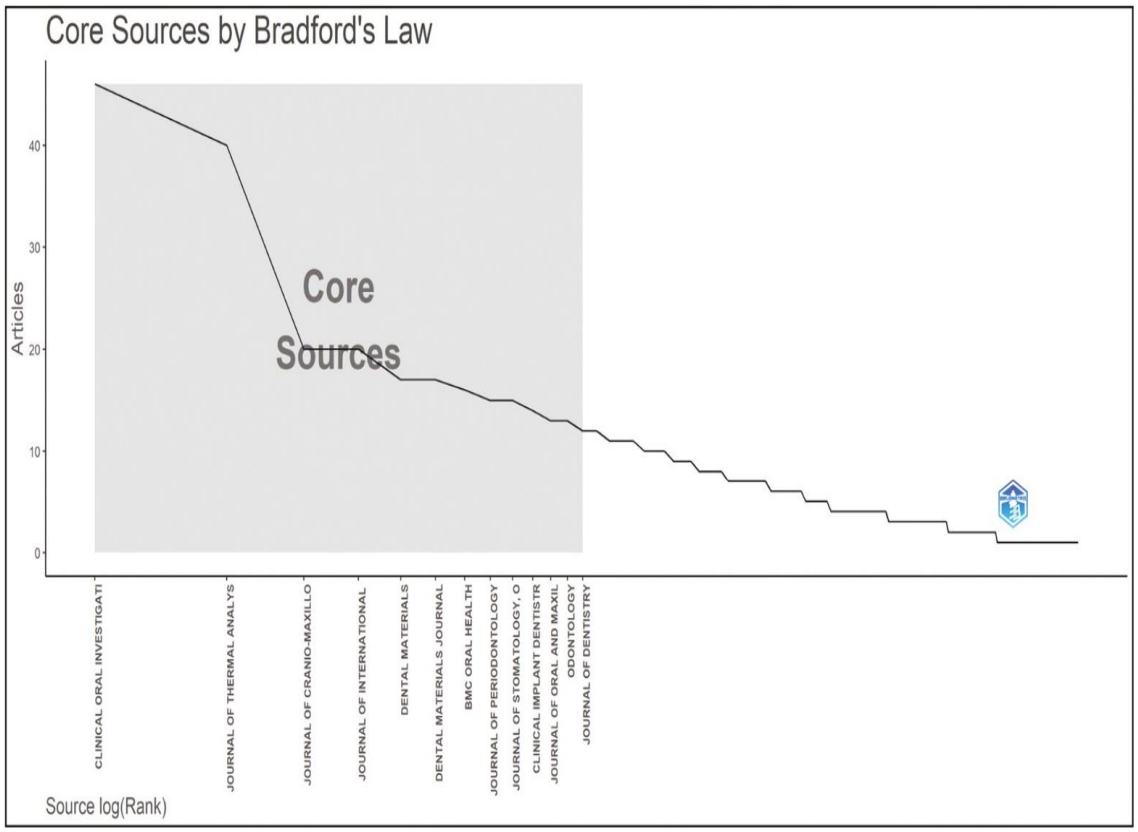


Fig. 1 Ley de Bradford

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En el mapa de colaboración mundial se evidenció distintas participaciones internacionales como China con Estados Unidos hasta en 10 ocasiones; y de igual manera, Italia con Suiza. Cabe destacar que Estados Unidos fue el país que tuvo más cooperaciones con diversos países; seguido de China, Brasil, Egipto y Japón (Fig.2).

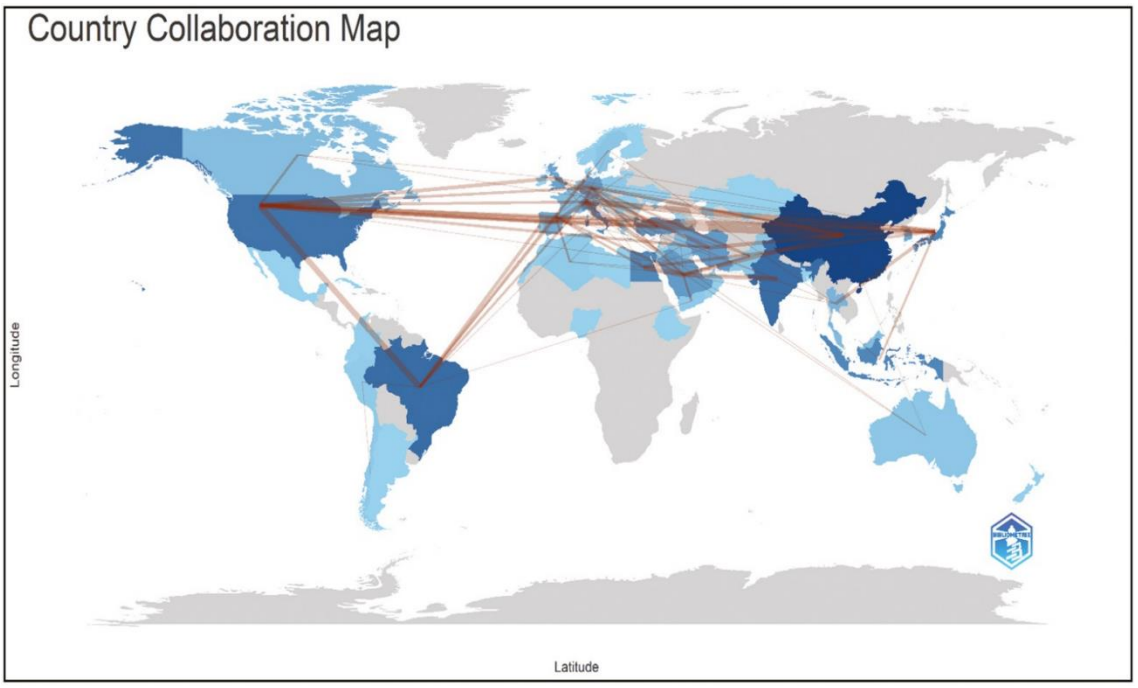


Fig. 2 Mapa de colaboración entre países

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En la figura 3 la evaluación de la ley de Lotka demostró que el 90% de los artículos fueron escritos por autores con un solo documento publicado. Mientras que un solo autor cuenta con 19 documentos indexados en Scopus. Este análisis reveló que la mayoría de los autores tuvo baja producción científica en el campo, siendo el menor porcentaje de autores los de mayor producción.

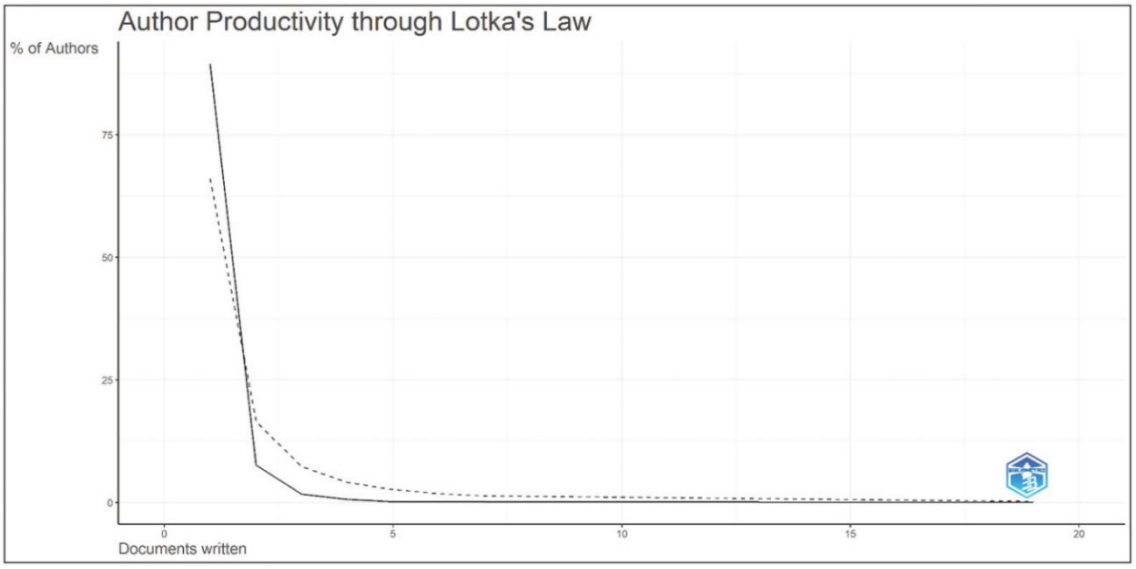
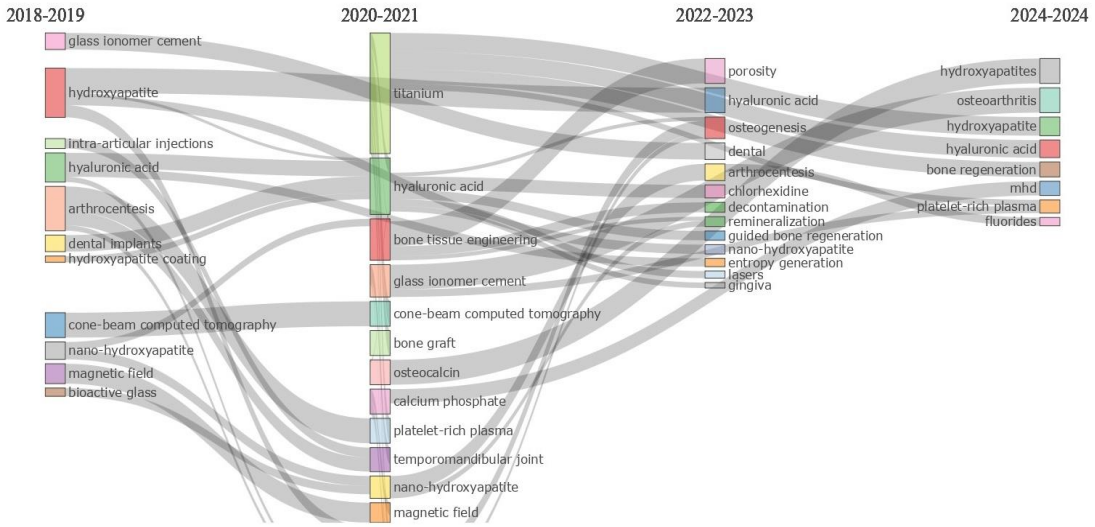


Fig. 3 Ley de Lotka

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Al analizar el gráfico de la evolución temática sobre los tesauros más importantes de los cuatro periodos, se reportó que del año 2018 al 2019, las palabras predominantes fueron hydroxyapatite, arthrocentesis y en tercer lugar hyaluronic acid. El primero en mención se relacionó en el 2020-2021 con los tesauros titanium y hyaluronic acid, los más predominantes de ese periodo de tiempo; y luego, el término titanium evolucionó a otros temas como porosity, hyaluronic acid y osteogénesis. Estos últimos, a su vez ampliaron su enfoque a hydroxiapatite, hyaluronic acid y bone regeneration en el año 2022-2023. Como se pudo observar, el campo de estudio hyaluronic acid mantuvo su relevancia en los 4 periodos de tiempo (Fig.4).



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Fig. 4 Evolución Temática

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IV. DISCUSIÓN

La biomolécula de HA tiene como funciones principales ser andamio de gel, desencadenante o disparador y reservorio para la liberación de señales químicas como hormonas o factores de crecimiento; sirviendo como complemento para la regeneración y cicatrización de heridas[16]. Es por esto que, debido a la aparición de nuevos biomateriales en odontología, el uso del HA en tratamientos dentales es relativamente innovador y ha mostrado gran interés en investigaciones científicas.

El presente estudio bibliométrico obtuvo como resultado un análisis de 767 documentos, mostrando que el autor de mayor producción científica fue Anton Sculean (Suiza) pero Meizi Eleizer (Israel) fue el autor de mayor impacto. Una de sus investigaciones conjuntas, indicó que la aplicación tópica de HA puede generar beneficios clínicos adicionales cuando se usa como complemento de la terapia quirúrgica y no quirúrgica en el área periodontal[17].

De igual manera, se evidenció un incremento continuo en la cantidad de publicaciones, dando como resultado el año 2023 el de mayor trabajo científico en revistas con alta exigencia (Q1). La revista Clinical Oral Investigation obtuvo la mayor cantidad de publicaciones y, también fue la de mayor impacto, destacando University of Bern como la institución de mayor contribución significativa. Estados Unidos aportó en gran cantidad a la elaboración de artículos sobre HA en odontología, participando activamente con otros países como China, Brasil, Egipto y Japón. En esa misma línea, Jun Zhang et al.[18] describieron a EE. UU como el país más productivo con el mayor número de citas sobre el HA en el campo de la osteoartritis, indicando que este país está a la vanguardia de la investigación científica. Por lo tanto, es fundamental destacar la relación y colaboración mundial entre diferentes autores e instituciones a fin de tener mejores resultados,

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generando impactos beneficiosos para la salud oral de las personas y la práctica profesional.

Por otro lado, en el transcurso de los años el término de estudio HA fue una constante y relevante en el tiempo[19], ampliando su enfoque a diferentes áreas. Así como se describe en la literatura[20] la medicina regenerativa dental, oral y craneofacial sirve para reparar o regenerar los tejidos, incluidos los dientes, la pulpa dental, los tejidos periodontales, las glándulas salivales, la articulación temporomandibular, huesos, cartílagos, músculos, nervios y piel.

Parisa Noohi et al.[21] mencionó en su artículo que la técnica de revascularización es prometedora, pero existen ciertas restricciones, lo que llevó a desarrollar nuevos protocolos para el diseño y fabricación de un andamio apropiado de HA que cumpla con los criterios necesarios. Sin embargo, se necesitan más estudios para desarrollar un armazón ideal para su uso en un entorno clínico. Mientras que en el área de periodoncia, Karakostas et al. [22] evaluó el uso complementario de HA para mejorar el curso clínico de la terapia de gingivitis, el tratamiento periodontal quirúrgico y no quirúrgico. Y de acuerdo a sus resultados el uso tópico de HA pareció ser seguro debido a que no se detectaron efectos adversos en ninguno de los estudios, pero concluyó que es necesario realizar más ensayos con un diseño apropiado para especificar el régimen ideal de modalidades de tratamiento basadas en HA.

Los trastornos de la articulación temporomandibular son enfermedades ampliamente investigadas en la literatura médica. Se asocian con muchos síntomas, como dolor, apertura bucal limitada y ruidos articulares, lo que resulta en una disminución de la calidad de vida del paciente. Tanto la inyección de HA como la inyección de plasma rico en plaquetas (PRP) tienen una eficacia notable en el tratamiento su tratamiento. Los resultados del estudio de Ali Nizar et al. [23] sugirieron que la inyección de HA y PRP

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proporciona una mayor mejora en los pacientes en comparación con la inyección de HA sola; esto puede deberse al aprovechamiento de las propiedades tanto del HA como del PRP. Por consiguiente, Abdulah Nur et al [24] indicaron que es seguro el uso de HA en tratamiento con implantes, ya que su estudio obtuvo resultados significativos, como reducción de sangrado, edema, carga bacteriana, tiempo de curación, profundidad de sondaje e incremento de formación de hueso.

Este estudio enfatizó las investigaciones actuales de los beneficios de HA en los tratamientos dentales, con la finalidad de proporcionar a los médicos una evidencia clínica actualizada, tomándose como punto de partida para búsqueda de futuros alcances y estar a la vanguardia de la información. Sin embargo, también presentó ciertas limitaciones como, por ejemplo, solo se analizó la base de datos de Scopus, por lo que se sugiere que se realicen más investigaciones que abarquen otras bases de datos como PubMed y Web of Science. En segundo lugar, pudo ocurrir un posible sesgo dado que todos los datos se extrajeron con herramientas de software. En tercer lugar, la búsqueda particularmente se enfocó en artículos del idioma inglés, lo que pudo generar la exclusión de estudios importantes publicados en otros idiomas. Además, la selección de términos de búsqueda pudo afectar los resultados al omitir probablemente algunas palabras relacionadas al tema y algunos artículos no fueron de acceso libre, por lo que no pudieron ser tomados en cuenta. Es probable también, que la falta de corrección de autocitas por parte de una revista o de un autor pueda dar lugar a un aumento del número de éste, lo que pudo desencadenar errores en el análisis. Finalmente, estudios similares al presente análisis bibliométrico no fueron encontrados en nuestra búsqueda, por lo que se sugiere más información sobre el campo del conocimiento.

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V. CONCLUSIONES

Según los manuscritos analizados referente al tema de estudio, existió un aumento gradual de publicaciones, donde las revistas de mayor producción científica se encuentran en Q1, demostrando que el uso del HA fue de gran interés en los últimos años para los investigadores del área bucal. Se demostró también que Estados Unidos fue el país con mayor colaboración científica con otros países, pero destacó que el autor Sculean Anton, procedente de Suiza, fue el que presentó mayor cantidad de investigaciones. Por lo tanto, con estas revelaciones se pretende que continúen y amplíen más conocimientos referentes a nuevas aplicaciones del ácido hialurónico en las diferentes ramas de la odontología.

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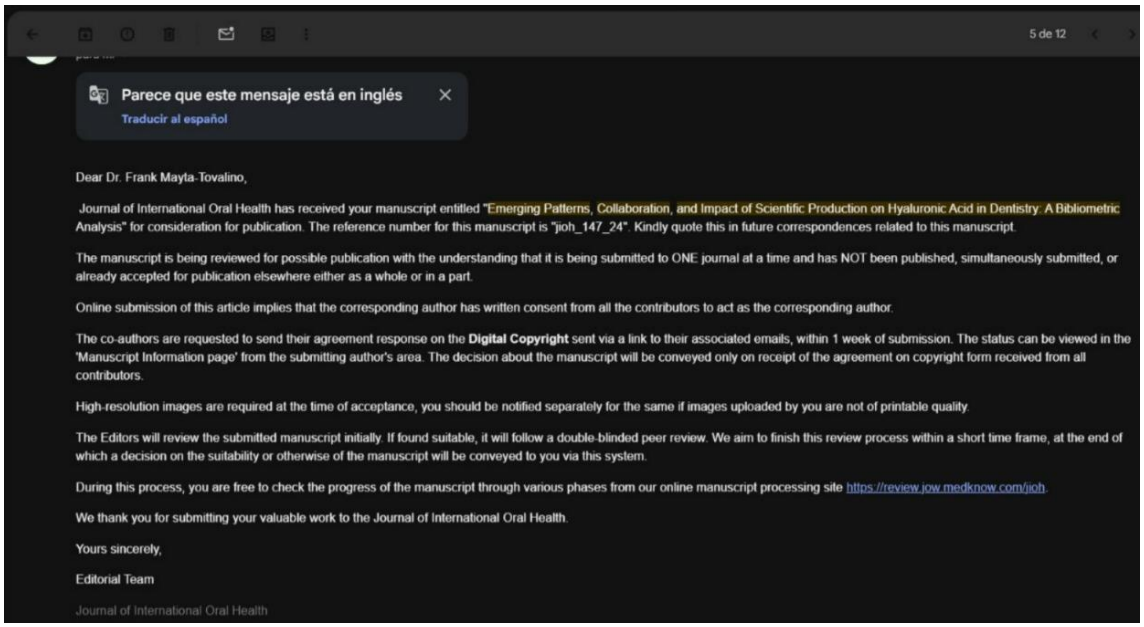
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5 de 12

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Dear Dr. Frank Mayta-Tovalino,

Journal of International Oral Health has received your manuscript entitled "Emerging Patterns, Collaboration, and Impact of Scientific Production on Hyaluronic Acid in Dentistry: A Bibliometric Analysis" for consideration for publication. The reference number for this manuscript is "jioh_147_24". Kindly quote this in future correspondences related to this manuscript.

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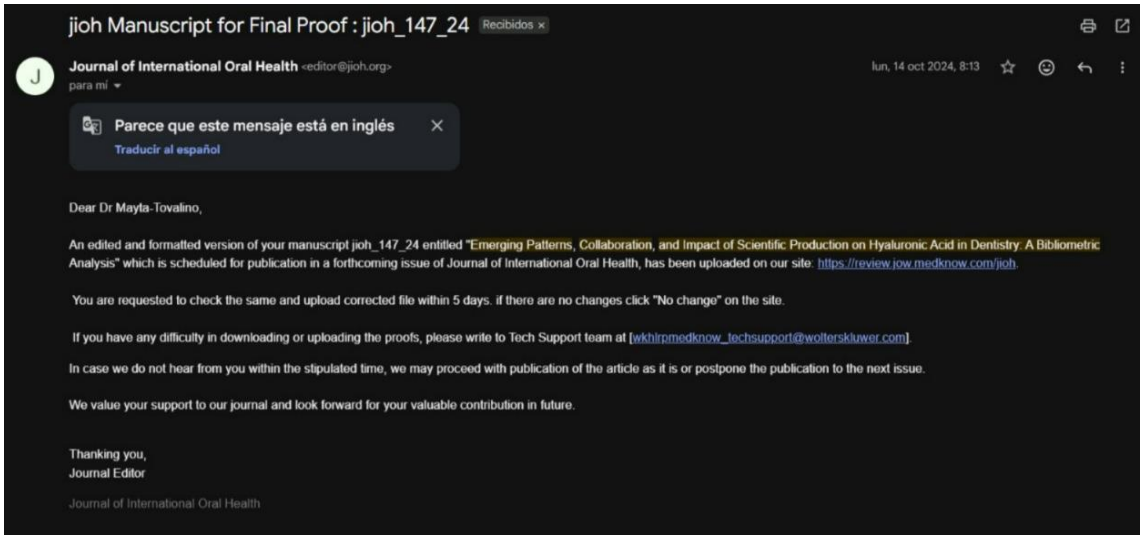
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Yours sincerely,

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An edited and formatted version of your manuscript jioh_147_24 entitled "Emerging Patterns, Collaboration, and Impact of Scientific Production on Hyaluronic Acid in Dentistry: A Bibliometric Analysis" which is scheduled for publication in a forthcoming issue of Journal of International Oral Health, has been uploaded on our site: https://review.jow.medknow.com/jioh.

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VII. ANEXOS

Review Article

Emerging Patterns, Collaboration, and Impact of Scientific Production on Hyaluronic Acid in Dentistry: A Bibliometric Analysis

Carla Quinteros-Quispe[1], Fiorella Jimenez-Obregón[1], Pedro Luis Tinedo-López[1], Fran Espinoza-Carhuancho[2], Josmel Pacheco-Mendoza[2], Frank Mayta-Tovalino[2]

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Abstract

Aim: This observational, descriptive, retrospective presentation aimed to analyze the emerging patterns, collaboration, and impact of scientific production on hyaluronic acid (HA) in dentistry. **Materials and Methods:** A bibliometric analysis of research indexed in Scopus from January 2018 to May 2024 was performed. Emerging patterns, collaboration, impact, Bradford's law, and Lotka's law were applied. In addition, thematic maps were designed to visualize the connections between authors and countries. **Results:** A total of 767 documents from 176 diverse sources were analyzed, identifying 3437 authors. Articles were the most common type of document. The author of the highest scientific output was Sculean Anton of the University of Bern, Switzerland. Most of the articles were published in first-quartile journals, with *Clinical Oral Investigation* and *Journal of Thermal Analysis and Calorimetry* having the highest number of publications. The University of Bern in Switzerland was the institution with the highest research output. **Conclusion:** This study provides a comprehensive overview of the academic production of HA in dentistry. The results highlight the importance of international collaboration and the concentration of scientific production in certain institutions and journals. These findings may be useful to researchers and institutions seeking to understand and navigate the field of HA in dentistry.

Keywords: Bibliometrics, Dentistry, Hyaluronic Acid

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Introduction

Hyaluronic acid (HA), a biopolymer, is naturally present in various human tissues, including skin, joints, and eyes.[1] This substance can be processed, altered, and combined with other materials, broadening its potential for various biomedical applications.[2-5]

Hyaluronan, often referred to in scientific literature, is a key glycosaminoglycan found in the extracellular matrix, where it plays an essential role in maintaining tissue hydration.[6-8] This component is present in a variety of vertebrate tissues and performs a range of biological functions that are influenced by its molecular weight. Hyaluronan with high molecular weight exhibits anti-inflammatory, anti-proliferative, anti-angiogenic, and immunosuppressive properties. It can bind to fibrinogen, thereby regulating the levels of inflammatory cytokines and the migration of stem cells. Conversely, low molecular weight hyaluronan exhibits immunostimulatory and angiogenic properties. It triggers the production of pro-inflammatory cytokines, chemokine, and growth factors, and promotes the remodeling of the extracellular matrix.[7]

The biocompatibility and regenerative properties of HA have garnered significant attention in the field of dentistry.[1] For instance, current studies in endodontics suggest that

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HA, in the form of hydrogels, provides biocompatible and minimally immunogenic structures that support stem cell therapy in the regeneration of the dentin–pulp complex.[8,9]

In addition, injections of HA have been found to encourage synovial cells to produce endogenous acid, which in turn aids in the repair of cartilage tissue. This method could provide an alternative treatment strategy for patients with temporomandibular disorders who experience chronic pain and/or who have not responded to traditional treatment. The procedure for injecting the temporomandibular joint is minimally invasive and associated with a low incidence of complications. Application in conjunction with techniques such as arthroscopy or arthrocentesis can synergize and enhance both short- and long-term effects, whereas its adverse effects are minor and transient.[10-12]

In periodontics, HA has been shown to provide symptomatic relief for both the marginal gingiva and deeper periodontal tissues. These treatments result in clinical improvements for patients with gingivitis, periodontitis, and periodontal defects, accelerating wound healing.[13] Furthermore, when used as a coating on titanium implants, HA gel enhances the implant–bone connection.[14] The material effectively reduces discomfort following implant placement, suggesting that it serves as a complementary method for managing post-surgical pain.[15]

Consequently, this bibliometric study aimed to analyze the emerging patterns, collaboration, and impact of scientific production on HA in dentistry.

Materials and Methods

Study design

An observational, descriptive, and retrospective study was conducted using a bibliometric approach to analyze research related to the topic indexed in the Scopus database. The search was conducted from January 2018 to May 2024.

Information search

Initially, an appropriate selection of keywords was made. Subsequently, terms available in the Medical Subject Heading thesaurus were included, and the logical operators, such as AND and OR, were used to define a search strategy. This strategy was designed to ensure a comprehensive and accurate retrieval of relevant studies on the topic: TITLE-ABS("hyaluronic acid" OR "hyaluronan" OR "HA" OR "sodium hyaluronate" OR "hyaluronate" OR "hyaluronic acid filler" OR "hyaluronic acid gel" OR "hyaluronic acid injection") AND SUBJAREA ("DENT"). The search was conducted on May 15, 2024, and 767 documents were found for the period from January 2018 to May 2024. These documents included 687 articles, 57 reviews, 8 short surveys, 5 book chapters, 4 errata, 3 notes, 1 letter, 1 conference paper, and 1 book. The diverse range of documents provides a comprehensive overview of the research landscape on the topic.

Bibliometric indicators

Several production, networking, and impact indicators were measured, including annual growth, *h*-index, journal quartile, Source-Normalized Impact per Paper (SNIP), CiteScore 2022, the number of citations and publications, citations per publication, authorship, country, institution, and type of collaboration. Additionally, Bradford's law, Lotka's law, and thematic evolution diagrams were applied. Thematic maps were also used to identify the relationships between authors and countries, and collaborations.

Bibliometric procedure

The bibliometric information of the scientific publications was exported as.xls files for metadata evaluation using the SciVal program (Elsevier). Additionally, Microsoft Excel 2019 was used to create a trend graph, and frequencies and percentages were calculated for categorical variables. The metadata exported in Comma-Separated Values format were analyzed with the bibliometrix tool of R Studio software version 4.2.3 (Bibliometrix, Boston, Massachusetts, USA). Furthermore, citation visualization networks by country were designed using the VOSviewer software version 1.6.19. This comprehensive approach allowed for a detailed and nuanced analysis of the scholarly literature on HA in dentistry.

Results

The bibliometric analysis spanned the years 2018–2024, during which it examined 767 documents sourced from 176 distinct outlets. The study noted an annual growth rate of −3.65%. The research identified 3437 authors, with an average of 5.2 co-authors per document and international co-authorships making up 27.12% of the total. The most prevalent type of document was articles, with 687 instances noted [Table 1].

The top 10 authors with the highest production were Sculean Anton from the University of Bern, Switzerland, with 19 articles and an *h*-index of 72. Meanwhile, Eliezer Meyzi from Tel Aviv University in Israel had the highest impact, with 31 citations per publication and having only published five articles. Finally, South Korea stood out with four researchers among the authors who had the highest research activity in this field of knowledge [Table 2].

Table 3 shows the number of articles on HA in dentistry according to the quartile of the journal where they were published. Most articles were in Q1 with 307, Q2 with 232, and Q3 and Q4 with 106 and 53, respectively, with 2023 being the year of highest production.

Two of the most important journals with the highest number of publications were *Clinical Oral Investigation* and the *Journal of Thermal Analysis and Calorimetry*. The *Dental Materials* journal presented a CiteScore of 9.2, which was the most valued, and an SNIP of 1.88, representing the highest probability of being cited per article in the field

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of HA in dentistry. However, the journal with the highest impact was the *Journal of Cranio-Maxillofacial Surgery*, with 18.5 citations per publication [Table 4].

The data in Table 5 show that the University of Bern in Switzerland ranks first as the institution with the most research work, with 13.3 citations per publication, and in second place was China, with Sichuan University, with 12.6 and 25.4 views per publication.

Figure 1 presents the main journals according to Bradford's law, indicating that in zone 1, the journals with the highest number of published articles were found. The *Clinical Oral Investigation* journal had the best impact indices, ranking first, followed by the *Journal of Thermal Analysis* and the *Journal of Cranio-Maxillofacial Surgery*. In total, 13 journals were considered most relevant for the dissemination of information on the subject.

The world collaboration map showed different international participation, such as China's participation with the United States up to 10 times; and in the same way, Italy's participation with Switzerland. It is noteworthy that the United States had more cooperation with various countries; followed by China, Brazil, Egypt, and Japan [Figure 2].

In Figure 3, the evaluation of Lotka's law shows that 90% of the articles were written by authors with only one published document. A single author has 19 documents indexed in Scopus. This analysis revealed that most authors had low scientific production in the field, with the smallest percentage of authors being the highest producers.

When analyzing the graph of thematic evolution on the most important thesauri of the four periods, it was reported that from 2018 to 2019, the predominant words were hydroxyapatite, arthrocentesis, and HA. The first mention was related in 2020–2021 with the thesauri titanium and HA, the most predominant of that period; then, the term titanium evolved to other topics, such as porosity, HA, and osteogenesis. These findings, in turn, broadened their

Table 1: Scholarly output

Description	Result
Period	2018:2024
Source	176
Articles	767
Annual growth %	−3.65
Document average	2.98
Average citations	7.412
References	26,811
Keywords plus	3,466
Author's keywords	1,974
Authors	3,437
Authors of single-authored docs	25
Single-authored docs	27
Co-authors per doc	5.2
International co-authorships %	27.12
Article	687
Book	1
Book chapter	5
Conference paper	1
Erratum	4
Letter	1
Note	3
Review	57
Short survey	8

Table 2: Top 10 authors

Author	Affiliation	Country/region	Scholarly output	*h*-index	Citations per publication
Sculean, Anton	University of Bern	Switzerland	19	72	18
Koo, Ki-tae	Seoul National University	South Korea	7	29	7.4
Widiyanti, Prihartini	Universitas Airlangga	Indonesia	7	9	2.4
Kannan, Thirumalu Ponnuraj	Universiti Sains Malaysia	Malaysia	6	15	7.5
Kim, Sunglae	Seoul National University	South Korea	6	17	5.8
Pilloni, Andrea	University of Rome La Sapienza	Italy	6	26	18.8
Shirakata, Yoshinori	Kagoshima University	Japan	6	18	15.8
Eliezer, Meizi	Tel Aviv University	Israel	5	8	31
Lee, Jungwon	Seoul National University	South Korea	5	10	5.6
Lee, Yongmoo	Seoul National University	South Korea	5	34	7.2

Table 3: Publications by journal quartile by CiteScore percentile

CiteScore quartile	Overall	2018	2019	2020	2021	2022	2023	2024
Q1	307	33	36	45	47	41	65	40
Q2	232	27	34	35	35	40	43	18
Q3	106	20	15	22	8	23	12	6
Q4	53	8	9	7	10	6	11	2
Total	698	88	94	109	100	110	131	66

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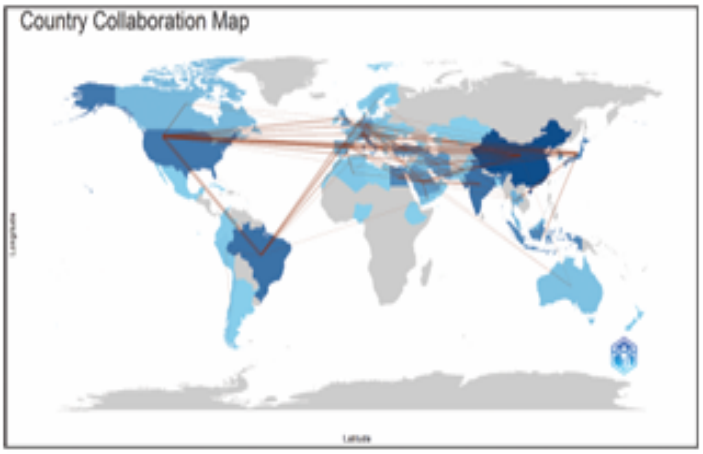


Figure 2: Country collaboration map

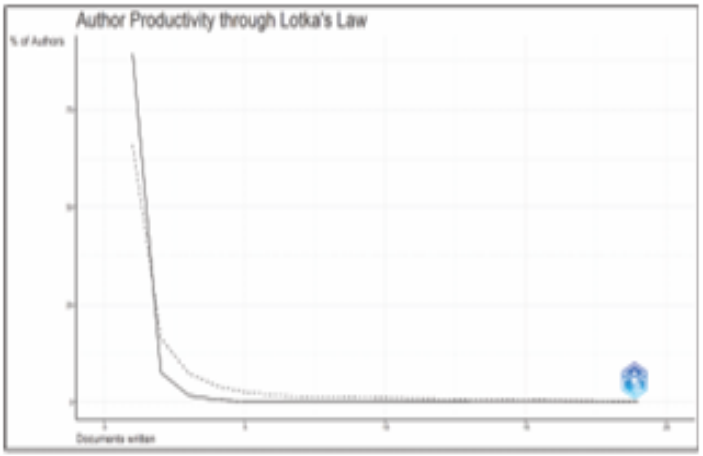


Figure 3: Author productivity through Lotka's law

chemical signals like hormones and growth factors. Therefore, it is a valuable supplement for the processes of wound healing and regeneration.[18] With the advent of new biomaterials in dentistry, the application of HA in dentistry has become relatively novel and has attracted considerable attention in scientific research.

This bibliometric study resulted in an analysis of 767 documents, revealing that the author with the highest scientific production was Anton Sculean (Switzerland), while Meizi Eleizer (Israel) had the highest impact. One of their joint studies found that topical application of HA can provide additional clinical benefits when used alongside both surgical and nonsurgical periodontal therapies.[17]

In a similar vein, there was a consistent rise in the number of publications, with 2023 marking the year with the highest scientific output in high-demand journals (Q1). The journal titled "*Clinical Oral Investigation*" had the most publications and was also the most impactful. The University of Bern was highlighted as making the most significant contribution. The United States produced a substantial number of articles on HA in dentistry and actively collaborated with other countries, such as China, Brazil, Egypt, and Japan. Correspondingly, Zhang *et al*.[19] described the U.S. as the country with the highest productivity and the highest number of citations for HA in osteoarthritis, indicating its leading position in scientific research. Therefore, it is essential to highlight the global relationships and collaborations among different authors and institutions to achieve better results, thereby generating beneficial impacts on oral health and professional practice.

Throughout the years, the research term "HA" has consistently maintained its relevance and focus, extending its reach to various fields.[19] As described in the literature,[20] regenerative medicine for dental, oral, and craniofacial applications repairs or regenerates tissues. This area encompasses teeth, dental pulp, periodontal

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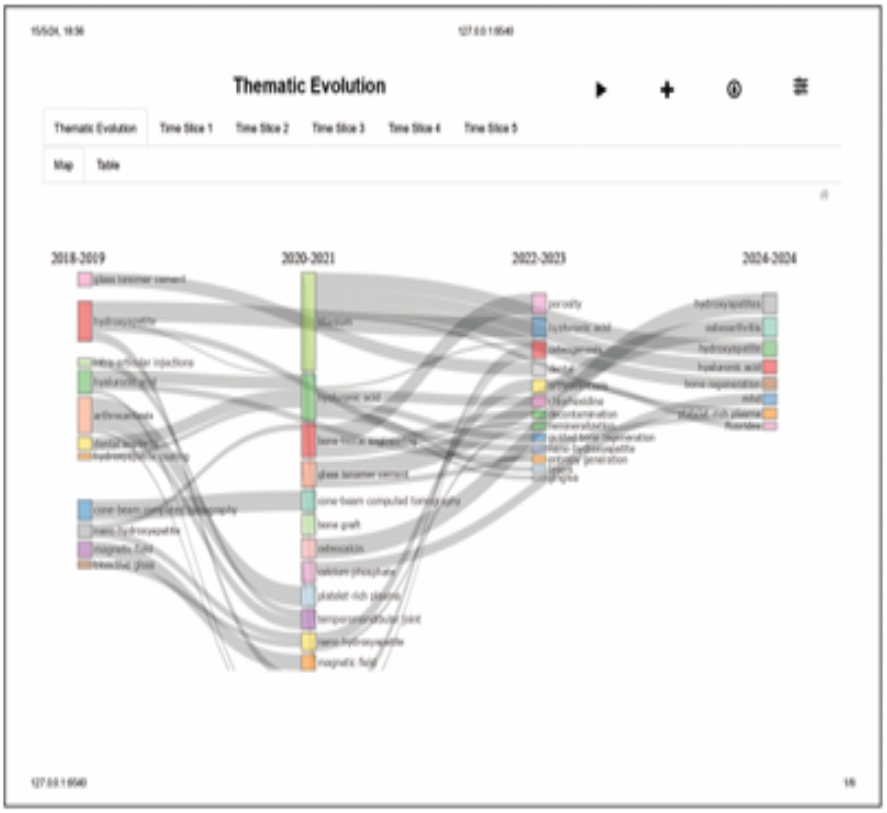


Figure 4: Thematic evolution

tissues, salivary glands, temporomandibular joints, bones, cartilage, muscles, nerves, and skin.

Noohi *et al.*[21] mentioned in their article that the technique of revascularization is promising, but there are certain restrictions. This led to the development of new protocols for the design and manufacture of appropriate HA scaffolds that meet the necessary criteria. However, additional studies are required to establish an optimal framework for clinical application.

In the field of periodontics, Karakostas *et al.*[22] evaluated the supplementary use of HA to enhance the clinical progression of gingivitis therapy, as well as surgical and non-surgical periodontal treatment. Their findings suggested that topical application of HA was safe, as no adverse effects were reported in any study. However, the authors concluded that further trials with a suitable design are required to determine the optimal regimen for HA-based treatment.

Temporomandibular joint disorders are extensively studied in the medical literature. These disorders are associated with numerous symptoms, including pain, restricted mouth opening, and joint noises, all of which can lead to a decline in quality of life. Both HA and platelet-rich plasma (PRP) injections have demonstrated significant effectiveness in treating these disorders. A study conducted by Nizar *et al.*[23] suggested that the combined injection of HA and PRP offers a greater improvement in patients than the injection of HA alone. This enhanced effectiveness may be attributed to the combined properties of both HA and PRP. Consequently, Abdulah *et al.*[24] indicated that the use of HA in implant treatment is safe, as their study obtained significant results, such as reductions in bleeding, edema, bacterial load, healing time, probing depth, and increase in bone formation. These findings highlight the potential of HA in various dental treatments and its impact on improving patient outcomes.

This study emphasized current research on the benefits of HA in dental treatments and aimed to provide physicians with up-to-date clinical evidence. It serves as a starting point for the search for future scopes and to be at the forefront of information. However, it also has certain limitations. For instance, only the Scopus database was analyzed, suggesting that further research should include other databases, such as Web of Science and PubMed. Second, a possible bias could have occurred because all data were extracted using software tools. Third, the search was particularly focused on English articles, which could have led to the exclusion of important studies published in other languages. In addition, the selection of search terms could have affected the results by likely omitting some words related to the topic. In addition, some articles were not freely accessible and thus

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could not be considered. It is also likely that the lack of self-citation correction by a journal or author could lead to an increase in this number, which could trigger errors in the analysis. Finally, studies similar to this bibliometric analysis were not found in our search, suggesting the need for more information about this field. This study underscores the importance of comprehensive and inclusive research practices[19] in dentistry, particularly when investigating the potential of innovative treatments, such as HA.

Conclusion

According to the manuscripts analyzed, there was a gradual increase in publications, with the journals with the highest scientific production being those in Q1. This demonstrates that the use of HA has been of great interest in recent years for researchers in the oral cavity. It was also shown that the United States was the country with the most scientific collaborations with other countries, but it was highlighted that Seulean Anton, from Switzerland, was the one who presented the most research. Therefore, with these revelations, this study is intended to continue and expand the knowledge regarding new applications of HA in different dental branches. This study underscores the importance of ongoing and expanded research into the diverse applications of HA in dentistry.

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Conflicts of interest

There are no conflicts of interest.

Author contributions

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RESOLUCIÓN DIRECTORAL DE ACEPTACIÓN DEL PROYECTO DE TESIS Y NOMBRAMIENTO DEL ASESOR

RESOLUCIÓN DIRECTORAL DE LA CARRERA DE ESTOMATOLOGÍA

Nº 116-POSG-DACE-DAFCS-U-CIENTÍFICA-2024

Lima, 27 de agosto del 2024

VISTO:

La solicitud de el/la tesista, asesor/a y la evaluación del Responsable de Investigación de la Carrera de Estomatología y de acuerdo a la RESOLUCIÓN DIRECTORAL No. 008-DGIDI-CIENTIFICA-2023 sobre Normas de precisiones de exoneración del Comité de Ética. Se aprueba el registro **Nº POS-78-2024-00626** del proyecto de Tesis Titulado: **"PATRONES EMERGENTES, COLABORACIÓN E IMPACTO DE LA PRODUCCIÓN CIENTÍFICA SOBRE ÁCIDO HIALURÓNICO EN ODONTOLOGÍA: ANÁLISIS BIBLIOMÉTRICO"** presentado por **JIMENEZ OBREGÓN FIORELLA AMALIA, QUINTEROS QUISPE CARLA OLGA MARIANA**.

CONSIDERANDO:

Que, de acuerdo al Reglamento General de la Universidad Científica del Sur y los reglamentos de posgrado para obtener el Título Profesional de Segunda Especialidad en **ENDODONCIA** en la Carrera de Estomatología de la Universidad Científica del Sur, se debe desarrollar un trabajo de investigación.

Que, de acuerdo con la normativa vigente de la Universidad Científica del Sur, en uso de las atribuciones conferidas al Decano Académico de Carrera.

SE RESUELVE:

ART. 1°: APROBAR E INSCRIBIR el Proyecto de Tesis titulado: **"PATRONES EMERGENTES, COLABORACIÓN E IMPACTO DE LA PRODUCCIÓN CIENTÍFICA SOBRE ÁCIDO HIALURÓNICO EN ODONTOLOGÍA: ANÁLISIS BIBLIOMÉTRICO"** de las **CD. JIMENEZ OBREGÓN FIORELLA AMALIA, QUINTEROS QUISPE CARLA OLGA MARIANA** con registro: **N° POS-78-2024-00626** y establecer la vigencia de aprobación de este documento de dieciocho (18) meses (hasta el 27 de febrero del 2026), periodo en el que puede desarrollarse el proyecto de investigación.

ART. 2°: NOMBRAR Asesor/a del trabajo de tesis señalado, al **Dr. Esp. FRANK ROGER MAYTA TOVALINO.**

Regístrese, comuníquese y archívese.

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